The Interaction Between Risk Classification and Adverse Selection:
Evidence from California’s Residential Earthquake Insurance Market

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Introduction

• I study the nature of selection issues and how they interact with risk classification in the context of California’s residential earthquake insurance market

• In this market:
  ➢ No mandate on demand
  ➢ The dominant semi-public insurer (California Earthquake Authority) uses coarse geographic risk classification
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could lead to adverse selection against the CEA
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  - Coexistence of public and private underwriters

the adverse selection might be worsened by the finer risk classification in the private sector.
Introduction

• I address three empirical questions:

  ➢ 1. How insurers classify earthquake risk geographically in California?
  ➢ 2. Does the limited risk classification by the CEA lead to adverse selection?
  ➢ 3. Are the private insurers picking up relatively lower-risk homeowners by using finer risk-classification schemes?
Literature Review

- **Adverse selection and asymmetric information**

- **Catastrophe insurance demand analysis**

- **Public vs. Private insurers**
  Czajkowski et al. (2012)

- **The Equity-Efficiency Trade-off**
  Picard (2008)
Background – The California Earthquake Authority (CEA)

- **CEA: Public-Private Partnership**
  - Publicly-managed, largely privately funded
  - 20 participating insurers (19 at the time of study)
  - representing 70% of the market

- **The CEA policies:**
  - Eligibility
  - Base rate: only varies by 19 territories

- A private fringe remains outside of the CEA
Data

• Unit of observation: zip-code level (1636 zip-codes in California)

- Insurance policy count data from the CDI (2009)
- Geological data on seismic risk from the USGS
- Census data from the U.S. Census Bureau
- Insurers rating schemes from public filings to the CDI
• Unit of observation: zip-code level (1636 zip-codes in California)

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- Census data from the U.S. Census Bureau
- Insurers rating schemes from public filings to the CDI
Data – Insurance policy count data

Table 3: Summary Statistics of Policy Counts and Take-up Rates by Zip-code

<table>
<thead>
<tr>
<th>Policy Type</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Min*</th>
<th>Median</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall Homeowners Policies</td>
<td>3,594</td>
<td>3,474</td>
<td>11</td>
<td>2,576</td>
<td>16,674</td>
</tr>
<tr>
<td>CEA Homeowners Policies</td>
<td>2,678</td>
<td>2,594</td>
<td>4</td>
<td>1,926</td>
<td>13,015</td>
</tr>
<tr>
<td>nonCEA Homeowners Policies</td>
<td>916</td>
<td>1,037</td>
<td>0</td>
<td>593</td>
<td>7,111</td>
</tr>
<tr>
<td>Overall Earthquake Policies</td>
<td>491</td>
<td>658</td>
<td>0</td>
<td>202</td>
<td>4,947</td>
</tr>
<tr>
<td>CEA Earthquake Policies</td>
<td>356</td>
<td>465</td>
<td>0</td>
<td>147</td>
<td>3,729</td>
</tr>
<tr>
<td>nonCEA Earthquake Policies</td>
<td>136</td>
<td>244</td>
<td>0</td>
<td>47</td>
<td>2,268</td>
</tr>
<tr>
<td>Overall Earthquake Policy Take-up Rate</td>
<td>12.84%</td>
<td>10.97%</td>
<td>0.00%</td>
<td>9.86%</td>
<td>69.29%</td>
</tr>
<tr>
<td>CEA Earthquake Policy Take-up Rate</td>
<td>12.38%</td>
<td>10.25%</td>
<td>0.00%</td>
<td>9.50%</td>
<td>54.55%</td>
</tr>
<tr>
<td>nonCEA Earthquake Policy Take-up Rate</td>
<td>15.56%</td>
<td>21.70%</td>
<td>0.00%</td>
<td>9.09%</td>
<td>450%**</td>
</tr>
</tbody>
</table>
Data – Geological data on Peak Ground Acceleration (PGA)

The higher the PGA value (from green to red), the higher the seismic risk.
CEA territory rates are strongly related to average PGA

$y = 6.2768x - 1.2321$

$R^2 = 0.796$
But there is substantial variation in underlying seismic risk within territory.

