Race Discrimination in the Adjudication of Claims: Evidence from Earthquake Insurance

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Abstract Catastrophic events, such as hurricanes and earthquakes, affect many people simultaneously. In this regard, they differ from automobile accidents and home fires, which typically inflict loss on only an individual or family at a time. We exploit this claim characteristic to test for evidence of racial discrimination in the adjudication of claims. There were eight earthquakes in Oklahoma between 2010 and 2016, most linked to fracking. Using zip code level data and publicly available information from the Oklahoma department of insurance, we test whether claim resolutions differed between the majority white population and minorities after controlling for factors including distance from the earthquake epicenter, insurance policy characteristics and the use of engineers and public adjusters in the examination of the claim. We find evidence that claims from minorities were less likely to result in an insurance company payment. Further, we find evidence that claim settlements were less for minorities when a claim was paid.

JEL Classification: C13; G22; H12.

Keywords: Earthquake insurance, Insurance claims.

1 Introduction

Economic research on racial discrimination has empirically tested for it in the labor market (see, for instance, Ashenfelter and Rees (1973)), residential mortgage market (see, for instance, Harrison (1998) and Munnell et al. (1996)); the small business credit market (Blanchflower et al. (2003)); the market for new automobiles (Ayres and Siegelman (1995)); as well as others. Becker (1993) in his Nobel Lecture asserted that tests for racial discrimination should assess whether profits differ between goods purchased by minorities and others. Evidence of discrimination reported in empirical work to date is mixed with some finding evidence of it and others not. The topic is of interest not only because of the social justice implications but also because discrimination in pricing would suggest some form of market failure. As Harrington et al. (1998) state in their research on discrimination in the market for automobile insurance, The existence of large numbers of insurers that are licensed to write auto insurance in most states with relatively low market concentration and entry costs (e.g., Klein (1989); Cummins and Tennyson (1992)) militates against substantive economic effects from racial discrimination. The alternative hypothesis is that racial prejudice is pervasive enough in conjunction with entry costs or other market imperfections to allow discriminatory practices to harm minorities signicantly.

Research on racial and other forms of demographic discrimination in the insurance industry, which has been somewhat sparse, has considered both the pricing of insurance and claims adjudication. Harrington and Niehaus (1998) test for racial discrimination in the pricing of automobile insurance at the market level with zip code data from Missouri. They find that loss ratios do not differ significantly between zip codes that have different racial compositions. They attribute higher premiums in urban areas with large minority populations to higher claims costs. Klein and Grace (2001) contribute to the debate on redlining by homeowners insurers in Texas by empirically testing for discrimination. Like Harrington and Niehaus (1998), they use zip code level data for their analyses. They find no statistical evidence for redlining and conclude that the terms of homeowners coverage is driven by the risk of loss and the demand for coverage, not racial discrimination. In contrast to the prior two studies, Doerpinghaus et al. (2003) consider claims settlement practices, as opposed to insurance company profitability. They used the 1997 Insurance Research Council Closed Claim Survey to test for gender and age discrimination. They report evidence of differences in assignment of fault in bodily injury automobile claims between genders and across age groups. They find, while controlling for the degree of actual fault, that claims adjusters assign greater degrees of fault in automobile accidents to female, young and elderly drivers.

This paper tests for evidence of racial and possibly other forms of demographic discrimination in the adjudication of earthquake insurance claims in Oklahoma, following earthquakes that can be contributed to a type of oil and gas drilling activity knowns as hydraulic fracturing. We contribute to the economic literature on racial discrimination by offering two unique perspectives. First, we look into the settlement of insurance claims, where the competitive market assumption is not necessarily relevant, as profitability is not achieved through pricing, but through a claim settlement process between the insurer and the insured. Second, we distinguish ourselves from other insurance claims literature by evaluating claims resulting from a single event that affects many people at the same time, for example, an earthquake event. We analyze detailed claim-level information, as well as neighborhood information based on the zip-code area from which a claim was filed, to identify contributing factors for a claim's approval or denial, its speed of settlement, and how much is the payment. Specifically, we seek answers to three important research questions:

1. Given the same earthquake event and control for distance to epicenter and policy-level differences, are insurers more likely to pay out claims from certain neighborhoods (e.g., discrimination based on the extent of minority presence in a zip-code)?
2. Given the same earthquake event and control for distance to epicenter and policy-level differences, are claims from certain neighborhoods get settled faster and/or get paid more?
3. Does public adjuster make a difference in reducing neighborhood-based racial or other demographic discrimination?

