Tornado Damage Mitigation: Homeowner Support for Enhanced Building Codes in Oklahoma: Tornado Damage Mitigation

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Tornado Damage Mitigation: Homeowner Support for Enhanced Building Codes in Oklahoma

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Tornadoes impose enormous costs on society. Relatively simple and inexpensive enhancements to building codes may reduce these costs by 30% or more, but only one city in the United States has adopted these codes. Why is this the case? This analysis addresses this question by examining homeowner support for more stringent building codes in Oklahoma, a conservative state that routinely experiences damaging tornadoes. Survey data show that support for mandatory mitigation policies like building codes is subject to countervailing forces. Push dynamics, including objective risk data, homeowners' risk perceptions, and damage experience, encourage support for mitigation. Pull dynamics, such as individualistic and conservative worldviews, and skepticism about climate change, generate opposition. At the margin, the pull dynamics appear to exert more force than push dynamics, creating only a weak basis of support that is not strong enough to overcome the status quo bias in a state that is cautious about regulatory measures. The concluding section offers suggestions for changing these dynamics.

KEY WORDS: Building codes; culture; risk mitigation; risk perception; tornadoes

1. INTRODUCTION

Natural disasters impose a vast array of costs on society. Some of these losses are avoidable, but individuals are subject to multiple biases that may lead them to oppose cost-effective mitigation measures (Meyer & Kunreuther, 2017). For instance, people tend to be myopic, focusing on overly short future time horizons when evaluating the benefits of these investments; optimistic in that they underestimate the likelihood that losses will occur from future disasters; and they exhibit inertia so they want to maintain the status quo. The problem can be made especially difficult when citizens are suspicious of, and object to, government-sponsored mitigation measures that impose mandatory upfront costs on households and businesses. In this study, we address two interrelated questions. First, can public support for mandatory mitigation measures be garnered when large losses from disasters are a regular occurrence and broadly experienced by a population? Second, can support be obtained even among a population that is distrustful of government and regulations?

This study addresses these questions by exploring homeowner support for relatively simple and inexpensive (~$2,000 per home) building code enhancements that are estimated to reduce tornado losses by 30% or more (Simmons, Kovacs, & Kopp, 2015). We focus on the U.S. state of Oklahoma, which experiences more than 65 tornadoes per

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year that impose significant costs on homeowners (Storm Prediction Center, 2017). At the same time, however, conservative and Republican politicians (who tend to distrust government and regulation) dominate the legislature and statewide elected offices by large margins (Stanley & Niemi, 2015).[4] This clash of risk and ideology makes Oklahoma an ideal case for studying the dynamics that push and pull public support for mandatory mitigation policies. Factors, such as high objective tornado risk, have the potential to push the population toward supporting more stringent building codes, while other factors, such as conservative political ideology, may pull them away from this support. When choosing between regulation (mandatory building codes) and risk reduction, what do Oklahomans decide, and why?

2. TORNADOES AND ENHANCED BUILDING CODES IN OKLAHOMA

The contiguous United States experienced 9,928 tornadoes between 2007 and 2014 that produced more than $24 billion in estimated property loss (Storm Prediction Center, 2017). A direct hit from the most intense (EF5) tornadoes will sweep even a well-built home from its foundation. However, 96% of tornadoes are rated at the lower end of the Enhanced Fujita Scale, summarized Table I (and described in WSEC, 2006). These "less intense" tornadoes normally cause some damage to wood frame homes but do not destroy them.

Even for the most intense tornadoes, most of the structural damage occurs at points along the tornado's path where the tornado was rated an EF2 or lower (Ramsdell & Rishel, 2007). For example, a postevent damage survey commissioned by the NWS to evaluate the EF5 tornado that occurred in Joplin, MO, on May 22, 2011—which caused $2.8 billion in damage—determined that 6,149 (86%) of the 7,191 structures that were damaged were exposed to an EF2 or lower tornado (Marshall, Davis, & Runnels, 2012). Similarly, 80% of the structures damaged by the third-most costly tornado in U.S. history—the EF5 tornado that struck Moore, OK, on May 20, 2013, and caused $2 billion in damage—occurred when the tornado was rated an EF2 or lower (Burgess et al., 2014). Thus, a substantial fraction of the damage caused by tornadoes comes from less intense tornadoes that produce wind speeds that range from 65 to 135 mph.

These findings have led to calls for upgraded building codes for construction of new homes in states that frequently experience damaging winds produced by EF0, EF1, and EF2 tornadoes (Prevatt et al., 2012; van de Lindt et al., 2012).[5] Surveys of the damage caused by less intense tornadoes have identified causes of structural problems, such as failure of toe-nailed truss-to-wall connections, poor attachment to foundations, horizontal "hinge" failure at the gable end truss-to-wall top plate connection, and inadequate structural wall sheathing panels (Prevatt et al., 2012, p. 261). Many of these causes are addressed in building codes that have proven to significantly reduce the amount of property damage caused by hurricanes (Gurley & Masters, 2010; Gurley et al., 2006). A simple adaptation of these codes, some argue, would reduce the property loss caused by less intense tornadoes (Prevatt et al., 2012).[6]

As of this writing, Oklahoma's statewide building code does not include these requirements, although individual communities are free to revise the codes to make them more stringent. In April 2014, the City of Moore, OK, adopted one such code, setting standards to mitigate damage caused by high-wind events from less intense tornadoes (EF2 or lower). The code increased the wind standard for new dwellings from 90 mph (three-second gust) to 135 mph, which required a series of changes in how wood frame homes are constructed, including:

> *Enhanced roof sheathing fasteners and fastener schedules, narrower spacing of the roof framing, enhanced connections in the roof framing including the use of hurricane straps, strengthening of gable end walls and wall sheathing, some structural changes to garages, and wind-rated garage doors*. (Simmons et al., 2015)

A recent study indicates that these improvements to construction practices could reduce residential tornado losses by 30%, resulting in $10.7 billion in savings over the next 50 years if they were applied across the state of Oklahoma (Simmons et al., 2015).

[4] As of November 2016, Republican officials held 40 of 48 seats in the Oklahoma Senate, 71 of 101 seats in the Oklahoma House of Representatives, the governorship, both seats in the U.S. Senate, and all five seats in the U.S. House of Representatives. In the 2016 presidential election, the Republican candidate (Trump) received 65.3% of the popular vote; the Democratic candidate (Clinton) received 28.9% of the vote.

[5] The new codes are similar to the International Code Council's (ICC) "Standard for Residential Construction in High-Wind Regions" and the American Society of Civil Engineers' "ASCE 7."

[6] Czajkowski and Simmons (2014) have shown the benefits of effective and well-enforced building codes in reducing damage from hail, which often coincides with tornado damage, on the order of 15–20% lower loss amounts.

Table I. Operational Enhanced Fujita Scale for Tornado Damage

EF Scale	Wind Speeds (MPH)	Characteristic Damage to Residential, Wood Frame Houses
0	65–85	Threshold of visible damage; loss of roof-covering material (less than 20%), gutters and/or awning; loss of vinyl or metal siding.
1	86–110	Broken glass in doors and windows; uplift of roof deck and loss of significant roof-covering material (20% or more); collapse of chimney; garage doors collapse inward; failure of porch or carport.
2	111–135	Entire house shifts off foundation; large sections of roof structure removed; most walls remain standing; exterior walls collapsed
3	136–165	Most walls collapsed, except small interior rooms
4	166–200	All walls collapsed
5	Over 200	Destruction of engineered and/or well-constructed residence; slab swept clean

The same study estimates that it would cost approximately \$3.3 billion (~\$2,000 per home constructed) to implement the codes throughout the state. The study concludes that the new building code in Moore, OK, "easily" passes a benefit-cost economic effectiveness test for the entire state by a factor of 3.2 to 1 (Simmons et al., 2015). In a follow-up study, Simmons and Kovacs (2017) cite a higher cost of approximately \$4,000 per home constructed (~\$2 per square foot). Even at this cost, the code improvements pass the benefit-cost economic effectiveness test. More importantly, the study shows that the new building code had no effect on the real estate market in Moore, OK, quashing economic fears that statewide adoption of these codes would increase the price, reduce the sale, and/or discourage the construction of new homes in Oklahoma.

