Housing Prices and Wildfires in Texarkana

DATA512 Final Report | John Michael | December 11, 2023

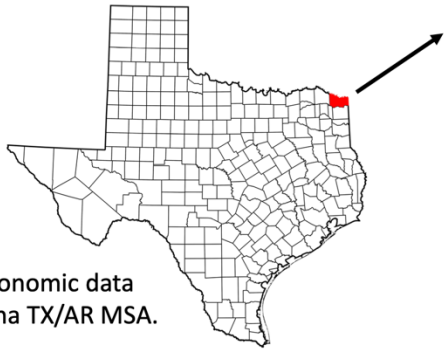
Introduction

Wildfires can disrupt the housing market of a city beyond just causing damage to properties. For example, sustained bad air quality due to wildfire smoke can decrease demand for single-family homes in a city. Displaced homeowners who lost their homes to wildfires can affect rental prices of a city due to a surge in demand[1]. All that is to say - while we can estimate the direct cost of wildfire damage to homes, the long-term effects of wildfires in an economy are more difficult to estimate.

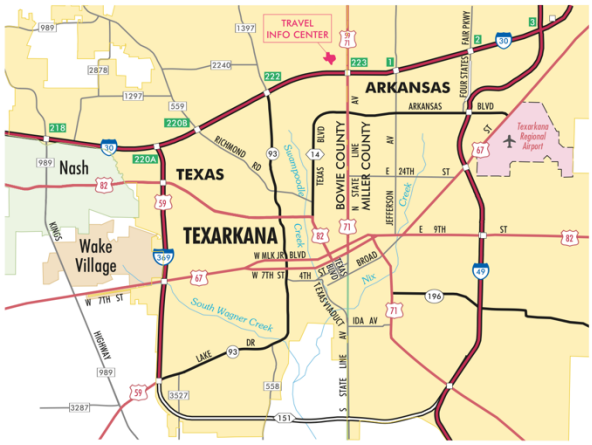
In cities such as Texarkana, TX, where wildfires are a relatively low risk[2], it is easy to be complacent with the impact of wildfires. However, the wildfire risk of Texarkana can worsen in the coming decades with climate change. In this report, I attempt to determine if wildfires have a significant impact on the Texarkana housing market, and outline steps that the city can take to protect the housing market from wildfire risk in the future.

Figure 1: Texarkana at a Glance

Population: 36,193
County: Bowie, TX
Area: 29,47 sq mi
Elevation: 299 ft
Industries: defense, healthcare, education, retail



*Analysis uses economic data from the Texarkana TX/AR MSA.



Sources: Avenza, Wikipedia

[1] CoreLogic, "The Impact of Wildfires on Rent & Home Prices", September 3, 2021, https://www.corelogic.com/intelligence/the-impact-of-wildfires-on-rent-home-prices/.
[2] Federal Emergency Management Agency (FEMA), "National Wildfire Risk Map", available at https://hazards.fema.gov/nri/map.

Background

Mueller et al. (2009)[3] found that repeated wildfires had a significant impact on housing sale price even though the wildfires were seasonal. The authors detail a market failure in which homebuyers displayed economic behavior that suggests that they repeatedly failed to assess the wildfire risk of properties. I use this paper as a motivation to the research question – can I determine a similar impact on Texarkana housing market where wildfires are a lower risk?

The wildfire data I use to help answer this question comes from the United States Geological Survey (USGS). This dataset contains polygon data for wildfires in the US from the 1800s to 2020. It also contains information such as the wildfire type and acres burned[4]. I use this dataset to create an estimate of the wildfire smoke impact that accounts for the distance of the wildfire to the city, the acres burned as well as the wildfire type. I filter the USGS wildfire dataset to fires that occurred after 1962 within 1,250 miles of the city of Texarkana.