![Box plot showing PGA distribution by territory.](image)
Private insurers (e.g. GeoVera) price risks at a finer level
Demand for CEA earthquake insurance – a map of zip-code level CEA take-up rates
Is the CEA take-up rate positively related to risk level (PGA) within a rating territory (adverse selection)?

<table>
<thead>
<tr>
<th>Territory</th>
<th>PGA</th>
<th>CEA Take-up Rates</th>
</tr>
</thead>
<tbody>
<tr>
<td>27</td>
<td></td>
<td>y = -0.0442 + 0.8418x  Adj. R² = 0.3602</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>y = -0.0641 + 0.2938x  Adj. R² = 0.0928</td>
</tr>
<tr>
<td>22</td>
<td></td>
<td>y = -0.006 + 0.1587x  Adj. R² = 0.0463</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>y = -0.0348 + 0.2004x  Adj. R² = 0.1033</td>
</tr>
<tr>
<td>12</td>
<td></td>
<td>y = 0.0045 + 0.7485x  Adj. R² = 0.8547</td>
</tr>
</tbody>
</table>

**Equation for Territory 27:**

\[ y = -0.0442 + 0.8418x \]

**Adj. R² for Territory 27:** 0.3602

**Equation for Territory 7:**

\[ y = -0.0641 + 0.2938x \]

**Adj. R² for Territory 7:** 0.0928

**Equation for Territory 22:**

\[ y = -0.006 + 0.1587x \]

**Adj. R² for Territory 22:** 0.0463

**Equation for Territory 6:**

\[ y = -0.0348 + 0.2004x \]

**Adj. R² for Territory 6:** 0.1033

**Equation for Territory 12:**

\[ y = 0.0045 + 0.7485x \]

**Adj. R² for Territory 12:** 0.8547
CEA take-up rate is positively related to risk level, all else equal

- **Regression Framework:**

  \[ CEA \text{ Earthquake Insurance Demand} = \beta_0 + \beta_1 \text{(Objective Risk)} + \beta_2 \text{Ln(Home Value)} + \beta_3 \text{Ln(Income)} + \beta_4 (\text{Demographic characteristics}) + \beta_5 (\text{Territory}) + \varepsilon \]

  Use the take-up rate of CEA policies as the dependent variable.

  Observations are 1636 zip-codes in California. Only the cross-sectional data in 2009 is used.
## CEA take-up rate is positively related to risk level, all else equal

