THE PRICE-SIZE RELATIONSHIP:

ANALYZING FRAGMENTATION OF RURAL LAND IN TEXAS

A Thesis

by

CRYSTELLE LEIGH MILLER

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

December 2006

Major Subject: Agricultural Economics

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Approved by:

Chair of Committee,	James W. Richardson
Committee Members,	Charles Gilliland
	Joe Outlaw
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ABSTRACT

The Price-Size Relationship:

Analyzing Fragmentation of Rural Land in Texas. (December 2006)

Crystelle Leigh Miller, B.S., Texas A&M University

Chair of Advisory Committee: Dr. James W. Richardson

According to the USDA, Texas leads all other states in the loss of rural farming and ranching land. Most research on rural land value has been associated with trying to explain price per acre movements, yet few studies have analyzed the relationship of market factors such as size on the total purchase price. This research focused on the parcel size and price per acre relationship that exists for Texas rural lands. The objective of this research was to examine the relationship between size and price per acre of land parcels sold in Texas and to analyze the presence of fragmentation of agricultural lands. Data on Texas land sales of parcels greater than ten acres from 1965-2004 were used.

The relationship between price per acre and parcel size was analyzed for Texas as a whole and for eight separate farmland regions. Each region was analyzed over eight time periods to test for changes in the land market for different periods. The results indicated a statistically significant inverse relationship between price per acre and parcel size which held in all eight regions and each of the eight five-year time periods. Personal income of the buyers had a greater influence on price per acre than net farm income.

Fragmentation was verified by comparing percent of sales in eight categories of acres sold, ranging from 10 acres to over 1,280 acres. Over the time period 1966-2004, the percent of sales for smaller parcels, 21-40 acres, increased and for moderate size

parcels, 81-320 acres, the percent of sales decreased. The increase in percent of sales for smaller parcels and the conversion of moderate size parcels of 81-320 acres into less than forty acre parcels, suggests that fragmentation has occurred. Furthermore, the percent of sales for parcels larger than 320 acres increased over the time period which mitigated the effects of fragmentation.

ACKNOWLEDGEMENTS

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CHAPTER I

INTRODUCTION

A recent study conducted by American Farmland Trust (2006) states that the United States loses 2 acres of prime farmland every minute to development. The loss of farmland can be seen throughout the United States and the statistics are alarming. For example, in Fresno County, California, a 20 acre parcel of farmland is cheaper than the cost of a city lot and in West Virginia, 25 of the most productive counties suffered a combined loss of 103,519 acres of productive farmland from 1982 through 1997 (American Farmland Trust, 2006).

This loss of land can be partially attributed to a trend called fragmentation: the act or process of breaking large acreage parcels of farmland into smaller pieces prior to selling. According to the USDA, Texas leads all other states in the loss of rural farming and ranching land, with the conversion of land into urban uses exceeding 2.6 million acres from 1982-1997 (Phillips, 2004). In 2005, all but two regions in Texas (Permian-West and Houston) with identifiable region wide price trends, posted strong increases in land prices and the median size of the land parcel being sold dropped from 108 to 102 acres (Gilliland, 2005b) . Fragmentation and urban sprawl has increased near large cities. Wilkens, et al. (2003) states that near the I35 corridor, on the outskirts of the Dallas/Fort Worth area, the Blackland Prairie lost more than 180,000 acres of rural farm and ranch land in 2005.

This thesis follows the format of the *American Journal of Agricultural Economics.*

Over the past forty years, the downward trend in the size of land parcels being sold has been exceedingly apparent in Texas. From about 1986 to 1992, when non-farm buyers abandoned the market, Texas rural land value was closely correlated to its production capacity (Gilliland, 2005a).. However, before that time and since that time, land prices in Texas are highly correlated with Texas personal income, a non-farm economic indicator More recently, higher demand for smaller acreage and the higher revenue generated for land owners who split their rural land into smaller parcels prior to selling, has encouraged the sales of smaller parcels. This implies challenges for Texas. First, farm and ranchland is disappearing, implying the number of land owners is greatly increasing. This trend of more land owners means a higher cost of administering programs by the local, state and national government. With more land owners, the policy implications for rural land owners including tax laws, conservation restrictions, EPA requirements and conservation funding must be spread to a much larger population.

An increase in price per acre contributes to this trend; in the first half of 2005, for example, prices for rural land moved up 11 percent compared with price levels in the first half of 2004, moving the weighted median price of Texas rural land from the 2004 median of $1,238 per acre to $1,379 per acre (Gilliland, 2005b). Several motives, including agricultural production, recreation and environmental preservation influence land purchases. “But, underlying these intents is an implied belief that the land represents a solid store of wealth that will grow in value over time” (Gilliland 2005c).

Objective

The primary objective of this research is to analyze the relationship between the size of land parcels being sold in Texas and their corresponding prices. The secondary objective is to analyze the existence and degree of fragmentation in each region as well as its trends and implications.

This research will test the hypothesis that fragmentation has occurred and is increasing over time while attempting to answer the question of when the trend of selling smaller parcels of land began. Regression models will be estimated to test and compare the changes in price to parcel size for different periods and regions of Texas. Separate regressions will be estimated to test eight time periods in each of the eight regions to analyze how the relationship between price per acre and parcel size has changed over time and how the relationship differs across regions.

Organization of Remaining Chapters

This research will be presented in a total of five chapters. Chapter II will review literature on price per acre and parcel size relationships with both the inclusion and exclusion of number of acres as a variable. Chapter III will discuss the proposed regression models, the data, the methodology and the validation of the model. Chapter IV will discuss the results, analysis and validation of all models including the Texas model, as a whole, the eight regional models based on the time period of 1965-2004, and the eight regional models broken into eight time cohorts between 1965-2004. Chapter V will summarize this research and make recommendations for future studies.

CHAPTER II

REVIEW OF LITERATURE

The majority of research previously conducted on rural land markets focuses on explaining price per acre movements. Multiple regression techniques have generally been utilized for the quantitative analysis of land values. Some commonly used explanatory variables include location, size, and property mix, yet few studies have analyzed the relationship of market factors such as size on the impact of the total purchase price.

Many studies have focused on farm enlargement tracts, which were hypothesized to show sensitivity to agricultural returns. Scofield (1964) utilized a cross sectional model to analyze data from years 1930 to 1963 and concluded that farm income's affect on farm value lessened in later years compared to earlier years.

Britney (1964) divided the U.S. into ten regions and fitted an ordinary least squares model on a regional basis. The dependent variable was the price per acre of farmland deflated by the consumer price index. "The independent variables were farm mortgage interest rate, lagged value of farmland, ratio of prices received index for all crops to prices paid for principal plant nutrients per ton to prices received index for all crops," (Britney, 1964). The results were statistically significant in only five regions which did not include the South and Southwest. The elasticties of farmland values with respect to average farm size were greater than all other variables which suggest the importance of size on price per acre of parcel sold.

Murray (1969) discusses size as a fundamental point in the sales price agreement, noting that it is usually true that a smaller size parcel of land will sell for a larger amount than a large size tract that is equally comparable. He also uses historical trends as a method of indexing property values. Murray notes that a farm of average size which is near an enlargement tract will sell for a greater amount if sold off in parcels rather than as a whole due to the fact that nearby farmers will pay a premium for the small tract and operate that additional plot of land with their existing resources, but the premium must be checked against the certain situation in the local land market. Prior to the publishing of *Farm Appraisal and Valuation*, 5th edition, Murray attended a land sale where a parcel of 40 acres was being sold and sought after by three adjoining land owners. The market price, at this time, was $600 per acre; the bidding for this parcel was carried to $930, $990, and finally $1000 per acre where the bidding ended. A week later an equally productive and well located parcel of 40 acres sold for $560 an acre, however, this auction did not have adjoining bidders vying for the parcel.

Suter (1974) recognized a changing rate of decline in land prices and used an approach which accounted for the size of parcel sold. As the parcel size increased, the price per acre declined at a decreasing rate. During the 1970’s, studies done on tract sizes of 80 to 360 acres, in Illinois and Oklahoma gave recognition to this fact (Reiss and Kensil, 1979 and Jennings and Kletke, 1977). In both studies, tract size negatively impacted price per acre. In Illinois, the over-all decline was $0.56 per acre and in Oklahoma, $2.50 an acre. Yet in both states, as tract size increased, the negative effect diminished. In Illinois, a 140 acre parcel sold for $0.83 less per acre than an 80 acre parcel and a 360 acre parcel sold for \$0.47 less per acre than an 80 acre parcel (Reiss and Kensil, 1979). In Oklahoma, a 140 acre parcel sold for \$3.87 less per acre than an 80 acre parcel and a 360 acre parcel sold for \$1.87 less per acre than an 80 acre parcel (Jennings and Kletke, 1977). With the different rate declines, he concluded that whether a negative relationship exists between parcel size and price per acre is not the question, but rather how greatly the price per acre is impacted due to differing parcel sizes (Suter, 1974).

Regarding research on Texas land value, Faubion (1976) conducted a study in which he utilized group regression analysis to observe rural land prices in Gillespie and Hamilton counties in 1969 and 1970. His explanatory variables included: distance to county seat on a paved road, distance to country seat on an unimproved road, value of buildings, number of acres of cropland, and number of acres of pasture and timberland. Total number of acres was in the initial specification, but was deleted following the selection of other variables. He concluded that land purchased for consumptive and speculative reasons sold for \$36 more per acre in Hamilton county and \$41 more per acre in Gillespie county than land which was used for agricultural production. This result is consistent with theory when evaluating property in a particular market using qualitative variables.

Hascall (1978) conducted a study of the Texas land market in which he used a stepwise multiple regression procedure, both cross sectional and time series. His explanatory variables included interest rates, population, agricultural income, effective buying income, inflation, and consumer sentiment. He did not however, reference size and although his results were favorable, questions of multicolinearity exist. One important aspect of his study is related to the division of the total land market into sub-markets, by region. The division of the Texas rural land market into twenty five regions aided in the understanding of specific characteristics that affect certain areas and their corresponding values.

More recently, Gilliland (2005a) quantified the correlation between the increase in price per acre of parcel sold and decrease in parcel size in Texas, as well as the changing buyer of rural land. His research agrees with the historical trend of farmland purchases throughout the United States. Demand for real estate, fueled by inflation, income tax provisions, and population growth continued to rise until the mid 1980's, when recessionary pressures aided the downturn of agriculture land prices. This downward trend held steady until the early 1990s when a new crop of land investors searching for recreational land appeared (Gilliland and Vine, 2004). Gilliland (2005a) points to the growing link between nonagricultural personal income and land prices and much of his evidence suggests that nonfarm buyers are dominating rural land markets. Gilliland (2003) has also done statistical analysis on tract size, weighted average price per acre, year to year percentage price change, and annual compound pretax growth rate compared to past years (both nominal and real) in 33 market areas in Texas, as well as trend analysis using the Mann-Whitney test. His results explain the significance of price per acre changes and yearly movements in land prices amongst the thirty three land market areas in Texas and also explain why the various reasons the shifts in price per acre have occurred. Some of those factors include greater demand for recreational property, increasing development outside large metropolitan areas, less demand for agricultural land and greater desire for land as an investment. Other research by Gilliland (2003) reports an increase in large parcels sales as well. In 2002, the average size of large parcel sold was 403 acres and price per acre for these large parcels climbed 14 percent.

Several articles have touched on the related subject of how nonfarm variables relate to real estate prices. Hardie, Narayan, and Gardner (2001) performed a study on land prices in the Mid-Atlantic States and concluded that the value of farmland is more closely correlated to non-farm factors rather than to farm returns. They also found that farm land prices are more responsive to household income changes, rather than farm revenues, therefore summarizing that policy changes which alter farm returns do not have near the power to spark changes for farmers as compared to changes that effect non-farm income.

Gilliland (2006) has also done research on the factors driving land market purchases, noting the intensifying desire for land ownership following the 9-11 attacks, which contributed to the 30 percent jump in land prices between 2002-2004, along with a 33 percent spike in sales volume. He also notes that Texas land prices are low when compared to other states, which encourages out of state buyers (Gilliland, 2005c). He has noted investors have turned to a more ‘stable’ investment following the collapse of Enron and WorldCom and turned to land to avoid corruption. (Gilliland, 2006).

Brewster (2005) has also analyzed the size/price relationship. She focused on the different regions of Texas and the effects fragmentation has caused. She notes that in the

Rio Grande Plains, the average size tract went from 700 acres in 1999 to 442 acres in 2003 and in the market surrounding Houston, the tract size dropped from 52 to 30 acres in the same time span. Even West Texas has seen the break-up of large land areas. In 2002, oilman Pickens and Dallas business partner Parks bought a 65,000 acre ranch north of Abilene and subdivided it into ten smaller ranches to sell to recreational buyers; this purchase was the sixth ranch Pickens had subdivided since 1991 (Brewster, 2005).

Wilkins, et al. (2003) produced a publication on Texas rural lands, which defines various trends in ownership size, land use, and land values and states that during the 1990's "mid size farms and ranches (500 to 2,000 acres) declined at a rate of 250,000 acres per year," most of this loss stemming from fragmentation into smaller parcels of land. The report states that Texas farm and ranch land prices have increased an average of 2.7% per year since 1992, with market values increasing the most near large metropolitan areas. Yet, agricultural value for farm and ranch land has seen an increase of a mere 0.4% annually. Their report shows a steadfast relationship between non-agricultural value and the break up of larger farms and ranches.

Summary

Britney (1964) was the first of these studies to report the importance of size on land value. His study, which divided the US into ten regions and fit a least squares model on a regional basis, concluded that the elasticities of farmland values with respect to average farm size were the greatest of all variables. Yet, the results were only statistically significant in five regions, which did not include the South and Southwest. Murray

(1969) notes that a smaller size parcel of land will usually sell for a larger amount per acre due to adjacent farmers who wish to purchase the land and utilize existing resources to operate the additional acreage. He did not mention additional reasons, such as recreation, as to why smaller parcels might generate a larger profit, other than the proximity factor for established farms. This could be attributed to more recent developments which highlight those additional variables.

Suter (1974) observed the decline in price per acre related to parcel size and noted studies done in Oklahoma (Jennings and Kletke, 1977) and Illinois (Reiss and Kensil, 1979) which proved that different size parcels decline at different rates. His observation that the decline in price per acre is highly dependent on area is important in that it influenced further research to be more cautious of using a large area of land and assuming its decline in price per acre is universal throughout.

Narrowing the research down to Texas, Faubion (1976) utilized group regression to observe rural land prices in Gillespie and Hamilton counties in 1969 and 1970. He concluded that land purchased for consumptive and speculative reasons sold for more in each county than land used for agricultural production. Hardie, Narayan, and Gardner (2001) also performed a study on the Mid Atlantic states which concluded that farmland price is more closely correlated to non-farm factors than farm returns.