How does a consumer file a claim and how is that claim settled is directly relevant to many stakeholders including consumers, insurers, and regulators. Cummins and Tennyson (1996) investigate the effect of costs and benefits of insurance claims on consumers' willingness to file claims, that is, moral hazard in insurance claiming. Browne and Schmit (2008) focus on the effect of the legal system or tort reform on liability claims filing. Doerpinghaus et al. (2008) look for biases in automobile claims settlement and find that insurers assign greater degree of fault against female, young, and elderly drivers, controlling for actual degree of fault. All of these studies focus on claims resulting from an individual event that affects individuals separately and one at a time. In this paper, we investigate earthquake claims that affect many people in one state simultaneously, to better identify the differences in claims settlement practice towards what should be an otherwise homogeneous group of people.

This paper also speaks to the very timely discussions about risk management of consequences from hydraulic fracturing. Man-made environmental risks such as this pose challenges to homeowners, the insurance industry, and policy-makers. The importance of insurance serving as a risk management tool for individuals cannot be enough emphasized. How the insurance industry handles claims has a direct impact on local residents' livelihood and the future of the hydraulic fracturing technology.

The paper is organized as follows. The next two sections first detail the dataset used in this paper, then offer background on earthquake insurance and hydraulic fracturing in Oklahoma. Section 4 reviews relevant literature. Section 5 offers preliminary analysis and results. Section 6 concludes and discusses further steps on this research topic.

2 Data and Summary Statistics

We use a recent dataset of individual earthquake insurance claims from the Oklahoma Insurance Department (OID). The OID has been collecting earthquake claims data on an ongoing basis since 2010 by surveying major insurers in the state. Our dataset includes information until the third quarter of 2017. We identify 8 noticeable earthquake events between 2010 and 2017 that occured in Oklahoma and link earthquake insurance claims to those events based on each claim's date of loss. We also exclude earthquake claims that do not have a percentage deductible [such as 2% or 5%] but a dollar amount deductible [such as USD500 or USD1000]. This is because homeowners may file an earthquake claim under their homeowner's insurance (which carries a dollar deductible), not knowing that such loss is excluded and will only be covered under a separate earthquake insurance policy or earthquake endorsement, which almost always carries a percentage deductible.

In total we are able to match 835 credible earthquake claims to an earthquake event.[1] Table 1 summarizes the number of claims filed after each earthquake event, along with the number of claims paid and the average claim payment if a claim is paid. Among all claims submitted, majority are not paid (except the first earthquake event in 2010), and the average claim payment is only USD12,112, though the largest single payment is USD257,550. Two earthquakes (the 2011 Prague earthquake and the 2016 Pawnee earthquake) account for the majority of earthquake claims filed and paid.

Table 1 Earthquake events and corresponding claims. Average claims payment is calculated conditional on a claim being paid.

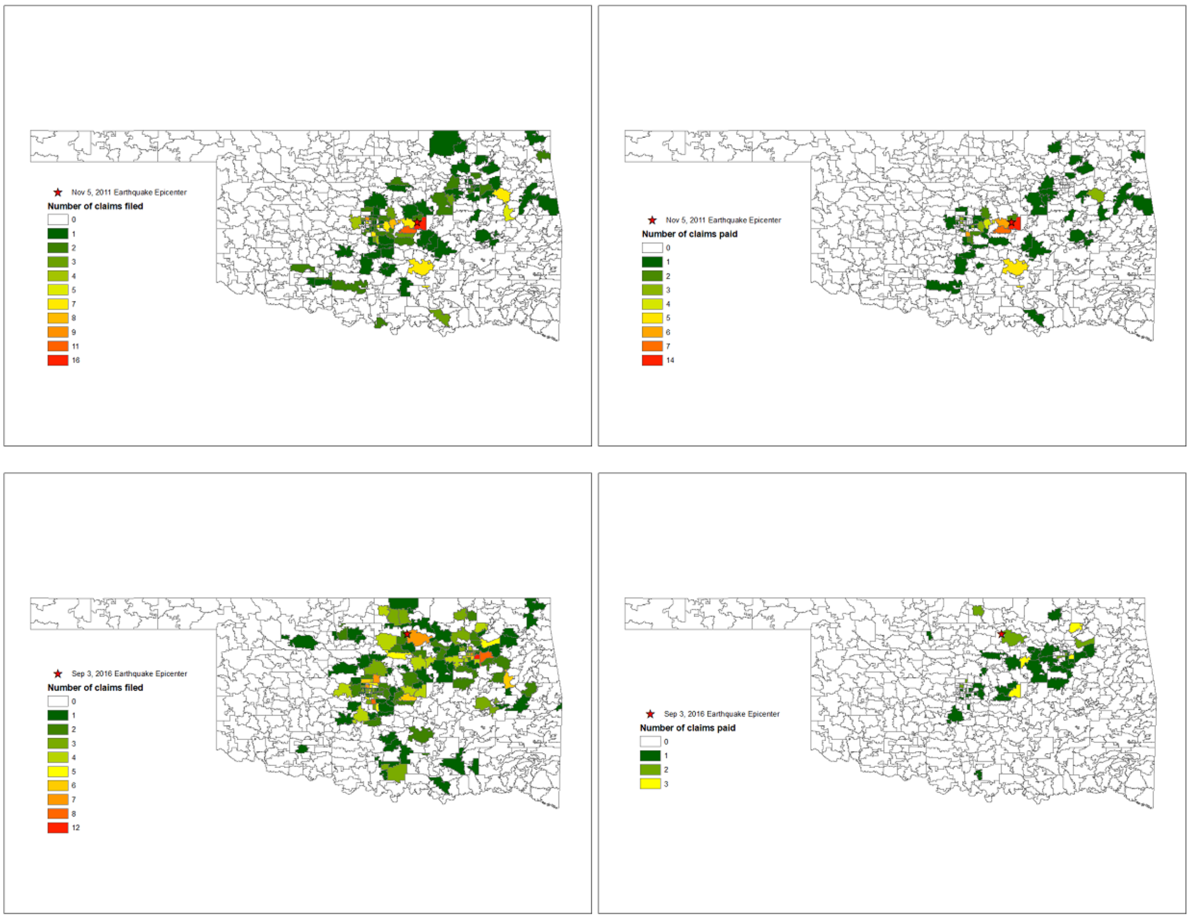
EVENT	Number of Claims filed	Number of Claims Paid (%)	Average Claims Paid ($)	Largest Claim Paid ($)
10/13/2010	30	20 (66.67%)	14,696	113,370
11/5/2011	234	111 (47.44%)	13,318	204,543
4/16/2013	23	4 (19.05%)	7,854	11,860
12/7/2013	21	5 (21.74%)	7,835	23,582
7/27/2015	16	3 (18.75%)	13,869	21,435
12/29/2015	36	7 (19.44%)	10,716	31,206
9/3/2016	388	67 (17.27%)	10,847	257,550
11/6/2016	87	27 (31.03%)	9,972	44,466
Total	835	244 (29.22%)	12,112	257,550

