Real Estate Market Response to Enhanced Building Codes in Moore, OK

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Abstract

Moore, OK, suffered 3 violent tornadoes from 1999-2013, the most recent causing $3 billion in damage and 24 fatalities. In response the city took the rare step of enhancing their building code based on wind engineering principles. To meet the new code, the Moore Association of Home Builders estimated an added cost of $1.00 per square foot but realized costs are closer to $2.00. Economic theory suggests that an isolated regulatory action will shift production to areas without the added cost, reducing quantity supplied of homes in Moore and potentially driving up price. We use a difference in difference regression model to compare the effect of the new code using Multiple Listing Services (MLS) data from Moore and an adjoining town, Norman, to examine the market impact of the new code. Our result show the code had no effect on either home sales or price per square foot for new homes in Moore.

JEL Code: L74, R31

Section A - Introduction

On May 20, 2013, the city of Moore, OK experienced its third violent tornado in 14 years resulting in over $3 billion in damage, of which $1.8 was insured (Swiss RE, 2014). In addition to the financial losses, 24 fatalities occurred including 7 children at Plaza Towers Elementary School. An additional 212 were injured (Storm Prediction Center, 2014). Eleven days later, May 31, another tornado struck in nearby El Reno. This tornado reached the maximum width ever recorded, over two miles. Fatalities from the El Reno tornado were 8, all in vehicles, as it crossed Interstate 40.[1] While the May 31 tornado did not occur in Moore, it was near enough to be a further reminder of the vulnerability central Oklahoma faces from these storms. In April 2014, the city responded by adopting the strongest building code for wind hazards in the nation becoming the only municipality to take such an action (City of Moore, 2014; Ramseyer et al., 2014). The new code required the use of oriented strand board (OSB) for exterior sheathing, narrowing spacing of roof joists, hurricane straps to secure the roof to the exterior wall, and wind rated garage doors. These changes increase the wind design standard from 90 to 135 miles per hour, sufficient to withstand up to an EF-2 tornado without collapse of the structure. Estimates by consulting engineers and the Moore Association of Home Builders expected construction costs to increase by $1 per square foot (Cannon, 2014) (Hampton, 2014) (Ramseyer, 2014). Actual costs, are closer to $2 per square foot with some builders reporting $2.50 per square foot plus $400 for the wind rated garage door.[2] No other city in OK followed Moore's lead, making this a natural experiment testing how real estate markets respond to an isolated regulatory action which increases production cost. Economic theory suggests such an action would decrease supply of new housing in Moore

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[1] http://www.spc.noaa.gov/climo/torn/fatalmap.php#

[2] http://www.dallasnews.com/news/news/2016/02/21/experts-urge-hig111111her-costlier-building-standards-in-aftermath-of-tornado

as producers shift production to cities with less regulation lowering quantity supplied and driving up price in Moore.

The remainder of the paper will be organized as follows, Section B will provide an overview of wind resistant building codes, Section C will describe data used for analysis, Section D will discuss the analytical methodology followed by Section E which will describe our statistical model. Section F will place the results from our statistical model within the analytical framework and Section G will discuss the results. Finally, Section H will conclude the paper and identify areas for additional research.

Section B - Review of Literature of Enhanced Windstorm Building Standards

Wind Engineering Design

Hurricane Andrew struck south Florida in August of 1992 causing over $26 billion (inflation adjusted) in insured losses and leaving 11 insurance companies insolvent as a result. More than 25,000 homes were destroyed and an additional 100,000 damaged (Fronstin and Holtmann, 1994). Post storm inspections discovered that construction practices which had been in place during the 1980's contributed to the large losses (Fronstin and Holtmann, 1994; Sparks et al, 1992; Keith and Rose, 1994). The hurricane prompted a move to design and construct homes that can withstand the pressures of a major wind storm using wind engineering principles. The objective is to keep the roof attached to the exterior walls, ensure good connections at the foundation and prevent flying debris from penetrating openings. To accomplish this, anchors are required to bolt the exterior wall's baseplate to the foundation, hurricane straps to attach the roof joists to the exterior wall and impact resistant glass or shutters to protect windows and doors. Additionally, a rigid material such as Oriented Strand Board (OSB) are used for the exterior wall sheathing providing added strength to the walls.

In response, to Hurricane Andrew the state of Florida began a review of its building code which led to adoption of the Florida Building Code (FBC), fully enacted in 2002, based on wind engineering principles (Dixon, 2009). In 2004, Florida was struck by Hurricane Charley, a Category 4 hurricane based on the Saffir Simpson scale. Inspections after the hurricane revealed that post FBC homes suffered 42% fewer losses and had 60% fewer claims (IBHS, 2004) providing the first validation of the effectiveness of building codes designed to withstand windstorms.

Economic Considerations

That stronger construction reduces loss from windstorms should not be a surprise but the test of good policy is whether the reduction in loss exceeds the additional cost to comply with the new code. Two recent studies, (Simmons et al, 2015; Simmons et al, 2017) provide a Benefit/Cost analysis (BCA) that enhanced codes do provide benefits exceeding implementation cost in regions susceptible to windstorm damage. Simmons et al, 2015 finds a 3 to 1 BCA for the local Moore, OK code while Simmons et al, 2017 finds a BCA for the statewide FBC of 5 to 1. From a public policy point of view, there is strong evidence that adoption of stronger building codes is a good decision.