Figure 2: Distribution of Wildfire Distances to Texarkana (1963-2020)

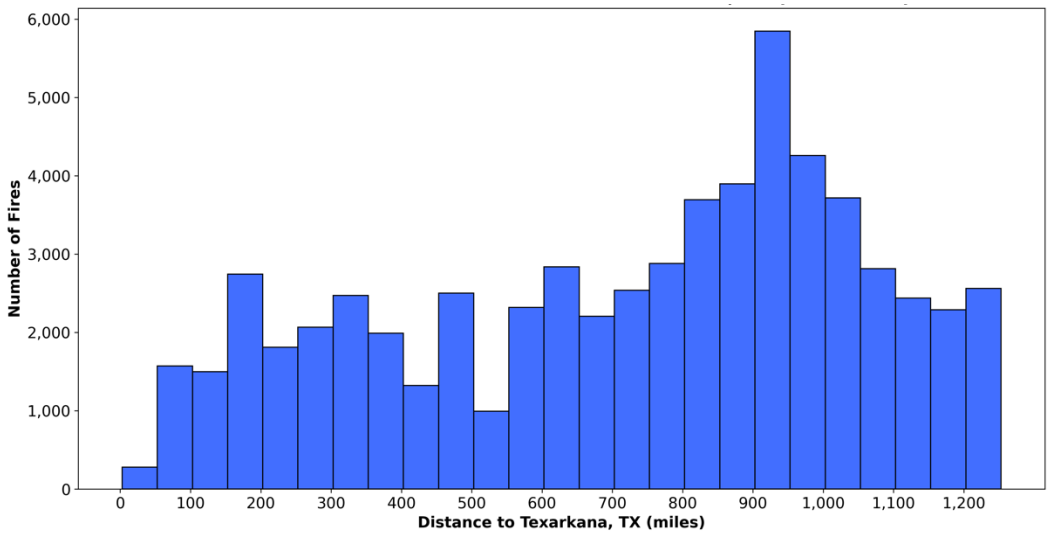


Figure *2* shows the distribution of distances to Texarkana of wildfires that occurred post-1962. We observe that the most frequent distance is in the 900-to-1,000-mile range. However, there are still quite a few fires that are within 400 miles of the city.

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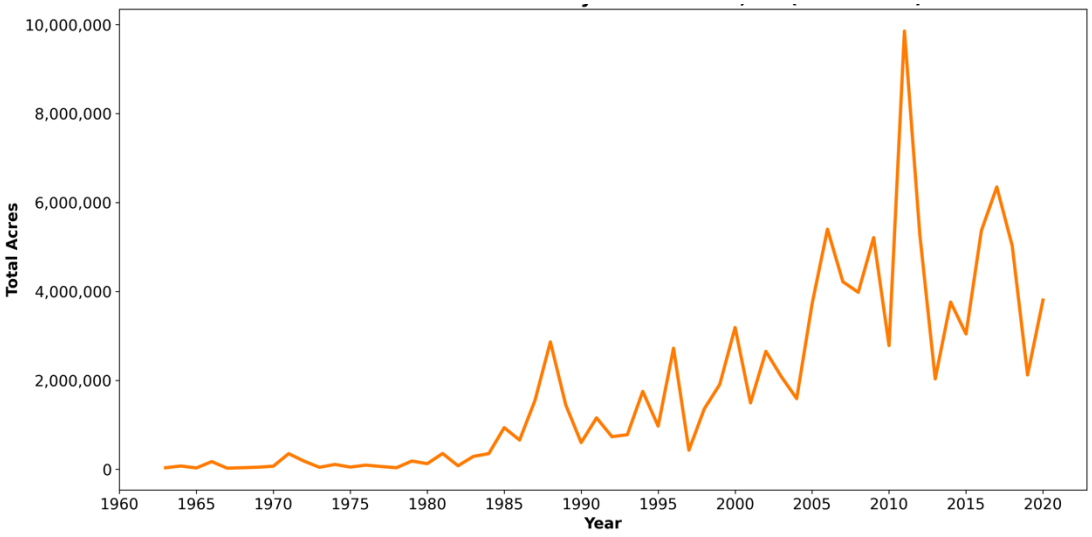
[3] Julie Mueller, John Loomis, Armando Gonzalez-Caban, "Do Repeated Wildfires Change Homebuyers' Demand for Homes in High-Risk Areas? A Hedonic Analysis of the Short and Long-Term Effects of Repeated Wildfires on House Prices in Southern California", The Journal of Real Estate Finance and Economics, 38, 155-172 (2009), https://link.springer.com/article/10.1007/s11146-007-9083-1.