Figure 1 shows the epicenters of these two major earthquakes and where claims were filed and paid. The two maps on the upper panel indicate claims associated with the 2011 Prague earthquake, and the two maps on the lower panel indicate claims associated with the 2016 Pawnee earthquake. The maps on the left indicate where and how many claims were filed, and the maps on the right indicate where and how many claims were paid. Surprisingly, both earthquakes had very large geographic impact (given the magnitude of 5.7 and 5.8, respectively), reaching a big part of the state. But maybe not so surprisingly,

[1] In majority of cases, the date of loss is the date of the earthquake. For a few of these earthquakes, we also include observations with date of loss being a few days after the main quake, when a major aftershock occurred, or within a two-day window of the earthquake when the event hour is close to the midnight (based on information recorded by the U.S. Geological Survey). There are still a couple hundred earthquake claims for which we are not able to match to a specific earthquake event, based on the date of loss information. So we drop those observations.

earthquakes triggered by human gas and oil drilling activities tend to be much shallower than those triggered by natural force, therefore are felt more significantly given a magnitude that measures the total energies released. The geographic locations of claims filed and paid seem quite random, suggesting that factors other than the distance to epicenter may play an important role.

Figure 1 Earthquake insurance claims filed and paid. Upper left: number of earthquake claims filed following the 2011 Prague earthquake; upper right: number of earthquake claims paid following the 2011 Prague earthquake; lower left: number of earthquake claims filed following the 2016 Pawnee earthquake; lower right: number of earthquake claims paid following the 2016 Pawnee earthquake;



Each earthquake claim comes with the following policy-level information: zip-code area from where the claim is filed, policy limit that approximately represents the value of the insured home, policy deductible, date of loss (i.e., date of the earthquake that causes damage), date of notice of claim, date of initial claim payment (if any), amount of claims paid (if any), date of close of claim, if an engineering report was obtained from a licensed structural engineer, and if a public adjuster was obtained by the claimant in the process.

Table 2 summarizes these variables. The 835 earthquake claims filed since 2010 have an average policy limit of USD192,248, with the largest limit of over 1.3 million dollars. Earthquake insurance policy deductible is a percentage of policy limit. More than half of these earthquake policies have a 2.00%

deductible, the lowest possible deductible option. Translated into dollar terms, the average dollar amount of deductible is USD6,257, the median deductible is USD3,766, still much larger than that of a standard homeowners' insurance. In terms of delay in the notice of claim after an earthquake, half of the claims were submitted within 9 days of an earthquake event, while the longest delay in claim submission takes about 4 years after an earthquake. 66% of these claims obtained an engineer report from a structural engineer, while 1.2% of them obtained a public claims adjuster (in addition to the claims adjuster assigned by the insurer).