If building codes provide a cost-effective solution to minimizing the damage caused by tornadoes, why is Moore the only city in OK that has adopted them? What are the barriers to adoption and implementation that are preventing Oklahoma and other tornado-prone states from following Moore's lead? One answer may involve public attitudes about risk governance, and, more specifically, the perceived tradeoffs between risk reduction and regulation (Vaughan & Turner, 2014). On the one hand, because of the frequency of tornadoes in the state, Oklahomans are keenly aware of the damage they cause and hence the value in reducing these losses. On the other hand, Oklahoma is an ideologically conservative state where regulation is likely viewed as an additional cost imposed on society.

The Republican Party in Oklahoma explicitly opposes infringement on individual property rights (Oklahoma Republican Party Platform Committee, 2013, p. 17). Enhanced building codes are at the intersection of the tradeoff between risk reduction and protection of private property rights; they would provide a prospective benefit (risk reduction), but they would also impose a state-mandated requirement and cost on homebuilders and buyers. For those who oppose the expansion of mandatory building codes, voluntary (rather than mandatory) risk mitigation programs may be more appealing because they do not infringe upon market interactions and/or impose involuntary costs on individuals.[7]

3. PREVIOUS RESEARCH AND CORRESPONDING EXPECTATIONS

Previous research on risk perception and behavior has substantially improved our understanding of the social, economic, and psychological mechanisms that influence individual and collective choices about how to reduce losses from natural disasters. For example, early research on mitigation indicates that most homeowners do not voluntarily adopt risk reduction measures, even if they are cost effective (Kunreuther et al., 1978, 2013; Kunreuther & Useem, 2010; Laska, 1991; Palm, Hodgson, Denise Blanchard, & Donald Lyons, 1990). Subsequent studies have identified several factors that explain this behavior. For instance, many studies indicate that homeowners do not invest in mitigation measures because they underestimate or ignore the probability that a disaster will cause damage to their home (e.g., Camerer & Kunreuther, 1989; Huber, Wider, & Huber, 1997; Kunreuther & Pauly, 2004; Magat, Viscusi, & Huber, 1987). Other studies

[7]Hamburger (2016) notes that a coalition of homebuilders and roofers oppose the update of ASCE-7-10, the new building code standard that includes new wind codes.

highlight economic constraints (high costs) and/or a kind of risk myopia by which homeowners—when confronted with potentially costly choices—tend to focus on short-term benefits and ignore or undervalue benefits that accrue over longer periods of time (Kunreuther, Onculer, & Slovic, 1998).

Given these tendencies, and the resulting low mitigation adoption rates, researchers have argued that hazard mitigation should involve a combination of voluntary and mandatory risk reduction measures, such as compulsory insurance and/or well-enforced building codes (e.g., Kunreuther, 2006; Kunreuther & Kleffner, 1992; Kunreuther & Michel-Kerjan, 2009). Yet, relatively little is known about public support or opposition for the imposition of mandatory risk reduction measures, such as enhanced building codes (see, e.g., Dake, 1992; Greenberg et al., 2014; Vaughan & Turner, 2014). This is problematic because mandatory measures are likely to generate different patterns of support and opposition than voluntary measures. For example, mandatory mitigation measures may generate opposition from homeowners who support risk reduction efforts but do not think these measures should be forced upon private citizens by way of building codes. Rather, they might believe that homeowners (and homebuilders) should have the freedom to choose to buy (or construct) higher-quality homes. Voluntary measures, by comparison, are unlikely to generate this sort of opposition because homeowners (and builders) can "opt out" if they choose to do so.

We theorize that support for mandatory risk mitigation is governed by a set of push dynamics that encourage support for mitigation and a countervailing set of pull dynamics that discourage support in a given population. Here, we discuss these dynamics with reference to homeowners in Oklahoma; in other communities, the dynamics may work in opposite directions. For example, we draw from research on adoptions of voluntary risk mitigation measures to hypothesize that objective and subjective characterizations of hazard risk will, on average, act as push variables that encourage support for mandatory risk mitigation in Oklahoma (i.e., Grothmann & Reusswig, 2006; Knocke & Kolivras, 2007; Siegrist & Gutscher, 2008; Thieken, Petrow, Kreibich, & Merz, 2006).

We expect that homeowners who live in areas of Oklahoma that routinely experience tornadoes will be more supportive of mitigation than homeowners who live in less tornado-prone locations. The same is true of risk perceptions and hazard knowledge—people who believe that tornadoes will occur more frequently in the future and/or understand the risks associated with tornadoes will be more supportive of mitigation. Conversely, we expect that people who underestimate or misconstrue the risk of tornadoes may exhibit an optimism bias that erodes support for mitigation (Costa-Font, Mossialos, & Rudisill, 2009). Along the same lines, we hypothesize that recent experience with tornado damage will trigger memories, risk perceptions, and impart knowledge about the hazard that will encourage support for enhanced building codes (McGee, McFarlane, & Varghese, 2009). We classify these variables as *push* variables because objective and subjective tornado risk are, on average, relatively high in Oklahoma, and many homeowners have experience with tornadoes. In communities where tornadoes are less common, these variables may exert the opposite force; low risk (be it objective, subjective, or both) and/or little experience with tornadoes will discourage community support for code improvements.

Even for people who support code improvements, economic costs are likely to influence their decision-making process. Therefore, we hypothesize that a critical pull factor is the cost of the regulation with respect to constructing homes. Other pull dynamics that discourage support for risk mitigation were identified in a recent study of lack of public support for hurricane risk mitigation in New Jersey following Hurricane Sandy (Greenberg et al., 2014). Individuals who identify with egalitarian and/or communitarian values were shown to be more supportive of mitigation than individuals who do not identify with those values. This finding is consistent with a broader literature on the relationship between values ("culture") and individual preferences about how to manage risk in society, which originates with the work of Mary Douglas and Aaron Wildavsky on the "cultural theory of risk" or cultural theory (CT) (Dake, 1992; Douglas, 1992; Douglas & Wildavsky, 1982; Thompson, Ellis, & Wildavsky, 1990).

Cultural theorists classify four types of biases with the following characteristics: hierarchy, individualism, egalitarianism, and fatalism (Dake, 1991; Rayner, 1992; Thompson et al., 1990). Hierarchs place the welfare of the group before their own, and are keenly aware of who is and is not a part of their group. They prefer that people have defined roles in society, and place great value on procedures, lines of authority, stability, and order. Individualists, by contrast, experience little if any group identity, and feel bound by few structural prescriptions. They dislike constraints imposed upon them by others and value liberty over order and stability. Egalitarians seek strong group identities but prefer minimal external prescriptions on social relationships. They place greater value on equality within the group than they do on liberty or order, and vest authority within the community rather than on experts or institutionally defined leaders. Finally, fatalists perceive themselves to be subject to binding external constraints, and feel they are excluded from the groups with the authority to impose those constraints. They believe that they have little control over their lives and value chance (luck or fate) over order, liberty, and equality.