Implementing a strict building code is not the only way to increase a community's resilience in the face of violent wind storms. Stronger construction does not have to come about solely by decree. Homeowners can, and do, voluntarily construct homes that exceed local codes. And in areas where windstorms are common, the reward for exceeding local codes can be found in higher resell prices. There exists evidence that code plus construction increases the selling price of homes in a similar way to remodeling a kitchen or bath. Homes on Galveston Island that had hurricane shutters sold at a premium (Simmons et al, 2002) and homes built in South Florida after the stricter 1994 South Florida Building Code was enacted sold at a premium, particularly after the high hurricane years of 2004/2005 (Dumm et al, 2011). One challenge for this trend is the ability to identify homes that have wind mitigation features since many of these features are "behind the walls". One existing program that could be used for this purpose is the FORTIFIED Home™ program of the Insurance Institute for Business and Home Safety.[3] A more recent study documenting the market impact of code plus construction was conducted by the University of Alabama and found that homes built to the FORTIFIED Home™ standard sold for a premium of 6.8%.[4]

Political Considerations

Despite the economic case for stronger construction, the homebuilding industry has been reluctant to embrace wind resistant features. The National Home Builders Association blocked recommendations for wind worthy construction by the American Society of Civil Engineers to the International Code Council in April 2016.[5] This reluctance to adopt higher standards places municipalities, who ultimately determine their local building codes, between two powerful business lobbies, the home building industry who want lower costs and the property insurance industry who want increased resilience. Most communities desire and encourage growth. New subdivisions bring new residents, more tax revenue and the commercial development that follows the growth. Adopting standards that raise production cost may send new development to neighboring towns willing to maintain lower standards.

It is often the case that jurisdictions only enhance their building codes after a tragic event places the issue in stark terms. The state of Florida did not adopt their statewide code for wind until after Hurricane Andrew, one of the largest disasters in the state's history. And Moore did not

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[3] https://disastersafety.org/fortified/fortified-home/
[4] http://ww1.prweb.com/prfiles/2016/08/30/13648417/FORTIFIEDReport_V2-2.pdf
[5] https://www.bloomberg.com/view/articles/2016-07-06/inside-the-lobby-against-tougher-homes

adopt their local code until after the third violent tornado struck in less than 15 years. Further, the tragic loss of 7 children at Plaza Towers Elementary School added the raw emotion that is often necessary for municipalities to resist the political pressure and adopt stricter codes. The objective of this paper is to determine if the decision by the city of Moore had the result many cities fear, that development is lost to neighboring cities.

Section C - Data

Data for the statistical model comes from eight sources, Multiple Listing Service (MLS) data provided by the Moore Board of Realtors and Norman Board of Realtors, new building permits from the cities of Moore and Norman plus macroeconomic data from the Bureau of Labor Statistics[6], Bureau of Economic Analysis[7] and mortgage interest rates from Federal Home Loan Mortgage Corporation.[8] The dominant industry in Oklahoma is the extraction of oil and natural gas so we also use the benchmark price of crude oil, West Texas Intermediate (WTI) from the U.S. Energy Information Administration.[9] MLS data provided transactions for both new and older homes from 2012-2015 providing for each sale, the square feet, number of bedrooms, bathrooms and year built. Macroeconomic data for the state of Oklahoma includes the unemployment rate and state level GDP as well as the consumer price index.

Both Moore and Norman reside in Cleveland County at the southern end of the Oklahoma City metropolitan area. Moore lies between Oklahoma City (OKC) to its north and Norman to its south and is immediately adjacent to both. Within the OKC metro area, the more affluent communities are to the north of downtown OKC including the suburbs of Nickols Hills and Edmond. Southern cities, including Moore had, until recently, a greater percentage of moderately

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[6] http://www.bls.gov/data/
[7] http://www.bea.gov/regional/histdata/releases/0616qgsp/index.cfm
[8]http://www.freddiemac.com/pmms/pmms30.htm
[9]http://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=rwtc&f=M

priced real estate. Norman is home to the University of Oklahoma and mirrors more closely the northern suburbs of the OKC metro than Moore and southern Oklahoma County.

Figure 1 shows state real GDP for Oklahoma and the price of its primary commodity, oil for 2009-2015. Increasing oil prices helped the economy of Oklahoma maintain a steady and improving trend as the number of operating rigs increased.[10] But oil prices began falling in 2014 and caused the state to fall into recession by the end of 2015.

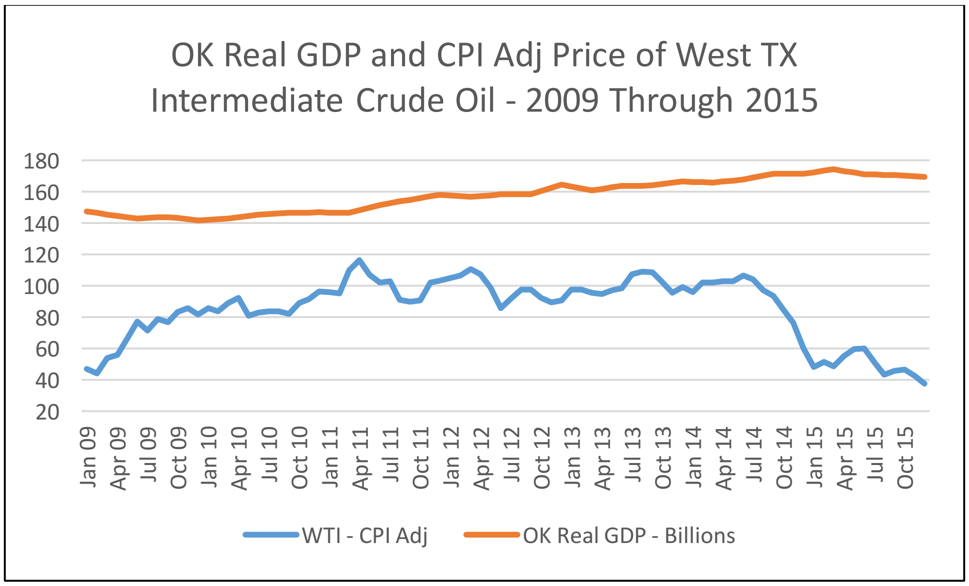

Figure 1 – OK Real GDP and WTI

This improvement in the Oklahoma economy from 2009 brought more upscale housing to Moore, though the average price per square foot (inflation adjusted) continued to be lower than its neighbor, Norman as can be seen in Figure 2.