Table 2 Summary statistics of claims data obtained from the Oklahoma Insurance Department (OID).

VARIABLES	Obs	Mean	Median	Std. Dev.	Min	Max
Policy limit ($)	835	192,248	169,739	119,396	12,000	1,309,886
Deductible (% of policy limit)	835	3.29%	2.00%	2.90%	2.00%	25.00%
Deductible ($)	835	6,257	3,766	7,642	240	95,040
Engineer report (1=yes, 0=no)	835	66.47%	1	0.472	0	1
Public adjuster (1=yes, 0=no)	835	1.20%	0	0.012	0	1
Delay in notice of claim (days)	835	51	9	115	0	1473

Finally, we link the claims dataset to the census dataset based on zip-code. For each claim, we then have information on the neighborhood characteristics of the zip-code area where that claim is from. Available information includes a zipcode area's population, population density, median household income, median home value, percentage of college graduates among those at least 25 years old, percentage of population that are black, Asian, Hispanic, Native or Indian Amercian. Table 3 shows summary statistics of the census in Oklahoma. We also created a "minority" variable that include all except non-hispanic white population. Table 4 tests the correlation among these zip-code level variables. The highest correlation is among the median household income, the median home value, and the eduction level in terms of percentage of college educated population. We should consider not using all of these variables in the regression analysis to avoid collinearity problem.

3 Background

3.1 Hydraulic Fracturing and Induced Seismicity

The United States has experienced an extraordinary shale gas boom in the past decade. The Energy Information Administration reports that the annual U.S. natural gas withdrawals from shale gas has grown from 1.99 trillion cubic feet in 2007 to 16.58 trillion cubic feet in 2016,[2] representing more than

[2] See https://www.eia.gov/dnav/ng/hist/ngm_epg0_fgs_nus_mmcfa.htm.

Table 3 Summary statistics of census data for all zip-code areas in Oklahoma.

VARIABLES	Obs	Mean	Median	Std. Dev.	Min	Max
Population	650	5,891	1,861	9,363	0	61,142
Population density (per square mile)	648	336	27	923	0	9483
Median household income ($)	631	45,138	43,021	13,623	14,306	136,694
Median home value ($)	629	93,232	82,900	40,709	34,100	387,300
Education (% with college degree)	648	18.75	16.26	10.84	0	100
Percent Black (%)	649	4.52	0.84	11.07	0	97.17
Percent Asian (%)	649	0.77	0.089	1.95	0	21.88
Percent Indian American (%)	649	8.46	5.80	8.46	0	53.75
Percent Native (%)	649	0.086	0	0.57	0	12.90
Percent Hispanic (%)	649	6.82	4.11	8.72	0	62.00
Percent Minority (%)	649	27.70	25.30	15.71	0	100

Table 4 Correlation Matrix of census variables

	Medinc	Medhov	Edu	Density	Minority
Median household income (Medinc)	1				
Median home value (Medhov)	0.6754	1			
Education percentage with college degree (Edu)	0.6276	0.7302	1		
Population density per square mile (Density)	0.0075	0.2639	0.3025	1	
Percent minority (Minority)	-0.4155	-0.1433	-0.2182	0.3258	1

half of the total U.S. natural gas production in 2016, up from about 8% in 2007.[3] This shale gas boom is thanked to technological development that combines hydraulic fracturing and horizontal drilling which reduces the required number of wells to access the same volume of rock, making oil and gas extraction from shale plays commercially viable. Hydraulic fracturing involves pumping a mixture of water, sand, and other chemicals into the production well at high pressure to crack open the rocks and hold the fractures open so that oil and gas trapped inside can escape when the water is removed and pressure releases. After production from fracturing is completed, large volumes of wastewater are created, which are often injected back into deep underground wells to be disposed. Wastewater injection involves much more uids at much higher pressure than the hydraulic fracturing production phase.

Research found that wastewater injection activities change the natural stress between faults and triggers shallow earthquakes, many of which large enough to cause damages (Rubinstein and Mahani (2015); Weingarten et al. (2015)). In 2017, the U.S. Geological Survey (USGS) produced a 1-year seismic hazard forecast for the Center and Eastern United States (CEUS) that takes into consideration induced earthquakes. The map shows that the probability of a damaging earthquake in some parts of the CEUS (noticeably Oklahoma) is at the same level as the shakiest part of California.[4]

[3] https://www.eia.gov/dnav/ng/hist/n9010us2a.htm
[4] https://earthquake.usgs.gov/hazards/induced/