Most recently, Gilliland (2005a) has narrowed in on the issue of price per acre increases and parcel size decreases in Texas coinciding with the changing consumer of rural land. He follows historical trends in the US and notes the high demand for real estate continued until the mid 1980's when recessionary forces and an economic downturn impacted the real estate market. In the early 1990's a new group of land buyers appeared demanding recreational land. This change in the rural land buyer helped bond the link between non agricultural income and land value. His statistical analysis on tract size, weighted average price per acre, year to year percentage change, and annual compound pretax growth rate compared to past years in all 33 market areas in Texas has helped explain the price per acre changes and year to year movements in rural land markets throughout Texas.

Gilliland, et al. (2005) has also focused on fragmentation of rural lands in Texas, citing that buyers are pushing for smaller parcel sizes and paying a higher price per acre for them. As land prices continue to rise, the size of a relatively affordable parcel of land is decreasing. These buyers are not purchasing land to farm or ranch; they are purchasing it for recreational purposes. These factors contribute to fragmentation of rural lands. Brewster (2005) has also written on the topic of fragmentation, citing the dwindling average size tract in several Texas markets. Wilkens, et al. (2003) concluded that since the 1990's, "midsize farms and ranches (500 to 2,000 acres) declined at a rate of 250,000 acres per year," mostly attributed to fragmentation.

CHAPTER III

METHODOLOGY

The primary objective of this research is to analyze the relationship between the size of land parcels being sold in Texas and their prices. The secondary objective is to analyze the existence and degree of fragmentation in each region as well as its trends and implications. Based on a review of literature, regression models will be estimated to test and compare the relationship between price and parcel size for Texas as a whole and by region.

OLS Regression

Simple regressions can be used to establish a relationship between two variables, while multiple regression estimates how several explanatory variables are related to a dependent variable (Woolridge, 2003). Ordinary least squares (OLS) regression, a multiple regression method, will be used to estimate the relationship between the dependent variable and the explanatory variables.

Ordinary least squares regression is a basic econometric method which explains a dependent variable (Y) in terms of one or more independent variables (X). The relationship between the variables can be defined as follows:

$Y = \beta_0 + \beta_1 X + u$

where:

Y =Dependent Variable,

β_0 =Intercept Parameter,

β_1 =Slope Parameter(s),

X =Explanatory variable(s), and

u =Error Term.

The intercept parameter represents the expected value of Y when X is equal to zero (Woolridge, 2003). The slope parameter is a more significant indicator in an OLS model, as it shows the relationship between X and Y when the factors contained in the error term are held constant. The error term (residual) accounts for extraneous factors besides X that effect Y. The residual is the difference between the actual value of Y and predicted value of Y.

The following is a list of the five Gauss-Markov assumptions that must be fulfilled for regression to be the appropriate technique (Woolridge, 2003):

1. Linear in parameters: the time series process follows a linear model,
2. Zero conditional mean: for each observation, the expected error term is zero,
3. No perfect collinearity: no independent variable is constant or a perfect linear combination of the others
4. Homoskedasticity: conditional on the independent variable(s), the variance of the error term is equal for all time periods
5. No serial correlation: conditional on the independent variable(s), the errors in two separate time periods are uncorrelated

Ordinary least squares is the best model to estimate the price per acre relationship with several exogenous variables as it is linear in parameters as well as being the simplest estimation procedure which accommodates multiple explanatory variables (Criddle, 2004). If the explanatory variables are statistically significant, they will improve the accuracy of the model. With the OLS method we are able to estimate the effect of each explanatory variable while controlling for the effect of all other explanatory variables. Ordinary least squares also minimizes the sum of squared residuals which aids in the accuracy of the model (Criddle, 2004).

Proposed Models

Ordinary least squares (OLS) regression will be used to estimate all regression equations in the land value model. Texas real estate parcel sales of ten or more acres from 1965-2004 will be used as data. One regression model will test the data from all sales which occurred in Texas from 1965-2004. Eight OLS models will test the effect of size on price per acre for eight separate regions in Texas from 1965-2004, and 64 additional models will test the same eight regions broken into eight time cohorts of five year intervals from 1965-2004.

All regression models will be estimated as double log functions based on earlier research by Jennings and Kletke (1977) on the relationships of parcel size and price. SAS 9.1 and Enterprise Guide 3.0 will be used to estimate the OLS equations (SAS Institute, 2002-2003).

Based on the literature review, the proposed model will test the effects of several independent variables (X) hypothesized to explain the dependent variable (Y). The relationship among variables can be explained as follows:

$$Y= \beta_0 + \beta_1X + \beta_2X + \beta_3X + \beta_4X + u$$

where:

Y =Real Price per Acre (natural log),

β_0 =Intercept Parameter

$\beta_1 X$ =Acres (natural log),

$\beta_2 X$ = Dummy Variable representing parcel size sold of less than 40 acres,

$\beta_3 X$ =Real Net Farm Income (natural log), and

$\beta_4 X$ = Real Personal Income (natural log),

u =Error Term.

The purpose of the research is to explain the effects that the size of the parcel, has on the price per acre of the parcel. To achieve this purpose, the price per acre variable must be used as the dependent variable for the OLS model.

The first independent variable proposed for the OLS model is the number of acres sold. Inclusion of the acreage variable is suggested by previous research and this variable is available for each sales record. The number of acres sold variable will test whether price per acre is affected negatively by an increase in parcel size or number of acres. The regression models, which will be separately estimated for all eight regions and eight time periods, will quantify changes in the significance of parcel size on price per acre over time and by region. If the per acre price of land declines as parcel size increases the coefficient on this variable will be negative.

The differences in the coefficients of the acreage variable will help determine the existence and degree of fragmentation in each region. Economic theory would suggest that more negative coefficients for the acreage variable, over time, signals greater price per acre increases for smaller parcels. Increases in per acre values for smaller parcels encourage land owners of large parcels to sub-divide their land for greater profit, which leads to fragmentation.

The next explanatory variable, DV1SIZE will be utilized as a dummy variable which will be activated by sales of less than 40 acres. The variable is “1” if the parcel is less than 40 acres in size and “0” otherwise. The dummy variable will help to test the hypothesis that parcels of less than 40 acres are gaining a premium or a higher price per acre. When the coefficient is statistically significant and positive, it will indicate that smaller parcels are selling for a higher price per acre, therefore encouraging fragmentation.

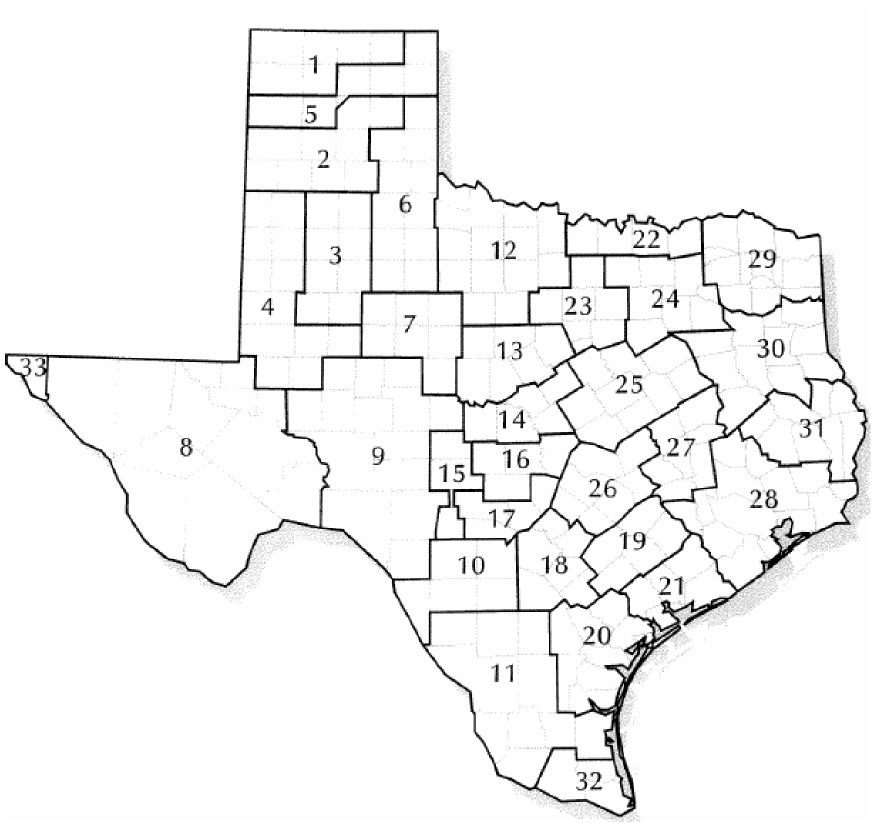
Personal income and net farm income are the next two proposed variables in the model. Personal income will be used to capture the effect of non-farm economic activity on land purchases and price per acre of parcel sold. Net farm income will be included to test whether or not it has an effect on price per acre of parcel sold. Previous literature suggests that non-farm or personal income affects price per acre positively. Similar results are expected for net farm income. Also it is hypothesized that the importance of non-farm income on price per acre of parcel sold will change over the 40 year planning horizon.

Data

Historical data from the Texas A&M Real Estate Center for land sales of parcels that are 10 or more acres, from the years 1965-2004, will be used. Each observation contains the sale date, county, size of parcel sold, and price of parcel sold. The observations are grouped into time series cross sectional data for the 33 regions of Texas (Figure 1) based on the homogeneity of agricultural use (land production). There are a different number of observations on sales each year. To specifically increase the focus on rural land markets and avoid metropolitan areas, markets 18, 22-24, 26, 28, and 33 will be excluded. The remaining land market areas will be divided into eight regions (Figure 2) to test the regional differences for land sales. The eight regions will be based on the twelve districts used by the Texas Cooperative Extension; with emphasis on reducing the regions to a manageable number, the metropolitan areas in Texas will be left out. Although the data are not exactly suited for analyzing fragmentation trends, it does allow one to start addressing the fragmentation issue by evaluating the sizes and prices of land parcels sold in each region of Texas over the past forty years.

Summary of Data

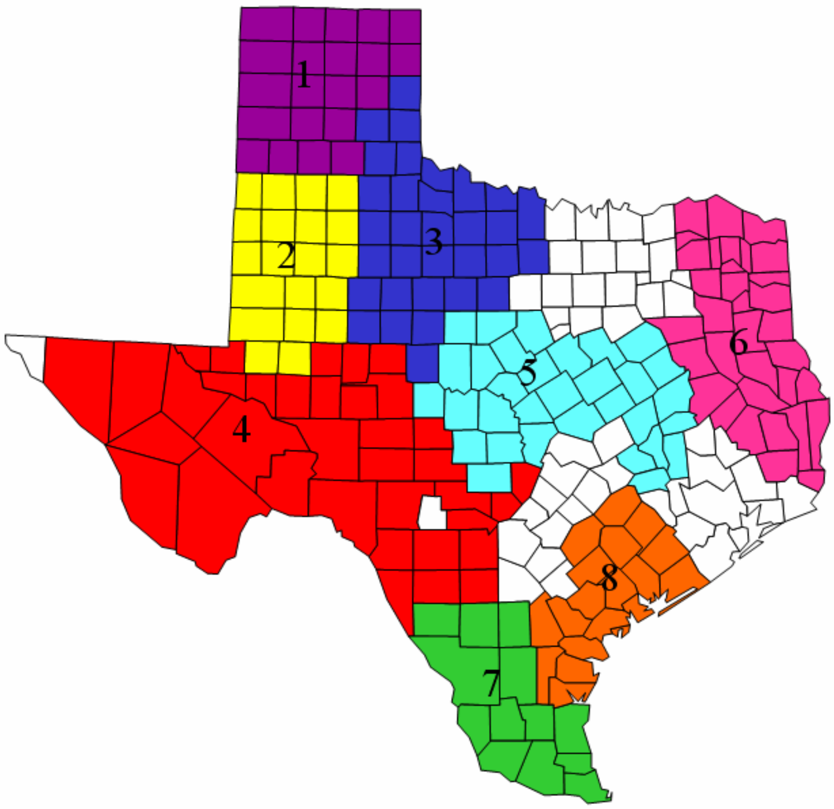
The number of parcels sold, median parcel size, and average price per acre were analyzed for Texas and each of the eight regions from 1965-2004 and for five year intervals from 1965-2004 in each of the eight regions (Table 1). The total number of parcels sold in each region from 1965-2004 varies, with the Central region seeing the highest number of sales at 39,574 and the South seeing the lowest number of sales at 6,087. The remaining six regions average 15,700 sales over the 40 year period. Between the time periods of 1995-1999 and 2000-2004, the number of parcels sold in Texas increased from 16,854 sales to 24,248 sales, the largest increase among all time periods.



1 Panhandle-North
2 Panhandle-Central
3 South Plains
4 Permian-West
5 Canadian Breaks
6 Rolling Plains-North
7 Rolling Plains-Central
8 Trans-Pecos
9 Edwards Plateau-West
10 Edwards Plateau-South
11 Rio Grande Plains
12 North Central Plains
13 Crosstimbers
14 Hill Country-North
15 Hill Country-West
16 Highland Lakes
17 Hill Country-South
18 San Antonio*
19 Coastal Prairie
20 Coastal Prairie-South
21 Coastal Prairie-Middle
22 Texoma*
23 Fort Worth Prairie*
24 Dallas Prairie*
25 Blacklands-North
26 Blacklands-South*
27 Brazos
28 Houston*
29 Northeast
30 Piney Woods-North
31 Piney Woods-South
32 Lower Rio Grande Valley
33 El Paso*
*Not used in regression analysis.

Source: Texas A&M University Real Estate Center, 2005

Figure 1. Texas Map with Land Market Area ID Numbers



Region 1: Panhandle
Land Markets Included: North Panhandle (1), Central Panhandle (2), Canadian Breaks (5)

Region 2: South Plains
Land Markets Included: Permian West (4), South Plains (3)

Region 3: Rolling Plains
Land Markets Included: Rolling Plains-Central (7), Rolling Plains-North (6), North Central Plains

Region 4: West
Land Markets Included: Edwards Plateau-West (9), Edwards Plateau-South (10), Hill Country-South (17), Hill-Country West (15), Trans Pecos (8)

Region 5: Central
Land Markets Included: Blacklands North (25), Hill Country-North (14), Brazos (27), Crosstimbers (13), Highland Lakes (16)

Region 6: East
Land Markets Included: Piney Woods-North (30), Piney Woods-South (31), North East (29)

Region 7: South
Land Markets Included: Rio Grande Plains (11), Lower Rio Grande Valley (32)

Region 8: Coastal Bend
Land Markets Included: Coastal Prairie-North (19), Coastal Prairie South (30), Coastal Prairie Middle (21)

Figure 2. Aggregate Land Market Regions in Texas

Note: Counties in white were not used.