10 http://oklahomaminerals.com/rig-count-september-2-2016/

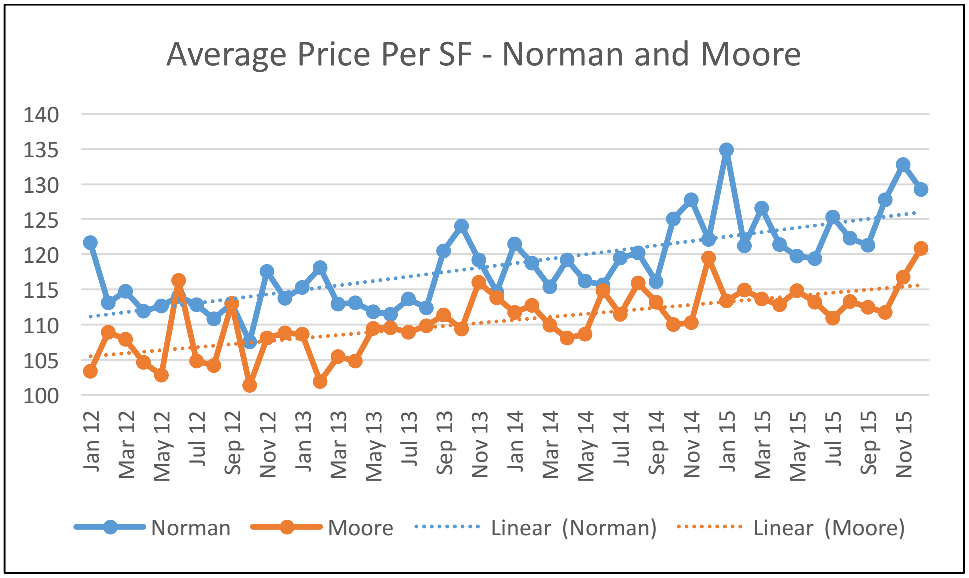

Figure 2 – Avg Price Per Square Foot – New Home Sales

Figure 2 also shows the increasing cost for housing in both Norman and Moore as the economy continued to expand. But in the latter half of 2015, real GDP in Oklahoma began to decline[11] moderating the price of housing in both Norman and Moore.

Figure 3 shows monthly sales for new homes in both Norman and Moore from 2012-2015. Month to month changes in sales can experience notable volatility but generally annual sales remain steady though showing a decline for both towns reflecting the effect of declining oil prices on Oklahoma's economy.[12]

[11] https://www.ok.gov/oesc_web/documents/lmiEconIndPub.pdf
[12] We removed the Moore building permits related to rebuilding damaged homes from the May 2013 tornado.

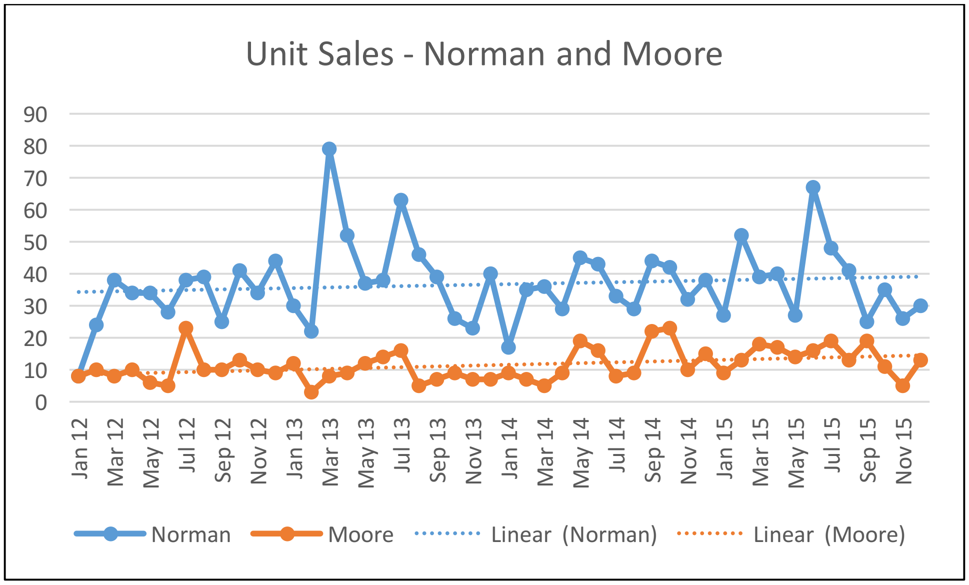

Figure 3 – Monthly New Single Family Sales

Section D - Difference in Difference Analysis

Difference in Difference (D-I-D) analysis provides a way to examine how a treatment, in our case the new Moore Building code, affects a response variable, in our case price per square foot and quantity of residential real estate. Early use of the procedure includes the effect of training programs on earnings (Ashenfelter and Card, 1985) and notably the effect on employment after an increase in the state minimum wage in New Jersey compared to Pennsylvania, which did not increase its state minimum wage (Card and Krueger, 1994).

Using a D-I-D approach allows the researcher to view the pre and post treatment effect compared to the expected change without treatment. Consider a hypothetical illustration in Figure 4. The black line represents the change from before and after treatment for the control group. The orange line shows the expected change for the treatment group if no treatment occurred and is a parallel shift from the control group line. Finally, the blue line shows the actual change for the treatment group from before and after treatment. A statistical test is then performed to determine if the difference between the expected effect without treatment differs from the realized effect, after treatment. When a regression approach is used the changes shown on the graph of the explanatory variables necessary to perform a D-I-D analysis are apparent through the coefficients of dummy variables for the difference between pre and post treatment, the difference between the control and treatment group and an interaction term reflecting the effects of both dummy variables.

