

Rural Land Fragmentation in Texas: 2010–2020

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Land fragmentation is a significant issue in Texas, where cattle operations rely upon a significant tract of land. This study examines the relationship of land fragmentation and sales, with other independent variables being state population growth rates, financing costs, and the real price per acre. We find that tract sizes are highly dependent upon population growth rates and financing costs. Meanwhile, the number of sales is highly dependent upon the price per acre. Both multiple regression models reveal the highly significant nature of these independent variables resulting in models with high coefficients of determination. This research's focus on Texas provides important insights to the land fragmentation literature, which frequently examines situations outside the United States.

Keywords: fragmentation, land, Texas, prices, tract size, population, interest rates, sales

INTRODUCTION

Fragmentation of farms, ranches, and rural lands has increased at an alarming rate and has become one of the single greatest threats to biodiversity (Kjelland, 2007). Land fragmentation can be defined as a situation in which a single farm or land ownership is divided and sold into separated parcels (King and Burton, 1982, McPherson, 2982). According to the American Farmland Trust, 11 million acres of agricultural land in America had been converted or fragmented between 2001 and 2016. Just this past April the American Farmland Trust reported that 1.4 million acres of agricultural land in Texas had been compromised, making Texas farmland the most threatened in the entire nation (Sallet, 2021). A study conducted between 2001 to 2017 by the United States Department of Agriculture came to a similar conclusion, reporting that “Texas currently leads all other states in the loss of rural farming and ranch land” (James, 2007).

Rural land fragmentation has primarily occurred near large cities where urban sprawl is more apparent (Zambrano et al. 2019). A great example of this includes the Texas Hill Country that borders the Greater Austin area (Lai and Lyons, 2011). However, it should be noted that it is not only limited to metropolitan suburbs and outskirts. Large ownership tracts, defined as those greater than 2,000 acres, have experienced increased fragmentation rates over time. However, recently there has been a tendency for the sale of even smaller land parcels (Texas Wildlife, 2009, Texas Realtors, 2019). During the COVID-19 pandemic land sales also increased in Texas, particularly in rural land (Texas Real Estate Research Center, 2021). With

111 persons per square mile, which is 19 above the national average (CDC, 2021), it is unlikely that this fragmentation will stop any time soon.

During 2020, 552,707 acres of land were sold in Texas for a record \$1.69 billion. These land transfers occurred through 7,684 sales, which were up 28.9 percent from 2019. In addition to the number of sales increasing, the price per acre increased as well. The increased demand shot statewide land prices up 3.1 percent to an average of \$3,064 an acre with the average rural land sale being 1,139 acres (Texas Real Estate Research Center, 2021). This change in ownership and rapid increase in sales may be an indicator for the occurrence of rural land fragmentation.

The goal of this study is to evaluate whether the COVID-19 pandemic has been a contributing factor to the increased land fragmentation in Texas. The specific objectives of this study include analyzing rural land rates over the past ten years and observing any recent trends that might be directly related to the COVID-19 pandemic. This analysis will be done by examining the relationship between the size of land parcels being sold and their associated prices. Texas is used as our model state because land fragmentation has been observed with alarming frequency, and the state's land market has been the most active in Texas history (Texas Real Estate Research Center, 2021).

LITERATURE REVIEW

Much of the recent empirical studies of land fragmentation tend to be conducted outside of the United States. For instance, Djurfeldt (2020) studies land fragmentation in terms of three African nations: Kenya, Rwanda, and Uganda. Cholo et al. (2019) looks at the impact of land fragmentation on climate change and food security in Ethiopia. While others such as Goncalves, Fishers, and Dirzo (2017) consider cattle within a biodiversity issue in Pantanal. Meanwhile, Laggner, and Röder (2017) studied land fragmentation in the Saxony region of Germany. However, Barati, Azadi and Scheffran (2021) tie land fragmentation in Iran back to the situation in Texas.

RESEARCH METHOD

Price-Size Comparison

Analyzing the relationship between the size of rural land tracts and the corresponding real price per acre at which they are being sold is an important first step in understanding the extent of fragmentation (Miller, 2006). An increase in price per acre paid for smaller rural tracts would indicate fragmentation because smaller tracts would be more affordable even at a higher price. Increased prices would also indicate a high demand for smaller acreage compared to larger acreage. Conducting a graphical analysis to observe the relationship is increasingly important. Data was separated into yearly periods that began in 2010 and ended in 2020. Both the average tract size sold and the corresponding real price per acre was collected from the Texas Real Estate Research Center.

