Securities Trading of Concepts (STOC)

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Students: Adlar Kim, Nicholas Chan

Presented at the DARPA workshop on Markets and Decisions
Arlington, Virginia

June 12, 2002
Today’s Agenda - Questions about STOC

- What is STOC? How does it work?
- Does it perform well?
- Is it accurate at identifying winners?
- What does it actually measure?
- How do traders behave? Do they learn?
- For what categories does it work?
- Does it work with fully integrated concepts? Attributes?
- Are real outcomes absolutely necessary?
The Virtual Customer:

- **Web-Based Conjoint Analysis (WCA)**
  - Ely Dahan
  - Rob Hardy
  - Limor Weisberg

- **Fast Polyhedral Conjoint Estimation (Fast Pace)**
  - Ely Dahan
  - John R. Hauser
  - Duncan Simester
  - Olivier Toubia

- **User Design (UD)**

- **Virtual Concept Test (VCT)**
  - Ely Dahan
  - V. Seenu Srinivasan
  - Leonard Lee

- **Securities Trading of Concepts (STOC)**
  - N. Chan, Ely Dahan
  - Andrew Lo, Tomaso Poggio
  - Adlar Kim
Impact of the WEB on Market Research

- Media
- Rich
- Virtual Customer Research

- Conceptualization
- Verbal

- Fixed Design
- Slow

- Communication

- Adaptive

- Traditional Market Research

- Fast
Pre-recruited Web Panels

- NFO Interactive Balanced 500,000 respondents
- DMS, Inc. (AOL) "Opinion Place" 1,000,000
- Knowledge Netwk. Rand. Digit Dialing 100,000
- Greenfield Online 3,000,000 online panel
- Harris Interactive 6,500,000 online panel

- Representativeness looks promising
e.g. Willkie, Adams, and Girnius (1999)

Game Markets

- Iowa Electronics Markets (http://www.biz.uiowa.edu/IEM)
- Foresight Exchange (http://www.ideosphere.com/FX)
- Hollywood Stock Exchange (http://www.HSX.com)
UD Allows Complex Interactions

- Slots, weight, battery, size, pricing

Click on an icon for a description of that feature.
Users Design High Utility Attribute Bundles

Participants design near-ideal configurations

CEB 1/16/01 and MBA’s 3/20/01 (n=129)
User Design as Conjoint Validation

Attribute-by-Attribute “Hit Rates”

Hit Rates for Each Feature (WCA vs. UD)
(By Individual by Feature, n=130)

CEB 1/16/01 and MBA’s 3/20/01 (n=130)
User Interface for Securities trading of Concepts (STOC)
Gore vs. Bush

Share of Vote

Probability of Winning

Source: Iowa Electronics Market (IEM), 11/7/00 at 2pm
Hooray for Hollywood

Source: HSX.com, December 7, 2001
Bragging rights to predicting the future...

The Foresight Exchange Prediction Market
Bet your reputation on the future!