[4] USGS, "Combined wildland fire datasets for the United States and certain territories, 1800s -Present (combined wildland fire polygons)", December 8, 2021, https://www.sciencebase.gov/catalog/item/61aa537dd34eb622f699df81.

Figure 3: Total Acres Burned Annually (1963-2020)



Note: Acres burned by wildfires within 1,250 miles of Texarkana.

Figure *3* shows the total acreage burned by wildfires that occurred within 1,250 miles of Texarkana. We observe a 3-5 cycle in the acreage burned, indicating a 3-5 seasonality. The peak in 2011 is due to the 2011 Texas Wildfires that damaged nearly 3,000 homes and caused an economic loss of over $3 billion[5].

To assess the validity of my smoke estimates, I use air quality data from the United States Environmental Protection Agency (EPA). The EPA hosts an API called the Air Quality Service (AQS) which has air quality index (AQI) from air quality monitoring stations throughout the United States[6].

For the regression model, I use data from the Federal Reserve Economic Data (FRED). Specifically, I use the housing price index (HPI)[7], real gross domestic product (GDP) in 2012 US dollars[8] and resident population[9] data that encompasses the Texarkana metropolitan statistical area that covers the twin city of Texarkana. The twin city of Texarkana has parts in both Texas and Arkansas.

[5] Wikipedia, "2011 Texas Wildfires", https://en.wikipedia.org/wiki/2011_Texas_wildfires.
[6] EPA, "Air Quality System (AQS) API", https://aqs.epa.gov/aqsweb/documents/data_api.html.
[7] FRED, "All-Transactions House Price Index for Texarkana, TX-Texarkana, AR (MSA)", available at https://fred.stlouisfed.org/series/ATNHPIUS45500Q.
[8] FRED, "Total Real Gross Domestic Product for Texarkana, TX-AR (MSA)", available at https://fred.stlouisfed.org/series/RGMP45500.
[9] FRED, "Resident Population in Texarkana, TX-Texarkana, AR (MSA)", available at https://fred.stlouisfed.org/series/TEXPOP.

Methodology

I define my wildfire smoke impact as:

$$SmokeImpact = \frac{AcresBurned}{Distance^2} + WildfireType^2$$

The smoke impact increases as acres burned increases and decreases as distance to the city increases. The formula considers wildfire type because prescribed wildfires are generally more controlled and less intense than naturally occurring wildfires.

I apply this formula to each wildfire in the dataset to assign each wildfire a smoke index. I then aggregate this data to an annual by taking a simple average in each year to obtain annual estimates of smoke index.

Figure 4: Smoke Index vs AQI in Texarkana (1999-2020)