3.2 Earthquakes and Earthquake Insurance in Oklahoma

Oklahoma was not a state known for earthquakes so far. However, the number of magnitude 3.0 or above earthquakes in Oklahoma has grown exponentially from 1 in 2007 to 20 in 2009, 579 in 2014, and 903 in 2015 (Oklahoma Geological Survey). Even though only very few of these earthquakes are damaging, the sheer frequency of earthquakes has become remarkable. It was suspected that these earthquakes were caused by oil and gas drilling activities and insurers were reported denying earthquake claims based on a "man-made earthquake exclusion". In March 2015, the Oklahoma Insurance Commissioner issued a Bulletin cautioning earthquake insurers that his Department would "take appropriate action to enforce the law" if insurers are found "denying claims based on the unsupported belief that these earthquakes were the result of fracking or injection well activity". He cites an "extraordinary denial rate of the earthquake claims" based on a preliminary 2014 data, indicating only 8 out of about 100 claims were paid in that year.[5]

Scientists, the public, and regulators finally reached the consensus that these earthquake phenomena are probably linked to unconventional oil and gas drilling activity known as hydraulic fracturing, or "fracking".[6] The Oklahoma Insurance Commissioner issued another Bulletin in October 2015, asking insurers to "clarify the issue of coverage by furnishing written notice to insureds and producers", acknowledging that "the majority of the numerous quakes experienced by Oklahomans are, more than likely, the result of waste water injection into disposal wells". The majority of insurers ended up clarifying that they cover natural and man-made earthquakes, whereas in the past man-made earthquake was excluded. Even with the "man-made earthquake exclusion" out of the way, a media report in March 2017 still claims "3 in 20 claims approved in Oklahoma since 2010", and that the denial rate is even higher for claims filed following the 2016 Pawnee earthquake than for those filed following the 2011 Prague earthquake.[7]

Oklahoman's exposure to earthquake risk since 2010 makes earthquake insurance as relevant as never before. Because homeowners' insurance policy does not cover losses from an earthquake, residents who want this coverage have to purchase additional earthquake endorsement or a separate policy. The take-up rate on earthquake coverage among Oklahoman residents has increased from 2% in 2011 to 15% in 2015.[8] This is quite significant, considering that only about 10% of Californian homeowners have earthquake insurance (Lin (2016)).

According to the Oklahoma Insurance Department, to this date, more than 90 percent of the insurance market covers man-made and natural earthquakes. Earthquake insurance deductibles are a percentage of

[5] Oklahoma Insurance Department: Earthquake Insurance Bulletin No. PC 2015-02. Retrieved from https://www.ok.gov/oid/documents/030415_Earthquake%20Bulletin%203-3-15.pdf

[6] This New York Times article describes several homes' damages from earthquakes and homeowners' lack of resources to recover, with the oil and gas industry to blame. Retrieved from https://www.nytimes.com/2015/04/04/us/as-quakes-rattle-oklahoma-fingers-point-to-oil-and-gas-industry.html.

[7] See http://www.tulsaworld.com/earthquakes/earthquake-insurance-in-claims-approved-in-oklahoma-since/articlede588725-1475-592c-9025-bdcfbf9b8bcd.html.

[8] Property Insurance Law Observer. Retrieved from http://propertyinsurancelawobserver.com/2015/04/02/oklahoma-insurance-commissioner-dont-deny-earthquake-claims-as-man-made-by-linking-them-to-fracking/

the insured value of a home and not the usual USD500 to USD1000 deductibles encountered in homeowners insurance. The lowest deductible plans are set at 2 percent, with premiums from about 30 cents to 71 cents per USD1,000 in coverage. A high deductible of 25 percent for USD1,000 in coverage has premiums that go from about 22 cents to 63 cents.

4 A view into the Literature

4.1 Literature on Hydraulic Fracturing

Hydraulic fracturing causes many different environmental problems. Muehlenbachs et al. (2015) find that the risk of water contamination is linked to lower house prices in Pennsylvania for houses that are dependent on ground water (without access to public water service). Drilling operations cause air pollution, which may in turn have negative health impacts on human-beings (Colborn et al. (2014), Roy et al. (2014)). Increased truck traffic may result in road damage, more accidents and noise (Muehlenbachs and Krupnick (2014)).

Three recent research papers look at the risk of induced seismicity from fracking activities. Gibbons et al. (2016) prove negative impact of seismic risk associated with fracking in U.K. Although hydraulic fracturing has not been commercialized in most parts of the U.K., and there have only been a couple of licensing for shale gas exploration, there has already been public fears, as evidenced in the decreased house prices where two minor earthquakes occurred. Liu et al. (2017) recover hedonic estimates of property value impacts from nearby shale oil and gas development within Oklahoma County. They found a decrease in values of properties within 2 km of injection wells, especially after the 2011 Prague earthquake, and generally, earthquakes happening in the county and the state. They suggest an enhanced risk perception of induced seismicity has occurred in the housing market in Oklahoma County. Cheung et al. (2016) also find negative impacts of fracking-induced earthquakes on residential property values. They focus on the entire Oklahoma state, and focus more on the experience of earthquakes. They find that experiencing earthquakes measuring higher on the Modified Mercalli Intensity Scale causes property prices to decline more, while experiencing lower-intensity quakes does not seem to a affect property prices.

