Do energy costs really affect commercial mortgage default risk? New results and implications for energy efficiency investments

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U.S. Department of Energy
How are energy and valuation (un)linked?

Energy directly affects Net Operating Income (NOI) used in mortgage valuation. Current practice does not fully account for energy factors in calculation of NOI:
- Usually based on historical average cost data, if available
- Does not account for energy use and price volatility during mortgage term

Energy Use Volume
- Electricity kWh/kW, fuel therms, etc.
- Driven by building features, operations, climate

Energy Use Volatility
- +/- change over mortgage term
- Driven by building operations, weather variation

Energy Price
- $/kWh, $/kW, $/therm
- Set by rate structure

Energy Price Volatility
- +/- change over mortgage term
- Driven by rate structure, forward prices

Energy risks are not properly assessed and energy efficiency is not properly valued. Commercial mortgages are a $2.5+ Trillion market and could be a significant channel for scaling energy efficiency.
Analyzing the impact of energy on default rate

Mortgage Default Rate = f (EUI, ElecPriceGap, CouponSpread, LTV, Region, …)

Empirical analysis combining
- Mortgage loan data (TREPP)
- Energy use data (Benchmarking disclosure)
## Default risk and source EUI

The coefficient estimates for **BOTH Source EUI** and **Electricity Price Gap** significant at p<.05 level

<table>
<thead>
<tr>
<th></th>
<th>Coefficient Estimate</th>
<th>Standard Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-0.40444**</td>
<td>0.18466</td>
</tr>
<tr>
<td>Log Source EUI</td>
<td>0.07335**</td>
<td>0.03129</td>
</tr>
<tr>
<td>Origination Loan-to-Value Ratio</td>
<td>0.00258***</td>
<td>0.00096</td>
</tr>
<tr>
<td>Coupon Spread to 10 Year Treasury</td>
<td>0.02188</td>
<td>0.01565</td>
</tr>
<tr>
<td>Electricity Price Gap</td>
<td>0.00003***</td>
<td>0.00001</td>
</tr>
<tr>
<td>Time to Maturity on Balloon</td>
<td>-0.00189***</td>
<td>0.00060</td>
</tr>
<tr>
<td>Origination Year Fixed Effects</td>
<td>Yes</td>
<td></td>
</tr>
</tbody>
</table>

|                                |                      |
|                                | 473 observations     |
|                                | \( R^2 = .1052        |

* p<0.1; ** p<0.05; ***p<0.01
Default risk and **scaled** source EUI

Scaled source EUI = source EUI / NOI per sf

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-0.00538</td>
<td>0.11067</td>
</tr>
<tr>
<td>Scaled Source EUI</td>
<td>0.00183***</td>
<td>0.000369</td>
</tr>
<tr>
<td>Origination Loan-to-Value Ratio</td>
<td>0.00263**</td>
<td>0.00117</td>
</tr>
<tr>
<td>Coupon Spread to 10 Year Treasury</td>
<td>0.00751</td>
<td>0.040</td>
</tr>
<tr>
<td>Electricity Price Gap</td>
<td>0.00003**</td>
<td>0.00001</td>
</tr>
<tr>
<td>Time to Maturity on Balloon</td>
<td>-0.00203**</td>
<td>0.00068</td>
</tr>
<tr>
<td>Origination Year Fixed Effects</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>339 observations</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$R^2 = .1768$</td>
<td></td>
</tr>
</tbody>
</table>

* p<0.1; ** p<0.05; ***p<0.01
What are the impacts on specific loans?

Collaborate with lenders to:
1. Demonstrate impact of energy use and price on specific mortgage loans
2. Develop recommendations

Approach
- Compile info from Appraisals, PCAs, other sources.
- Estimate source EUI variations.
  - Simulation and empirical approaches
- Compute elec price gap using price volatility.
- Compute default risk impact due to source EUI and elec price gap.
A wide range of operational factors affect year-to-year energy use variations

Facilities management
- Economizer settings
- VAV box minimum flow setting
- Supply air temperature reset
- Static pressure reset
- Chilled water/Hot water supply temperature reset
- Condenser water temperature reset
- Chiller /boiler sequencing
- ... 

Occupant behavior
- Lighting controls
- Window operation
- Thermostat setpoints/setback
- Local heating/cooling equipment
- Plug in equipment

Maintenance
- Damper/ valve check
- Filter change
- Coil cleaning
- ... 