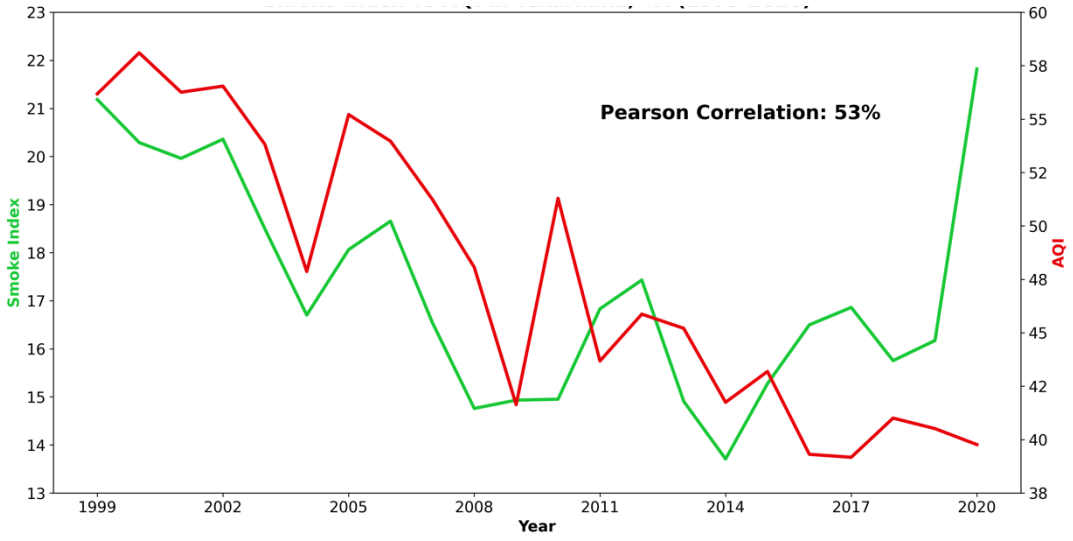


Figure *4* shows how my annual smoke index compares with the AQI in Texarkana from 1999 to 2020. I find a Pearson correlation of 53%. The AQI shown in the figure is the average daily AQI during the fire season that runs from May to October every year.

To determine the effect of the smoke index on the housing prices in Texarkana, I create a regression model with the following specification:

$$HPI = \beta_0 + \beta_1 SmokeIndex + \beta_2 Year + \beta_3 RealGDP + \beta_4 Pop$$

The year is a binary from 0 to the last year of the data. The presence of the year variable serves the purpose of controlling for temporal effects in the data. Real GDP and population are in the model to account for economic growth. Accounting for economic growth here is important

because we need to account for how the individual wealth of Texarkana people changes over time. I run ordinary least squares regression using the model above on 20 years of data from 2001 to 2020.

Findings

Figure 5: OLS Regression Results

Dep. Variable:	hpi	**R-squared:**	0.990
Model:	OLS	**Adj. R-squared:**	0.988
Method:	Least Squares	**F-statistic:**	380.7
Date:	Fri, 08 Dec 2023	**Prob (F-statistic):**	7.00e-15
Time:	18:31:52	**Log-Likelihood:**	-42.017
No. Observations:	20	**AIC:**	94.03
Df Residuals:	15	**BIC:**	99.01
Df Model:	4		
Covariance Type:	nonrobust		

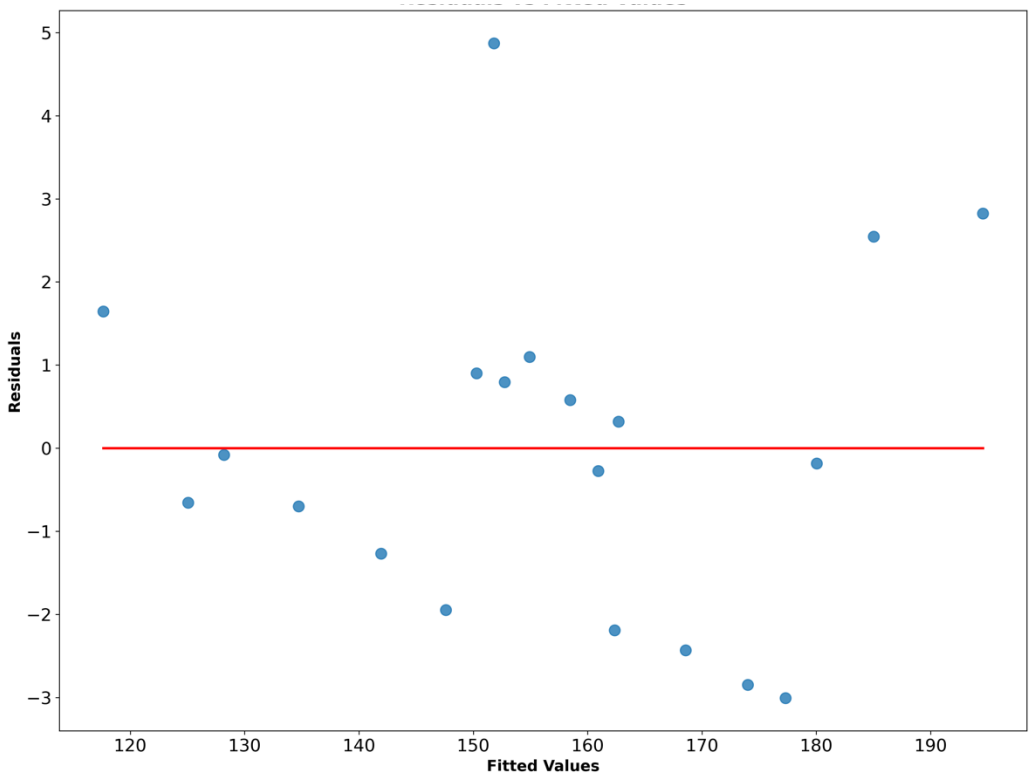
	coef	**std err**	**t**	**P>|t|**	**[0.025**	**0.975]**
const	-8405.3282	395.395	-21.258	0.000	-9248.092	-7562.564
smoke_index	0.8595	0.316	2.718	0.016	0.185	1.534
year	4.2539	0.205	20.703	0.000	3.816	4.692
real_gdp	0.0171	0.003	6.366	0.000	0.011	0.023
pop	-0.6439	0.150	-4.285	0.001	-0.964	-0.324