4.2 Literature on Earthquake Risks and Insurance

The literature on earthquake risks and insurance coverage for these catastrophic risks is scarce. A first study by Anderson (1976) proposes all risks ratings for cat insurance systems: Properties in most states could be endorsed with earthquake at a small additional cost. However, important rating problems would occur with areas that have a high earthquake exposure; subsidies as a potential remedy are discussed. Brookshire et al. (1985) show that the expected utility hypothesis reasonably describes individual decision-making under low-probability-high-loss natural hazards. Brillinger (1993) discusses the problem of seismic risk assessment and the challenges. Following Anderson, Naoi et al. (2010) show in a theoretical model that uniform community rating for earthquake insurance premiums may unintentionally cross-subsidize consumers living in high risk areas at the expense of consumers living in low risk areas.

Kleffner and Doherty (1996) study that tax convexity, principal-agent relationships within the firm, and the costs of financial distress jointly determine the capacity of insurers to write earthquake insurance. May and Feeley (2000) provide an overview of regulatory challenges for earthquake risks. Ibragimov et al. (2008) evaluate the conditions when insurers may not want to diversify risks and thus would not want to offer coverage for catastrophic risks, which they call the "nondiversification trap". These traps occur when distributions have heavy tails and insurers face limited liability. In these cases, a centralized agency needs to ensure risk sharing.

Specific earthquakes and their economic consequences are also studied. For instance, Shelor et al. (1992) as well as Aiuppa et al. (1993) discuss the changes in insurance stock prices following the Loma Prieta Earthquake in in California 1989. Vatsa (2002) studies the Bhuj earthquake that happened 2001 in India, and evaluates the potential for a national seismic mitigation program that encourages both the structural and non-structural measures as means of reducing seismic risk and institutional capabilities to do so. Bommer et al. (2002) describe how the government in Turkey adjusted to the rising financial burden after the Kocaeli and Dzce earthquakes in 1999. Sawada and Shimizutani (2008) investigate the financial coping strategies employed by victims after the Kobe earthquake 1995 in Japan.

Athavale and Avila (2011) examine insurance purchase decision-making by analyzing data on earthquake insurance price and penetration in the New Madrid fault zone in Missouri. Results indicate that homeowners acquire earthquake insurance due to risk considerations, at higher levels of risk the demand for earthquake insurance is higher, and the price of earthquake coverage does not provide incremental information in explaining the demand for earthquake coverage.

Most related to this paper, Palm and Hosdgson (1992) use Californian survey data to study the locational concentrations of home insurance buyers and the socioeconomic, demographic, and attitudinal characteristics that distinguish insured from noninsured homeowners. Interestingly, insurance purchase is not spatially related to geophysical risk. In these data, the purchase of insurance is not systematically related to income and other socioeconomic characteristics; instead, perceived risk is the primary factor associated with home insurance purchase. Baker and McElrath (1996) use quantitative and qualitative data collected after Hurricane Andrew to demonstrate that higher income, age, and education tend to be associated with having home insurance and that Hispanics and blacks were less likely than non-Hispanic whites to have such insurance. The study also provides evidence of a statistically significant bias in the insurance claims process by documenting ethnic differences in the timing of insurance payments.

5 Preliminary Analysis and Results

5.1 Is Race a Factor in the Probability of a Claim Being Paid?

This section focuses on identifying factors that affect the probability of a claim being paid after an earthquake. For each claim filed, we observe if it is paid (Claim = 1) or not (Claim = 0). Based on the zip-code location of a claim, we can use the distance between the zip-code centroid and the earthquake epicenter to proximate the distance between the property with which the claim is associated and the earthquake epicenter. Logically, the closer to the epicenter, the more violent the shaking, and the more likely that an earthquake claim would be paid. The effect of distance to epicenter on shaking intensity is likely different for different earthquake events, so we control for the distance to epicenter by event in our empirical model.

Besides the distance to an earthquake epicenter, policy deductible, policy limit (which proxies the value of the house), and the policyholder's delay in notice of claim after an earthquake also likely affect the probability of a claim being paid. In addition, we observe if a claim has an engineer report obtained from a licensed engineer (which is usually requested by the insurer to verify the extent of damage, if any), and if a public adjuster was involved (which is usually hired by the insured to represent him/her independently from the insurer). In regards to neighborhood characteristics of the zip-code area from where the claim was filed such as median income and race, we are interesting in seeing if any of those charactistics is significantly associated with the probability of a claim being paid.

