Environmental Performance Improvement in Residential Construction:

The Impact of Products, Biofuels, Processes and Consumer Attitudes

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Questions

1. What is the environmental performance of different building materials involved in new home construction?

2. Do homebuyers value improved environmental performance in new home construction?
Increased Consumer Attention to Environmental Performance

- Rise of the organic food industry (Whole Foods, WalMart)
- Sensitivity to environmental performance in forest products (forest certification)
- Monetization of ecosystem services: carbon trading, green energy programs, socially responsible investing, etc.
- Emergence of life cycle analyses for building products (CORRIM) and standards (LEED)
Measuring Environmental Values

CORRIM has measured the impacts of different construction systems and their environmental effects.

CORRIM considers:

- Air Pollution
- Water Pollution
- Global Warming Potential
- Solid Waste
- Embodied Energy
Exterior Wall Designs

- Green-Wood Wall
- KD (kiln dried)-Wood Wall
- Steel Wall
- MN-Subs Wall
- Concrete
Plywood and wood-based product substitutions to reduce energy
Global Warming Potential (GWP) - Plywood and wood-based product substitutions to reduce GWP

- Plywood and wood-based product substitutions to reduce GWP
- Gypsum
- Plywood
- Fiberglass
- Lumber
- EPS
- Steel
- Vapor
- Vinyl Siding
- Vinyl Siding
- MN - Subs
- MN - Steel
- MN - KD Lumber

Chart showing kg of CO2 per 2000 sq. ft. for different wall types and materials.
Water Pollution Index (WPI)  

Plywood and wood-based product substitutions for MN-Subs design

![Graph showing Water Pollution Index (WPI) per 2000 sq. ft. for different wall types: MN-Subs, MN-Steel, MN-KD Lumber. The graph compares Plywood, 1/4" Plywood wall covering, 1/2" Plywood Siding, and Steel. The WPI values are indicated by bars of different colors: green for Plywood, blue for 1/2" Plywood Siding, and black for Steel. The MN-KD Lumber category has a smaller bar representing Plywood.]
Air Pollution Index (API)
Plywood and wood-based product substitutions for MN-Subs design.
Solid waste
Plywood and wood-based product substitutions for MN-Subs design

![Graph showing solid waste emissions for different wall types and materials]

- **MN-Subs**
  - Plywood: 350 kg
  - Lumber: 700 kg
  - Vinyl Siding: 200 kg
  - Gypsum: 250 kg

- **MN-Steel**
  - Plywood: 300 kg
  - Lumber: 1000 kg
  - Vinyl Siding: 300 kg
  - Gypsum: 150 kg

- **MN-KD Lumber**
  - Fiberglass: 50 kg
  - Plywood: 200 kg
  - Vinyl Siding: 150 kg
  - Gypsum: 250 kg
Fossil fuel energy

Wall Type

MJ per 2000 sq. ft.

Concrete

Plywood

Vinyl Siding

Fiberglass

Gypsum

Vapor

Lumber

ATL - KD Lumber

ATL - Concrete
Global Warming Potential (GWP) per wall component – warm climate.

The chart illustrates the kg of CO₂ per 2000 sq. ft. for different wall types: ATL - KD Lumber, ATL - Concrete, Plywood, Lumber, Fiberglass, Gypsum, Vinyl Siding. The chart shows that concrete walls have the highest GWP, followed by ATL - Concrete and ATL - KD Lumber. Plywood and Lumber have the lowest GWP among the listed materials.
Global Warming Potential (GWP) per floor component

- Lumber
- Concrete
- Steel
- Plywood

Wood I-joists: 2% CO₂ per 768 sq. ft.
Wood Dimension Joists: 454% CO₂ per 768 sq. ft.
Concrete Slab: 731% CO₂ per 768 sq. ft.
Steel Joists: 3500% CO₂ per 768 sq. ft.
Do homebuyers value improved environmental performance in new home construction?
Traditionally environment treated as “externality” in economics

Emergence of environmental and natural resource economics subsector
Environmental Valuation Methodologies