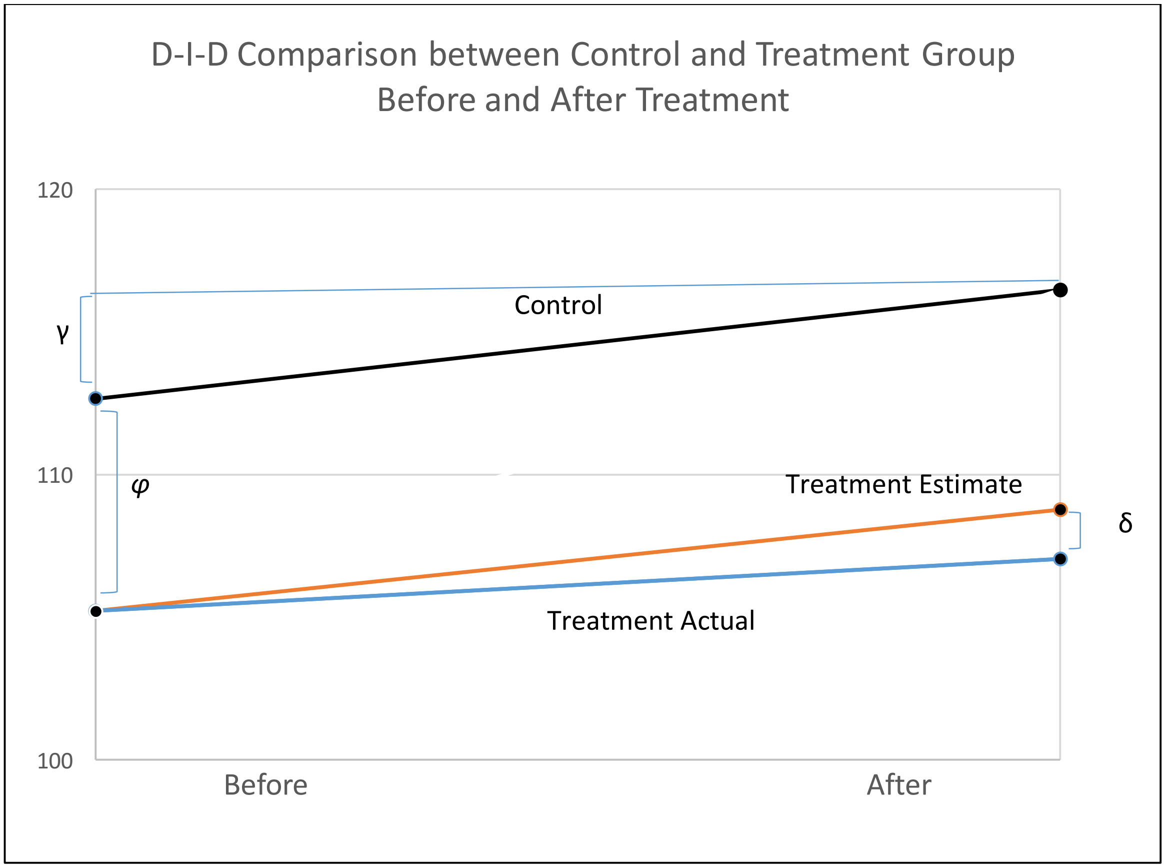

Figure 4

The following equation is used to create Figure 4:

$$Y = \beta_0 + \gamma D_1 + \varphi D_2 + \delta D_3 + Other\ Explanatory\ Variables + \varepsilon$$

The variables D_1 and D_2 are dummy variables and D_3 is the interaction between D_1 and D_2. To begin, the model intercept, β_0, forms the point on the Control line on the left axis. On the right axis, the point on the Control group line is found by adding β_0 and γ. The coefficient of D_1, γ, represents the effect of the treatment on both control group observations and treatment group observations while the coefficient of D_2, φ, represents the difference between the control and treatment groups and forms the left axis point for the treatment group. The point on the right axis for the treatment group is the sum of $\beta_{0,}$ γ and φ to form a parallel line (orange) from the Control (black) line. Finally, the blue line has the same left axis point as the orange line but its right axis point is the sum of $\beta_{0,}$ γ, φ and δ. The coefficient of D_3, δ, represents the interacted effect of the treatment and the difference between the control and treatment group and is our variable of interest where:

$$\delta = (\bar{y}_{b,2} - \bar{y}_{b,1}) - (\bar{y}_{a,2} - \bar{y}_{a,1})$$

$\bar{y}_{b,2}$ = average outcome for treatment group in time period 2,
$\bar{y}_{b,1}$ = average outcome for treatment group in time period 1,
$\bar{y}_{a,2}$ = average outcome for control group in time period 2,
$\bar{y}_{a,1}$ = average outcome for control group in time period 1. (Woolridge, 2006)

Section E - Statistical Models

Our purpose is to evaluate how price per square foot and sales changed after the implementation of the Moore building code. Further, we want to see if the change in price per square foot and weekly sales for Moore are significantly different than what occurred in Norman. The code was enacted in April 2014 so permits after March 2014 would be subject to the new standards. But sales for homes subject to the new code did not occur until December 16, 2014, making mid-December the effective date of the new code. Most homes permitted under the old code regime sold prior to the effective date. However, not all homes sell quickly and some homes in Moore, permitted prior to April 1, did not sell until after December 16. We matched those sales to the permit file to ensure that they were coded for the previous code regime.

Price Model

We first employ an ordinary least squares (OLS) model using price per square foot as the dependent variable. The model form for the price model is:

(1)

$$\textit{Price per Square Foot} = \beta_0 + \beta_1 \textit{Bedrooms} + \beta_2 \textit{Baths} + \beta_3 \textit{Low Market} + \beta_4 \textit{High Market} + \beta_5 \textit{Sales Surge} + \beta_6 \textit{Lagged Int Rate} + \beta_7 \textit{Lagged UR} + \gamma \textit{New Code} + \varphi \textit{Moore} + \delta \textit{Moore*New Code} + \varepsilon.$$

The dependent variable, price per square foot, is calculated for each sale as the closing price divided by the square feet of the home and CPI adjusted to 2015. Our explanatory variables fit into four categories; 1) variables related to an individual property; number of bedrooms, number of bathrooms, a dummy variable for homes where the closing price is in the lower 20% and a dummy variable for homes where the closing price is in the upper 20%, 2) a dummy variable for the high sales season of May through September, 3) macroeconomic variables that impact demand for housing, mortgage interest rates lagged 2 months and the state unemployment rate, lagged 2 months and 4) a dummy variable for implementation of the new Moore code, a dummy variable for Moore, and an interaction term between the new code dummy and Moore dummy,