Table 1. Summary of Data

	Number of Parcels Sold	Median Parcel Size	Average Price Per Acre
Texas			
1965-2004	*140,000*	*155.00*	*806.038*
1965-1969	20,461	142.00	239.072
1970-1974	19,373	160.00	341.211
1975-1979	16,077	159.00	583.936
1980-1984	13,397	158.00	987.080
1985-1989	13,655	157.00	859.351
1990-1994	15,935	160.00	756.044
1995-1999	16,854	156.79	992.343
2000-2004	24,248	140.42	1576.400
Panhandle			
1965-2004	*11,100*	*320.00*	*415.733*
1965-1969	1,612	315.00	280.714
1970-1974	1,636	317.00	309.571
1975-1979	1,544	294.00	490.011
1980-1984	1,051	320.00	539.699
1985-1989	1,228	320.00	362.536
1990-1994	1,061	322.25	398.352
1995-1999	1,310	320.36	423.327
2000-2004	1,658	321.40	548.527
Central			
1965-2004	*39,574*	*115.00*	*1037.75*
1965-1969	5,648	121.00	197.413
1970-1974	4,990	124.00	340.673
1975-1979	3,696	119.00	618.184
1980-1984	4,223	133.00	1068.140
1985-1989	3,703	112.32	1128.730
1990-1994	4,224	126.70	947.680
1995-1999	5,040	112.94	1268.410
2000-2004	8,050	93.70	2097.130
South			
1965-2004	*6,087*	*98.64*	*1394.190*
1965-1969	887	37.00	461.620
1970-1974	679	55.50	627.843
1975-1979	542	50.00	1345.330
1980-1984	538	169.00	1744.560
1985-1989	686	238.00	1029.670
1990-1994	753	177.03	1124.910
1995-1999	806	160.00	1636.820
2000-2004	1,196	128.16	2600.520
West			
1965-2004	*13,484*	*290.00*	*911.004*
1965-1969	1,529	238.00	213.737
1970-1974	1,464	395.00	297.416
1975-1979	1,119	322.00	547.179
1980-1984	1,230	315.00	937.676
1985-1989	1,352	310.00	856.164
1990-1994	1,841	335.57	617.258
1995-1999	1,934	330.81	844.151
2000-2004	3,015	158.78	1933.540

Table 1. Continued

	Number of Parcels Sold	Median Parcel Size	Average Price Per Acre
East			
1965-2004	*18,259*	*77.00*	*776.974*
1965-1969	3,776	75.00	248.342
1970-1974	2,621	78.00	391.940
1975-1979	2,322	77.00	644.585
1980-1984	2,051	79.00	1104.370
1985-1989	1,783	80.00	1000.580
1990-1994	1,970	82.29	877.589
1995-1999	1,981	73.75	1184.650
2000-2004	1,755	67.12	1481.640
South Plains			
1965-2004	*15,511*	*177.00*	*455.639*
1965-1969	2,425	160.00	297.265
1970-1974	2,994	164.00	320.975
1975-1979	2,335	167.00	499.194
1980-1984	1,258	168.00	683.169
1985-1989	1,424	177.10	421.512
1990-1994	1,367	177.10	452.980
1995-1999	1,306	184.50	500.512
2000-2004	2,402	188.50	619.226
Coastal Bend			
1965-2004	*15,511*	*99.00*	*1101.070*
1965-1969	1,565	100.00	290.927
1970-1974	1,719	105.00	518.248
1975-1979	1,685	104.00	805.041
1980-1984	1,344	98.00	1463.360
1985-1989	1,603	90.01	1226.490
1990-1994	2,472	100.00	968.688
1995-1999	2,240	91.49	1253.930
2000-2004	2,883	89.10	1817.450
Rolling Plains			
1965-2004	*20,474*	*160.00*	*393.646*
1965-1969	3,019	160.00	157.002
1970-1974	3,270	162.00	202.754
1975-1979	2,834	160.00	348.005
1980-1984	1,702	160.00	565.597
1985-1989	1,876	160.00	477.258
1990-1994	2,247	169.00	398.664
1995-1999	2,237	164.29	454.395
2000-2004	3,289	165.00	658.520

Only the Panhandle and East regions did not see a large increase in the number of sales in the most recent period while the Central region saw 3,010 more sales in 2000-2004 than it did from 1995-1999. From the 1995-1999 to 2000-2004, median parcel size in the West decreased 172 acres, the largest decrease among all regions. Four other regions showed a decrease in the median parcel size sold in recent years. Average price per acre increased between the two time periods of 1995-1999 and 2000-2004 in each region, with the West, Central, and South regions increasing around $1,000 each. Texas, as a whole, saw an increase of $583 per acre between the last two time periods, the largest increase between any two five-year periods. These increases in number of parcels sold, decrease in median parcel size, and increases in average price per acre support the hypothesis of smaller parcels selling for a higher price per acre and suggest that fragmentation may actually be accelerating.

Personal income for Texas (http://www.bea.gov/bea/regional/spi/action.cfm) will be gathered for each year 1965-2004 and then deflated by the implicit price deflator for each year (http://www.econstats.com/gdp/gdp__q4.htm) to modify the data into 2004 dollars. Net farm income for the Texas (http://www.ers.usda.gov/Data/FarmIncome/finfidmu.htm) will be obtained for each year, 1965-2004 and also converted to 2004 dollars using the implicit price deflator.

Validation

The OLS regression results will be statistically tested to verify that the variables in the equations were statistically significant. Student t-tests, R^2 and F-tests will be used to evaluate the overall fit of each OLS equation.

Each independent variable's Student t-statistic is used to calculate its p-value, which represents the smallest significance level at which the null hypothesis of statistical significance can be rejected. The Student t value of the variables will be used to determine if each variable is statistically significant in the OLS equations. The alpha level used to determine statistical significance is .05.

The R^2 or coefficient of determination represents the percentage of the observed variation in price per acre that is explained by the independent variables (Criddle, 2004). In the regression analysis which covered Texas and its eight regions over the time period of 1965-2004, the R^2 will be expected to be generally higher for all variables due to the large number of observations included. When the regions are tested separately and broken into time cohorts, the R^2 is expected to be slightly lower due to reduced sample size (Criddle, 2004).

The F test is a joint hypothesis test on all of the included explanatory variables. Considering the large amount of observations in the data, as well as the number of explanatory variables, an F test score would be acceptable if it is over 2.1 for an alpha level of .05 (Criddle, 2004).

Summary

To test the hypotheses implied in the research objectives, OLS regression models will be estimated to test the relationship between price per acre and several explanatory variables. The objectives of this research will be in large part answered by the relationship of the dependent variable, price per acre sold, and the explanatory variable, size of the parcel sold. The basis for fragmentation trends rely on smaller parcels selling for a higher price per acre, placing the greatest emphasis on the size of parcel variable, or acres. The remaining proposed explanatory variables to be used are personal income, net farm income, and a dummy variable used to identify parcels of less than 40 acres. Historical data from the Texas A&M Real Estate Center for land sales of parcels that are 10 or more acres, from the years 1965-2004, will be used.

CHAPTER IV

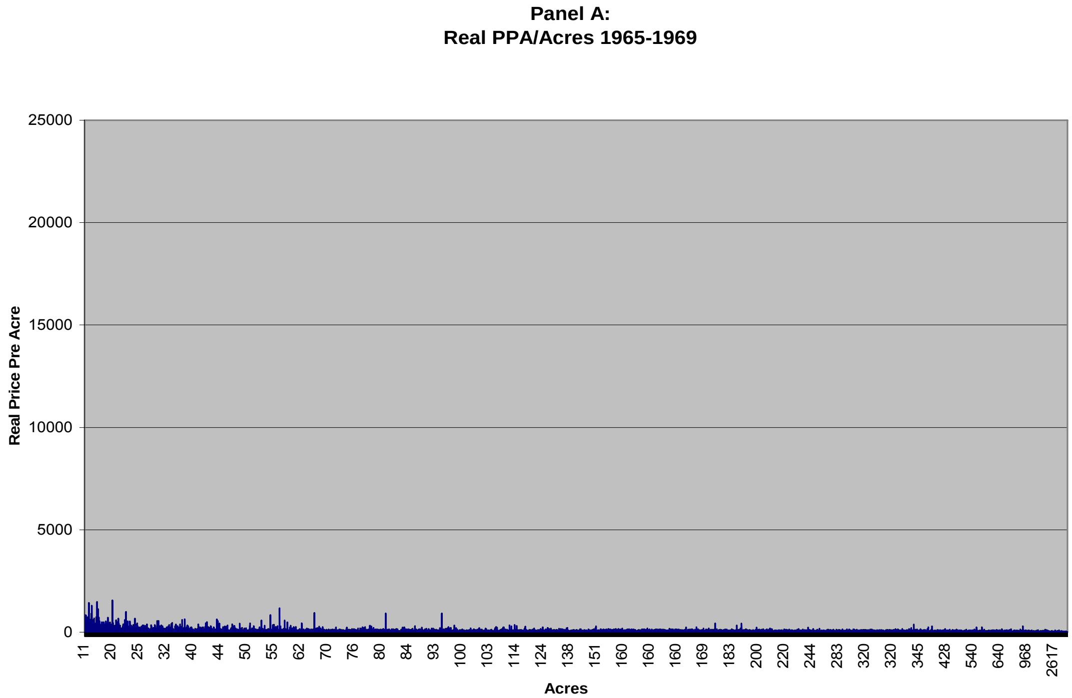
RESULTS

The objective of this study is to analyze the relationship between the size of land parcels being sold in Texas and their corresponding prices. The secondary objective is to analyze the existence and degree of fragmentation in each region. To achieve this objective, the data set was first summarized and graphically analyzed to detect characteristics and trends in land value of the eight regions. Next, the means and standard deviations for differing time periods were calculated and compared. To address the first objective, OLS regression models were used to quantify the relationships between the dependent variable of price per acre and several explanatory variables including the size of parcel sold.

Graphical Analysis

A series of frequency charts showing the number of parcels sold at each size and the price per acre were developed to analyze the changing nature of the Texas land market. The data was separated into five year periods (Figure 3), beginning with 1965-1969 in panel A and ending with years 2000-2004 in panel H. The real price per acre (2004 dollars) was shown on the Y axis against acres sold on the X axis for each sale of Texas agricultural land greater than ten acres.

The real price for each parcel sold (by acre size) from 2000-2004 is represented in Panel H. Reading the graph from left to right, the left side begins with the smallest



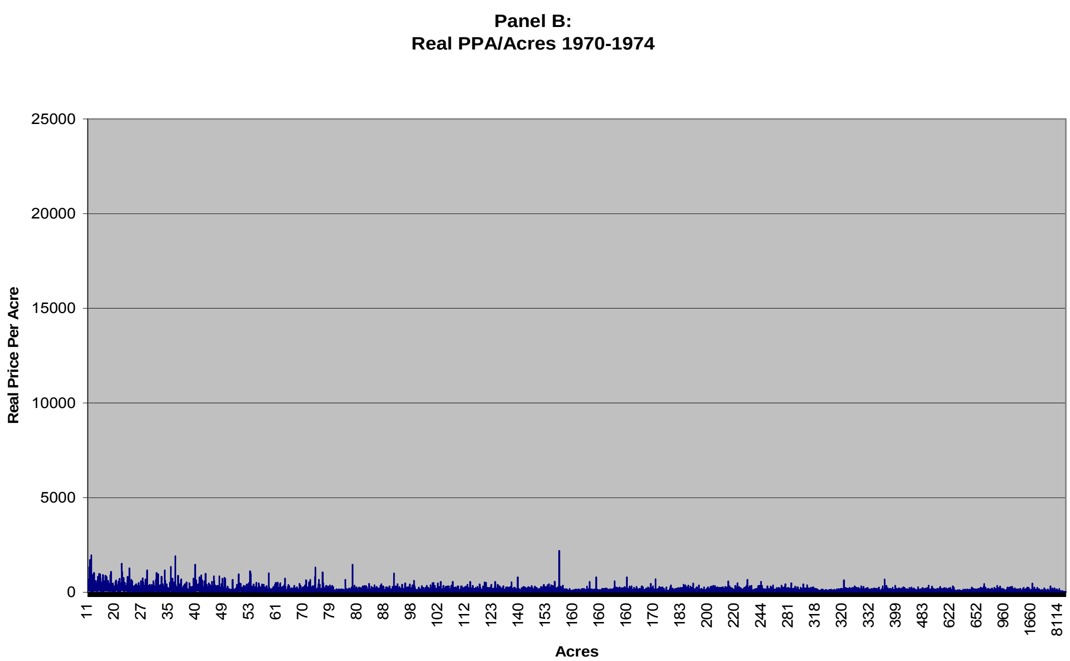
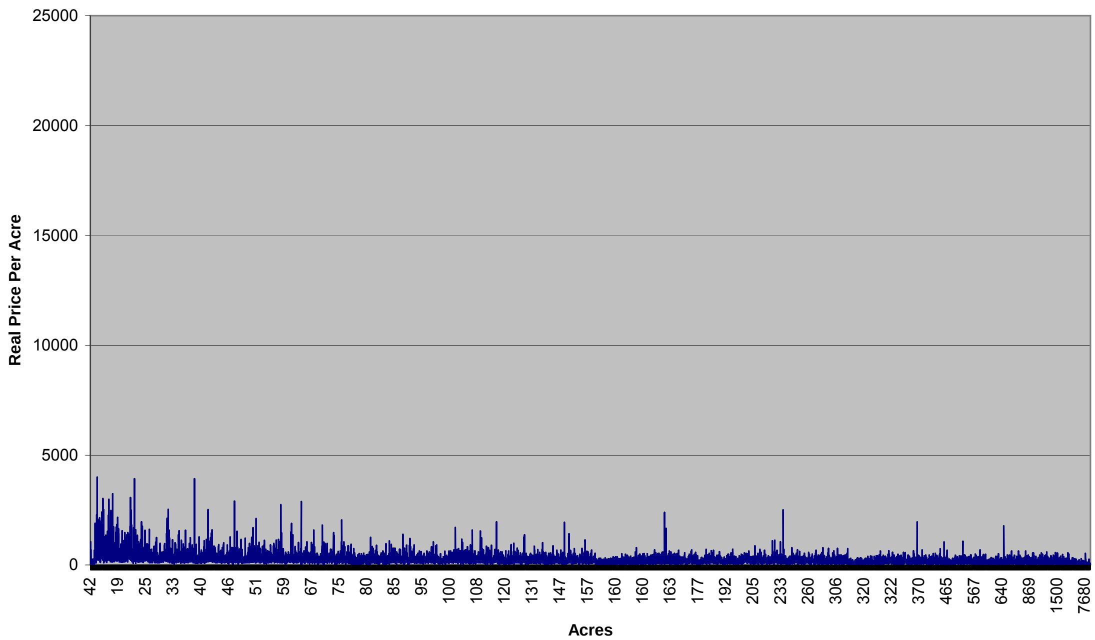