We expect that individualists will oppose the adoption of statewide building codes because they constrain their choice. In their view, homeowners should have the right to build or buy a home that meets an enhanced standard of construction. Egalitarians, by comparison, will support building codes and other well-enforced standards because they provide equitable protection for everyone, including homebuyers who may not have the resources to build a higher-quality home. We expect that fatalists will oppose nearly all risk mitigation measures (including mandatory measures) because they doubt the efficacy of protective action, believing instead that risk is a matter of chance or fate. This expectation is relatively prevalent in disaster research communities, where fatalism is found to promote apathy and nonresponse to risk (Eriksen & Wilkinson, 2017; Grothmann & Reusswig, 2006; Sims & Baumann, 1972). Hierarchs are likely to be divided: if they believe that the "experts" or authority figures in their group support (oppose) enhanced building codes, then they too will support (oppose) them.

These four cultural biases likely represent just one among an overlapping set of broad beliefs and identities that would influence support for mandatory mitigation programs. Oklahoma homeowners are also likely to take cues from the broad positions of the Republican or Democratic Party when formulating preferences about building codes. Although rarely taking positions on building codes, the parties represent distinct philosophies and values from which citizens might draw upon when making decisions about new policies. For example, the Democratic Party supports generally liberal (or left-leaning) policies, including progressive taxation and government regulation of industry-generated externalities, whereas the Republican Party espouses more conservative (or right-leaning) policies, including reductions in taxation and, more generally, the burdens posed by government regulations (Noel, 2014). Given these differences, we expect that homeowners who identify with the Republican Party, the majority party in Oklahoma, will be more likely to oppose mandatory risk mitigation measures (including the adoption of statewide building codes) because they impose government regulations on businesses and individuals.

A related but distinct concept is that of political ideology, representing a broad set of normative values about the "good society" and how it can be achieved. Political parties present (sometimes inconsistent) ideologies in competing for voter support (see, e.g., Downs, 1957). At various points in time, political parties in the United States have represented quite diverse ideological groups (e.g., conservative southerners as a subgroup of a generally more liberal Democratic Party), although in recent decades the primary political parties in the United States appear to have become more homogeneous and polarized (Levendusky, 2009; Miller & Schofield, 2003). Conservatives tend to prefer fewer government interventions, and to reject both evidence and arguments (like that for anthropogenic climate change) that would justify such interventions (Kellstedt, Zahran, & Vedlitz, 2008; Leiserowitz, 2006). Hence conservatives, who tend to dominate the ideological landscape in Oklahoma, will be more likely to oppose the more expansive mandatory building codes. We expect that liberals will take a more collective perspective more conducive to support for building standards imposed broadly on homebuilders and buyers.

In addition to these "value-based" constraints in states like Oklahoma that are dominated by individualists, Republicans, and conservatives, we again draw from Greenberg et al. (2014) to hypothesize that general skepticism about the risk of global climate change will discourage support for tornado risk mitigation in Oklahoma. As documented in prior research (Leiserowitz, Maibach, Roser-Renouf, & Hmielowski, 2012), people who believe that anthropogenic climate change is occurring also perceive that weather events, such as tornadoes and hurricanes, will become more frequent and intense in the future. Skeptics, by comparison, tend to reject this connection, believing that the frequency and intensity of extreme weather are subject to natural variability and hence no more (or less) likely in the future (Whitmarsh, 2011). Given these arguments, we expect that homeowners who are skeptical about the risks of anthropogenic climate change (the majority group in Oklahoma) will be less supportive of enhanced building codes than homeowners who are more concerned about climate change.

We also account for the effects that socioeconomic status, age, and gender may have on support for mandatory risk mitigation. Income and education may increase homeowner support for enhanced building codes because higher-income homeowners can pay for more expensive housing and homeowners with higher levels of education are likely to be more aware of the long-term benefits associated with mitigation. In addition, more highly educated homeowners may also be less susceptible to cognitive biases, like risk myopia, that lead to undervaluation of mitigation because of their upfront costs relative to the perceived short-term benefits from these measures (Kunreuther et al., 1998; Meyer & Kunreuther, 2017).

Older respondents are expected to be more supportive of enhanced building codes than younger respondents because they are more likely to have experienced tornado damage in the past, which is expected to bolster support for mitigation. Older homeowners are also less likely than younger homeowners to be "in the market" for a new home, thus the cost of building codes (i.e., higher prices on new homes) are less constraining financially for older homeowners.

Following Greenberg et al. (2014), we hypothesize that gender may influence risk perceptions and subsequent support for enhanced building codes in Oklahoma. As noted in other areas of study, women often exhibit higher risk perceptions and a greater propensity to engage in protective action than men (Flynn, Slovic, & Mertz, 1994; Terpstra & Lindell, 2012; Ripberger et al., 2015a, 2015b). Therefore, we expect that female respondents will be more supportive of enhanced building codes than male respondents.

Fig. 1 provides an illustrative summary of the push and pull dynamics thought to influence support for enhanced building codes in Oklahoma. Note again that each variable can exert a net push *or* pull effect on support for the policy in a given population. The direction of the net effect will vary according to the central tendency of these variable within the population. In Oklahoma, for example, the objective risk of tornadoes is relatively high and the majority of homeowners perceive and understand the risk, often because of a recent experience with tornadoes. As such, we expect that these factors will, on net, push support for mitigation in Oklahoma. In other states, where objective and subjective risk, knowledge, and experience are relatively low, the same variables may have either the opposite net effect, or no effect at all. The same is true of culture, partisanship, ideology, and skepticism about climate change. In states like Oklahoma, where a majority of people are individualists, conservatives, and Republicans who tend to doubt climate change—culture, ideology, partisanship, and climate change skepticism constrain support for the policy. In other states, where egalitarians, liberals, and Democrats are more prevalent, the same set of variables may have the opposite net effect, making them push variables that encourage support for building code enhancements.

4. DATA AND MEASURES

The data for this project were collected via the Meso-scale Integrated Socio-geographic Network (M-SISNet), a panel survey that is administered four times a year to an address-based random sample of approximately 2,500 Oklahoma residents (Jenkins-Smith et al., 2017). Each wave of the M-SISNet survey contains a large set of reoccurring questions and a small set of wave-specific questions designed to measure household perceptions and opinions about the weather and climate in Oklahoma. The Spring 2015 wave—which was in the field from June 4 to July 22, 2015—included reoccurring questions and a wave-specific set of questions about property damage from high-wind events (like less significant tornadoes) and risk mitigation measures. In total, 2,527 M-SISNet panelists completed a survey for the Spring 2015 wave; we use responses from the subset of 2,200 respondents who own the residence in which they reside.[8]

The outcome variable in this analysis is a measure of homeowner support for building codes in Oklahoma. We measure this with the following prompt and question:

> *According to structural engineers, there are steps that some homeowners can take to protect the structure of their homes from damage caused by high-wind events like tornadoes. Though estimates differ, many engineers suggest that these steps can protect the structure of some homes from wind speeds up to 150 mph. While tornadoes differ in the wind speeds they produce, the majority of tornadoes in Oklahoma produce wind speeds that range from 65 mph to 135 mph. On the Enhanced Fujita (EF)*

[8]Respondents who were not homeowners were not asked about their support for the enhanced building codes, and therefore are excluded from this analysis.