Table 1

	OLS			GARCH		
Parameter	**Estimate**	**Std Error**	**Pr > [t]**	**Estimate**	**Std Error**	**Pr > [t]**
Intercept	121.2411	5.5904	***	123.7353	6.3721	***
Beds	-3.1592	0.5663	***	-3.5238	0.7382	***
Baths	6.2819	1.1435	***	5.1044	1.3506	***
low_mkt	-3.2352	0.5084	***	-3.6205	0.5646	***
hi_mkt	16.2058	0.9274	***	16.1313	1.1696	***
sales_surge	-1.562	0.444	***	-1.4955	0.6274	**
lag_int	2.0765	0.7335	***	2.1028	0.8887	**
lag_ur	-3.5816	0.6154	***	-3.3966	0.7466	***
new_code	3.0351	0.8279	***	3.4267	1.3139	***
Moore	-7.4938	0.5627	***	-7.2921	0.6763	***
Moore_New_Code	-1.4727	1.0952		-1.5547	1.5313	
Obs	2294			2294		
AIC	17486			17137		
Adj. R Squared	0.4557			0.4933		

The data spans 4 years and is a financial time series with price per square foot as the dependent variable. Since the price per square foot in the current month is influenced by the price paid for a similar home in the previous month, it is no surprise that the data suffers from autocorrelation. And a White test also indicates the presence of heteroskedasticity. So, in addition to an OLS model, shown in Table 1, we also utilize a generalized autoregressive conditional heteroskedasticity (GARCH) model which is also shown in Table 1.

Our explanatory variables perform as expected, an increase in bedrooms decreases price per square foot while an increase in the number of bathrooms increase it. Homes in Moore sell for a discount compared to Norman and the implementation of the Moore code shows an increase in price per square foot for both Norman and Moore. Homes in the lower end of the market sell for less per square foot and homes in the upper end sell for more indicating the market value of extra amenities for the higher end of the market compared to the lower. During the high sales months, price per square foot declines reflecting increased competition among builders. Higher mortgage interest rates show a positive effect on price, which at first seems counter intuitive, but may reflect buyers wanting to hurry a sale before interest rates increase further. Finally, we see the effect that the change in unemployment has on price. As the economy suffers and unemployment goes up, the housing market reacts with lower prices per square foot. The implementation of the Moore code shows an increase in price per square foot for both Norman and Moore while homes in Moore sell for a discount compared to Norman. The interaction variable between the Moore dummy and the New code dummy is negative and fails to attain significance. This variable will play a key role in our D-I-D analysis in the next section.

To test the robustness of our explanatory variables we run 3 models with the GARCH specification, first a regression with the basic market variables only, then we add the seasonal sales effect and finally, we add the macroeconomic variables. Results are shown in Table 2.

Table 2

Parameter	Estimate	Std Error	Pr > [t]	Estimate	Std Error	Pr > [t]	Estimate	Std Error	Pr > [t]
Intercept	113.9594	3.2431	***	114.4683	3.2937	***	123.7353	6.3721	***
Basic Market Variables									
Beds	-3.4662	0.7116	***	-3.4388	0.7025	***	-3.5238	0.7382	***
Baths	5.1587	1.3395	***	5.152	1.3355	***	5.1044	1.3506	***
low_mkt	-3.8575	0.5745	***	-3.8786	0.5765	***	-3.6205	0.5646	***
hi_mkt	16.3621	1.1783	***	16.3514	1.168	***	16.1313	1.1696	***
new_code	5.7458	1.1833	***	5.7452	1.1893	***	3.4267	1.3139	***
Moore	-7.0327	0.6978	***	-6.9782	0.6963	***	-7.2921	0.6763	***
Moore_New_Code	-1.8807	1.507		-1.9478	1.5271		-1.5547	1.5313	
High Season									
sales_surge				-1.0683	0.6353	*	-1.4955	0.6274	**
Macro-Economic Effects									
lag_int							2.1028	0.8887	***
lag_ur							-3.3966	0.7466	***
Obs	2294			2294			2294		
AIC	17169			17167			17137		
Total R Squared	0.4865			0.4874			0.4933		

The coefficients on most explanatory variables change little as we add each category of variables indicating the results are robust and stable while coefficients on the New Code and the Interaction variable diminish in magnitude and significance when the macro-economic variables are added.

Unit Sales Model

To examine the potential effect the new Moore code may have on the quantity of new homes in Moore, we sum unit sales by week. In addition to the same dummy variables for the new code, Moore and the interaction between those dummies, we use a dummy variable for the high sales month of May through September and mortgage interest rates lagged 2 months and the state unemployment rate lagged 2 months. The model has the form:

$$Sales = \beta_0 + \beta_1 Sales\text{-}Surge + \beta_2 Int + \beta_3 Lagged\ UR + \gamma New\ Code + \varphi Moore + \delta Moore*New\ Code + \varepsilon. \quad (2)$$

Our sales model does not indicate the presence of autocorrelation but it does indicate heteroscedasticity so we report robust standard errors. Since we are evaluating the change in weekly aggregate sales instead of individual transactions we use the effective date of mid-December for the new Moore code.[13]

The high sales months of May-September shows an expected increase in weekly sales while an increase in mortgage rates shows a significant decrease in sales. This result differs from the price model where we saw an increase in interest rates increased price per square foot. Increasing interest rates may motivate serious buyers into a quicker decision, reducing their ability to pressure builders to lower price. But it may also discourage less motivated buyers from the market reducing overall sales. Lagged unemployment rate is negative and significant indicating that sales decrease with an increasing unemployment rate. The new code had almost no effect on unit sales in the combined market of Norman and Moore. But just as the price per square foot is lower in Moore than in Norman generally, the same is true for unit sales. Finally, the interaction between the new code and Moore is positive but does not attain significance.

[13] We ran an alternative specification that dropped any observation permitted prior to the new code but sold after the effective data before summing the sales by week. The coefficient for the Moore/New Code interaction variable also failed to attain significance and was somewhat lower in magnitude.