Figure 3. Prices Per Acre (Real 2004 dollars) Versus Number of Acres Sold in Five Year Intervals 1965-2004

Panel C:
Real PPA/Acres 1975-1979



Panel D:
Real PPA/Acres 1980-1984

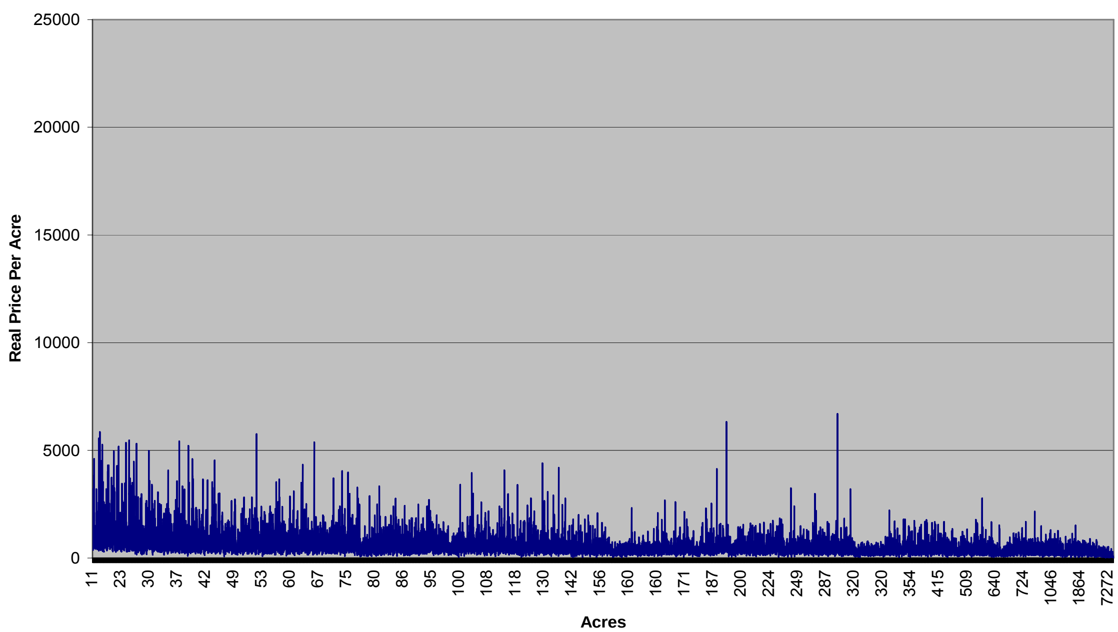
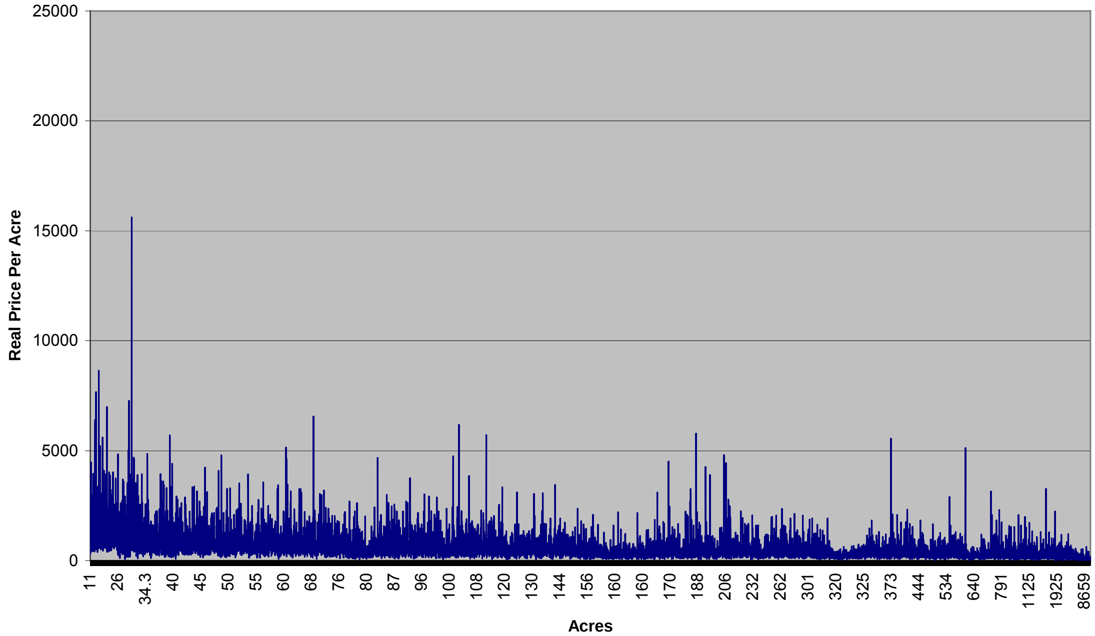


Figure 3. Continued

Panel E:
Real PPA/Acres 1985-1989



Panel F:
Real PPA/Acres 1990-1994

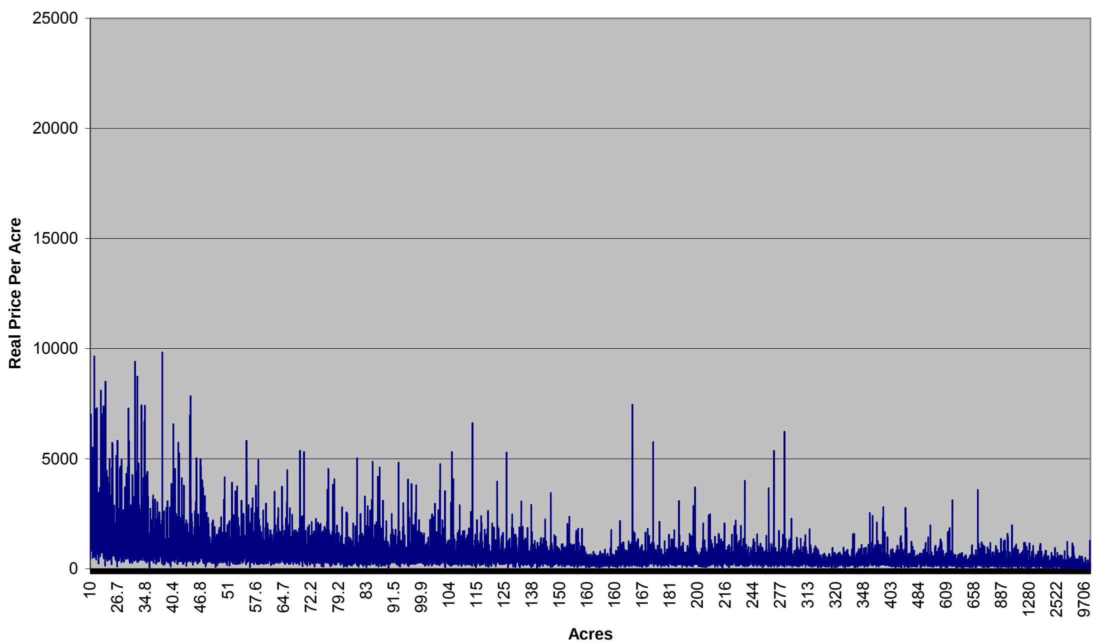
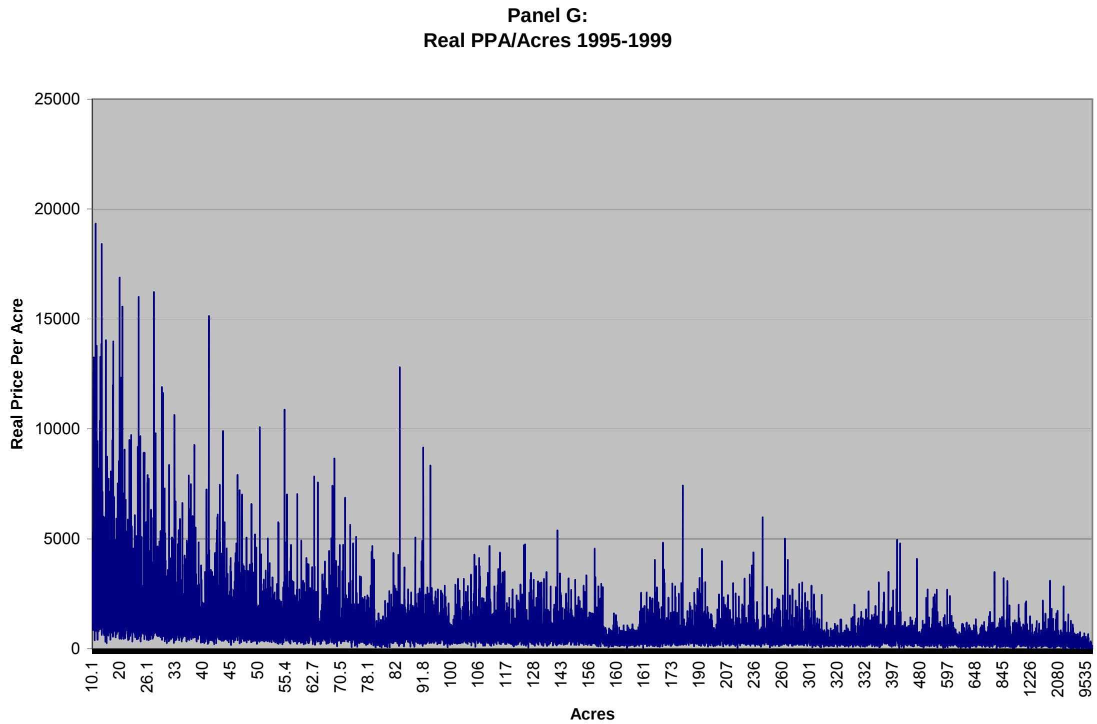


Figure 3. Continued



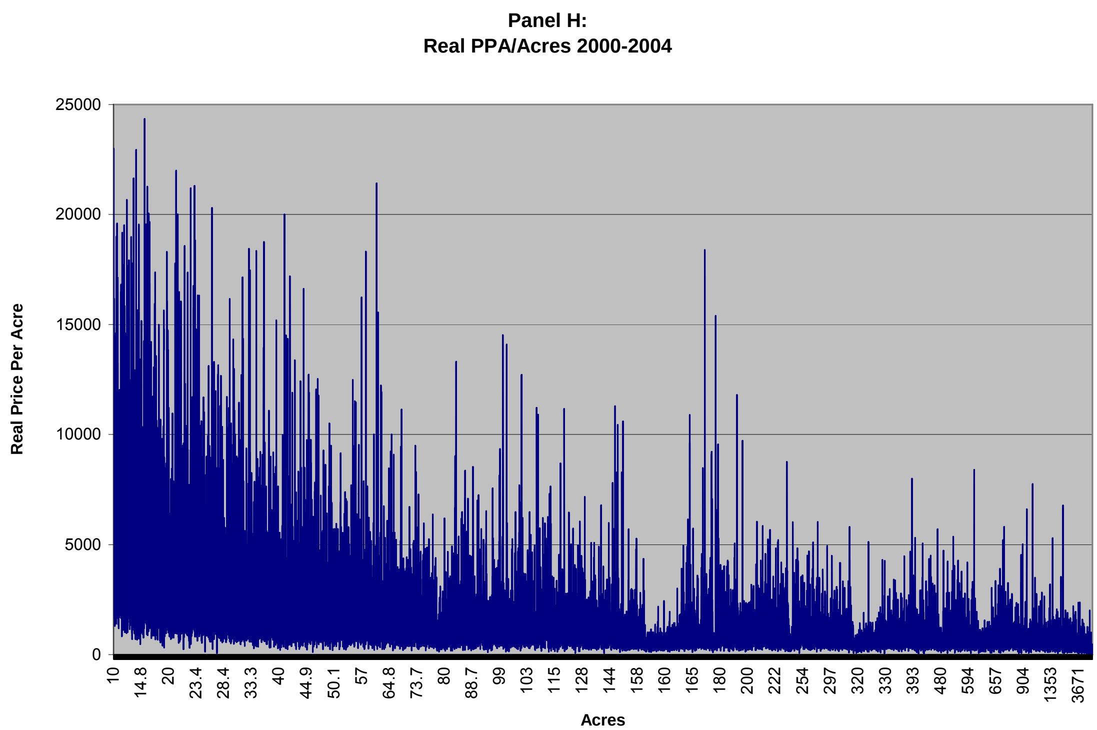


Figure 3. Continued

parcel sales (10 to 14.8 acres) and increases to the largest parcel sales on the far right side (more than 3,600 acres). The real price per acre on the vertical axis reaches a high of almost $25,000 a parcel in the 14.8 to 20 acre size range. If the graph is split into thirds on the horizontal axis, the first section (less than 80 acres) represents the smallest parcel sales, by acre. The less than 80 acre parcels obviously bring a considerably higher price per acre than the larger parcels as the price per acre decreases as the parcel size increases.

The patter observed in Panel H of higher prices per acre paid for smaller parcels occurs in each panel, from A to H, with the most pronounced increases occurring in panels F, G and H, which represent the period of 1990-2004. The pattern of higher prices being paid for smaller parcels is observed in panels A-E, but it is not as pronounced due to deflating the land prices to 2004 dollars.

An increase in the frequency of small parcel sales is evident in Panel H and is further supported by the increase in number of sales in Table 1 during the last five year period of 2000-2004. In 2000-2004, the number of sales in Texas increased from 992 sales to 1,576 sales, by far the largest increase among all five year periods (Table 1).

Therefore, two conclusions can be drawn. The first being that smaller parcels have sold for higher real prices per acre and that this trend has increased over time, and the second being that the frequency of small parcel sales has dramatically increased between the last two year periods of 1995-1999 and 2000-2004. Economic theory suggests that an increase in the prices paid for smaller parcels leads to division of large

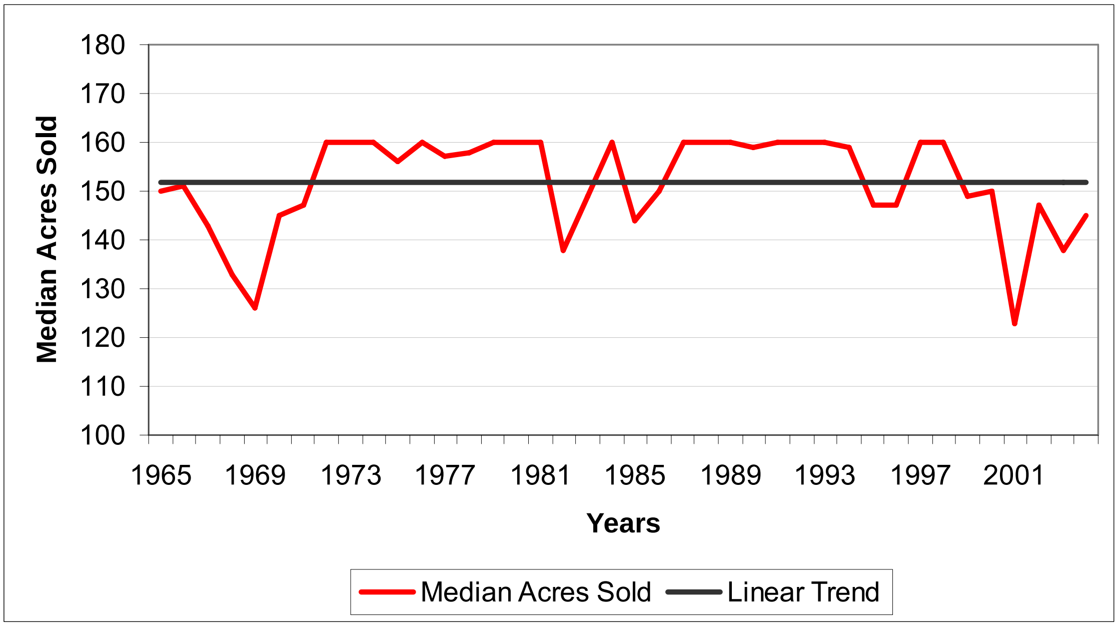


Figure 4. Median Acres Sold 1965-2004

parcels to realize greater profit, a trend otherwise defined as fragmentation. This trend of smaller parcels being sold for a higher price will be further tested using OLS regression.