Before running regression models, we first perform T-tests on zip-code characteristic differences by whether or not a claim is paid across all 8 earthquake events. Table 5 shows the differences. The percentage minority of zip-codes from where claims have not been paid is consistently larger than that from where claims have been paid. Although similar differences exist in the population density of zip-code areas (in Oklahoma, as Table 4 shows, that population density may be positively associated with minority percentage). There is no obvious difference in likelihood of claims being paid based on zip-code median household income.

Table 5 Independent T-test on the differences in zip-code characteristics based on claims outcome.

Mean difference of Paid (Claim=1) minus Unpaid (Claim=0)				
EVENT	Observations	Ln(Medinc)	Ln(Density)	Minority percentage
10/10/2010	30	0.034	-0.072	-3.76
11/5/2011	234	0.015	-0.48**	-4.18**
4/16/2013	21	0.22	-2.02***	-25.97*
12/7/2013	23	0.26	-0.98	-14.17*
7/27/2015	16	-0.26	-1.07*	-4.45
12/29/2015	36	-0.048	-0.15	0.38
9/3/2016	388	-0.020	-0.33	-2.63
11/6/2016	87	-0.086**	-0.98***	-4.95*

*** p<0.01, ** p<0.05, * p<0.1

Our regression model takes on the following form:

$$\begin{aligned} Logit(\text{Claim}_{ijz}) = {} & \alpha_1(\text{Distance})_{iz}\alpha_z + \alpha_2\ln(\text{Deductible})_{ijz} + \alpha_3\ln(\text{Limit})_{ijz} + \alpha_4\ln(\text{Delay})_{ijz} + \alpha_5(\text{Engineer})_{ijz} \\ & + \alpha_6(\text{PubAdjuster})_{ijz} + \beta_1\ln(\text{PopDensity})_j + \beta_2\ln(\text{MedIncome})_j + \beta_3(\text{Minority})_j + \alpha_z + \sigma_{ijz} \end{aligned}$$

with

$$Logit(\text{Claim}) = ln(\frac{Pr(\text{Claim is paid})}{1 - Pr(\text{Claim is paid})}),$$

where the subscript i indicates individual insurance policy, subscript j indicates zip-code, and subscript z indicates an earthquake event. All standard errors are clustered at the earthquake event level.

Table 6 presents our preliminary results. The dependent variable is a dummy variable $Claim = 1$ if the claim is paid and $Claim = 0$ if it is denied. As expected, lower dollar amount of deductible and higher policy limit significantly increases the probability of a claim being paid. Also as expected, the delay in policyholder's notice of claim is negatively associated with the probability of it being paid, as a delay in filing claim may indicate fraud. Both the presence of engineer report and public adjuster increases the probability of a claim being paid. It may not be intuitive why the insurer is more likely to pay claims after ordering an engeer report (perhaps out of suspision of the policyholder's account), but they may both be driven by a potential higher value of claim. In turns of zip-code level variables, neighborhoods with higher median income, higher population density, as well as higher minority presence seem to be associated with lower probability of claims being paid. Interestingly, in column (3) when interacting the zip-code minority percentage variable with the public adjuster indicator, the interaction term shows up significantly positive, possibly suggesting that public adjusters most signicantly helped claimants from a higher minority neighborhood get their claims paid.

5.2 Is Race a Factor in the Speed of Paying Claims?

Conditional on that a claim is paid, we further investigate if the speed of paying claim is associated with demographic factors including race, controlling for earthquake event, distance to earthquake epicenter by event, and policy characteristics. The same regression model as in the previous section is used. The dependent variable is the log of days it takes for the insurer from receiving a claim to the first claim payment. Results are presented in Table 7 columns (1) - (3).

It seems that insurer's speed of paying claims is not particularly related to any demographic characteristics of a neighborhood, not most of the policy-level characteristics, except one - if an engineer report has been obtained. This is not surprising, as obtaining engineer report takes time and could slow down the claim process.

Table 6 Logit regression of Claim (1=paid, 0=denied) on distance to epicenter, policy characteristics and neighborhood characteristics

VARIABLES	If a Claim is Paid (YES=1)		
	(1)	(2)	(3)
Log of Dollar Deductible	-1.518***	-1.539***	-1.545***
	(0.216)	(0.219)	(0.211)
Log of Policy Limit	1.296***	1.356***	1.364***
	(0.161)	(0.184)	(0.176)
Log of Delay in Filling Claims	-0.0823**	-0.0768**	-0.0780**
	(0.0335)	(0.0344)	(0.0342)
Engineer Report (YES=1)	0.523***	0.505***	0.501***
	(0.141)	(0.134)	(0.138)
Public Adjustment (YES=1)	2.372***	2.266***	
	(0.448)	(0.485)	
Log of Population Density		-0.0645*	-0.0662*
		(0.0374)	(0.0387)
Log of Median Household Income		-0.845***	-0.840***
		(0.146)	(0.146)
Minority Percentage		-0.0167***	-0.0166***
		(0.00214)	(0.00221)
Public Adjuster*Minority			0.114***
			(0.0332)
Event FE*Distance to Epicenter	YES	YES	YES
Event FE	YES	YES	YES
Observations	835	835	835
Log pseudolikelihood	-397.377	-393.197	-392.77