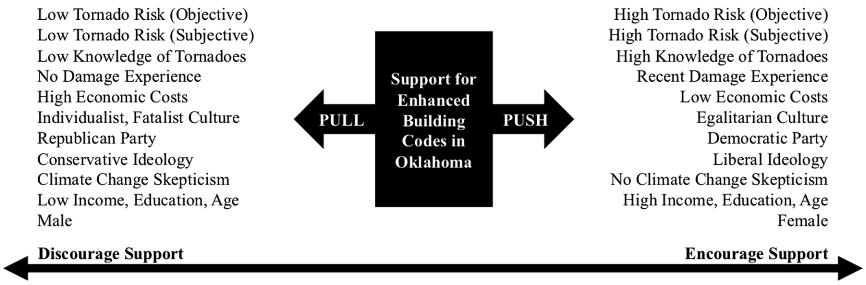

Fig. 1. The push and pull dynamics that influence public support for enhanced building codes in Oklahoma.

> *scale for tornado damage, these wind speeds are consistent with EF0, EF1, and EF2 tornadoes.*
>
> *In hurricane-prone regions of the United States, building codes often require that new homes are equipped with a number of wind-protective components when they are constructed. Suppose that through a statewide referendum, the state of Oklahoma was considering a law that would mandate similar building codes in Oklahoma. This law would require that all new homes in the state are equipped with a set of components that would protect the structure of the home from the majority of high-wind events that occur in Oklahoma, including most EF0, EF1, and EF2 tornadoes. On average, installing these components during construction would increase the price of new homes in the state by* $*[RANDOMIZE: 2,000/3,000/4,000]. Because this is a statewide referendum, you would have an opportunity to directly cast a vote for or against this law.*
>
> *Would you vote for or against this law in Oklahoma? As you think about your answer, remember that if this law were to pass, it would cost more to build a home in Oklahoma.*

Survey participants registered their responses on a five-point scale that included the following options: *definitely oppose, probably oppose, not sure, probably support*, and *definitely support*. Note that this question includes an experiment wherein respondents are randomly assigned to one of three cost conditions of $2,000, $3,000, or $4,000.[9] This variation allows us to estimate the influence of cost on support for building codes. In addition to cost, we expect that responses to this question will be driven by the push and pull dynamics that we describe above.

Beginning with the push dynamics that are expected to encourage support for enhanced building codes, we use the Storm Prediction Center (SPC) tornado database to estimate the spatial risk (frequency) of EF0, EF1, and EF2 tornadoes across the state of Oklahoma (a proxy for objective tornado risk). The tornado database provides information on the date, time, location, and intensity of nearly every tornado in the United States since 1950.

Given our interest in less intense tornadoes, we limit the data to every EF0, EF1, or EF2 tornado that was reported in the continental United States between 1985 and 2014 ($n = 33{,}582$ tornadoes) and use kernel density estimation (KDE) to estimate the annual probability of an EF0, EF1, and EF2 tornado within 5 km of every point in Oklahoma.[10] To facilitate interpretation, we standardize these scores such that zero indicates an average risk of less significant tornadoes, negative scores indicate lower than average risk, and positive scores indicate higher than average risk. The units of measurement represent standard deviations from the average. Fig. 2 plots the spatial distribution of this variable.

We measure subjective tornado risk with a question about the future frequency of tornadoes: *Do you think that tornadoes will happen more frequently, less frequently, or with about the same frequency over the next few springs as they have this spring? [2 = more; 1 = same; 0 = less].* Given the relatively short time horizon in this question ("next few springs"), we call this subjective short-term tornado risk in the sections that follow. We measure damage experience by asking respondents if (in the past three years) the structure of their home has been damaged by an extreme weather event (1 = yes; 0 = no) and tornado knowledge by asking respondents to answer a set of four factual questions about when tornadoes generally occur in Oklahoma (in the spring, between 3:00 PM

[9]Simmons, Kovacs, and Kopp (2015) estimate that enhanced building codes will increase construction costs by approximately $2,000 (or $1 per sq. ft.). In personal conversations, homebuilders have expressed the view that this estimate is a lower bound, so we include $3,000 and $4,000 to capture the upper bound.

[10]For more information on this approach to estimating objective tornado risk, see, i.e., Coleman and Dixon (2014), Dixon, Mercer, Choi, and Allen (2011), and Marsh and Brooks (2012).

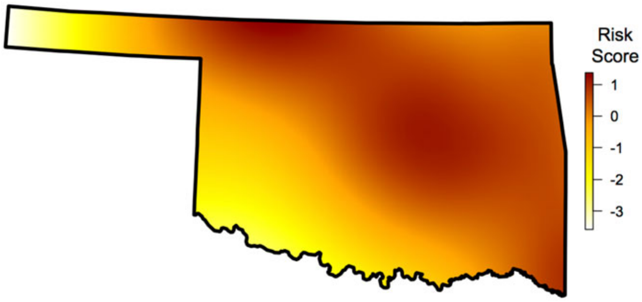

Fig. 2. Objective risk from less significant tornadoes in Oklahoma.

and 9:00 PM), the direction they typically travel (in a diagonal line, from southwest to northeast), and the damage rating that most tornadoes receive (EF0-EF1, with wind speeds that range from 65 to 110 miles per hour). For each "correct" answer, respondents receive one point on the tornado knowledge scale, which ranges from 0 (no correct responses) to 4 (all correct responses).

Turning to the pull dynamics that we expect will discourage support for enhanced building codes in Oklahoma, we measure cultural biases by asking respondents to rate the degree to which a set of four statements describe their outlooks on life. Using the questions described in Ripberger et al. (2014), each respondent rated his or her affinity to each of four cultural types, and was asked a "tie-breaker" question when affinities for two of the types tied for first place (see Appendix B for the wording of this question). In the analysis that follows, we place respondents into a "culture" category (egalitarian, individualist, hierarch, or fatalist) based on the statement that they rate the highest.

We measure party identification by asking homeowners to indicate which political party they most identify with: the Democratic Party, Republican Party (or GOP), independent, or other. In this analysis, respondents who marked other are included with independents. As an alternative to measures of partisanship, we include a measure of self-identified political ideology. The scale ranges from "strong liberal" (1) through "middle of the road" (4) to "strong conservative" (7).

To measure skepticism about global climate change, we asked respondents the following question: "On a scale from zero to ten, where zero means no risk and ten means extreme risk, how much risk do you think global warming poses for people and the environment?" To make this a measure of skepticism, we reverse-code this scale, making 0 the least skeptical and 10 the most skeptical.

To account for the socioeconomic and demographic characteristics that may influence homeowner support for enhanced building codes, we use questions that measure household income, age, gender, and education. See Appendix A for the wording of all the questions.

As noted above, the M-SISNet is a panel survey. Questions on subjective short-term tornado risk, damage experience, skepticism about global climate change, and socioeconomics/demographics were included in the Spring 2015 wave of the survey, the same wave as the referendum question. Questions on tornado knowledge were included in the Fall 2015 wave, which was in the field December 11, 2015 to February 1, 2016. Approximately 88% (1,950) of the homeowners who responded to the Spring 2015 wave responded to the Fall 2015 wave of the survey. Questions on culture, party identification, and ideology were on the Winter 2015 wave, which was in the field March 6, 2015 to April 27, 2015. Roughly 91% (2,001) of the homeowners who responded to the Spring 2015 wave responded to the Winter 2015 wave of the survey. Although small, this panel attrition explains the different sample sizes shown in Table II.