Table 3

Parameter	Estimate (OLS)	Robust Std Error (OLS)	Pr > [t] (OLS)
Intercept	20.45106	3.77018	***
sales_surge	0.80766	0.33934	**
lag_int	-1.84689	0.5951	***
lag_ur	-1.00947	0.4784	**
new_code	-0.71404	0.78249	
Moore	-5.71757	0.37779	***
Moore_New_Code	0.32789	0.75674	
Obs	392		
Adj. R Squared	0.4147		

Table 4

Parameter	Estimate	Robust Std Err	Pr > [t]	Estimate	Robust Std Err	Pr > [t]	Estimate	Robust Std Err	Pr > [t]
Intercept	8.47368	0.35513	***	8.05449	0.42906	***	20.45106	3.77018	***
Basic Market Variables									
new_code	0.30409	0.71844		0.32001	0.71497		-0.71404	0.78249	
Moore	-5.6901	0.38787	***	-5.7103	0.38299	***	-5.71757	0.37779	***
Moore_New_Code	0.29694	0.77109		0.33265	0.76435		0.32789	0.75674	
High Season									
sales_surge				0.80655	0.34708	**	0.80766	0.33934	**
Macro-Economic Effects									
lag_int							-1.84689	0.5951	***
lag_ur							-1.00947	0.4784	**
Obs	392			392			392		
Adj R Squared	0.395			0.4017			0.4147		

Table 4 tests our specification to see if alternative specifications alter significantly the coefficients. As with the price model, we begin with basic market variables, then add the seasonal effect and finally macro-economic variables. The new code dummy does change sign in the final specification but since it never attains significance has no impact on our finding. But we observe no change in either the magnitude or significance of our other variables of interest particularly the most important, the interaction between Moore and the new building code.

Section F - Difference in Difference Analysis for Moore

Using the results from the statistical models, we examine whether the change in price per square foot and weekly sales were affected by the Moore building code implemented in April of 2014. We use the template in Figure 4 but with coefficient values from our statistical models for both price per square foot and weekly sales.

Figure 5 shows this analysis for price per square foot. Coefficient values that form the graph come from the GARCH model in Table 1.

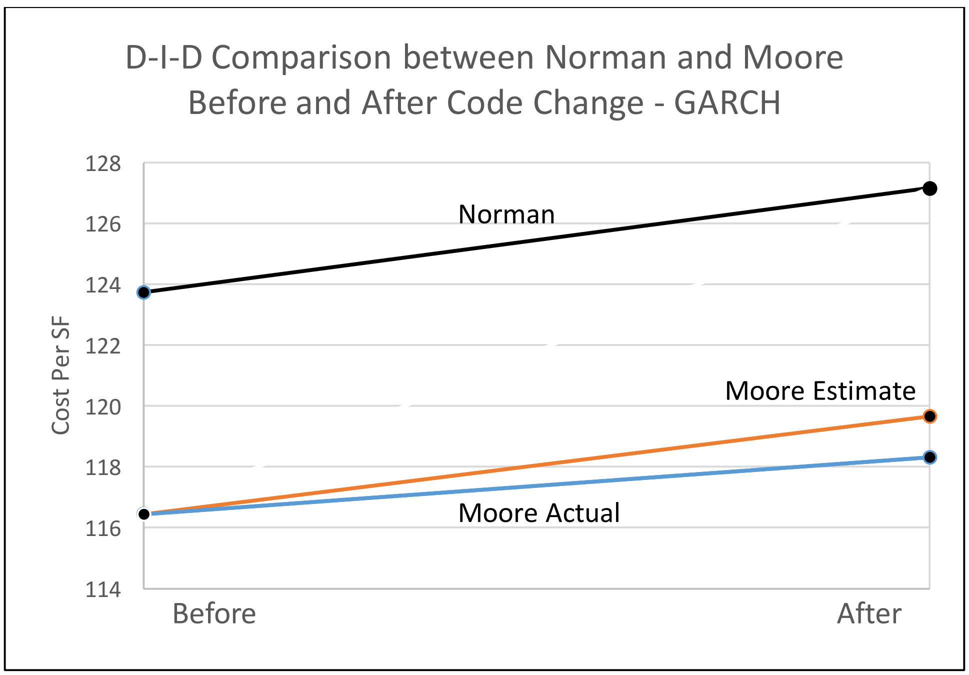

Figure 5

Our price per square foot D-I-D analysis begins with an intercept value of \$124 (β_0) per square foot shown as the point on the left axis for the Norman (black) line. After the implementation of the Moore code, price per square foot rises to just over \$127 ($\beta_0 + \gamma$) shown as the point on the right axis of the Norman line. Homes in Moore sold for a discount of \$7.29 per square foot compared to Norman so the point on the left axis for Moore is \$117 ($\beta_0 + \varphi$). The right axis point for Moore Estimate (orange line) is found by estimating what the price per square foot for Moore would be after the implementation of the code if it increased by the same percentage as Norman ($\beta_0 + \gamma + \varphi$). Actual change due to the new code for Moore is found on the blue line. The point on the left axis is the same as the orange line. But the point on the right axis is found by the sum of the coefficients of the intercept, D_1, D_2 and D_3 ($\beta_0 + \gamma + \varphi + \delta$).

There is a difference of \$1.55 between the expected price per square foot for Moore and the actual price per square foot. But, while D_3 is negative, it fails to attain significance so we fail to reject the null hypothesis that realized price per square foot equals the expected price per square foot.

A similar story is found when we examine what happened to weekly sales. Figure 6 shows the same analysis as Figure 5 except for sales.