Robust standard errors clustered by event in parentheses
*** p<0.01, ** p<0.05, * p<0.1

5.3 Is Race a Factor in the Amount of Claims Payment?

Conditional on that a claim is paid, we now examine the size of claim payment. The same regression models and control variables are used as in the previous section, except that the dependent variable is the log of the dollar amount of claim payment. Results are presented in Table 7 columns (4) - (6).

The variable of zip-code minority percentage is marginally significant, indicating the possibility of lower claims payment to areas with larger minority population, controlling for other factors. There is no evidence of public claims adjusters helping to negotiate a higher amount of claim payment, as both the public adjuster term itself and the interaction term of minority percentage and public adjuster are insigificant.

Table 7 Least square regression using the log of days it takes from receiving claim to initial claim payment (if any) as the dependent variable and using the log of dollar amount of claim payment (if any) as the dependent variable

VARIABLES	Days till Initial Claim Payment			Dollar amount of Claims Paid		
	(1)	(2)	(3)	(4)	(5)	(6)
Log of Dollar Deductible	0.0148	0.0287	0.0172	0.800**	0.726**	0.713**
	(0.303)	(0.289)	(0.294)	(0.318)	(0.305)	(0.289)
Log of Policy Limit	0.000383	-0.0364	-0.0269	-0.318	-0.231	-0.220
	(0.402)	(0.415)	(0.422)	(0.217)	(0.259)	(0.255)
Log of Delay in Filling Claims	0.141	0.142	0.139	0.0514	0.0590	0.0571
	(0.0884)	(0.0872)	(0.0819)	(0.0835)	(0.0802)	(0.0811)
Engineer Report (YES=1)	1.158***	1.162***	1.164***	0.675	0.662	0.663
	(0.250)	(0.240)	(0.250)	(0.446)	(0.437)	(0.445)
Public Adjustment (YES=1)	0.606	0.606		0.378	0.364	
	(0.536)	(0.573)		(0.704)	(0.701)	
Log of Population Density		0.000276	-0.00462		-0.0912	-0.0940*
		(0.0251)	(0.0280)		(0.0528)	(0.0489)
Log of Median Household Income		0.468	0.484		-0.498	-0.489
		(0.323)	(0.351)		(0.416)	(0.419)
Minority Percentage		0.00363	0.00401		-0.0145*	-0.0143*
		(0.00667)	(0.00705)		(0.00625)	(0.00637)
Public Adjuster*Minority			0.0398			0.0246
			(0.0281)			(0.0308)
Event FE*Distance to Epicenter	YES	YES	YES	YES	YES	YES
Event FE	YES	YES	YES	YES	YES	YES
Observations	250	250	250	244	244	244
R-squared	0.346	0.351	0.362	0.182	0.211	0.214

Robust standard errors clustered by event in parentheses
*** p<0.01, ** p<0.05, * p<0.1

6 Summary and Outlook

This paper studied claim characteristics to test for evidence of racial discrimination in the adjudication of earthquake claims. There were eight earthquakes in Oklahoma between 2010 and 2016, most linked to fracking. Using zip code level data and publicly available information from the Oklahoma department of insurance, we test whether claim resolutions differed between the majority white population and minorities after controlling for factors including distance from the earthquake epicenter, insurance policy characteristics and the use of engineers and public adjusters in the examination of the claim.

Our study finds evidence that claims from minorities were less likely to result in an insurance company payment. Claim settlements tend to be fewer for minorities when a claim is paid. However, there is no evidence of public claims adjusters helping to negotiate a higher amount of claim payment. Furthermore, it seems that insurer's speed of paying claims is not particularly related to any demographic characteristics of a neighborhood, not most of the policy-level characteristics, except one - if an engineer report has been obtained. This is not surprising, as obtaining engineer report takes time and could slow down the claim process.

Finally, the present analyses come with several qualifications. For instance, other models (such as Tobit, two-part model) need be explored to better model the distribution of these claims payments, many of which are zero or are close to the policy deductible threshold. Differences in patterns of claims submitted for different earthquakes may also arise from passage of time (as time went on, Oklahomans might have become more aware of this risk and this insurance coverage), change in regulation (for instance, the Oklahoma Insurance Department has issued several notices to earthquake insurers in the state), or change in insurance pricing (methods).

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