Analysing Sustainability in Real Estate through Obsolescence

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Increase in the number of sustainable buildings

- More stringent regulations (new thermal regulations every five to ten years)
- Voluntary initiatives: 75% of new or retrofitted office buildings (over 1000 m²) are certified

Regulatory pressure for a reduction of the energy consumption of the existing stock.

How will these trends impact the value of existing buildings?
How to integrate them into refurbishment decision-making?
**Literature review (1)**

- **Cost and benefits of green refurbishment**

<table>
<thead>
<tr>
<th>For the occupant</th>
<th>For the owner</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Assets</strong></td>
<td><strong>Drawbacks</strong></td>
</tr>
<tr>
<td>Reduction of charges</td>
<td>Eventual increase of rents</td>
</tr>
<tr>
<td>Productivity gains</td>
<td>Eventual obligations as regards energy consumption and monitoring</td>
</tr>
<tr>
<td>Image</td>
<td></td>
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<tr>
<td>Reduction of dependency towards the evolution of energy prices</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Assets</strong></th>
<th><strong>Drawbacks</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduction of charges (paid by the owner)</td>
<td>Increase of the initial investment</td>
</tr>
<tr>
<td>Premium on rent value</td>
<td>Smaller surface area</td>
</tr>
<tr>
<td>Decrease of the vacancy period</td>
<td>Negotiation with the tenants</td>
</tr>
<tr>
<td>Reduction in risk of litigation</td>
<td>Increase costs for measurement, monitoring…</td>
</tr>
<tr>
<td>Decrease of the obsolescence risk</td>
<td></td>
</tr>
</tbody>
</table>
## Hedonic studies on “green value”

<table>
<thead>
<tr>
<th>Study</th>
<th>Certification</th>
<th>Market Value</th>
<th>Rental value</th>
<th>Occupation Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuerst et McAllister (2008)</td>
<td>LEED, Energy Star (USA)</td>
<td>31-35%</td>
<td>6%</td>
<td></td>
</tr>
<tr>
<td>Wiley et al. (2008)</td>
<td>LEED (USA)</td>
<td>130$/square foot</td>
<td>15-17%</td>
<td>16-18%</td>
</tr>
<tr>
<td></td>
<td>Energy Star (USA)</td>
<td>30$/square foot</td>
<td>7%-9%</td>
<td>10%-11%</td>
</tr>
<tr>
<td>Miller et al. (2008)</td>
<td>LEED (USA)</td>
<td>10%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Energy Star (USA)</td>
<td>6%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kok (2008)</td>
<td>LEED , Energy Star (USA)</td>
<td>16%</td>
<td>6%</td>
<td></td>
</tr>
<tr>
<td>Pivo et Fisher (2009)</td>
<td>Energy Star (USA)</td>
<td>6,7%-10,6%</td>
<td>4,8%-5,2%</td>
<td>0,2-1,3%</td>
</tr>
<tr>
<td>Fuerst et McAllister (2010)</td>
<td>LEED (USA)</td>
<td></td>
<td></td>
<td>8%</td>
</tr>
<tr>
<td></td>
<td>Energy Star (USA)</td>
<td></td>
<td></td>
<td>3%</td>
</tr>
<tr>
<td>Eichholtz al. (2010)</td>
<td>LEED (USA)</td>
<td>11%</td>
<td>6%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Energy Star (USA)</td>
<td>13%</td>
<td>7%</td>
<td></td>
</tr>
<tr>
<td>Chegut et al.(2011)</td>
<td>BREEAM (Londres, GB)</td>
<td>26%</td>
<td>21%</td>
<td></td>
</tr>
<tr>
<td>Kok, Newell et MacFarlane (2011)</td>
<td>NABERS 5 stars (Australie)</td>
<td>9%</td>
<td>3%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Green Star (Australie)</td>
<td>12%</td>
<td>5%</td>
<td></td>
</tr>
<tr>
<td>Fuerst et McAllister (2011)</td>
<td>LEED (USA)</td>
<td>26%</td>
<td>5%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Energy Star (USA)</td>
<td>25%</td>
<td>4%</td>
<td></td>
</tr>
<tr>
<td>Fuerst, Tommasso, McAllister (2012)</td>
<td>LEED (USA) 2007 to 2012</td>
<td></td>
<td>4,5%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Energy Star (USA)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kok, Miller, Morris (2012)</td>
<td>LEED EBOM 2005 to 2010</td>
<td></td>
<td>7-9%</td>
<td></td>
</tr>
</tbody>
</table>
Literature review (2)

Hedonic studies show the existence of a green premium

- Higher rental value
- Higher occupation rate
- Higher market value

- More recent works indicate that this rental premium diminishes with the expanding supply of certified buildings (chegut, 2012)
Literature review (3)

Frameworks for the integration of sustainability into financial appraisals

- Lorenz and Lützkendorf (2007, 2011): accounting for sustainability in the value drivers (rents, operation costs, risk premium ...).