Weather 

Vacancy rates
## Denver Office - Range of practice

<table>
<thead>
<tr>
<th>Factor</th>
<th>Good practice</th>
<th>Average practice</th>
<th>Poor practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lighting controls</td>
<td>Daylight-dimming + occ sensor</td>
<td>Occ sensor only</td>
<td>Timer only</td>
</tr>
<tr>
<td>Plug load controls</td>
<td>Turn off when occupants leave</td>
<td>Sleep mode by itself</td>
<td>No energy saving measures</td>
</tr>
<tr>
<td>Plug load intensity</td>
<td>0.4 W/sf</td>
<td>0.75 W/sf</td>
<td>2.0W/sf</td>
</tr>
<tr>
<td>Occupant density</td>
<td>400 sf/per</td>
<td>200 sf/per</td>
<td>130 sf/per</td>
</tr>
<tr>
<td>Occupant schedule</td>
<td>8 hour WD</td>
<td>12 hour WD</td>
<td>16 hour WD</td>
</tr>
<tr>
<td>HVAC schedule</td>
<td>optimal start</td>
<td>2hr +/- Occupant sch</td>
<td>n/a</td>
</tr>
<tr>
<td>Thermostat settings</td>
<td>68°F heating, 78°F cooling Setback: 60 - 85</td>
<td>70°F heating, 76°F cooling Setback: 68 - 80</td>
<td>72°F heating, 74°F cooling No setback</td>
</tr>
<tr>
<td>Supply air temp reset</td>
<td>Reset base on warmest zones</td>
<td>Reset based on stepwise function of outdoor air temperature</td>
<td>Constant supply air temperature</td>
</tr>
<tr>
<td>VAV box min flow settings</td>
<td>15% of design flow rate.</td>
<td>30% of design flow rate.</td>
<td>50% of design flow rate.</td>
</tr>
<tr>
<td>Economizer controls</td>
<td>Enthalpy</td>
<td>Dry bulb</td>
<td>none/broken</td>
</tr>
</tbody>
</table>
Impact of energy use variations: Denver office

Facilities Management (FM):
- HVAC schedule
- Thermostat setback
- SAT control
- VAV min flow control
- Economizer controls
- Lighting controls

Occupancy factors (OP):
- Occupant density
- Occupant schedule
- Plug load density
- Plug load controls

Compare to TREPP average default rate of 800bp
Impact of energy price variations: Denver

Mean: +330 bp
1 Std dev: -159 - 501 bp
## Five case studies show material impacts

<table>
<thead>
<tr>
<th>Building</th>
<th>Source EUI variation (%)</th>
<th>Default rate variation (bp)</th>
<th>Default rate variation relative to TREPP avg (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Denver Office</td>
<td>-54% to +132%</td>
<td>-248 to +268</td>
<td>-31% to +34%</td>
</tr>
<tr>
<td>Sonoma Office</td>
<td>-40% to +183%</td>
<td>-161 to +331</td>
<td>-20% to +41%</td>
</tr>
<tr>
<td>San Jose Office</td>
<td>-62% to +119%</td>
<td>-308 to +249</td>
<td>-39% to +31%</td>
</tr>
<tr>
<td>Denver Hotel</td>
<td>-11% to +17%</td>
<td>-37 to +49</td>
<td>-5% to +6%</td>
</tr>
<tr>
<td>San Francisco Multi-family</td>
<td>-20% to +26%</td>
<td>-72 to +74</td>
<td>-9% to +9%</td>
</tr>
</tbody>
</table>

*Compare to TREPP average default rate of 800bp*

<table>
<thead>
<tr>
<th>Wholesale price region</th>
<th>Default rate variation (bp)</th>
<th>Default rate variation relative to TREPP avg (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Denver area</td>
<td>+159 to +501</td>
<td>+20% to +63%</td>
</tr>
<tr>
<td>Northern California</td>
<td>-49 to +705</td>
<td>-6% to +88%</td>
</tr>
</tbody>
</table>
"These results showing the impact of energy on default risk are clearly meaningful. I don't currently consider energy efficiency when making a loan and seeing this makes me think I would want to ask about it"

"I would like to apply these findings but would want an easy way to use it. A simple score or ratio for energy risk would be good. In fact, I would be interested to pilot test it."

Keith Hanley, Silicon Valley Bank
Toward an Energy Risk Score for Mortgages

• Characterize default risk impact due to *level* and *potential increase* in energy cost relative to NOI.

*Uses:*

• Screen for higher energy risk
• Incentivize low energy risk building

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**Flowchart:**

1. Calculate Energy Risk (ER) score
   - *Appraiser/PCA*

2. Set Energy Risk Limit Value (LV)
   - *Lender*

3. **ER > LV?**
   - **Y**
     - High risk: Consider risk mitigation options
       - Higher interest rate
       - Require/recommend additional analysis and building efficiency improvements
         (e.g. energy benchmarking, asset rating, retrofit, recommissioning)
   - **N**
     - Low risk: Conduct periodic scoring as needed

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*Note:*

- **ER** = Energy Risk
- **LV** = Energy Risk Limit Value
- **Y** = Yes
- **N** = No
Actions you can take now

**Lenders:**
- Ask owners to provide info on energy cost range.
  - Could be done as part of Property Condition Assessment.
  - Can reference ASTM standard 2797
- **Incorporate energy risk factor into underwriting and terms**
  - e.g. Interest rate discount/premium, mitigating measures
- **Offer additional loan proceeds for EE investments**
  - e.g. similar to Fannie Mae Green Rewards program

**Borrowers:**
- Ask lenders to account for energy efficiency in mortgage terms.
- Provide data on energy costs to lender.
  - Historical and anticipated
  - In appraisal and/or PCA
Looking Ahead

Vision:
Energy factors are fully and routinely incorporated in commercial mortgages, accelerating demand for buildings with lower energy risk.

Show that energy matters
Develop and pilot interventions
Disseminate best practices
Institutionalize

Analysis of energy impacts
Case studies on actual mortgage loans
Protocols and tools for lenders and owners
Industry Standards

Scope of current effort
Long term
Thank You

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