Table II also summarizes the distribution and central tendency of our measures. For categorical (binary) variables, percentages are listed instead of means. On average, homeowners in the sample believe that tornadoes are going to happen more frequently in the future (mean = 2.14 on the three-point scale) and are highly knowledgeable about the hazard (mean = 2.93 on the four-point scale). Similarly, a significant portion of the sample (21%) has recent experience with weather damage. If our theory is correct, these *push* dynamics will, on average, increase support for tornado risk mitigation, even if the program is mandatory. At the same time, however, the sample is dominated by individualists (49%), Republicans (47%), conservatives (mean = 4.61 on the seven-point scale), and homeowners who

Table II. Descriptive Statistics

	Mean/Percent	St. Dev.	Min	Max	N	Survey Wave[b]
Vote in building code referendum	3.64	1.19	1	5	2,200	Sp-15
Vote for building code (yes = 1)[a]	62%	–	0	1	2,200	Sp-15
Cost: $2,000[a]	33%	–	0	1	2,200	Sp-15
Cost: $4,000[a]	33%	–	0	1	2,200	Sp-15
Cost: $4,000[a]	33%	–	0	1	2,200	Sp-15
Objective tornado risk	0.31	0.75	−2.84	1.18	2,200	Sp-15
Subjective short-term tornado risk	2.14	0.53	1	3	2,178	Sp-15
Weather damage experience[a]	21%	–	0	1	2,194	Sp-15
Tornado knowledge	2.93	0.78	0	4	1,902	F-15
Cultural bias: egalitarian[a]	22%	–	0	1	1,992	W-15
Cultural bias: fatalist[a]	8%	–	0	1	1,992	W-15
Cultural bias: hierarch[a]	21%	–	0	1	1,992	W-15
Cultural bias: individualist[a]	49%	–	0	1	1,992	W-15
Partisanship: Democrat[a]	34%	–	0	1	1,961	W-15
Partisanship: independent[a]	20%	–	0	1	1,961	W-15
Partisanship: Republican[a]	46%	–	0	1	1,961	W-15
Political ideology (conservative = 7)	4.65	1.70	1	7	1,965	W-15
Skepticism about global climate change	4.32	3.13	0	10	2,184	Sp-15
Household income	76,735	80,785	$10K	$1,750K	1,936	Sp-15
Education (college = 1)[a]	51%	–	0	1	2,199	Sp-15
Age	59.91	13.86	21	92	2,200	Sp-15
Gender (male = 1)[a]	39%	–	0	1	2,193	Sp-15

[a]Indicates categorical (binary) variable.
[b]Wave W-15 was fielded in the winter of 2015; Sp-15 was fielded in the spring of 2015; F-15 was fielded in the fall of 2015.

are skeptical of climate change (mean = 4.32 on the 10-point scale). On average, these pull dynamics are expected to lessen support for mandatory risk mitigation programs, even if those programs limit the damage caused by tornadoes.

In the analysis that follows, we assess the balance between the push–pull dynamics by exploring support for enhanced building codes in the entire sample of homeowners. Then, we exploit the variation within the sample to identify the influence of each factor on support for the program. We do this with a set of logistic regressions that model support for building codes as a function of the variables we describe above. As shown in previous research (Jones, 2011; McCright & Dunlap, 2011; Ripberger, Song, Nowlin, Jones, & Jenkins-Smith, 2012; Swedlow & Wycoff, 2009) cultural biases, partisanship, political ideology, and skepticism about global warming are highly correlated with one another, so we estimate separate models that include these variables in isolation, followed by a single model that includes all the explanatory variables.[11] Before we estimate these models, we use the multiple imputation approach outlined in Blackwell, Honaker, and King (2015) to impute entries for missing observations in five "complete" data sets.[12] We estimate the models using data from all five data sets and present mean point estimates and standard errors.

To facilitate interpretation, we scale the numeric inputs to the model by dividing them by two standard deviations so that we can directly compare the resulting coefficients to coefficients for untransformed binary indicators (Gelman, 2008). In addition, we present our results as "marginal effects" rather than logit coefficients. The marginal effects approximate expected differences in the predicted probability that an individual will support enhanced building codes = Yes, given a 1-unit difference in an independent variable when the other variables in the model are held constant. The marginal effects are calculated at the

[11]In addition to these correlations, there is a modest negative correlation (−0.22; $p < 0.001$) between subjective short-term tornado risk and skepticism and global climate change. On average, people who are skeptical of climate change believe that tornados will occur less frequently in the future, whereas people who worry about climate change believe that they will occur more frequently in the future.

[12]We also estimate the models using listwise deletion of missing values. As shown in Appendix B (Table B-I), the results we get when using this approach are quite consistent with the estimates we present in Table III.

sample mean of the independent variables and the standard errors are calculated using the delta method (Greene, 2003).

5. RESULTS

Fig. 3 plots the distribution votes for the enhanced building code referendum among all homeowners in the sample who completed this portion of the survey ($n = 2{,}200$). As the figure indicates, almost two-thirds of the homeowners in the sample said that they would probably or definitely vote in favor of the referendum. When the reported increase in the cost of constructing new homes due to the enhanced building code was $2,000, the percentage support ("definitely" plus "probably") was 65%; at $3,000 it fell to 62%; and at $4,000, which is almost twice the estimated cost of mitigation, 60% of homeowners indicated that they would probably or definitely vote in favor of the enhanced building code.

More than a third of the homeowners in the sample indicated that they are unsure or do not support the adoption of building codes that would protect new homes from damage caused by less significant tornadoes even when the cost of new construction was as low as $2,000. When the costs of new construction increased to $4,000, the percentage who indicated that they are unsure or do not support the adoption increased to 40%.

To statistically test for the impact of cost on building code support while also controlling for the impact of other pull and push factors, we use a binary logistic regression to explore the difference between respondents who support the referendum ($y = 1$) and respondents who are not sure or oppose it ($y = 0$).[13] Table III presents the marginal effects (and standard errors) from our regression models. As noted above, some of the variables are correlated, so separate models estimate the effects of culture, partisanship, ideology, and climate change beliefs. The fifth column in Table III shows the results when all the variables are included in a single model. As a group, the five models demonstrate that support for code enhancement is modestly reduced by increases in the price of new homes, as noted from the data in Fig. 3. On average, the probability of support decreases by approximately 0.05 as new home prices increase from $2,000 to $4,000.

Beginning with the push variables hypothesized to encourage support for the building code enhancement, the estimates from all five models show that greater objective tornado risk, greater subjective short-term tornado risk, and experiencing damage from an extreme weather event all increase homeowner support for the building code referendum. In the complete model (5), a two standard deviation increase in objective tornado risk corresponds with a 0.04 increase in the probability of support for building codes. Increases in subjective short-term tornado risk and tornado knowledge (by two standard deviations) produce similar increases in the probability of support (increases of 0.05 and 0.04, respectively). The same is true of recent experience with weather damage—the probability of support for building codes is 0.04 higher among respondents who have this experience. With one exception (Model 1, where tornado knowledge is not statistically significant), the push effects in all five models are positive and statistically significant.

The second set of estimates in Table III speak to the pull dynamics that constrain support for enhanced building codes in Oklahoma. Model 1 shows that cultural biases significantly influence support for the referendum. Consistent with our expectations, fatalists, hierarchs, and individualists (the predominant group in Oklahoma) are less likely to support the referendum than are egalitarians. All else equal, support among hierarchs and individualists is roughly 0.11 lower than expected support among egalitarians; support among fatalists is even lower (0.14). These differences remain significant, but diminish in size when partisanship, political ideology, and beliefs about climate change are held constant (Model 5).