Omnibus:	1.475	**Durbin-Watson:**	1.056
Prob(Omnibus):	0.478	**Jarque-Bera (JB):**	0.822
Skew:	0.496	**Prob(JB):**	0.663
Kurtosis:	2.944	**Cond. No.**	4.20e+06

The regression results in Figure *5* show that if we control for time and economic growth, there is a statistically significant relationship between the smoke index and the housing price index (HPI). While the coefficient of 0.8595 is difficult to interpret, this is nonetheless a significant result that is indicative of wildfire impact on the Texarkana housing market. In other words, we have evidence that even in a city with low wildfire risk such as Texarkana, the effects of wildfires in surrounding regions does in fact influence the city's housing market. Figure *6* shows that the

linearity assumption of ordinary least squares is largely satisfied with the data I use, barring a few outliers.

Figure 6: Residuals vs Fitted Values



Implications

My findings provide evidence that wildfires do have an impact on the housing market of the twin city of Texarkana, despite the city being a low risk for wildfires historically. The wildfire risk profile of the city would also likely change due to climate change in the coming years. As a result, it is imperative that policymakers of Texarkana get ahead of the wildfire issue before too late.

An example of how the city can help mitigate the risk of wildfires in the future is by establishing wildfire risk awareness campaigns specific to the housing market. The state of Colorado initiated such a program in 2022[10] by providing a free wildfire inspection service for properties.

[10] Yale Climate Connections, "Colorado program helps homeowners reduce wildfire risk", September 14, 2022, https://yaleclimateconnections.org/2022/09/colorado-program-helps-homeowners-reduce-wildfire-risk/.

Limitations

One way in which the regression model above could improve is if it used other economic factors such as median household income and unemployment rate instead of GDP. GDP measures the economic output of a place, but this does not necessarily tie well to the individual wealth of people living in that place. For example, a country can have a very high GDP, but its citizens can have low per capita income due to issues such as inequality.

Another limitation of the model above is the lack of topography or weather variables. Both topography and weather are important predictors of how wildfires spread[11]. Including topography and weather data should improve the accuracy of the model above.

Additionally, the data used in the model only covers 20 years. Having access to more years of data should further validate the findings of the model.

Conclusions

Through a regression model, I find that wildfires do have a statistically significant effect on the Texarkana housing market. With climate change, the risk of wildfires can change and become more unpredictable. Policymakers can help mitigate the risk of wildfires and protect the housing market of Texarkana by establishing wildfire risk awareness campaigns catered to homebuyers and homeowners.

References

CoreLogic, "The Impact of Wildfires on Rent & Home Prices", September 3, 2021, https://www.corelogic.com/intelligence/the-impact-of-wildfires-on-rent-home-prices/.

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Wikipedia, "2011 Texas Wildfires", https://en.wikipedia.org/wiki/2011_Texas_wildfires.

[11] Andrew Moore, "Explainer: How Wildfires Start and Spread", NC State University College of Natural Resources News, December 3, 2021, https://cnr.ncsu.edu/news/2021/12/explainer-how-wildfires-start-and-spread/.

Yale Climate Connections, “Colorado program helps homeowners reduce wildfire risk”, September 14, 2022, https://yaleclimateconnections.org/2022/09/colorado-program-helps-homeowners-reduce-wildfire-risk/.

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Data Sources

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FRED, “Resident Population in Texarkana, TX-Texarkana, AR (MSA)”, available at https://fred.stlouisfed.org/series/TEXPOP.