Multiple Regression

Average tract size and real price per acre data were collected from the Texas A&M Real Estate Center for the average tract size and real price per acre for 2010-2020 (Texas Real Estate Research Center, 2021). Long-term 30-year interest rates were collected from the U.S. Treasury Department, while the annual increase in state-wide population was collected from the Texas Demographic Center (2020 Census; U.S. Treasury Department, 2019). A regression was then run with the average tract acreage being the dependent variable and the other variables (i.e., real price per acre, 30-year interest rates, and statewide population) being used as the independent variables. A follow-up multiple regression was run with the volume of tracts being sold as the dependent variable and with the other variables being the independent variables. We hypothesize there will be a strong relationship between tract size and price per acre. The two multiple regression equations used in this analysis can be found below:

$$TS_1 = a + b_1 (POP) + b_2 (INTRATE) + b_3 (SALE) + b_4 (PPA) \quad (1)$$

$$SALE_i = a + b_5 (POP) + b_6 (INRATE) + b_7 (TS) + b_8 (PPA) \quad (2)$$

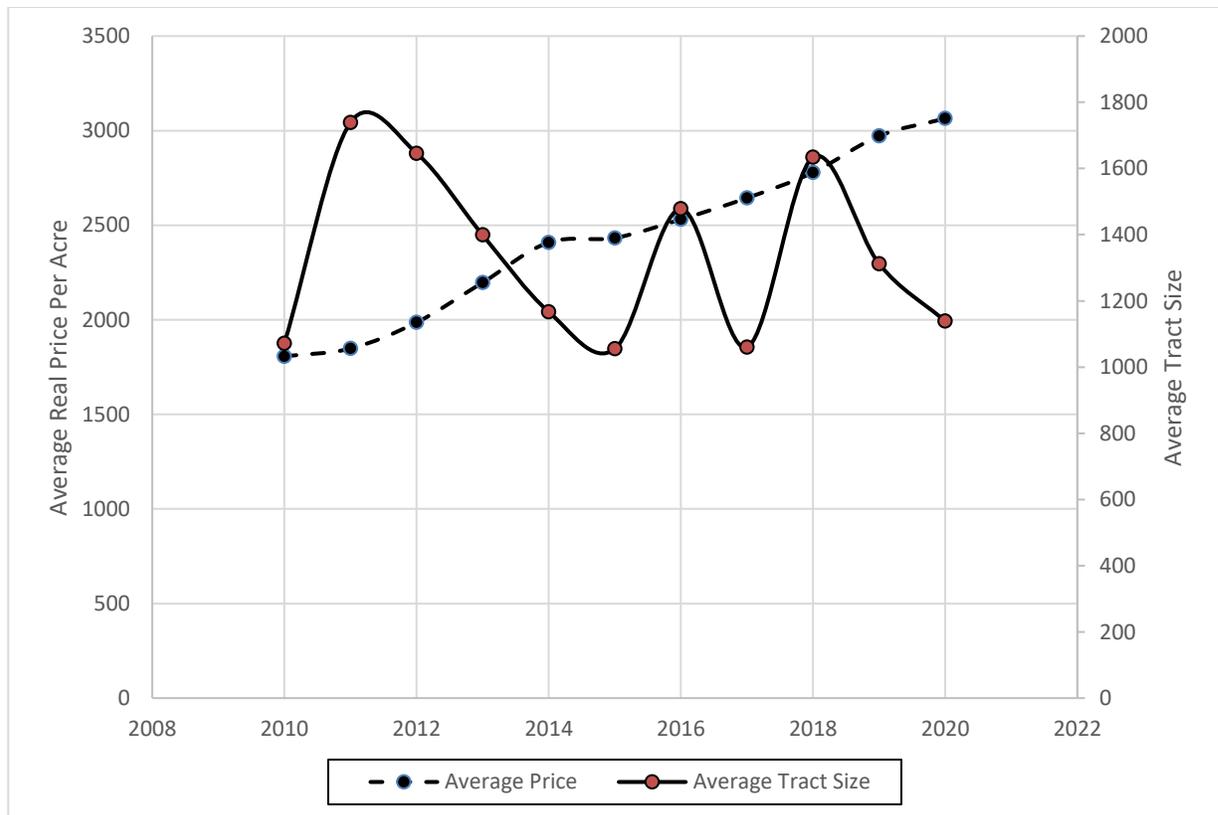
where: TS is the average tract size
 POP is the population growth rate in percentage terms
 INTRATE is the average 30-year interest rate yield
 SALE is the volume of sales
 PPA is the real price per acre

FINDINGS

Tract Size Analysis

Two conclusions can be drawn. The first is that the average tract size is haltingly decreasing, whereas the average price per acre is increasing. There is an inverse relationship here, with the average tract size being sold decreasing as the price per acre rises. This relationship is illustrated in Figure 1. This can also be backed by recent findings showing smaller tracts of land being sold for higher prices per acre (Texas Real Estate Research Center, 2021). Another consistent finding is that these findings are consistent with rural land sales during the COVID-19 pandemic (Martin, 2021). It should be noted that the average tract size is high due to being skewed upward by larger tracts being sold, whereas smaller tracts being sold is consistent with findings in recent reports. It can be assumed that an increase in prices for a smaller tract of land resulted from the division of a larger tract, also known as fragmentation. This hypothesis was further tested by using the reported multiple regressions.