Models 2 and 3 indicate that partisanship (Republican and Democrat) and political ideology also constrain support. The marginal effects from Model 2 indicate that the difference in support between Republicans and Democrats is 0.11, with Republicans being significantly less supportive than Democrats. Independents are also less supportive than Democrats, but the difference between the two groups is smaller (0.06). Model 3 tells a similar story for ideology. The difference between liberals and conservatives is roughly 0.16, with conservatives being significantly less supportive than liberals. Although sizable, these differences are suppressed in Model 5, making the estimated coefficients statistically insignificant, which is unsurprising

[13] Extensive comparisons of survey responses with voting behavior on public referenda show that survey respondents who express uncertainty typically vote "no" if they decide to vote at all (e.g., Carson, Hanemann, & Mitchell, 1987; Champ & Brown, 1997). We follow this logic in treating "not sure" responses as opposition to the building code referendum.

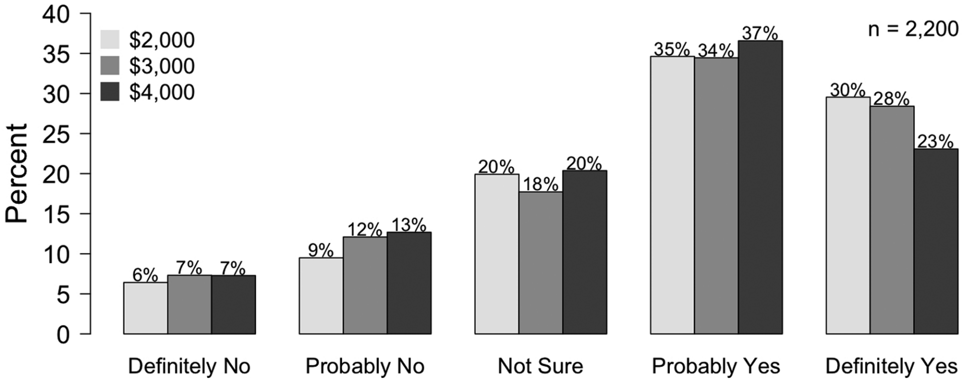

Fig. 3. Distribution homeowner responses to a hypothetical referendum that would require enhanced building codes for tornado risk mitigation in Oklahoma.

Table III. Multiple Imputation Logistic Regression Models of Homeowner Support for Building Codes to Mitigate Tornado Damage

	Model 1	Model 2	Model 3	Model 4	Model 5
Cost: \$3,000 (vs. \$2,000)	−0.01 (0.03)	−0.01 (0.03)	−0.01 (0.03)	−0.01 (0.03)	−0.01 (0.03)
Cost: \$4,000 (vs. \$2,000)	−0.04* (0.03)	−0.05* (0.03)	−0.05* (0.03)	−0.05** (0.03)	−0.05* (0.03)
Objective tornado risk	0.05** (0.02)	0.05** (0.02)	0.04** (0.02)	0.05** (0.02)	0.04** (0.02)
Subjective short-term tornado risk	0.08*** (0.02)	0.08*** (0.02)	0.07*** (0.02)	0.06*** (0.02)	0.05** (0.02)
Weather damage experience	0.05** (0.02)	0.05** (0.02)	0.05* (0.03)	0.04* (0.03)	0.04* (0.03)
Tornado knowledge	0.03 (0.02)	0.04* (0.02)	0.04* (0.02)	0.04* (0.02)	0.04* (0.02)
Individualist (vs. egalitarian)	−0.11*** (0.03)				−0.06* (0.03)
Hierarch (vs. egalitarian)	−0.11*** (0.03)				−0.07** (0.04)
Fatalist (vs. Egalitarian)	−0.14*** (0.04)				−0.11** (0.05)
Republican (vs. Democrat)		−0.11*** (0.02)			0.01 (0.03)
Independent (vs. Democrat)		−0.06** (0.03)			−0.002 (0.03)
Political ideology			−0.16*** (0.02)		−0.09*** (0.03)
Skepticism about climate change				−0.17*** (0.02)	−0.12*** (0.03)
Household income	−0.002 (0.02)	0.004 (0.02)	0.001 (0.02)	0.01 (0.02)	0.002 (0.02)
College (vs. no college)	0.11*** (0.02)	0.11*** (0.02)	0.10*** (0.02)	0.10*** (0.02)	0.09*** (0.02)
Age	0.05** (0.02)	0.06*** (0.02)	0.07*** (0.02)	0.06*** (0.02)	0.06*** (0.02)
Male (vs. female)	0.02 (0.02)	0.02 (0.02)	0.03 (0.02)	0.04 (0.02)	0.04 (0.02)
Constant	−0.20** (0.09)	−0.25*** (0.09)	−0.09 (0.09)	−0.16* (0.09)	−0.01 (0.09)
Observations	2,200	2,200	2,200	2,200	2,200
Log likelihood	−1411.61	−1410.71	−1395.82	−1390.03	−1379.69
Akaike inf. crit.	2851.21	2847.43	2815.65	2804.06	2795.38
Imputations	5	5	5	5	5

Note: Average approximate marginal effects, calculated at the means of the independent variables; average standard errors in parentheses; $^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$.

given the high correlations among cultural dispositions, partisanship, ideology, and skepticism about climate change.[14]

Model 4 shows that beliefs about climate change are influential as well. Homeowners who are skeptical about climate change are significantly less supportive of enhanced building codes than homeowners who are worried about climate change. In fact, the expected difference in support between the two groups is 0.17, which is the largest effect we observe in the data. Although somewhat reduced in size, this difference remains statistically significant and relatively large (0.12) when culture, partisanship, and political ideology are held constant (Model 5).

The final set of socioeconomic and demographic estimates in Table III (income, education, age,

[14]Pearson correlations: Republican vs. political ideology = 0.59; Republican vs. skepticism about climate change = 0.44; political ideology vs. skepticism about climate change = 0.59.

gender) shows that general education and age also influence support for building codes. Consistent with our expectations, the probability of support among homeowners with a college degree is 0.09 higher than the probability of support among homeowners who did not graduate college. The difference between older and younger homeowners is smaller (0.06), but statistically significant. Contrary to our prediction, household income has little or no discernable influence on support for the policy, suggesting that economic considerations have little bearing on homeowners' preferences over prospective enhancements of building codes for new homes in Oklahoma.[15] The same is true of gender—men are a bit more supportive than women, but the effect is not statistically significant.

As a group, the estimates in Table III provide consistent support for our theory that the tension between risk and regulation in Oklahoma is governed by a set of push dynamics that encourage support for mandatory mitigation programs and a countervailing set of pull dynamics that discourage support. Up until now, we have investigated these dynamics in isolation, revealing the relative effect of each variable in the push and pull sets. Now, we extend this analysis to explain how the variables in the respective sets combine to influence support for building codes.

To accomplish this, we use the parameter estimates from Model 5 (in Table III) to estimate the probability that three different groups of homeowners will support building codes—an average, push, and pull group. For the average group, we set the numeric inputs to the model at their mean values and the categorical indicators to their modes. For the push group, we increase objective tornado risk, subjective short-term tornado risk, weather damage experience, and tornado knowledge to their max values, while holding the other inputs to their average value. For the pull group, we set culture to fatalist, party to Republican, and political ideology and skepticism about global climate change to their max values. Then, we use these settings to predict the probability of support for each group. To account for and display the uncertainty in these predictions, we use the simulation approach outlined in King, Tomz, and Wittenberg (2000). The distributions of these simulations are shown in Fig. 4.

The simulations generate a mean probability of support for the building code enhancements of approximately 0.64 for the average group, with 95% confidence intervals (CIs) that range from 0.58 to 0.70.[16] When the push parameters are maximized (the push group, as described above), the estimated probability of support increases to roughly 0.76 (95% CI, 0.69–0.82), revealing a combined effect of 0.12 (95% CI, 0.03–0.20) for the push dynamics. When the pull parameters are maximized (the pull group, described above), the estimated probability of support decreases to approximately 0.40 (95% CI, 0.32–0.50), yielding slightly larger combined effects of 0.24 (95% CI, 0.12–0.34) for the pull dynamics.