<table>
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<tbody>
<tr>
<td>Objective Risk Measure (PGA)</td>
<td>0.4233</td>
<td>0.0228 ***</td>
<td>0.3268</td>
<td>0.0171 ***</td>
<td>0.3368</td>
<td>0.0157 ***</td>
<td>0.3421</td>
<td>0.0156 ***</td>
<td>0.3453</td>
<td>0.0156 ***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Log (Median Value of Owner-Occupied Homes)</td>
<td>0.1382</td>
<td>0.0038 ***</td>
<td>0.0910</td>
<td>0.0067 ***</td>
<td>0.0852</td>
<td>0.0067 ***</td>
<td>0.0736</td>
<td>0.0070 ***</td>
<td>0.0788</td>
<td>0.0087 ***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Log (Median Household Income)</td>
<td>-0.0750</td>
<td>0.0067 ***</td>
<td>-0.0565</td>
<td>0.0073 ***</td>
<td>-0.0288</td>
<td>0.0087 ***</td>
<td>-0.0279</td>
<td>0.0092 ***</td>
<td>-0.0362</td>
<td>0.0112 ***</td>
<td></td>
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</tr>
<tr>
<td>Population with At Least College Degree (%)</td>
<td>0.2666</td>
<td>0.0163 ***</td>
<td>0.2178</td>
<td>0.0194 ***</td>
<td>0.2231</td>
<td>0.0210 ***</td>
<td>0.2358</td>
<td>0.0222 ***</td>
<td>0.2482</td>
<td>0.0246 ***</td>
<td></td>
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<tr>
<td>Median Household Size</td>
<td>-0.0202</td>
<td>0.0035 ***</td>
<td>-0.0362</td>
<td>0.0062 ***</td>
<td>-0.0362</td>
<td>0.0062 ***</td>
<td>-0.0362</td>
<td>0.0062 ***</td>
<td>-0.0362</td>
<td>0.0062 ***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender (female%)</td>
<td>-0.2789</td>
<td>0.0648 ***</td>
<td>-0.3741</td>
<td>0.0680 ***</td>
<td>-0.3741</td>
<td>0.0680 ***</td>
<td>-0.3741</td>
<td>0.0680 ***</td>
<td>-0.3741</td>
<td>0.0680 ***</td>
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<tr>
<td>Median Age</td>
<td>0.0003</td>
<td>0.0005</td>
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<tr>
<td>Percentage of Black or African American</td>
<td>0.0032</td>
<td>0.0194</td>
<td></td>
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<tr>
<td>Percentage of Asian</td>
<td>-0.0180</td>
<td>0.0142</td>
<td></td>
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<tr>
<td>Percentage of other races</td>
<td>0.1215</td>
<td>0.0335 ***</td>
<td></td>
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<tr>
<td>Household with Children under 18 Years Old</td>
<td>-0.0127</td>
<td>0.0333</td>
<td></td>
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<tr>
<td>Log (Population Per Square Mile)</td>
<td>0.0074</td>
<td>0.0012 ***</td>
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<tr>
<td>Territory 2</td>
<td>-0.2104</td>
<td>0.0271 ***</td>
<td>-0.0978</td>
<td>0.0203 ***</td>
<td>-0.1144</td>
<td>0.0187 ***</td>
<td>-0.1106</td>
<td>0.0185 ***</td>
<td>-0.1130</td>
<td>0.0182 ***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Territory 4</td>
<td>-0.2136</td>
<td>0.0352 ***</td>
<td>-0.0732</td>
<td>0.0263 **</td>
<td>-0.0984</td>
<td>0.0243 ***</td>
<td>-0.0987</td>
<td>0.0240 ***</td>
<td>-0.1009</td>
<td>0.0236 ***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Intercept)</td>
<td>0.0309</td>
<td>0.0052 ***</td>
<td>-1.7047</td>
<td>0.0477 ***</td>
<td>-0.3564</td>
<td>0.0898 ***</td>
<td>-0.2756</td>
<td>0.0973 **</td>
<td>-0.4209</td>
<td>0.1084 ***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>1636</td>
<td></td>
<td>1636</td>
<td></td>
<td>1636</td>
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<td>1636</td>
<td></td>
<td>1636</td>
<td></td>
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</tr>
<tr>
<td>Adjusted R-squared</td>
<td>0.3581</td>
<td>0.648</td>
<td>0.7025</td>
<td>0.7108</td>
<td>0.7226</td>
<td></td>
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</tbody>
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Note: The observations are 1636 zip-codes in California. All regressions are estimated using weighted least square method, with the number of homeowners' policies in each zip-code being the weight.
Is the adverse selection problem against the CEA worsened by private insurers?

Private sector uses finer risk classification schemes

To compare the demand for public (CEA) vs. private:

\[
\text{CEA EQ share} = \frac{\text{CEA's earthquake market share}}{\text{Territory average of the CEA's earthquake market share}}
\]

- \[
\text{CEA EQ share} = \beta_0 + \beta_1 (\text{Objective Risk}) + \beta_2 \text{CEA HO share} + \beta_3 \ln(\text{Home Value}) + \beta_4 \ln(\text{Income}) + \beta_5 (\text{Demographic characteristics}) + \beta_6 (\text{Territory}) + \epsilon
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Is there a positive relationship between variation in CEA’s earthquake market share and underlying risk?
Conclusion and Discussion

- CEA offers highly cross-subsidized rates (while GeoVera uses much finer classification schemes)

- Strong evidence of adverse selection against the CEA

- Slight evidence of private insurers cherry-picking the CEA

  -- Why?: *other possible drivers of demand; different marketing tactics*
Thank you! Questions and Suggestions?