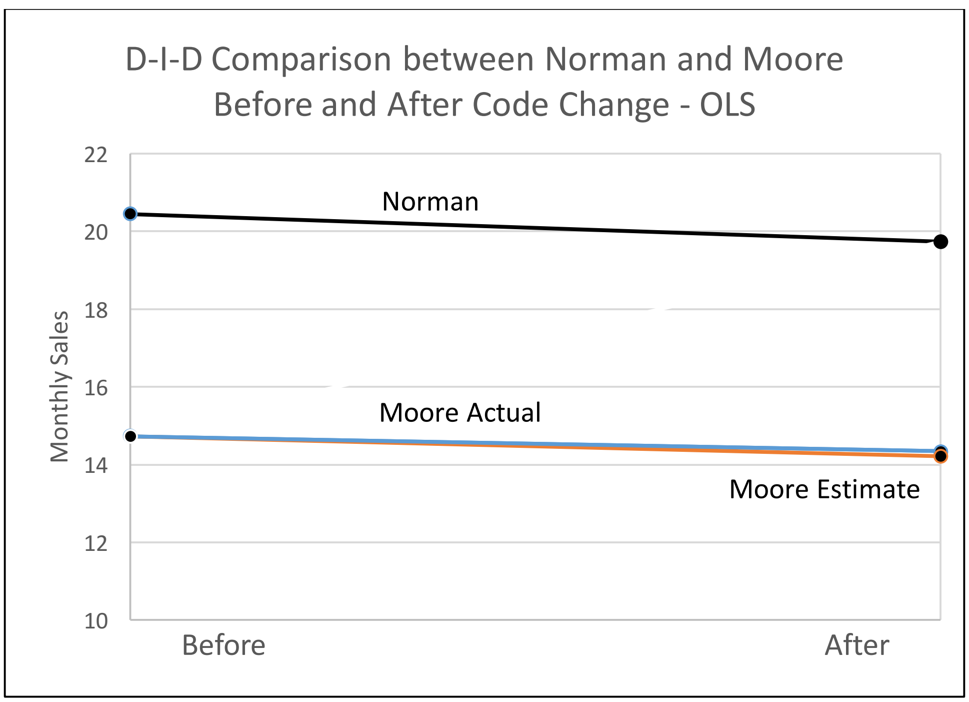

Figure 6

The number of weekly sales for Norman declines slightly from before the code change. Actual values of weekly sales for Moore is essentially unchanged from expected weekly sales, and fails to attain significance.

D-I-D Analysis of Permits

As a further test of the possible effect from the Moore code, we now look at permits instead of sales. Permits are a more direct reflection of the response to the code on the part of home builders. Further, we are able to add an additional year, 2016, to our data. This allows us to see if the failure of δ to obtain significance in either the price per square foot or sales model may have been due to a lag caused by builders having already made commitments on lots in the subdivisions of Moore. Also, it is an exact calculation of the implementation of the code since any permit in Moore taken after March 31, 2014 was subject to the new code. Finally, it is a view of the whole new home market in Moore and Norman since some builders do not list their homes with a realtor.

Figure 7 shows new home permits for Norman and Moore from 2012 through 2016.

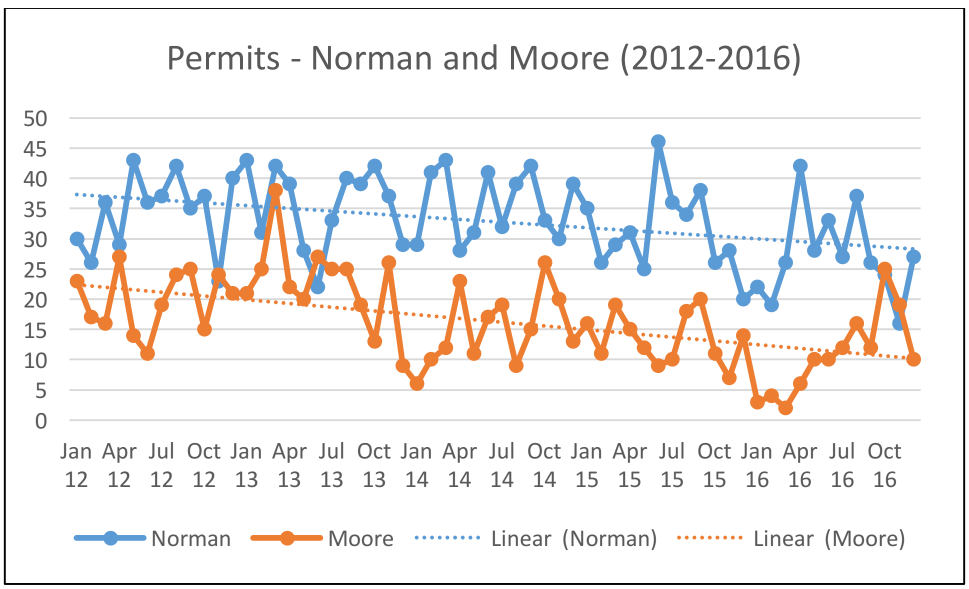

Figure 7

The effect on permits due to the state falling into recession in second quarter 2015 is evident in both Norman and Moore. But renewed optimism in the market can be seen beginning in January 2016 for Norman and Moore shortly after. The graph has a linear trend line for both Norman and Moore and appears to show little difference in trend for permits after the enactment of the Moore code.

We next run a similar regression model for permits that we ran for sales. Since builders alone decide whether or not to take out a permit different macro-economic variables are used. Instead of mortgage interest rates we use the 10 year constant maturity rate to reflect changes in the borrowing costs of homebuilders rather than home buyers. Next, we use the price of oil (WTI) instead of the lagged state unemployment rate as the decision to begin construction is forward looking and a rising price of oil would suggest to builders that the state's economy would likely be improving. The dependent variable is monthly permits and has the form:

$$Permits = \beta_0 + \beta_1 Permit\text{-}Surge + \beta_2 Int + \beta_3 Lagged\ UR + \gamma New\ Code + \varphi Moore + \delta Moore*New\ Code + \varepsilon. \quad (3)$$

Table 5 shows the result and Figure 8 shows the D-I-D graph.

Table 5

	OLS		
Parameter	**Estimate**	**Std Error**	**Pr > [t]**
Intercept	27.52733	3.15672	***
Int	-3.77398	1.63818	**
adj_wti	0.14934	0.02403	***
permit_surge	2.15624	1.11094	*
new_code	2.87537	1.65626	*
moore	-15.79487	1.44892	***
Moore_New_Code	-2.01465	2.1959	
Obs	120		
Adj. R Squared	0.6749		