A line graph of median acres per parcel sold in Texas, from 1965-2004 was created and fit with a linear regression trend line (Figure 4). The OLS regression statistics for the trend report an R^2 of zero and an F-test statistic of zero. The beta for the intercept was 151.8, with a t-test statistic of 46.854 and a p-value of zero. The beta for trend was -0.001, with a t-test statistic of -0.009 and a p-value of .993, proving trend to be statistically insignificant. Despite the absence of a trend, it is apparent from the line graph that the size of parcels sold fell below the mean each year since 1997.

A graphical representation detailing the shares of annual real estate sales by size category in Texas from 1966-2004 (Figure 5), was prepared to show trends in sales for different size categories. The timeline for 1966-2004 is represented on the horizontal axis and percent sales on the vertical axis. There are eight different categories of acres sold represented in the graph. The eight size categories displayed in Figure 5 reflect three small parcel sizes (10-20, 21-40, and 41-80 acres) and remaining five parcel sizes are in multiples of 80 acres to reflect farmland sales.

The first category, 10-20 acres (yellow line), shows a steady decrease in years 1976-1992, approaching 1%, but after 1992, there is steady growth in the percent of sales in this category, nearing 10% by 2004 (Figure 5). The OLS regression trend for this category does not show a statistically significant trend (Table 2). The next category of 21-40 acres remained rather steady during the years 1966-1992, fluctuating between approximately 6 to 10% of sales. After 1992, there was an increase in the percent of sales for the 21-40 acre category which continued to rise until 2002 when it reached approximately 13% and then fell a small amount to about 11% in 2004. This category shows a statistically significant trend in the OLS regression results, with a p-value of .016 and a trend slope coefficient of 0.00044. These two ranges represent the smallest ranges in acre size and although the 10-20 acre category does not show a statistically significant trend, the increases in percent sales in recent years support the hypothesis that number of smaller parcel sales (less than 40 acres) has increased, reaching about 21% of all parcels sold in 2004.

The third category of 41-80 acres was fairly volatile, ranging from approximately 15% to 22% and ending at one of its lowest points in 2004. There was no statistically significant trend present in the percent of sales for this size category.

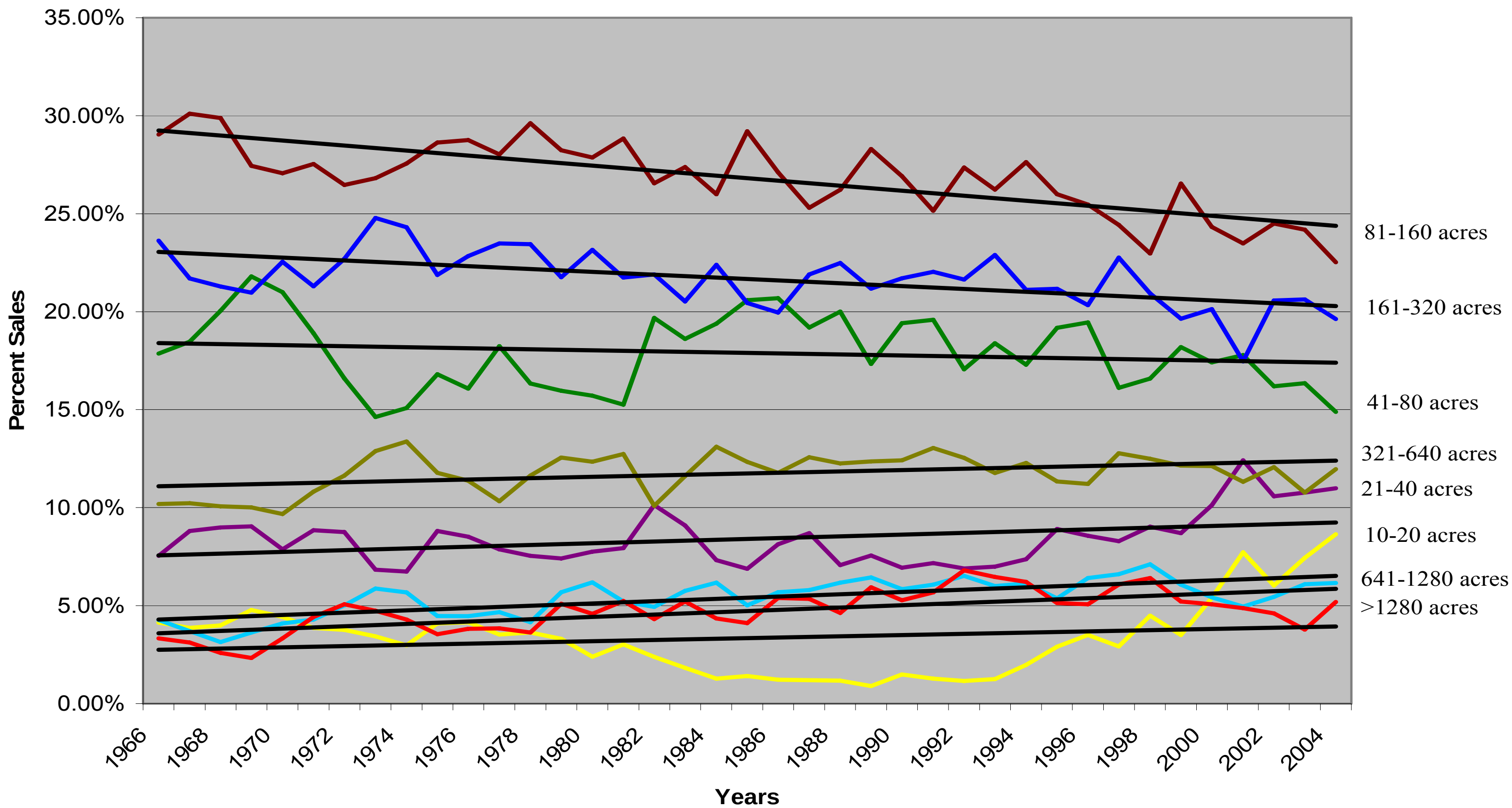


Figure 5. Share of State Wide Annual Real Estate Sales by Size of Parcel Sold 1966-2004

Table 2. OLS Regression Trend Results for Fraction of Sales by Parcel Size in Texas, 1966-2004

OLS Regression Trend Results				
	Intercept	Trend	R^2	F-test
10-20 acres	-0.58335	0.00031	0.035	1.361
p value	0.277	0.251		
21-40 acres	**-0.79059**	**0.00044**	0.146	6.322
p value	0.029	0.016		
41-80 acres	0.70133	-0.00026	0.026	0.991
p value	0.190	0.326		
81-160 acres	**2.81410**	**-0.00128**	0.592	53.609
p value	0.000	0.000		
161-320 acres	**1.66188**	**-0.00073**	0.341	19.135
p value	0.000	0.000		
321-640 acres	**-0.56487**	**0.00034**	0.159	6.981
p value	0.035	0.012		
640-1280 acres	**-1.10301**	**0.00058**	0.506	37.952
p value	0.000	0.000		
>1280 acres	**-1.13550**	**0.00060**	0.415	26.200
p value	0.000	0.000		

Note: Bold values indicate significance at alpha=.05.

The fourth category, 81-160 acres, makes up the greatest percent of sales in every year, the highest being approximately 30% in 1968 and the lowest occurring in 2004 at approximately 22%. The 81-160 acre range has a statistically significant downward trend with a p-value of zero and a trend slope coefficient of -0.00128. The trend for the fifth sales size category, 161-320 acres, was statistically significant, with a p-value of zero and trend slope coefficient of -0.00073. The 161-320 acre sales size category hit its lowest percent of sales, 17%, in 2002 and its second lowest point, approximately 20%, in 2004. The 2004 figures for these mid-size ranges, being at or near their lowest percent of sales in 38 years, support the hypothesis that these two sales size categories have become less popular. The statistically significant decreasing trends for both categories suggest that in the future, sales of 81-160 and 161-320 acres will makeup a smaller and smaller percent of total sales.

The percent of sales for the sixth category of 321-640 acres remained fairly steady from 1966-2004, with an average of approximately 13% of sales. The 321-640 acre category did see a statistically significant trend with a p-value of .00034 and a trend slope coefficient of .012. The seventh category of 641-1280 acres also remained fairly steady throughout, with a statistically significant trend coefficient of .00058 and a p-value of zero. The last category of 1,280 acres and greater also tested statistically significant for trend with a coefficient of .0006 and a p-value of zero. All three of the larger sales size categories showed statistically significant positive trends and all were at a higher percent of sales in 2004, suggesting that recent land sales of 321-1280 acres have made up a greater percent of total sales. The statistically significant trends present in large parcel sales support earlier research by Gilliland (2003), who found that sales of both small and large parcels have increased in frequency. A conclusion can be drawn that small parcel sales (less than 40 acres) and large parcel sales (320 acres and greater) are gaining in proportion of sales while the traditional parcel sizes of 81-320 acres are decreasing in proportion.

Mean and Standard Deviation Analysis

An analysis was conducted to compare the mean and standard deviation of parcel sizes sold in Texas from 1965-2000 to the parcel sizes sold in years 2001-2004 (Tables 3 and 4). The mean of the data set is the average parcel size sold over the specific time

Table 3. Comparison of Mean and Standard Deviation of Parcels Sold in Texas, 1965-2000, in 5 Year Increments Compared to Years 2001-2004

		2001	2002	2003	2004
TEXAS					
Mean Acre/Parcel		353.831	400.3473	349.3267	436.968
Std Dev Acre/Parcel		1065.348	1913.226	1228.415	1661.539
Number of Sales		3756	4665	5727	6413
		P Values for Testing Mean & Standard Deviation for year i compared to 2001-2004 values			
		2001	**2002**	**2003**	**2004**
1965					
Mean Acre/Parcel	356.8247322	0.92	0.23	0.79	**0.01**
Std Dev Acre/Parcel	1492.87067	**0.00***	**0.00**	**0.00**	**0.00**
1970					
Mean Acre/Parcel	334.0146475	0.472	0.060	0.569	**0.001**
Std Dev Acre/Parcel	1224.806531	**0.000**	**0.000**	0.426	**0.000**
1975					
Mean Acre/Parcel	400.3758669	0.236	0.999	0.188	0.371
Std Dev Acre/Parcel	1890.791559	**0.000**	0.242	**0.000**	**0.000**
1980					
Mean Acre/Parcel	413.5552508	0.112	0.761	0.083	0.551
Std Dev Acre/Parcel	1681.282688	**0.000**	**0.000**	**0.000**	0.236
1985					
Mean Acre/Parcel	402.6090876	0.11	0.76	0.08	0.55
Std Dev Acre/Parcel	1463.724766	**0.00**	**0.00**	**0.00**	**0.24**
1990					
Mean Acre/Parcel	475.3693629	**0.137**	0.954	**0.098**	0.322
Std Dev Acre/Parcel	1870.580439	**0.000**	0.000	**0.000**	**0.000**
1995					
Mean Acre/Parcel	480.4229315	**0.002**	0.088	**0.001**	0.312
Std Dev Acre/Parcel	2070.34567	**0.000**	**0.000**	**0.000**	**0.000**
2000					
Mean Acre/Parcel	504.0185823	**0.003**	0.061	**0.002**	0.198
Std Dev Acre/Parcel	2899.705539	**0.000**	**0.000**	**0.000**	**0.000**

*bold values indicate reject null hypothesis at alpha=.05 level

Table 4. Comparison of Mean and Standard Deviation of Parcels Sold in Panhandle Region, 1965-2000, in 5 Year Increments Compared to Years 2001-2004

		2001	2002	2003	2004
PANHANDLE					
Mean Acre/Parcel		749.3845	725.7698	734.0197	562.8066
Std Dev Acre/Parcel		1716.26	1460.959	2171.565	779.7809
Number of Sales		279	384	355	362
		P Values for Testing Mean & Standard De for year i compared to 2001-2004 values			
		2001	**2002**	**2003**	**2004**
1965					
Mean Acre/Parcel	465.0836	**0.017***	**0.006**	0.039	0.176
Std Dev Acre/Parcel	1161.639	**0.000**	**0.000**	**0.000**	**0.000**
1970					
Mean Acre/Parcel	598.4138	0.402	0.443	0.470	0.817
Std Dev Acre/Parcel	2107.606	**0.001**	**0.000**	0.320	**0.000**
1975					
Mean Acre/Parcel	595.5552	0.306	0.327	0.384	0.780
Std Dev Acre/Parcel	1980.108	**0.007**	**0.000**	0.045	**0.000**
1980					
Mean Acre/Parcel	429.285	**0.003**	**0.000**	**0.011**	**0.009**
Std Dev Acre/Parcel	447.4391	**0.000**	**0.000**	**0.000**	**0.000**
1985					
Mean Acre/Parcel	439.0094	**0.007**	**0.001**	**0.019**	0.05
Std Dev Acre/Parcel	704.2438	**0.000**	**0.000**	**0.000**	0.05
1990					
Mean Acre/Parcel	635.3834	0.367	0.389	0.471	0.389
Std Dev Acre/Parcel	1032.384	**0.000**	**0.000**	**0.000**	**0.000**
1995					
Mean Acre/Parcel	750.4653	0.995	0.862	0.921	0.141
Std Dev Acre/Parcel	1659.371	0.310	**0.019**	**0.000**	**0.000**
2000					
Mean Acre/Parcel	870.0425	0.669	0.597	0.635	0.248
Std Dev Acre/Parcel	4374.556	**0.000**	**0.000**	**0.000**	**0.000**

*bold values indicate reject null hypothesis at alpha=.05 level period and the standard deviation of the data set is the square root of the variance which measures how far the data set deviates from the mean.