FIGURE 1
RELATIONSHIP BETWEEN AVERAGE REAL PRICE PER ACRE AND AVERAGE TRACT SIZE



Both multiple regressions revealed impressive information that backs the hypothesized relationship between the average tract size and cost, but adds insight regarding the very important impact of population growth rates and financing costs. In Multiple Regression 1, exhibited in Table 1, the average tract size is the dependent variable. As shown in the statistical results, arising from Equation 1, presented below, even after adjusting for the small sample size of ten years, the independent variables still explained almost 40 percent of the variation in tract size. The most significant factor was the growth of population in Texas. As the population grows, there is a decrease in tract size. The next most important factor is the cost of financing the purchase. As interest rates rise, tract size falls. Although they are not significant, the coefficients on both of the other variables are logical. As the number of sales fell, the tract size would rise. Meanwhile, as the price per acre rises, the tract size falls.

TABLE 1
MULTIPLE REGRESSION MODEL 1: TRACT SIZE STATISTICS

R Square	0.66	
Adjusted R Square	0.40	
Observations	10	
	<i>Coefficients</i>	<i>t Stat</i>
POP	-824.23	2.54
INTRATE	-105.83	-2.23
SALE	-0.16	-0.56
PPA	-1.46	-0.93

Sales Volume Analysis

The second regression, Equation 2, considers the volume of sales as the dependent variable. Once again, the findings are highly significant. In fact, the coefficient of determination, after adjusting for the limited sample, is over ninety percent. Once again, we observe the hypothesized inverse relationship between tract size and the number of sales. However, once again, the term is not significant. We also find that population and interest rates are not significant variables. An increase in interest rates is correlated with a lower tract size being in demand and sold since fewer people can afford the price. Population isn't a big indicator, therefore making it not as relevant in this regression as well. This finding makes sense in that it is not the number of Texas residents, but the number of residents who can afford to purchase the tract for sale that is the critical factor. This ultimately reduces the number of sales. Instead, what is driving the regression equation's high level of significance is the price per acre, or PPA.

One might initially be concerned about the positive relationship between land prices and the number of sales. However, this would likely be the case in an environment with high fragmentation. As the price goes up, large tracts will be priced beyond the buyer's means. They will have to focus on smaller tracts, which would increase the number of sales because large tracts will have to be broken up to make them affordable to buyers. Stated another way, the higher price is driving the land's cost above the amount that purchasers can pay. This indicates a demand for land regardless and that the number of sales driving the price higher is making the real estate market a "seller's market".

TABLE 2
MULTIPLE REGRESSION MODEL 2: VOLUME OF SALES STATISTICS

Multiple R	0.97	
Adjusted R Square	0.90	
Observations	10	
	<i>Coefficients</i>	<i>t Stat</i>
PPA	18.02	2.39
TS	-0.90	-0.93
POP	-1443.41	-1.38
INTRATE	-562.72	-1.48

CONCLUSION

One conclusion that can be drawn from this study is that different factors are driving tract sizes and land sale frequencies in Texas. Population increases are forcing tract to be smaller and smaller, especially if interest rates are high. Though insignificant, we observed that as the price per acre goes up, the tract size will go down; there is a negative correlation. This means fewer people can afford larger tracts since they would be priced higher which causes the focus to be on the smaller tracts being sold even if they are pricier on a per acre basis than the larger parcels. What this also means is that those who are selling large tracts of land are more likely to sell it in multiple tracts, which is also known as fragmentation. Since people aren't buying large acreage, the multiple tracts being sold for higher-than-average prices means the seller is making a generous profit while keeping the market hot. Price per acre drives the number of sales.

Overall, price matters when both selling and purchasing land. In terms of the COVID-19 pandemic, we found that there was a significant increase in sales. The price per acre has also increased; however, the average tract size dipped compared to previous years. This could indicate that the COVID-19 pandemic was a contributing factor of increased land fragmentation. However, we only have a single year on which to base observations and hence any generalization to subsequent years must be done with great caution.

Further studies could examine these findings in terms of their generalizability across more years. One could also compare Texas to other regions of the country. Geographic expansion could also allow for comparisons of regions with rapid and slower population growth.

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