- Environmental attributes as “externalities”
- Environmental and natural resource economics
  - Revealed preference methods:
    - Travel cost method
    - Hedonic method
  - Stated preference methods:
    - Contingent valuation
    - Experimental choice analysis
Experimental Choice Analysis

- Based on random utility theory
- Multiple choices may be simultaneously evaluated
- Estimable using a multinomial conditional logit model
- Conduct using a mail survey
Choice Set Design

- 4 environmental variables; 3 price levels
- Baseline scenario
- 15 final choice sets (each set had four choices)
Given the plans listed below, please circle your most preferred plan:

<table>
<thead>
<tr>
<th>Plan</th>
<th>Plan A</th>
<th>Plan B</th>
<th>Plan C</th>
<th>Plan D</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Increase</td>
<td>Reduce</td>
<td>Reduce</td>
<td>Reduce</td>
</tr>
<tr>
<td></td>
<td>Monthly</td>
<td>Greenhouse</td>
<td>Air</td>
<td>Water</td>
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<tr>
<td></td>
<td>Mortgage</td>
<td>Gas Emission</td>
<td>Pollution by</td>
<td>Emissions by</td>
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<tr>
<td></td>
<td>Payments by</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plan A</td>
<td>$45</td>
<td>16 tons</td>
<td>15%</td>
<td>5 %</td>
</tr>
<tr>
<td>Plan B</td>
<td>$15</td>
<td>6 tons</td>
<td>5 %</td>
<td>25%</td>
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<tr>
<td>Plan C</td>
<td>$0</td>
<td>0 tons</td>
<td>0 %</td>
<td>0 %</td>
</tr>
<tr>
<td>Plan D</td>
<td>$5</td>
<td>11 tons</td>
<td>25%</td>
<td>15%</td>
</tr>
</tbody>
</table>
### Final Survey Design

<table>
<thead>
<tr>
<th>Variables</th>
<th>Level for fixed option</th>
<th>Levels for variable options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greenhouse gas emissions</td>
<td>0</td>
<td>6, 11, 16, 25 tons (reduction)</td>
</tr>
<tr>
<td>Air pollution</td>
<td>0</td>
<td>5, 10, 15, 25 % (reduction)</td>
</tr>
<tr>
<td>Water pollution</td>
<td>0</td>
<td>5, 10, 15, 25 % (reduction)</td>
</tr>
<tr>
<td>Solid waste emissions</td>
<td>0</td>
<td>5, 10, 15, 25 % (reduction)</td>
</tr>
<tr>
<td>Payments</td>
<td>0</td>
<td>5, 15, 45, 95 $ (increase)</td>
</tr>
</tbody>
</table>
Survey Administration

- 1500 mail surveys sent out to general population and 120 usable results returned
- 100 surveys sent out to real estate agents and 9 usable results returned
Household Survey Results: Marginal WTP

GHG: $27.39 for first unit
Air: $10.88 for first unit
Solid: $9.99 for first unit
Real Estate Agents Results: Marginal WTP

Solid: $20 for first unit
Air: $10.13 for first unit
GHG: $8.84 for first unit
### Comparison between Reductions in Different Building Materials and WTP

<table>
<thead>
<tr>
<th>Environmental attribute</th>
<th>Minneapolis steel vs. wood</th>
<th>Atlanta concrete vs. wood</th>
<th>Maximum amount respondents WTP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greenhouse gas emissions</td>
<td>9.8 tons</td>
<td>6.6 tons</td>
<td>11 tons</td>
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<tr>
<td>Air emissions</td>
<td>14%</td>
<td>23%</td>
<td>18%</td>
</tr>
<tr>
<td>Solid waste emissions</td>
<td>-0.9%</td>
<td>51%</td>
<td>18%</td>
</tr>
</tbody>
</table>
Conclusions

- Water insignificant
- Positive WTP for other variables
- Individuals are sensitive to particular attributes!
- CORRIM and EPA “Green Star” type label?
- Target label at particular attribute?