These findings indicate that the net effects of the pull dynamics in our models are stronger (on average) than those of the push dynamics. That is, the net pull effects of ideology, partisanship, and cultural dispositions can substantially erode support for the enhanced building codes—drawing it well below a 50% threshold among the most conservative, Republican, and fatalistic survey respondents. Note, however, that these findings are subject to considerable uncertainty, as indicated by the spread for each group shown in Fig. 4. Similarly, it is important to reiterate that these simulations are based on correlations between survey measures, not experiments or interviews. As such, we cannot attribute causality to the relationships.

6. IMPLICATIONS

Between 1989 and 2013 Oklahoma experienced 1,597 tornadoes that produced roughly $30 billion in insured losses. If tornadoes continue at this rate, the state will experience more than $100 billion in insured losses over the next 50 years. Other states, including Mississippi, Alabama, and Missouri, face a similar plight. Engineers indicate that relatively simple and inexpensive enhancements to building codes may reduce insured losses by 30% or more and economists indicate that such measures "easily pass the benefit cost test" in multiple states (Simmons, Kovacs, & Smith, 2018). Although promising, only one city in the United States—Moore, OK—has adopted these codes. Why is this the case? What is stopping other communities and states in

[15]This null result for income may reflect that the mitigation requirements are imposed only on future residential construction. Thus, from the perspective of our respondents, all costs would be deferred until (and if) they purchased a new home built after the new regulations take force.

[16]As we would expect, the mean level of support for the "average" group is nearly identical to the mean in the raw data.

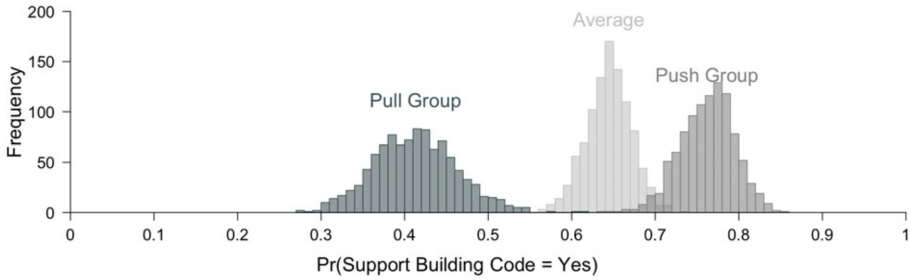

Fig. 4. Simulated probability of support for building codes by group.

tornado-prone regions of the United States from adopting more stringent building codes?

One answer to these questions may be found in public views about risk and regulation. In Oklahoma, support for mandatory mitigation policies like building codes is subject to countervailing forces. Push dynamics, such as risk perceptions and damage experience, encourage support for mitigation. Pull dynamics, like individualistic (or fatalistic) and conservative worldviews, generate opposition. At the margin, the support-eroding pull dynamics appear to exert more force than do support-enhancing push dynamics. Homeowners in Oklahoma tend to recognize the risks that tornadoes pose, but are reluctant to resort to compulsory efforts to manage those risks. Currently, the balance of these dynamics favors building codes (65%), but that balance is tenuous—only 27% of our respondents say they would be "certain" to vote for mandatory codes in a hypothetical statewide referendum, whereas 35% said they would "probably" vote for them. Extensive comparisons of survey responses with voting behavior on public referenda show that survey respondents who express uncertainty often vote "no" if they decide to vote at all (e.g., Carson, Hanemann, & Mitchell, 1987; Champ & Brown, 1997). Thus, our data indicate that public support for policy change is likely, in reality, to be relatively modest.

Modest public support for a policy of this kind is unlikely to result in its adoption. Preliminary data indicate that the new building code in Moore, OK, is having little or no effect on the price and volume of home sales, despite increases in the cost of construction (Simmons & Kovacs, 2017). This suggests that the costs of the new code are likely to fall disproportionately on homebuilders, which would explain why the coalitions opposing enhanced building codes have included the home construction industry (National Association of Homebuilders, 2016). At the state level, entrenched opposition by Oklahoma homebuilders is therefore likely to make passage of the enhanced building codes quite challenging.

Changing this opposition to stricter building codes will require an increase in the push dynamics and/or amelioration in the pull dynamics. Those interested in increasing the likelihood of adoption of mandatory mitigation policies should target these dynamics. For instance, they might consider enhancing the "push" side of the equation through public information campaigns that highlight the benefits of enhanced building codes and/or the losses that communities might incur if they fail to adopt them. In addition to emphasizing individual homeowners' benefits/costs of mitigation, which may strengthen the push side of the equation, the program should emphasize the negative externalities of inaction, which could weaken the pull side.

When tornadoes strike poorly constructed homes, the debris field often produces missiles that damage adjacent homes, even if those adjacent homes are built to higher standards (Lee, 1974). In situations like this, market externalities (the increased risks of tornado damage to homeowners with a well-designed home adjacent to a poorly constructed home) can serve to justify government-imposed enhanced building standards. This kind of argument would directly address the reluctance of many homeowners to support an expansion of government regulations. Similar dynamics were evident in increasing public support for laws against public smoking and drunk driving. Historically, large segments of the population were resistant to government intervention—If people want to harm themselves, why stop them? Over time, however, community programs and advertisement campaigns brought awareness to the negative externalities of these activities and, consequently, strengthened the support for regulation (see, e.g., Elder at al., 2004; McMillen, Winickoff, Klein, & Weitzman, 2003).

In addition to community programs and/or advertisement campaigns, policymakers who are interested in fostering support for building codes in states like Oklahoma might consider ways to assure that the value of the enhanced building code is captured in the price of the home. As noted above, current evidence indicates that homebuilders bear the additional costs of complying with the new codes in Moore, OK (Simmons & Kovacs, 2017), and homebuilders are active and potent participants in the building code policy arena. If the value of the "hardened" (or "fortified") homes is recognized (see, e.g., Awondo, Hollans, Powell, & Wade, 2017), such that the sale prices of these homes capture (or perhaps even exceed) the added building costs, homebuilders would be less likely to oppose the added building codes. To facilitate this recognition, a program targeting realtors and home buyers might highlight the "tornado resilience" of hardened homes as a distinguishing feature in localities that adopt building codes. This may increase demand for new homes in this area (relative to old homes in the same area, or new homes in a different area), and thereby allow homebuilders to recapture the added costs of construction. Home buyers would benefit by way of safety improvements, damage mitigation, and (ideally) higher resale values.

These benefits are appealing, but a cautionary note on affordability is necessary. Small increases in the price of homes can exclude a large number of people from the housing market. One study reports that a $1,000 increase in costs to new construction leads to more than 200,000 people being excluded from the housing market (Shapiro, 2016). To ease this burden, code enhancement programs are likely to be more effective if insurance companies are willing to adjust premiums and/or lending agencies are willing to provide long-term, low-interest loans for hardened homes (Czajkowski, Ripberger, Silva, Michel-Kerjan, & Simmons, 2016). These ideas have been discussed in the context of mitigating flood-related losses and could be extended to wind-related damage from tornadoes (Kousky & Kunreuther, 2014; Kunreuther, 2018; Zhao, Kunreuther, & Czajkowski, 2016).

