Mortgage Stress without Government Guarantees. Lessons from Hurricanes and the Credit Risk Transfers.

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Goals:

- What would be the price of mortgage credit risk without the GSEs?
- How would markets price credit risk from natural disasters?
From July 2013 to June 2017, the GSEs, using CRTs, transferred risk on $1.3 trillion of mortgage loans.
Strategy, Step 1:

- Hand-collected a unique database of CRTs by combining information from different sources.

- Exploit heterogeneity in CRT exposure to unpredictable exogenous local shock that alters credit risk.
  
  - Hurricanes Harvey and Irma in 2017 are such shock.
Strategy, Step 1 continued:

- CRTs differ in
  - seniority of tranches
  - loan-to-value (LTV)
  - geographical composition of reference pool

- Study effects of hurricanes in spreads of CRTs traded in secondary market
  - Control for liquidity, time to maturity and many other factors
Strategy, Step 2:

- Calibrate model of credit supply to match estimates from Step 1

- Run simulations and predict market-implied mortgage rates for crisis and non-crisis scenarios with no GSEs
Hurricanes increased spreads for the riskiest CRTs by 10% of the average spreads before the landfall. That is, by 0.73 percentage points.

During the Global Financial Crisis mortgage rates would have increased by 3.89 percentage points, that is, by 29% absent government guarantees and monetary policy interventions.
CRTs heterogeneous in geographical exposure

Average share of unpaid principal balance delinquent for more than 120 days. Vertical lines show the landfalls of Harvey and Irma.
Daily spread (yield to maturity - Libor) in the secondary market of CRTs.
CRTs heterogeneous in LTV

Average share of unpaid principal balance delinquent for more than 120 days. Vertical lines show the landfalls of Harvey and Irma.
Daily spread (yield to maturity - Libor) in the secondary market of CRTs.
Overall CRT spreads

CRT daily spreads in secondary market

Daily spread (yield to maturity - Libor) in the secondary market of CRTs.
Recently issued CRTs

CRT daily spreads in secondary market of CRTs issued in 2017 before the news about Harvey

Daily spread (yield to maturity - Libor) in the secondary market of CRTs.
**Specification Diff-in-Diff**

\[ S_{i,t} = \beta_0 + \beta_1 T_t + \beta_2 E_i + \beta_3 T_t E_i + C_i + D_t + u_{i,t} \]

- **\( S_{i,t} \)**: spread over one month U.S. Dollar Libor of CRT security \( i \) at day \( t \)
- **\( T_t \)**: 1 for \( t \) on and after the first trading day after the landfall in the U.S. coast of Hurricane Irma on September 11th 2017, zero otherwise
- **\( E_i \)**: geographical exposure to default: share of CRT unpaid principal balance of mortgages in the counties hit by Harvey and Irma
- **\( C_i \)**: controls as floater spread, dummy for Freddie, issuance year dummies; **\( D_t \)**: 10-year and 2-year treasury rates
- Separate estimations for junior versus mezzanine tranches, and for LTV ratios below versus above 80%
### Junior Tranches React to Hurricanes

<table>
<thead>
<tr>
<th>Window (weeks)</th>
<th>±2</th>
<th>±3</th>
<th>±4</th>
<th>±5</th>
<th>±6</th>
<th>±7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landfall × exposure</td>
<td>0.11***</td>
<td>0.09***</td>
<td>0.08***</td>
<td>0.07***</td>
<td>0.06***</td>
<td>0.05***</td>
</tr>
<tr>
<td>Hurricane landfall</td>
<td>0.04</td>
<td>0.07</td>
<td>0.14</td>
<td>0.20**</td>
<td>0.26***</td>
<td>0.30***</td>
</tr>
<tr>
<td>Exposure</td>
<td>0.12***</td>
<td>0.12***</td>
<td>0.13***</td>
<td>0.13***</td>
<td>0.14***</td>
<td>0.15***</td>
</tr>
<tr>
<td>Observations</td>
<td>231</td>
<td>341</td>
<td>451</td>
<td>561</td>
<td>671</td>
<td>781</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.834</td>
<td>0.82</td>
<td>0.80</td>
<td>0.78</td>
<td>0.77</td>
<td>0.75</td>
</tr>
</tbody>
</table>