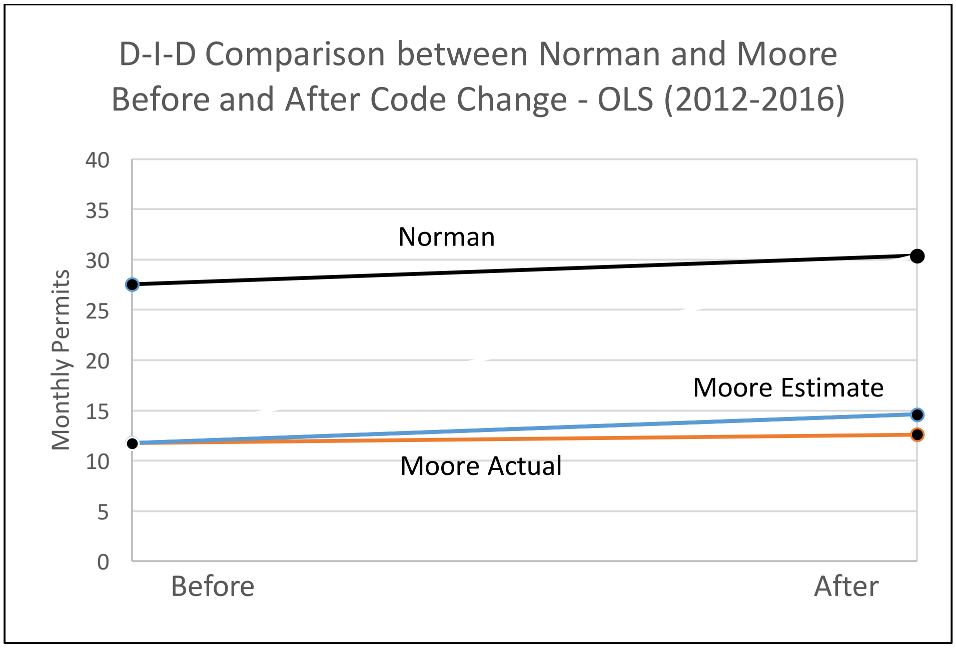

Figure 8

Once again, the interaction between the Moore and New Code dummies (δ) fails to attain significance. This provides verification of our results from the price and sales models showing a negligible effect of the Moore code.

Section G - Discussion

The enhanced Moore building code was adopted in the midst of an emotional reaction to two deadly tornadoes the year before including the deaths of 7 children at an elementary school. Given the raw tragedy of those events, it's not surprising that the community felt compelled to respond. One of the rare elements of this decision, was that it included positive input from the Moore Association of Home Builders, the very stakeholders normally opposed to changes to the code that would increase cost. But the decision was a risk, as economic theory would suggest that suppliers would leave Moore for neighboring towns with lower regulations. Yet, our study shows that the change to a stronger building code had no significant effect on either quantity sold, price or permits.

One possible reason for the fact that little changed in the market for new homes in Moore is the increase in cost (roughly $2.00 per square foot) was not large enough in percentage terms to radically effect the price of housing. New residential housing is a competitive business and firms compete with other new homes, not only located in Moore, but in surrounding communities nearby. So attempts to raise price will encounter those competitive pressures regardless of the differing cost structures. Relatedly, some builders in the Oklahoma City market had adopted some of the features of the Moore enhanced code prior to the enactment of the code. Most notably, Home Creations, the largest home builder in Oklahoma, had adopted some of the features after the 1999, F5 tornado that hit Moore.[14] So while the added cost for the enhanced Moore code may have approached $2.00 per square foot, for some builders the incremental cost was less than that and was priced into the market already.

A second reason may be that the difference in price per square foot between Norman and Moore, was maintained after code implementation. Real estate prices in Moore, generally, are lower than Norman meaning that, other things equal, a home buyer could still buy the same home in Moore for less than Norman even after the change in cost due to the code.

Third, it may be that as builders gained experience with implementing the new codes, efficiencies were devised that lowered cost from what was initially experienced. This can be done through labor efficiencies but also the material cost as those suppliers compete for a new larger market for their products. One potential future modification to the code from the consulting engineer that designed the code relates to the most expensive piece of the new standard, changing the spacing of rafters from 24" to 16". Lab tests at the University of Oklahoma have determined

[14] Personal communication with the authors. They also highlight these features on their website. https://www.homecreations.com/why-home-creations/behind-the-walls/

that the same strength result can be accomplished with different nail patterns on the decking that would allow the standard to return to 24" spacing.[15]

Given our results and the fact that some builders voluntarily adopted some of the features in other markets, it is surprising that more communities fail to follow Moore's lead. Central Oklahoma is highly prone to long track violent tornadoes and safety has a value that finds its way into the market for housing by increasing the price of homes that have tornado shelters (Simmons and Sutter, 2007a) and a premium for lot rentals in mobile home parks that have community shelters (Simmons and Sutter, 2007b). It follows that demand for safer homes should have a similar response. We see no significant change in demand for housing in Moore compared to Norman and one final reason may be that increased demand for safer homes is keeping builders from leaving Moore.

Section H - Conclusion and Extensions

As more people move into areas subject to wind storms, whether along the coast or in the heartland, damage from wind storms inevitably increases. The "expanding bull's eye" that is an outgrowth of urban sprawl, makes each wind storm a possible nightmare for residents, insurers and communities (Ashley et al, 2014). To adapt, communities must be proactive and pursue options to mitigate future damage. Policies range from finding incentives that encourage voluntary mitigation to adoption of stronger building codes designed for the threats posed. But each policy brings with it risks that make decisions difficult. This paper suggests that the action by Moore, OK has not brought the negative consequences municipalities fear.

Our data examined real estate transactions all within three years of a tragic storm. The long term test of the policy is how builders and home buyers value stronger construction if many

[15] Personal communication with the authors.

years go by without a violent storm. A long term extension of this paper would be to examine the value of real estate in and near Moore over time. It's likely that a drought of tornadoes in central Oklahoma will create complacency. The state of Florida adopted a similar code statewide after Hurricane Andrew and the high hurricane years of 2004 and 2005 provided validation of the wisdom of that policy. But since, there has been no land falling major hurricane in the state. Knowing that any lull in wind storm activity is temporary, it behooves policy makers to develop strategies that remind the public that violent wind storms are inevitable to battle the tendency to underestimate the risk.

This paper only viewed the effect on new homes sales. A second extension would be to examine the effect on sales price in the resell market once the new code has been in place long enough to have sufficient reselling of homes built after the enactment of the enhanced Moore code. As mentioned earlier, evidence exists that mitigation features add value so homeowners of homes built to the enhanced code may use that as a selling feature.

Increasing regulations on the sale of real estate is a risky move that could drive away development. Moore, OK took a bold step toward increased resiliency by adopting a strong code designed with wind engineering principles. Our study indicates that the risk of driving away new home construction did not materialize meaning that Moore has increased the safety of residents in new homes and set a standard for other communities to follow.

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