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journal homepage: www.elsevier.com/locate/ijdrReal estate market response to enhanced building codes in Moore, OK[☆]Kevin M. Simmons^{a,*}, Paul Kovacs^b^a Austin College and National Institute for Risk and Resilience–University of Oklahoma, USA^b Institute for Catastrophic Loss Reduction, Canada

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ABSTRACT

Moore, OK, suffered 3 violent tornadoes from 1999 to 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 results show the code had no effect on price per square foot, home sales or new building permits.

1. 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 [26]. In addition to the financial losses, 24 fatalities occurred, including seven children at Plaza Towers Elementary School. An additional 212 were injured [25]. 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 eight, 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 [5,16,17]. 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 [3,11,17]. 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 as producers shift production to cities with less regulation lowering quantity supplied and driving up price in Moore. But the new code may increase demand for homes in Moore since the enhanced code produces a superior product in the face of a common hazard in central Oklahoma. This policy not only affects the supply side through increased cost but may also modify demand as buyers differentiate between homes in Norman and Moore based on perceived safety.

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.

2. Review of literature

In a seminal article [6], a stock-flow approach is used to examine how prices for real estate fluctuate over time. At the time of its

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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-hig11111her-costlier-building-standards-in-aftermath-of-tornado>.

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publication, there was fear of real estate price declines due to demographic shifts [15]. The DiPasquale and Wheaton paper takes a macro view using national data from which the authors show that markets do not clear instantly but rather adjust prices gradually. The paper had important implications for understanding national real estate market trends but does not provide insight into how variations in construction cost affect local markets. Our study adds to the literature by examining the difference between two local markets and the sudden increase in cost on one and not the other. While the statewide price of real estate in Oklahoma may indeed shift gradually, micro shifts within local markets are possible with implications for municipalities that require features which increase cost relative to their neighbors.

2.1. 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 [9]. Post storm inspections discovered that construction practices which had been in place during the 1980's contributed to the large losses [9,12,24]. The hurricane prompted a move to design and construct homes that can withstand the pressures of a major wind storm using wind engineering principles with an impervious envelope and continuous load path. 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 including strong connections from the top plate to the exterior wall studs and impact resistant glass or shutters to protect windows and doors. Additionally, a rigid material such as Oriented Strand Board (OSB) is used for the exterior wall sheathing providing added strength to the walls. The Moore code also requires a wind rated garage door, which is often the weakest point of a home.

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 [7]. 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. More recently, Hurricane Irma provided further verification of the efficacy of the FBC as noted in a Wall Street Journal article not long after the storm [13].

2.2. 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, [20,21] provide a Benefit/Cost analysis (BCA) that enhanced codes do provide benefits exceeding implementation cost in regions susceptible to windstorm damage. [20] finds a 3 to 1 BCA for the local Moore, OK code while [21] finds a BCA for the statewide FBC of 6 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 [19]

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 [8]. In a forthcoming paper, Gatzlaff et al. show that both visible and hidden hurricane mitigation features in Florida homes are significantly correlated with price increases. 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 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

2.3. Political considerations

Despite the economic case for stronger construction, the home-building 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 homes as affordable as possible 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 adopt their local code until after the third violent tornado struck in less than 15 years. Further, the tragic loss of seven 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 whether the decision by the city of Moore had the result many cities fear - that development is lost to neighboring cities.

3. Data

Data for the statistical model comes from eight sources, Multiple Listing Service (MLS) data provided by the Midwest City-Dell City-Moore Board of Realtors and MLS OK Inc.; new building permits from the cities of Moore and Norman; macroeconomic data from the Bureau of Labor Statistics,⁶ Bureau of Economic Analysis⁷; 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 to 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

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>.

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>.

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