Absent proactive efforts to encourage support and/or limit opposition, widespread adoption of building codes that reduce losses from tornadoes in states like Oklahoma will be difficult to accomplish. Instead, we will likely see a patchwork of reactive mitigation policies that are adopted in the wake of major disasters, like the devastating tornado that struck Moore, OK, on May 20, 2013, which caused $3 billion in damage. Like many disasters, the Moore tornado was a singular "focusing event" that led to major policy change (Birkland, 1998)—in this case, an enhanced building code that was adopted less than a year after the tornado. Other communities may follow Moore's lead, but it will be unfortunate if we are forced to rely on future disasters to generate the strong push for risk mitigation that overwhelms public opposition to regulation.

7. FUTURE RESEARCH

Beyond tornadoes, this analysis provides direction for future research in other hazard domains where objective risk, subjective perceptions, and experiences compete with values and beliefs to enhance or undermine public support for mitigation policies. Prime examples include the enforcement of building codes that limit property damage from hail storms (Czajkowski & Simmons, 2014) and hurricanes (Gurley & Masters, 2010) and land use (zoning) policies to limit damage from flooding (Aerts & Botzen, 2011). More extreme examples may include land acquisition and population relocation to mitigate the impact of sea level rise and other hazards that stem from climate change (McDowell, 2013). The results of this analysis suggest that the mandatory nature of these policies will generate friction between risk, beliefs, and values that will make them difficult to implement in many communities.

Motivated by this tension, future research should identify the factors that weaken or "disarm" the negative effects of culture, partisanship, and ideology on support for mandatory mitigation policies. Recent research on climate change risk communication may provide a starting place. For example, one study shows that "practical information" about risk can override political identity cues when people are making decisions that involve climate change vulnerability (Wong-Parodi & Fischhoff, 2015). Other studies find that experience (Myers, Maibach, Roser-Renouf, Akerlof, & Leiserowitz, 2013), engagement (Tompkins, Few, & Brown, 2008), and information about scientific agreement (Van der Linden, Leiserowitz, Rosenthal, & Maibach, 2017) can counteract the influence of values and beliefs on support for climate change mitigation and adaptation. If applied to the study of building codes and other involuntary risk reduction mechanisms, we theorize that these factors may ameliorate some of the tension in Oklahoma and other communities that perceive risk but distrust government and regulation.

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APPENDIX A: Question Wording

Cultural Affinity

{Egalitarian} My most important contributions are made as a member of a group that promotes justice and equality, to combat unfairness and corruption in society. Within my group, everyone should play an equal role without differences in rank or authority. It is easy to lose track of what is important, so I have to keep a close eye on the actions of my group. It is not enough to provide equal opportunities; we also have to try to make outcomes more equal.

{Individualist} Groups are not all that important to me. I prefer to make my own way in life without having to follow other people's rules. Rewards in life should be based on initiative, skill, and hard work, even if that results in inequality. I respect people based on what they do, not the positions or titles they hold. I like relationships that are based on negotiated "give and take," rather than on status. Everyone benefits when individuals are allowed to compete.

{Hierarch} I am more comfortable when I know who is, and who is not, a part of my group, and loyalty to the group is important to me. I prefer to know who is in charge and to have clear rules and procedures; those who are in charge should punish those who break the rules. I like to have my responsibilities clearly defined, and I believe people should be rewarded based on the position they hold and their competence. Most of the time, I trust those with authority and expertise to do what is right for society.

{Fatalist} Life is unpredictable and I have very little control. I tend not to join groups, and I try not to get involved because I can't make much difference anyway. Other people make the rules; I just have to abide by them. Getting along in life is largely a matter of

Table B-I. Logistic Regression Models of Homeowner Support for Building Codes to Mitigate Tornado Damage

	Mode 1	Model 2	Model 3	Model 4	Model 5
Cost: \$3,000 (v. \$2,000)	−0.03 (0.03)	−0.02 (0.03)	−0.02 (0.03)	−0.02 (0.03)	−0.02 (0.03)
Cost: \$4,000 (vs. \$2,000)	−0.04 (0.03)	−0.04 (0.03)	−0.04 (0.03)	−0.04 (0.03)	−0.04 (0.03)
Objective tornado risk	0.07*** (0.02)	0.07*** (0.02)	0.06*** (0.02)	0.07*** (0.02)	0.06*** (0.02)
Subjective short-term tornado risk	0.10*** (0.03)	0.10*** (0.03)	0.09*** (0.03)	0.08*** (0.03)	0.07*** (0.03)
Weather damage experience	0.07** (0.03)	0.07** (0.03)	0.07** (0.03)	0.07** (0.03)	0.07** (0.03)
Tornado knowledge	0.03 (0.02)	0.03 (0.02)	0.03 (0.02)	0.04 (0.03)	0.04 (0.03)
Individualist (vs. egalitarian)	−0.13*** (0.04)				−0.08** (0.04)
Hierarch (vs. egalitarian)	−0.13*** (0.04)				−0.09** (0.04)
Fatalist (vs. egalitarian)	−0.15** (0.06)				−0.12** (0.06)
Republican (vs. Democrat)		−0.10*** (0.03)			0.01 (0.04)
Independent (vs. Democrat)		−0.04 (0.04)			0.02 (0.04)
Political ideology			−0.14*** (0.03)		−0.05 (0.04)
Skepticism about climate change				−0.16*** (0.03)	−0.12*** (0.03)
Household income	−0.03 (0.03)	−0.03 (0.03)	−0.03 (0.03)	−0.03 (0.03)	−0.02 (0.03)
College (vs. no college)	0.10*** (0.03)	0.11*** (0.03)	0.10*** (0.03)	0.10*** (0.03)	0.09*** (0.03)
Age	0.05** (0.02)	0.06** (0.02)	0.07*** (0.02)	0.06** (0.02)	0.06** (0.03)
Male (vs. female)	0.03 (0.03)	0.03 (0.03)	0.04 (0.03)	0.04 (0.03)	0.04 (0.03)
Constant	−0.18* (0.11)	−0.26** (0.10)	−0.12 (0.11)	−0.16 (0.10)	−0.04 (0.11)
Observations	1,502	1,502	1,502	1,502	1,502
Log likelihood	−921.92	−923.00	−916.44	−910.02	−904.62
Akaike inf. crit.	1,871.85	1,872.00	1,856.88	1,844.04	1,845.24

Note: Approximate marginal effects, calculated at the means of the independent variables; standard errors in parentheses; $^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$.

doing the best I can with what comes my way, so I just try to take care of myself and the people closest to me. It's best to just go with the flow, because whatever will be will be.

Income: *Thinking specifically about the past 12 months, what was your annual household income from all sources?*

Age: *How old are you?*

Gender: *Are you male or female? [1 = male; 0 = female]*

Education: *What is the highest level of education you have COMPLETED? [1 = Less than High School; 2 = High School/GED; 3 = Vocational or Technical Training; 4 = Some College (no degree); 5 = 2-year College/Associate's Degree; 6 = Bachelor's Degree; 7 = Master's Degree; 8 = PhD, JD, or MD]*

APPENDIX B: Model Results and Robustness

As shown in Table B-I, the estimates we get when using listwise deletion of missing values are quite consistent with the estimates we present in Table III, which rely on multiple imputation. There are, however, a few noteworthy differences. First, the push and pull estimates are a bit larger (on average) than the estimates from the model using imputed data, with one exception—the difference between liberals and conservatives (political ideology) is smaller and becomes statistically insignificant when culture, party, and skepticism about climate change are held constant. Second, the estimates shown in Table B-I are less precise (larger estimated standard errors) because there are fewer observations. Because of this, although the estimates of the effects of cost ($4,000 vs. $2,000) and tornado knowledge are similar (in size) to the estimates from the model using imputed data, they are statistically insignificant. Overall, however, the consistency of the results shown in Tables IV and B-I indicate that the results described in this article are robust.

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