A two sample Student-t test was used to compare the means of different years; the test accounts for the unequal number of observations that exists between years. An F test was used to compare the differences in standard deviations. The null hypothesis for both tests is that the means or standard deviations of the two years are equal. When the null hypothesis is rejected, the means or standard deviations are not equal. The Student-t statistic is used to generate the p-value, which represents the smallest significance level at which the null hypothesis of statistical significance can be rejected. A confidence level of 95% was used in these tests. Simetar (Richardson, Schumann and Feldman, 2006a) was used to calculate the mean and standard deviation for each year and to perform the Student-t and F tests.

The first tests compared the mean and standard deviation of land parcels sold in Texas to the years 2001-2004 (Table 3). In 1965 and 1970, the mean parcel size was 356 and 334 acres, respectively, which were not statistically different from the mean parcel size in 2001-2003 but were significantly different from the mean in 2004. For 1975, 1980, and 1985 average parcel size sold is not statistically different from the mean parcel sizes sold in 2001-2004. In 1990, 1995, and 2000, the mean parcel size was statistically larger than parcels sold in 2001 and 2003. The standard deviation of parcel size, however, is significantly different for most of the years analyzed. This result suggests that there is a different variability in the number of acres per parcel sold in year i than the years 2001-2004. A larger standard deviation or larger variability in the parcel size sold could be due to several situations. One could be that several sales of large amounts of acreage, greater than 5,000 acres for example, occurred in a given year. Another could be that a large number of sales which are greater in acres sold than the mean acres sold, exist in the given year. Both situations would extend the tails of the distribution, increasing the standard deviation.

A second statistical comparison tested the mean and standard deviation of land parcels sold in the Panhandle region of Texas from 1965-2000, for every fifth year, to the years 2001-2004 (Table 4). Once again, the standard deviations are more frequently statistically different, while the mean size of parcels sold is not statistically different in most years. The means were significantly different in the years 1980 and 1985, with means in 1980 and 1985 of 429.3 acres and 439 acres, respectively, compared to means of approximately 736 acres in years 2001-2003 and a mean of 562.8 in 2004. The standard deviations were also significantly lower in those years, 447.4 acres and 704.2 acres, respectively. The lower means and standard deviations in 1980 and 1985 could be attributed to buyers being less able to make large land purchases during the economic crisis of the 1980's.

In the Panhandle regional analysis, it is important to focus on the smaller mean of 562.8 acres in 2004 compared to the three previous years where means were approximately 700 acres. The drop in average size purchased supports the hypothesis that smaller parcels are becoming more popular. There is also a much smaller standard deviation of 779.8 acres in year 2004 compared to previous years 2001 to 2003 of 1716.3, 1461, and 2171.6 acres, respectively. The smaller standard deviation indicates there was less variability from the mean in 2004. This implies that there were more parcel sales of acreage closer to the mean, or more parcels sold that were smaller in acreage relative to pervious years.

OLS Regression Results

The Ordinary Least Squares regression models were used to analyze the effects of parcel size and several other explanatory variables on price per acre of land sold in Texas. Several forms of the regression model were tested. The models were specified in double log form to make the coefficients elasticities. In logarithmic form, a negative sign existed on the coefficient for net farm income. The model was changed from logarithmic to linear, which still produced results of negative coefficients on the net farm income explanatory variable. Attempts were also made to change time periods and regions included in the model, which also produced similar results for net farm income. Government payments were included as an additional explanatory variable and the model was run with nominal, rather than real values for price per acre, personal income, government payments, and net farm income; still, there was no change in results. Dummy variables were added to account for each alternative farm program from 1965-2004. The addition of these variables did not change the sign of the net farm income variable. Based on a variance inflation factor test, it was concluded that net farm income and personal income were multicollinear.

In response to the multicollinear conclusion, two different regression models were estimated for Texas as a whole (Table 5). One of the regression models included personal income as an explanatory variable and the other included net farm income as an explanatory variable. Additional variables included in both models were acres sold and the dummy variable for parcels less than 40 acres. All explanatory variables in both models were statistically significant, yet the model which included personal income yielded the higher significance for acres sold and the dummy variable for small parcel sales as well as the higher R^2 and F value of .767 and 153,329, respectively. The model which included personal income was therefore chosen to estimate all additional regression models.

For the Texas regression model, which included personal income, the natural log of acres sold variable has a large t value of -169.11 and a coefficient of -.297, which means a decrease of 2.97% in price for a 10 percent increase in acres for the parcel sold. The coefficient of -.297 supports the research hypothesis that larger parcels receive a lower price per acre. The natural log of personal income shows a 6.74% increase in price per acre for a ten percent increase in personal income. The positive relationship between price per acre and personal income corroborates with prior research which concluded that personal income has a positive effect on farm price per acre of parcel sold. The dummy variable, used to represent parcels of less than 40 acres has a positive coefficient of .254, meaning that smaller parcels receive a higher price per acre.

A regression model was estimated for each of the eight separate regions over the entire time period of 1965-2004 (Table 5). The region that saw the greatest decrease in price per acre as the number of acres sold increases was the West, with a coefficient of

Table 5. Regression Analysis of Texas and Eight Regions 1965-2004

	Intercept	lnacres	DV1SIZE	lnperinc	lnnfi	R^2	F value
1965-2004							
Texas							
Parameter Est	-4.300	-0.297	0.247		0.820	0.698	107723
T Value	**-182.44***	**-148.75**	**33.81**		**531.51**		
Parameter Est	-5.286	-0.297	0.254	0.674		0.767	153329
T Value	**-248.96**	**-169.11**	**39.64**	**638.21**			
Panhandle							
Parameter Est	-2.594	-0.198	0.436	0.480		0.627	6204
T Value	**-35.59**	**-30.96**	**11.48**	**135.43**			
South							
Parameter Est	-5.497	-0.273	0.347	0.695		0.778	7084
T Value	**-56.54**	**-38.96**	**13.82**	**140.14**			
Rolling Plains							
Parameter Est	-4.796	-0.253	0.389	0.611		0.794	26240
T Value	**-105.66**	**-63.46**	**19.88**	**271.45**			
Central							
Parameter Est	-7.310	-0.189	0.292	0.763		0.844	71567
T Value	**-198.70**	**-53.74**	**28.21**	**440.99**			
East							
Parameter Est	-6.685	-0.173	0.163	0.722		0.810	25889
T Value	**-122.15**	**-29.78**	**12.22**	**275.42**			
Coastal Blend							
Parameter Est	-5.012	-0.205	0.123	0.652		0.792	19621
T Value	**-85.45**	**-37.81**	**8.42**	**233.20**			
West							
Parameter Est	-4.539	-0.386	0.199	0.668		0.767	14749
T Value	**-57.69**	**-89.12**	**7.21**	**171.44**			
South Plains							
Parameter Est	-2.562	-0.301	0.203	0.516		0.676	10806
T Value	**-42.22**	**-47.85**	**7.32**	**176.10**			

Note: lnacres = natural log of acres
lnperinc = natural log of personal income
lnnfi = natural log of net farm income
DV1SIZE = dummy variable for acres sold < 40 acres
*bold values indicate significance at alpha= .05

-.386 for acres sold. All regions have positive effects from personal income and the Central saw the greatest effect with a coefficient of.763 and a t value of 440.99. The Panhandle region of Texas has the least effects from personal income, but has the largest premium on small parcel sales shown by the coefficient of .436 for the dummy variable, which represents sales of less than 40 acres.

Panhandle Region

A regression model to explain price per acre was estimated for the Panhandle region over the time period of 1965-2004 and separate regressions were estimated for eight five-year intervals (Table 6).The Panhandle region encompasses the North Panhandle (1), Central Panhandle (2) and the Canadian Breaks (5) land market areas. Land sales, specifically in the North Panhandle slowed from 2002-2003 due to increased costs of production, but were back on the increase in 2004 attributed some to an active, steady demand for smaller ranches for recreational purposes (ASFMRA, 2005). Yet, agricultural operations are still dominate as the “area lacks splendor, geologic uniqueness and varied recreational opportunities.”

The acres variable was statistically significant and negative in each time period. The effect of parcel size on price per acre decreased by more than 50 percent over the period as the elasticity of price with respect to acres declines from -.248 to -.113. The greatest effect from the acres explanatory variable, in absolute terms, was seen for the 1965-1969 period, with a .259% decrease in price for a 1% increase in parcel size. The dummy variable which accounts for sales of less than 40 acres was statistically significant in the periods 1970-1979 and then again in the 2000-2004 time period, where it had the greatest effect with a 1.079 coefficient; this supports the hypothesis that smaller parcels have received larger prices in recent years. Personal income had a

Table 6. Regression Analysis of Panhandle Region 1965-2004 in 5 Year Increments

	Intercept	lnacres	DV1SIZE	lnperinc	R^2	F value
1965-1969						
Parameter Est	0.85	-0.259	0.22	0.285	0.173	112
T Value	0.66	**-13.73***	2.53	**3.49**		
1970-1974						
Parameter Est	-8.615	-0.248	0.279	0.862	0.268	199
T Value	**-8.61**	**-14.75**	**3.65**	**14.26**		
1975-1979						
Parameter Est	-4.385	-0.219	0.361	0.607	0.239	161
T Value	**-4.52**	**-11.59**	**4.48**	**10.95**		
1980-1984						
Parameter Est	5.384	-0.191	0.331	0.068	0.114	45
T Value	**3.92**	**-10.07**	2.26	0.91		
1985-1989						
Parameter Est	2.094	-0.197	-0.195	0.233	0.09[illegible]	45
T Value	0.79	**-11.5**	-1.16	1.66		
1990-1994						
Parameter Est	-6.009	-0.206	0.626	0.661	0.144	59
T Value	-2.31	**-11.57**	2.59	**4.93**		
1995-1999						
Parameter Est	0.339	-0.142	0.827	0.315	0.084	40
T Value	0.14	**-9.48**	3.06	2.65		
2000-2004						
Parameter Est	-23.423	-0.113	1.079	1.489	0.114	71
T Value	**-6.5**	**-7.24**	**7.36**	**8.36**		

Note: lnacres = natural log of acres
lnperinc = natural log of personal income
DV1SIZE = dummy variable for acres sold < 40 acres
*bold values indicate significance at alpha = .05

significantly positive effect on price per acre during the years 1965-1979, 1990-1994 and 2000-2004.

South Region

A regression model to explain price per acre was estimated for the Southern region over the time period of 1965-2004 and separate regressions were estimated for eight five-year

Table 7. Regression Analysis of South Region 1965-2004 in 5 Year Increments

	Intercept	lnacres	DV1SIZE	lnperinc	R^2	F value
1965-1969						
Parameter Est	-5.916	-0.386	0.069	0.748	0.474	265
T Value	**-3.62***	**-16.22**	1.10	**7.21**		
1970-1974						
Parameter Est	-14.778	-0.309	0.168	1.272	0.520	243
T Value	**-9.39**	**-14.48**	2.65	**13.36**		
1975-1979						
Parameter Est	-8.988	-0.327	0.112	0.938	0.543	213
T Value	**-5.55**	**-14.00**	1.41	**10.06**		
1980-1984						
Parameter Est	0.449	-0.309	0.272	0.411	0.571	237
T Value	0.23	**-14.72**	3.46	**3.86**		
1985-1989						
Parameter Est	14.309	-0.23	0.395	0.363	0.505	232
T Value	**4.17**	**-14.69**	**6.22**	-2.00		
1990-1994						
Parameter Est	-0.092	-0.259	0.400	0.44	0.552	307
T Value	-0.03	**-15.62**	**2.36**	6.76		
1995-1999						
Parameter Est	-6.433	-0.254	0.56	0.724	0.608	414
T Value	-2.09	**-15.5**	**8.73**	**4.67**		
2000-2004						
Parameter Est	-40.685	-0.22	0.59	2.416	0.572	532
T Value	**-9.34**	**-15.15**	**10.41**	**11.27**		

Note: lnacres = natural log of acres
lnperinc = natural log of personal income
DV1SIZE = dummy variable for acres sold < 40 acres
*bold values indicate significance at alpha = .05

periods (Table 7). The South region encompasses the Rio Grande Plains (11) and the Lower Rio Grande Valley (32), land market areas. The main source of demand for land in recent years is recreation, investment, and ranch development (ASFMRA, 2005). Hunting ranches, which have established game command premiums in this area and non-hunting recreational users are also on the increase, especially near the coast. Demand for farmland has also held steady, mainly being purchased by farmers.

The acres sold explanatory variable is statistically significant and negative in each time period indicating a premium bring paid for smaller parcels. The elasticity with respect to acres declined from -.309 to -.220 over the 40 year period. The greatest impact from the acres variable occurred during the years 1965-1969, with a coefficient of -.386 and a t-value of -16.22. The dummy variable for small parcels is statistically significant in years 1985-2004, with the highest values occurring from 1995-2004. The results of the acres sold explanatory variable and the dummy variable for parcels of less than 40 acres support the hypothesis that larger parcels have received a lower price per acre in recent years and smaller parcels have received higher prices per acre in recent years. Personal income is statistically significant and positive in years 1965-1984 and 1995-2004.

South Plains Region

A regression model to explain price per acre was estimated for the South Plains region over the time period of 1965-2004 and separate regressions were estimated for eight five-year intervals (Table 8). The South Plains region encompasses the Permian West (4) and South Plains (3) land market areas. This area is composed of diverse topography, with rolling plains, broad valleys and flood plains and the majority of land is utilized for cattle grazing (ASFMRA, 2005). Sales of dry cropland in recent years have increased simultaneously with land values. Agriculture operations dominate this area and it lacks a plethora of scenery and recreational opportunity.

Table 8. Regression Analysis of South Plains Region 1965-2004 in 5 Year Increments

	Intercept	lnacres	DV1SIZE	lnperinc	R^2	F value
1965-1969						
Parameter Est	5.160	-0.408	0.122	0.056	0.261	285
T Value	**4.7***	**-23.95**	1.78	0.81		
1970-1974						
Parameter Est	-10.626	-0.322	0.162	1.005	0.331	493
T Value	**-14.85**	**-23.09**	3.22	**23.18**		
1975-1979						
Parameter Est	-9.067	-0.31	0.156	0.905	0.306	343
T Value	**-11.47**	**-19.98**	2.66	**20.00**		
1980-1984						
Parameter Est	3.213	-0.277	-0.100	0.22	0.149	73
T Value	2.62	**-13.72**	-0.91	3.31		
1985-1989						
Parameter Est	-9.610	-0.255	0.114	0.870	0.166	94
T Value	**-3.93**	**-14.49**	1.13	**6.74**		
1990-1994						
Parameter Est	1.366	-0.256	-0.227	0.297	0.133	69
T Value	0.64	**-14.10**	-1.79	2.72		
1995-1999						
Parameter Est	1.430	-0.339	-0.048	0.320	0.205	112
T Value	0.58	**-17.71**	-0.29	2.59		
2000-2004						
Parameter Est	-16.197	-0.168	0.933	1.149	0.161	153
T Value	**-5.71**	**-11.42**	**10.89**	**8.21**		

Note: lnacres = natural log of acres
lnperinc = natural log of personal income
DV1SIZE = dummy variable for acres sold < 40 acres
*bold values indicate significance at alpha = .05

The explanatory variable representing acres sold was statistically significant and negative in all years. The dummy variable which accounts for sales of less than 40 acres was not statistically significant in all periods except the years 2000-2004, in which the t-value and coefficient increased substantially from the earlier period. This supports the hypothesis of smaller parcels receiving higher price per acre in recent years. Although not statistically significant, this region had several negative dummy variable coefficients, a pattern that stands out from the other regions. This could be due to the large number of agricultural operations in the area and farmers wishing to purchase larger parcels for farming. The personal income coefficients were statistically significant in years 1970-1979, 1985-1989 and 2000-2004.