- Meins (2010): global coefficient applied to the final result of a DCF calculation.

Investment decisions in sustainable retrofits through option pricing theory

- Menassa (2011): options to defer and to stage a refurbishment, gains from operation savings.

=>Static visions of building refurbishment and users’ expectations
Research question:

Propose a dynamic framework to account for the drivers of green refurbishment

- What are the market drivers underlying the evolution of the value of sustainability in real estate?
- How to account for the refurbishment cycles?
Sustainability as a cause of depreciation?

- **Depreciation**: loss in the use value of property due to physical deterioration and obsolescence

- **Obsolescence**: “decline in utility not directly related to physical usage or the passage of time” (Baum, 1993)

Different forms of obsolescence (Mansfield, 2000): Functional, economic, external

Integration in financial calculations: adaptation of the Gordon Growth model

\[
\text{Initial yield of investment} = \text{risk free rate} + \text{risk} - \text{growth} - \text{depreciation}
\]

- **Sustainability**: Demand for sustainability can be seen as a consequence of changes in the regulations and in the users’ expectations.
  
  \(\rightarrow\) Sustainability can be interpreted as a source of obsolescence

- **Green refurbishment to counteract obsolescence**
Evolution of environmental quality over building life cycle

Environmental quality

- Physical deterioration without repairs
- Users' expectations
- Physical deterioration with proper maintenance and repairs

Time

Refurbishment 1

Refurbishment 2
Refurbishment cycles, costs and rents

Costs

Revenues

Quality
Refurbishment cycles

Analogy: Faustmann model to calculate optimal Forestry rotation

=> Infinite Cashflows stream to compare the durability of two buildings and calculate the optimal duration for the refurbishment cycles
Refurbishment cycles

- When users’ expectation does not increase
  \[ \text{NPV}^{*\infty} = (R - M - Ce^{-rNt}) \frac{1}{1 - e^{-rNt}} \]

- Optimisation of the optimal span between refurbishments:
  \[ \frac{dR}{dN} \frac{dM}{dN} + rtCe^{-rNt} = rtNPV_{\infty}e^{-rNt} - \frac{dC}{dN}e^{-rNt} \]
  - Marginal profit from waiting for one more period
  - Marginal loss from waiting for one more period

- When users’ expectation increases
  \[ \text{NPV}_{\infty} = \text{NPV}^{*\infty} - F_{\text{irr}}(N) \frac{e^{-rNt}}{(1 - e^{-rNt})^2} \]

- Optimisation of the optimal span between refurbishments: further incentives not to wait for one more period if the added cost linked to obsolescence treatment is not too high.

- Not accounting for an increase in users’ expectation delays the refurbishment.
Rental Revenue

Direct effect:
- Decrease of maintenance cost
- Decrease of energy expenses

Indirect effect:
- Increase of rental value: new value for rent+ expenses must not exceed its initial value
- Decrease of the vacancy period
- Increase of the lease duration

How to calibrate these factors?
Rental revenue: response drivers

- Environmental quality
  - Performance gap
    - Regulatory standard
    - Average market performance

- Costs and benefits sustainability performance

- Impact of sustainability on rental revenue

- Demand for sustainability features
  - Trusted information on sustainability features
## Risks and uncertainties underlying the response drivers

<table>
<thead>
<tr>
<th>Market risk</th>
<th>Technical uncertainties</th>
<th>Legal uncertainties</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Evolution in the rental value gap between green and conventional buildings</td>
<td>- Installations remaining lifespan&lt;br&gt;- Evolution in the replacement costs of component&lt;br&gt;- Gap between conception and actual performance</td>
<td>- Evolution in the regulatory context</td>
</tr>
</tbody>
</table>
Approach proposition

Define Refurbishment cycles (LCC)  
Integrate scenario of increase in users expectation

Define potential impacts on rental revenues  
Account for uncertainty on the response drivers

Simulations of sequential costs and cashflows generated by leases
Thank you for your attention