Standard errors in parentheses. ***sig. at 1%; **sig. at 5%. Sample: Fannie Mae’s and Freddie Mac’s CRTs issued up to August 15th 2017.
<table>
<thead>
<tr>
<th>Window (weeks)</th>
<th>±2</th>
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<tr>
<td></td>
<td>(0.01)</td>
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<td>(0.01)</td>
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<td>(0.01)</td>
<td>(0.01)</td>
</tr>
<tr>
<td>Hurricane landfall</td>
<td>0.23***</td>
<td>0.18***</td>
<td>0.17***</td>
<td>0.17***</td>
<td>0.16***</td>
<td>0.17***</td>
</tr>
<tr>
<td></td>
<td>(0.09)</td>
<td>(0.07)</td>
<td>(0.06)</td>
<td>(0.06)</td>
<td>(0.05)</td>
<td>(0.05)</td>
</tr>
<tr>
<td>Exposure</td>
<td>0.08***</td>
<td>0.07***</td>
<td>0.05***</td>
<td>0.05***</td>
<td>0.05***</td>
<td>0.06***</td>
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<tr>
<td></td>
<td>(0.01)</td>
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<td>(0.01)</td>
<td>(0.01)</td>
<td>(0.01)</td>
<td>(0.01)</td>
</tr>
<tr>
<td>Observations</td>
<td>272</td>
<td>402</td>
<td>532</td>
<td>662</td>
<td>792</td>
<td>922</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.90</td>
<td>0.90</td>
<td>0.90</td>
<td>0.90</td>
<td>0.89</td>
<td>0.88</td>
</tr>
</tbody>
</table>

Standard errors in parentheses. ***sig. at 1% level. Sample: Fannie Mae’s and Freddie Mac’s CRTs issued up to August 15th 2017.
Takeaway: Impact of hurricanes on CRT spreads

<table>
<thead>
<tr>
<th>Window (weeks)</th>
<th>±2</th>
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<th>±4</th>
<th>±5</th>
<th>±6</th>
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<tbody>
<tr>
<td>LTV 81-97%</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Change in CRT spread (pp)</td>
<td>0.73</td>
<td>0.68</td>
<td>0.66</td>
<td>0.67</td>
<td>0.66</td>
<td>0.64</td>
</tr>
<tr>
<td>LTV 61-80%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change in CRT spread (pp)</td>
<td>0.63</td>
<td>0.59</td>
<td>0.57</td>
<td>0.56</td>
<td>0.56</td>
<td>0.55</td>
</tr>
<tr>
<td>Change in 1 month Libor (pp)</td>
<td>0.001</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
<td>0.14</td>
<td>0.14</td>
</tr>
</tbody>
</table>

- CRT spreads increase by 0.73 pp on average two weeks after the landfall, compared to two weeks before
- equivalent to 10% of the average level of spreads before the landfall
Credit Supply Model

- Lenders price mortgages to ensure costs equal expected revenue from the mortgage.

- Mortgage supply equation comes from zero-profit condition:

\[(1 + r^d_t + r^w_t)L = (1 - \pi_t)(1 + r^m_t)L + \pi_t\gamma_tP_h\]

- \(r^d_t\) = lenders cost of funds (e.g. deposits or warehouse funding); \(r^w_t\) = origination costs per mortgage.

- \(L\) = loan size; \(P_h\) = house value.

- \(\pi_t\) = default probability; \(r^m_t\) = mortgage rate.

- \(\gamma_t\) = recovery rate of collateral. Also proxies risk aversion.
\( r_t^g \) is the market-implied guarantee fee:

\[
 r_t^g = r_t^m - r_t^d - r_t^w
\]

That is, decompose mortgage rates into:

- compensation for credit risk
- cost of funds
- origination costs
### Exogenous parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P_h L$</td>
<td>1.215</td>
<td>Inverse of a 82.3% loan-to-value ratio</td>
</tr>
<tr>
<td>$r_0^d$</td>
<td>0.910%</td>
<td>Lender’s cost of funds: 5y CD rate in July 2017</td>
</tr>
<tr>
<td>$r_0^w$</td>
<td>1.170%</td>
<td>Lender’s origination cost in July 2017</td>
</tr>
<tr>
<td>$r_0^m$</td>
<td>8.442%</td>
<td>Avg mortgage rate 2 weeks before landfall</td>
</tr>
<tr>
<td>$\pi_0$</td>
<td>9.512%</td>
<td>Avg default probability 2 weeks before landfall</td>
</tr>
<tr>
<td>$\pi_1 - \pi_0$</td>
<td>1.456 pp</td>
<td>Change in default probability due to landfall</td>
</tr>
</tbody>
</table>
### Targets

\[ r_m,1 - r_m,0 \quad 0.728 \text{ pp} \quad \text{Change in rates from CRT estimates} \]

\[ \frac{d\gamma}{d\pi} \bigg|_{\pi_0} = -0.5 \quad \text{Avg slope of } \gamma_t = f(\pi_t) = 1 - a\pi_t^{b-1} \]

### Endogenous parameters

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td>0.551</td>
<td>Value of (a) in (\gamma_t = f(\pi_t) = 1 - a\pi_t^{b-1})</td>
</tr>
<tr>
<td>(b)</td>
<td>0.113</td>
<td>Value of (b) in (\gamma_t = f(\pi_t) = 1 - a\pi_t^{b-1})</td>
</tr>
</tbody>
</table>
Simulations: stress is exogenous change in default risk
Mortgage rates under stress without government guarantees