Rolling Plains Region

A regression model to explain price per acre was estimated for the Rolling Plains region over the time period of 1965-2004 and separate regressions were estimated for eight five-year intervals (Table 9). The Rolling Plains region includes Rolling Plains-Central (7), Rolling Plains-North (6), and the North Central Plains (12) land market areas. In recent years, this region saw an increase in the sales of smaller parcels and a decrease in parcel sales of 500 to 2,000 acres (ASFMRA, 2005). Irrigated farms in this region remain stable and are being purchased by neighboring farmers. In 2004, the large cotton crop spurred farmers to reinvest their profits into land, causing an increase in demand for farmland.

The acres sold variable is statistically significant and negative in each time period. The dummy variable for small parcels is statistically significant and positive in each year except 1965-1969 and the highest coefficients for the dummy variable, .520 and .624, occurred in the last two periods. The significance and effect of both variables support the hypothesis that smaller parcels are receiving a higher price per acre. Personal income was statistically significant and positive in all years except 1985-1989. Although

Table 9. Regression Analysis of Rolling Plains Region 1965-2004 in 5 Year Increments

	Intercept	lnacres	DV1SIZE	lnperinc	R^2	F value
1965-1969						
Parameter Est	-3.181	-0.272	0.053	0.508	0.223	288
T Value	**-4.32***	**-25.26**	1.04	**10.89**		
1970-1974						
Parameter Est	-11.493	-0.251	0.294	1.012	0.384	679
T Value	**-20.49**	**-27.57**	**6.74**	**29.75**		
1975-1979						
Parameter Est	-8.129	-0.246	0.37	0.811	0.397	621
T Value	**-14.51**	**-24.7**	**9.13**	**25.34**		
1980-1984						
Parameter Est	-3.806	-0.239	0.336	0.576	0.294	235
T Value	**-3.83**	**-18.25**	**5.60**	**10.72**		
1985-1989						
Parameter Est	11.073	-0.282	0.322	-0.214	0.276	238
T Value	**4.9**	**-22.57**	**4.77**	-1.8		
1990-1994						
Parameter Est	-0.583	-0.267	0.317	0.391	0.270	277
T Value	-0.35	**-25.40**	**4.73**	**4.52**		
1995-1999						
Parameter Est	-0.585	-0.271	0.520	0.393	0.261	262
T Value	-0.35	**-23.42**	**6.78**	**4.69**		
2000-2004						
Parameter Est	-24.792	-0.201	0.624	1.583	0.318	511

Note: lnacres = natural log of acres
lnperinc = natural log of personal income
DV1SIZE = dummy variable for acres sold < 40 acres
*bold values indicate significance at alpha = .05

not statistically significant, the personal income coefficient for years 1985-1989 is negative. This negative coefficient could be attributed to the economic recession and high interest rates during those years.

Central Region

A regression model to explain price per acre was estimated for the Central region over the time period of 1965-2004 and separate regressions were estimated for eight five-year

Table 10. Regression Analysis of Central Region 1965-2004 in 5 Year Increments

	Intercept	lnacres	DV1SIZE	lnperinc	R^2	F value
1965-1969						
Parameter Est	-8.31	-0.155	0.344	0.804	0.229	557
T Value	**-15.16***	**-18.12**	**12.69**	**23.17**		
1970-1974						
Parameter Est	-18.991	-0.140	0.259	1.460	0.398	1097
T Value	**-39.07**	**-17.28**	**10.06**	**49.23**		
1975-1979						
Parameter Est	-6.567	-0.192	0.072	0.734	0.270	454
T Value	**-13.35**	**-20.05**	0.95	**26.26**		
1980-1984						
Parameter Est	-12.638	-0.151	0.072	1.062	0.256	483
T Value	**-19.26**	**-16.65**	2.46	**30.01**		
1985-1989						
Parameter Est	21.210	-0.191	0.272	-0.733	0.196	301
T Value	**13.81**	**-18.25**	**8.58**	**-9.05**		
1990-1994						
Parameter Est	-2.060	-0.266	0.194	0.503	0.261	496
T Value	-1.63	**-28.63**	**6.13**	**7.74**		
1995-1999						
Parameter Est	-7.223	-0.247	0.289	0.762	0.294	701
T Value	**-6.26**	**-26.08**	**10.61**	**13.13**		
2000-2004						
Parameter Est	-33.326	-0.23	0.355	2.055	0.345	1411
T Value	**-20.6**	**-27.25**	**16.20**	**25.71**		

Note: lnacres = natural log of acres
lnperinc = natural log of personal income
DV1SIZE = dummy variable for acres sold < 40 acres
*bold values indicate significance at alpha = .05

periods (Table 10). The Central region includes the Blacklands-North (25), Hill Country-North (14), Brazos (27), Crosstimbers (13), and Highland Lakes (16) land market areas. Appreciation rates for land in this area have increased in recent years with land values showing constant upward price trends (ASFMRA, 2005). Recreational use dominates this area, especially hunting, and buyers typically come from metropolitan areas in

Texas. The hill country of Texas attracts buyers to its aesthetic qualities such as water and scenic landscapes.

The acres sold variable is statistically significant in each time period. The periods 1990-1994 and 1995-1999 have the largest absolute elasticity for price with respect to parcel size with values of -.266 and -.247, respectively. In absolute terms, the elasticity of price with respect to acres almost doubled over the 40 year period. The dummy variable for size of parcel less than 40 acres is positive and statistically significant over the years 1965-1974 and 1985-2004, with the 1995-1999 and 2000-2004 coefficients being the greatest, .289 and .355, respectively. The results from both the acres sold and the dummy variable for smaller size parcels explanatory variables support the hypothesis that smaller parcels received a higher price per acre in recent years. Personal income was positive and statistically significant in all years, with the 2000-2004 estimate nearly doubling all others with a coefficient of 2.055, meaning personal income was highly instrumental for explaining price per acre sold during the last time period.

West Region

A regression model to explain price per acre was estimated for the West region over the time period of 1965-2004 and separate regressions were estimated for eight five-year intervals (Table 11). The West region includes the Edwards Plateau-West (9), Edwards

Plateau-South (10), Hill Country-South (17), Hill Country-West (15) and Trans-Pecos (8) land market areas. The region is mostly composed of native rangeland used for

Table 11. Regression Analysis of West Region 1965-2004 in 5 Year Increments

	Intercept	lnacres	DV1SIZE	lnperinc	R^2	F value
1965-1969						
Parameter Est	-4.224	-0.399	0.224	0.637	0.572	679
T Value	-3.33	**-38.68***	3.24	**7.9**		
1970-1974						
Parameter Est	-16.562	-0.404	0.031	1.405	0.575	658
T Value	**-14.19**	**-38.62**	0.35	**19.77**		
1975-1979						
Parameter Est	-8.732	-0.371	0.026	0.921	0.522	405
T Value	**-8.06**	**-30.03**	0.23	**14.87**		
1980-1984						
Parameter Est	-7.512	-0.353	0.172	0.846	0.474	368
T Value	**-5.37**	**-28.59**	1.59	**11.21**		
1985-1989						
Parameter Est	41.565	-0.422	-1.747	0.028	0.496	442
T Value	**13.33**	**-33.47**	-10.61	**0.23**		
1990-1994						
Parameter Est	-4.137	-0.411	0.078	0.641	0.507	630
T Value	-1.68	**-40.02**	-0.91	**5.04**		
1995-1999						
Parameter Est	1.741	-0.396	0.032	0.345	0.458	543
T Value	0.71	**-36.23**	0.43	2.81		
2000-2004						
Parameter Est	-47.303	-0.337	0.436	2.766	0.448	814
T Value	**-13.58**	**-31.19**	**9.27**	**16.07**		

Note: lnacres = natural log of acres
lnperinc = natural log of personal income
DV1SIZE = dummy variable for acres sold < 40 acres
*bold values indicate significance at alpha = .05

cattle grazing; the ownership of the rangeland is mostly held by established ranching families, but low income levels and increased pressure from non-agricultural land buyers have influenced changes in property ownership (ASFMRA, 2005). Large ranches are being broken into ranchettes, or several smaller ranches, and sold to buyers for non-agricultural purposes. Although much of the area lacks scenic splendor, demand for land in this area is generally stable.

The acres explanatory variable is highly statistically significant and the coefficient is negative throughout all periods. The dummy variable for parcel size is statistically significant in only years 2000-2004 with a .436 coefficient, the largest of all periods, supporting the hypothesis that smaller parcels are going for a larger price per acre in recent years. Personal income was statistically significant in years 1965-1994 and 2000-2004, with by far the largest coefficient of 2.766 existing in 2000-2004.

East Region

A regression mode to explain price per acre was estimated for the East region over the time period of 1965-2004 and separate regressions were estimated for eight five-year periods (Table 12). The East Region includes the Piney Woods-North (30), Piney-Woods South (31) and North East (29) land market areas. Over the past four years, this area has seen a strong trend of subdivision of wooded and pasture properties into rural residential or tracts for recreational use (ASFMRA, 2005). This has influenced rural land prices greatly. In Northeast Texas, there has been an increase in purchases of large tracts of crop and pasture land, with the majority of the buyers coming from the Midwest farm belt and West Texas. The Piney woods areas attract buyers who want mixed-use tracts for hunting and weekend retreats.

The variable for acres is statistically significant and negative in each period with the greatest decrease in price per acre due to increases in acres sold occurring in 1995-1999 with a coefficient of -.256. The absolute elasticity of price with respect to acres doubled over the 40 year time period. The parcel size dummy variable is

Table 12. Regression Analysis of East Region 1965-2004 in 5 Year Increments

	Intercept	lnacres	DV1SIZE	lnperinc	R^2	F value
1965-1969						
Parameter Est	-13.459	-0.143	0.370	1.128	0.268	461
T Value	**-16.31***	**-10.91**	**12.4**	**21.66**		
1970-1974						
Parameter Est	-16.725	-0.112	0.202	1.319	0.351	472
T Value	**-26.45**	**-8.71**	**7.01**	**34.3**		
1975-1979						
Parameter Est	-8.119	-0.100	0.063	0.801	0.243	249
T Value	**-14.64**	**-8.02**	2.26	**25.15**		
1980-1984						
Parameter Est	-10.040	-0.158	0.111	0.923	0.236	210
T Value	**-11.55**	**-10.6**	3.32	**19.76**		
1985-1989						
Parameter Est	22.351	-0.232	-0.003	-0.79	0.173	124
T Value	**10.53**	**-15.51**	-0.07	**-7.04**		
1990-1994						
Parameter Est	-0.016	-0.199	0.167	0.374		
T Value	-0.01	**-12.1**	**3.98**	**3.73**	0.129	97
1995-1999						
Parameter Est	-6.819	-0.256	0.126	0.737	0.198	163
T Value	**-3.50**	**-14.51**	3.10	**7.5**		
2000-2004						
Parameter Est	-22.595	-0.212	0.221	1.507	0.273	219
T Value	**-7.06**	**-12.91**	**5.72**	**9.52**		

Note: lnacres = natural log of acres
lnperinc = natural log of personal income
DV1SIZE = dummy variable for acres sold < 40 acres
*bold values indicate significance at alpha = .05

statistically significant in years 1965-1974, 1990-1994, and 2000-2004. The sporadic significance is hard to relate to certain occurrences, but the most recent period of 2000-2004 definitely saw a premium paid for smaller parcels, with a coefficient of .221. Personal income was statistically significant in all years, but was negative and statistically significant in years 1985-1989, which can most likely be tied to troubling economic times and record high interest rates.

Coastal Bend Region

A regression model to explain price per acre was estimated for the Coastal Bend region of Texas over the time period of 1965-2004 and separate regressions were estimated for eight five-year intervals (Table 13). The Coastal Bend region includes Coastal Prairie-North (19), Coastal Prairie-South (20) and Coastal Prairie-Middle (21) land market areas. Many affluent residents in the Houston area have purchased farms and ranches in this region for recreation and weekend getaways (ASFMRA, 2005). Hunting is an important recreational activity in the area, but the aesthetic qualities of the region are the main motivator in sales for the region. Those not as affluent are purchasing smaller size tracts in the area of ten to fifty acres, which has spurred the subdivision of much of the rural land in the area.

The acres variable is statistically significant and negative in every time period, with the largest coefficients of -.266 and -.253 occurring in the last two periods. The dummy variable for smaller parcels is statistically significant and positive from 1965-1969 and in the more recent years of 1985-2004, supporting the hypothesis that smaller parcels are selling for higher prices. Personal income was statistically significant in years of 1965-1989, but the coefficient was negative during the period 1985-1989.

Table 13. Regression Analysis of Coastal Bend Region 1965-2004 in 5 Year Increments

	Intercept	lnacres	DV1SIZE	lnperinc	R^2	F value
1965-1969						
Parameter Est	-7.227	-0.181	0.18	0.764	0.174	109
T Value	**-6.19***	**-9.66**	**3.8**	**10.28**		
1970-1974						
Parameter Est	-16.392	-0.149	0.123	1.326	0.332	284
T Value	**-19.82**	**-10.09**	2.90	**26.36**		
1975-1979						
Parameter Est	-9.192	-0.16	0.043	0.896	0.339	287
T Value	**-14.48**	**-13.21**	1.18	**24.76**		
1980-1984						
Parameter Est	-9.111	-0.145	0.05	0.888	0.278	168
T Value	**-9.8**	**-10.2**	1.29	**17.7**		
1985-1989						
Parameter Est	26.252	-0.178	0.193	-0.995	0.256	184
T Value	**14.55**	**-13.65**	**5.53**	**-10.43**		
1990-1994						
Parameter Est	7.447	-0.218	0.113	0.004	0.215	225
T Value	**4.99**	**-20.69**	**3.53**	0.05		
1995-1999						
Parameter Est	-9.684	-0.266	0.129	0.892	0.311	337
T Value	**-6.68**	**-20.55**	**3.84**	**12.2**		
2000-2004						
Parameter Est	-34.19	-0.253	0.162	2.103	0.362	544
T Value	**-14.95**	**-21.58**	**5.41**	**18.61**		

Note: lnacres = natural log of acres
lnperinc = natural log of personal income
DV1SIZE = dummy variable for acres sold < 40 acres
*bold values indicate significance at alpha = .05

Analysis of Variables over All Regions

Although the acres variable is statistically significant and negative in all regions over all time periods, there is considerable variability among the estimates. The majority of regions see greater effects on price per acre from increases in acreage in more recent time periods, but the majority also saw large effects in earlier time periods with some seeing the largest effects in 1965-1970. Thus the trend of a lower price per acre as size of parcel increases is not a recent phenomenon in Texas.

The DV1SIZE variable which accounts for parcel sales less than 40 acres differs in its sign and significance. The majority of the regions saw this variable becoming statistically significant at the .05 level in more recent years, and two regions see the only significance for this variable in years 2000-2004 (South Plains and West), suggesting that smaller parcels selling for a higher price per acre has become more important in recent periods for some areas. The Rolling Plains, however experienced premiums for smaller parcels over the time period 1970-2004 and the East, Coastal Bend and Central regions have seen it sporadically in several time periods.

Personal income is a stronger determinant of price per acre than net farm income, as indicated by the higher statistical significance for the model using personal income as an explanatory variable versus net farm income (Table 5). The result supports earlier research by Hardie, Naryan, and Gardner (2001), who found that farmland prices are more responsive to household income changes, rather than farm revenues. Personal income varies in sign among the different time periods, with three of the regions seeing a statistically significant negative coefficient for personal income for 1985-1989. During this period, the economy of the United States was suffering, interest rates were at an all time high and the real estate market was stagnant. Farm income was also suffering and agriculture was hit hard with the economic downturn, all of which contributed to a decrease in personal income and most likely caused the negative signs on the personal income coefficients for those regions.

Summary

Data summarization, graphical analysis, mean and standard deviation comparisons, and OLS regression analysis were used to analyze the relationship of parcel size and corresponding price of rural land in Texas, as well as the existence of fragmentation.

The summary of data proved that nearly all regions in Texas saw increases in the number of parcels sold, decreases in the median parcel size, and increases in price per acre (Table 1). The graphical analysis of price per acre versus number of acres sold from 1965-2004 (Figure 3) showed that the proportion of sales for smaller and larger parcel sales have steadily increased, especially in more recent years and that the frequency of small parcel sales has increased over 2000-2004. The line graph of median acres sold (Figure 4), which was fit with linear regression trends, showed that no trend exists in the median size of parcels sold from 1965-2004. The shares of state wide annual real estate sales by size of parcel, from 1966-2004 (Figure 5), showed that as a percentage of total sales in Texas, sales of small parcels (10-20 acres and 21-40 acres) have increased in recent years, which is the result of fragmentation. As a percentage of total sales, the sales of mid size parcels, 41-320 acres, were at or near their lowest levels in 2004, supporting the hypothesis that sales of smaller size parcel sales have become more frequent. As a paradox, the sales for large parcels (more than 320 acres) as a percentage of total sales, has increased over time and reached a record high in 2004. Thus sales for small parcels and for large parcels has increased relative to sales in the 41-320 acre size category. This is most likely attributed to two types of demand, one from recreational buyers who want smaller affordable parcels and the other from agricultural purchasers, who want larger farming and ranching units or investors who are looking for safe alternatives to traditional methods of investing, such as the stock market.

The mean and standard deviation analysis, which compared parcel sizes sold in Texas and the Panhandle region from 1965-2000 to parcel sizes sold from 2001-2004 (Tables 3 and 4), showed that the standard deviation of parcel size was more often significantly different from one year to the other at the 95 percent confidence level. The mean parcel sizes sold were hardly significantly different between years, but the 2004 mean in the Panhandle region (Table 4) had dropped to 562.81 acres from the three previous year's means which averaged 700 acres. The 2004 standard deviation for parcel size in the Panhandle had also dropped to 779.78 acres, compared to the three pervious year's average standard deviation of 1,783 acres.

The OLS regression analysis estimated models for Texas and eight regions over the time period 1965-2004 to identify the effects of parcel size on price per acre. Due to the results from the variance inflation factor test, which proved that net farm income and personal income are correlated, two models were estimated for Texas from 1965-2004. One model included an explanatory variable for net farm income and one included an explanatory variable for personal income. Both models included the variables for acres sold and the dummy variable for small parcel sales. Based on higher statistical significance of variables, as well as a higher R^2 and F value, the model which included personal income was used to run the remaining OLS regression equations.

Separate OLS models were estimated for the eight regions from 1965-2004 and then for the eight regions broken into five year time periods. The Texas and regional models, which covered the years 1965-2004 had high R^2 values and significant F-values. All regional models, broken into separate time periods had statistically significant, but lower R^2 and F-values due to fewer observations. All explanatory variables in the regression models had the expected signs. Personal income was significant in at least four time periods in each region, but saw a negative sign on the coefficient for years 1985-1989 in several regions, most likely attributed to the economic recession and high interest rates which occurred during that time period. All regional regression models showed significance and negative signs on the acres sold explanatory variable. All regional models showed significance in at least one time period for the dummy variable used to account for parcel sales of less than 40 acres. The results of the acres sold variable and the dummy variable for small parcel sales support the hypothesis that the smaller parcels have sold for a higher price per acre, especially in recent years. Economic theory would support the assumption that the rise in smaller parcel sales and the higher price per acre for smaller parcels have influenced the trend of fragmentation as those who have larger parcels are more likely to subdivide the parcel into several sections to gain a greater profit if the price per acre is greater for smaller parcels.

CHAPTER V

SUMMARY AND CONCLUSIONS

According to the USDA, Texas leads all other states in the loss of rural farming and ranching land, with the conversion of land into urban uses exceeding 2.6 million acres from 1982-1997 (Phillips, 2004). Over the past forty years, the downward trend in the size of land parcels being sold has been exceedingly apparent. Nearly every region of Texas has seen increases in land prices and decreases in parcel sizes, with the majority of new consumers investing in rural land for recreation or an escape from 'city life,' rather than for farming and ranching.

The primary objective of this research was to analyze the relationship between the size of land parcels being sold in Texas and their corresponding prices. Data summarization, graphical analysis, mean and standard deviation analysis, and OLS regression models were used to achieve the objective.

Ordinary least squares regression on historical data for Texas land sales (10 or more acres) over the years 1965-2004, were used to estimate the effect of size on price per acre. Due to the correlation between net farm income and personal income, two regression models were estimated to test the effect on parcel sales which occurred in Texas from 1965-2004. One model included personal income as an explanatory variable and one included net farm income as an explanatory variable. Both models included the acres sold and dummy variable for small parcel sales as additional explanatory variables. The model which incorporated personal income was chosen to estimate the remaining regression equations based on the higher student t tests, R^2 and F values it produced. Eight OLS models tested the effect of parcel size on price per acre in eight regions in Texas from 1965-2004, and 64 additional OLS models tested the effect in the same eight regions broken into eight time cohorts of five year intervals from 1965-2004.

A summary of the data showed changes over time in the number of sales, median parcel size, and average price per acre for Texas and the eight regions from 1965-2004. Results showed that for Texas and the majority of the regions, the greatest increase in frequency of sales and average price per acre, as well as the greatest decrease in median parcel size occurred in years 2000-2004. Frequency graphs were used to analyze the land sale data. A graph of the real price per acre versus the number of acres sold from 1965-2004 showed an increase in price per acre for smaller parcel sales with the most pronounced increase in years 1990-2004. A line graph was used to analyze the median acres sold, yearly, from 1965-2004. Although there was not a statistically significant trend present, the graph did show that the size of median parcels sold fell below average in the last four years. An analysis to evaluate the percent of sales from 1966-2004 in several size categories, supported the hypothesis that smaller parcels have become increasingly popular with buyers. Trend analysis showed a statistically significant positive trend in the percent of sales in the 21-40 acre category over the 1965-2004 period. Further analysis showed positive statistically significant trends in percent of sales for parcels larger than 320 acres, indicating that sales of larger parcels have increased as a percent of total sales as well. Sales of 81-320 acre parcels, however, showed statistically significant decreasing trends as a percent of sales.

The mean and standard deviation analysis compared means and standard deviations for acres of land sold from 1965-2000 in Texas and the Panhandle region to size of acres sold during the years 2001-2004. This analysis showed that the standard deviation was more frequently different from one year to the next with statistically significant p-values and that mean of total acres sold was rarely statistically different over the period. It was concluded that the mean of total acres sold per year has not changed even though the proportion of sales for the smallest and largest parcels has increased over time.

The results for the OLS regression of all land sales greater than 10 acres from 1965-2000 in Texas supported the hypothesis that smaller parcels are selling for a higher price as the coefficient for acres sold was negative and statistically significant. The dummy variable for parcels less than 40 acres supported the same hypothesis with statistically significant and positive coefficients for all models. The regional models also support the hypothesis for eight different five-year periods from 1965-2004. The personal income coefficient was positive and statistically significant in at least half of the time periods in each region. Negative signs for the personal income coefficient occurred only in the years 1985-1989 when high interest rates contributed to a depressed land market.

Fragmentation can be described as either a loss of large ownership or a proliferation of smaller ownership. Evidence that supports the hypothesis that fragmentation has occurred in Texas was apparent in several results reported in this research. Graphical analysis of price per acre and frequency of sales by size category showed a definite increase in the price per acre paid for smaller parcels, especially the more recent years of 1990-2004. The increase in price per acre paid for smaller parcels leads to fragmentation as land owners who sell smaller parcels received a higher price per acre then those who sell larger parcels. Additional results which supported the existence of fragmentation came from the analysis which showed an increase in the percent sales of smaller parcels (21-40 acres); this category of acres saw a statistically significant trend with the percent of sales reaching 11% in 2004, one of its highest values since 1966. The OLS regression results also supported the existence of fragmentation by showing statistically significant negative coefficients on the size of parcel sold in each region and each time period. The negative coefficients suggest that an increase in size of parcel sold decreases price per acre, therefore encouraging fragmentation. The coefficients on a dummy variable for parcel sales less than 40 acres were statistically significant and positive in at least one time period in each region, which also support the hypothesis that smaller parcels received a higher price per acre.

From the results, it appears that not only has fragmentation occurred in the past thirty-nine years, but it has accelerated more recently. Fragmentation increases the number of land owners in a county and this higher number of land owners makes it much less economical to deliver certain services to land owners such as agricultural extension and education programs. With a larger number of land owners, the cost of administering for these programs greatly increases. A larger number of land owners also means a higher cost to implement and carry out environmental improvement programs. The majority of consumers who are purchasing these smaller parcels may be first-time rural land owners and lack experience dealing with agricultural land or policies which affect the land. The implementation of a new regulation such as a hunting restriction would have to be explained in detail to more land owners to assure full understanding and compliance.

In conclusion, this research failed to reject the hypothesis that smaller parcels of agricultural land all over Texas are selling for a higher price per acre and also supported the existence of fragmentation.

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APPENDIX A

Table A-1. Counties Included in Texas Land Market Areas 1-33

Land Market Area	Counties in LMA
LMA 1	Dallam, Hansford, Hartley, Moore, Ochiltree, Sherman
LMA 2	Armstrong, Briscoe, Carson, Castro, Deaf Smith, Gray, Parmer, Randall, Swisher
LMA 3	Borden, Crosby, Dawson, Floyd, Garza, Hale, Lubbock, Lynn
LMA 4	Andrews, Bailey, Cochran, Ector, Gaines, Hockley, Howard, Lamb, Martin, Midland, Terry, Yoakum
LMA 5	Hemphill, Hutchinson, Lipscomb, Oldham, Potter, Roberts
LMA 6	Childress, Collingworth, Cottle, Dickens, Donley, Hall, Kent, King, Motley, Stonewall, Wheeler
LMA 7	Fisher, Jones, Mitchell, Nolan, Runnels, Scurry, Taylor
LMA 8	Brewster, Crane, Culberson, Hudspeth, Jeff Davis, Loving, Pecos, Presidio, Reeves, Terrell, Ward, Winkler
LMA 9	Coke, Concho, Crockett, Edwards, Glasscock, Irion, Kinney, Reagan, Schleicher, Sterling, Sutton, Tom Green, Upton, Val Verde
LMA 10	Frio, Maverick, Medina, Uvalde, Zavala
LMA 11	Brooks, Dimmit, Duval, Jim Hogg, Kenedy, La Salle, McMullen, Starr, Webb, Zapata
LMA 12	Archer, Baylor, Clay, Foard, Hardeman, Haskell, Jack, Knox, Shackelford, Stephens, Throckmorton, Wichita, Wilbarger, Young
LMA 13	Brown, Callahan, Coleman, Comanche, Eastland, Erath
LMA 14	Hamilton, McCulloch, Mills, Lampasas, San Saba
LMA 15	Kimble, Menard, Real
LMA 16	Burnet, Gillespie, Lllano, Mason
LMA 17	Bandera, Blanco, Kendall, Kerr
LMA 18*	Atascosa, Bexar, Comal, Guadalupe, Karnes, Wilson
LMA 19	Colorado, DeWitt, Fayette, Gonzales, Lavaca
LMA 20	Aransas, Bee, Goliad, Jim Wells, Kleberg, Live Oak, Nueces, Refugio, San Patricio
LMA 21	Calhoun, Jackson, Matagorda, Victoria, Wharton
LMA 22*	Cooke, Fannin, Grayson, Montague
LMA 23*	Hood, Johnson, Palo Pinto, Parker, Somervell, Tarrant, Wise
LMA 24*	Collin, Dallas, Denton, Ellis, Hunt, Kaufman, Rains, Rockwall, Van Zandt
LMA 25	Bell, Bosque, Corylee, Falls, Freestone, Hill, Limestone, McLennan, Navarro
LMA 26*	Bastrop, Caldwell, Hays, Lee, Milam, Travis, Williamson
LMA 27	Brazos, Burleson, Grimes, Leon, Madison, Robertson, Washington
LMA 28*	Austin, Brazoria, Chambers, Fort Bend, Galveston, Hardin, Harris, Jefferson, Liberty, Montgomery, Orange, San Jacinto, Walker, Waller
LMA 29	Bowie, Camp, Cass, Delta, Franklin, Hopkins, Lamar, Marion, Morris, Red River, Titus, Upshur, Wood
LMA 30	Anderson, Cherokee, Gregg, Harrison, Henderson, Houston, Nacogdoches, Panola, Rusk, Shelby, Smith
LMA 31	Angelina, Jasper, Newton, Polk, Sabine, San Augustine, Trinity, Tyler
LMA 32	Cameron, Hidalgo, Willacy
LMA 33*	El Paso
	*LMA not used in regression

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