<table>
<thead>
<tr>
<th>Initial level of default mortgage rate</th>
<th>Change in default mortgage rate</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.35%</td>
<td>3.89 pp 288% ↑</td>
<td>During Great Recession (2007-2011)</td>
</tr>
<tr>
<td>1.58%</td>
<td>1.76 pp 114% ↑</td>
<td>During Covid pandemic (second quarter 2020)</td>
</tr>
<tr>
<td>2.55%</td>
<td>0.55 pp 21% ↑</td>
<td></td>
</tr>
</tbody>
</table>
Conclusions

- Hurricanes significantly increased spreads for the riskiest CRTs by 10% of the average spreads before the landfall.

- CRT investors are absorbing part of the risk of natural disasters due to climate change.
GSEs imply countercyclical policy:

- strong subsidies to mortgage rates during mortgage stress episodes
- Market-implied g-fees rise above actual levels in market stress scenarios
- Rises in actual g-fees before COVID brought them above what market would price in good times
Appendix
# Summary statistics: Securities in the sample

<table>
<thead>
<tr>
<th></th>
<th>Fannie Mae</th>
<th>Freddie Mac</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Loan-to-Value Ratio</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>81-97%</td>
<td>27</td>
<td>45</td>
<td>72</td>
</tr>
<tr>
<td>61-80%</td>
<td>42</td>
<td>49</td>
<td>91</td>
</tr>
<tr>
<td><strong>Tranches</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junior</td>
<td>15</td>
<td>23</td>
<td>38</td>
</tr>
<tr>
<td>Mezzanine</td>
<td>54</td>
<td>71</td>
<td>125</td>
</tr>
<tr>
<td><strong>Issuance Year</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>2</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>2014</td>
<td>9</td>
<td>17</td>
<td>26</td>
</tr>
<tr>
<td>2015</td>
<td>8</td>
<td>26</td>
<td>34</td>
</tr>
<tr>
<td>2016</td>
<td>29</td>
<td>31</td>
<td>60</td>
</tr>
<tr>
<td>2017</td>
<td>21</td>
<td>16</td>
<td>37</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>69</td>
<td>94</td>
<td>163</td>
</tr>
</tbody>
</table>

The sample consists of the Fannie Mae’s and Freddie Mac’s CRT securities issued from July 23, 2013 to August 15, 2017.
### Summary Statistics for Junior Tranches

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LTV 81-97%</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spread daily (pp)</td>
<td>7.519</td>
<td>0.790</td>
<td>5.645</td>
<td>9.004</td>
</tr>
<tr>
<td>Hurricane landfall dummy</td>
<td>0.524</td>
<td>0.501</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Geographical exposure (%)</td>
<td>6.475</td>
<td>2.777</td>
<td>2.160</td>
<td>9.300</td>
</tr>
<tr>
<td>Floater spread (pp)</td>
<td>10.273</td>
<td>1.552</td>
<td>7.950</td>
<td>12.750</td>
</tr>
<tr>
<td>Issue by Freddie dummy</td>
<td>0.727</td>
<td>0.446</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td><strong>LTV 61-80%</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spread daily (pp)</td>
<td>7.020</td>
<td>0.882</td>
<td>5.020</td>
<td>8.486</td>
</tr>
<tr>
<td>Hurricane landfall dummy</td>
<td>0.522</td>
<td>0.500</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Geographical exposure (%)</td>
<td>5.474</td>
<td>2.777</td>
<td>2.170</td>
<td>9.600</td>
</tr>
<tr>
<td>Floater spread (pp)</td>
<td>10.249</td>
<td>1.366</td>
<td>7.550</td>
<td>12.250</td>
</tr>
<tr>
<td>Issue by Freddie dummy</td>
<td>0.614</td>
<td>0.488</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td><strong>Ten year treasury rate (%)</strong></td>
<td>2.170</td>
<td>0.066</td>
<td>2.050</td>
<td>2.280</td>
</tr>
<tr>
<td><strong>Two year treasury rate (%)</strong></td>
<td>1.358</td>
<td>0.056</td>
<td>1.270</td>
<td>1.460</td>
</tr>
</tbody>
</table>
Data

- Time series of daily yields in the secondary market of CRTs and one month U.S. Dollar Libor benchmark from Thomson Reuters Eikon
- All CRT issuances: issuance date, original principal balance, floater spread, seniority tranches from Bloomberg
- Mortgages’ features and performance in CRT reference pools, from the GSEs: LTV, geographical composition, and delinquencies
- Delinquency rates and guarantee-fees (g-fees) since 1991