Top 10 Players by Score, as of 2001/12/10 06:16:04 GMT

<table>
<thead>
<tr>
<th>Rank</th>
<th>User</th>
<th>Score</th>
<th>Networth</th>
<th>Email</th>
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<tbody>
<tr>
<td>1</td>
<td>157</td>
<td>5.131</td>
<td>10362.79</td>
<td>thor <a href="mailto:fred@ix.netcom.com">fred@ix.netcom.com</a></td>
</tr>
<tr>
<td>2</td>
<td>167</td>
<td>4.984</td>
<td>11611.12</td>
<td>jim <a href="mailto:jim@acm.org">jim@acm.org</a></td>
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<tr>
<td>3</td>
<td>73</td>
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<td>10273.65</td>
<td>Karl Hallo <a href="mailto:khallow@hotmail.com">khallow@hotmail.com</a></td>
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<td>4</td>
<td>78</td>
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<td>5998.31</td>
<td>jbs <a href="mailto:jbs@quietix.COM">jbs@quietix.COM</a></td>
</tr>
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<td>5</td>
<td>2631</td>
<td>3.844</td>
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<td>veazie <a href="mailto:rush73@worldnet.att.net">rush73@worldnet.att.net</a></td>
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<td>5334.34</td>
<td>ant <a href="mailto:andre@earth.ev.de">andre@earth.ev.de</a></td>
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<td>7</td>
<td>2116</td>
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<td>kenshin <a href="mailto:kenshin@email.unc.edu">kenshin@email.unc.edu</a></td>
</tr>
<tr>
<td>8</td>
<td>303</td>
<td>2.549</td>
<td>5098.02</td>
<td>Tucker Tucker</td>
</tr>
<tr>
<td>9</td>
<td>1877</td>
<td>2.332</td>
<td>4663.53</td>
<td>BigFatSlag</td>
</tr>
<tr>
<td>10</td>
<td>1782</td>
<td>2.309</td>
<td>4617.17</td>
<td>veseyk <a href="mailto:veseyk@vesey.org">veseyk@vesey.org</a></td>
</tr>
</tbody>
</table>

Top 10 Claims by Transaction Volume in the Last 7 Days

<table>
<thead>
<tr>
<th>Rank</th>
<th>Volume</th>
<th>% Symbol</th>
<th>Short Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>969</td>
<td>28.3%</td>
<td>Amazon crashes by 2002</td>
</tr>
<tr>
<td>2</td>
<td>678</td>
<td>19.1%</td>
<td>Lord of the Rings sets record</td>
</tr>
<tr>
<td>3</td>
<td>677</td>
<td>19.0%</td>
<td>100% Stock Big changes in 01 Stock Market</td>
</tr>
<tr>
<td>4</td>
<td>790</td>
<td>17.8%</td>
<td>10 Million Big, Prime etc 2002</td>
</tr>
<tr>
<td>5</td>
<td>513</td>
<td>9.9%</td>
<td>Tran Machine Translation by 2005</td>
</tr>
<tr>
<td>6</td>
<td>415</td>
<td>3.1%</td>
<td>planum Fizz w/0 majority on 2/1/05</td>
</tr>
<tr>
<td>7</td>
<td>101</td>
<td>2.7%</td>
<td>Martik Habitats Earth-class planet</td>
</tr>
<tr>
<td>8</td>
<td>101</td>
<td>2.7%</td>
<td>Terasu Another 3D Terrorist &lt; 2010</td>
</tr>
<tr>
<td>9</td>
<td>100</td>
<td>2.7%</td>
<td>HAPROE X PRIZE: Low-cost space flight</td>
</tr>
<tr>
<td>10</td>
<td>94</td>
<td>2.5%</td>
<td>STEREN Smalltalk-like &lt;100K J8 lik</td>
</tr>
</tbody>
</table>

Total 3702 100%
Current game markets share some traits

- All three predict *actual* future outcomes
- Underlying *reasons* are not made explicit
STOC Outcomes vs. Virtual Concept Testing: Bicycle Pumps

Median Stock Prices

$r^2 = 0.78$ Physical, $0.85$ Web
$r^2 = 0.87$ Physical, $0.92$ Web
Choice Out of a Set of Eight (Rank order): Crossover Vehicles

Pontiac Aztek
$24,000
The Aztek features a unique body design, 10 storage bins, a sliding rear cargo tray, and sporty handling.

Mercedes-Benz ML 320
$39,000
Rugged, but luxurious, the ML-320 features solid on/off road performance, plus 5000 lbs. of towing capacity.

BMW X-5
$49,000
The X-5 "Sports Activity Vehicle" performs and handles like a sports sedan. Its interior is very luxurious, but cargo storage is limited.

Acura MD-X
$37,000
The MD-X's middle and rear seats fold flat into the floor. It boasts a high-tech, two-tone interior.

Audi Allroad
$42,000
The Allroad takes Audi's A6 Avant Wagon to new heights, up to 6" ground clearance with 2" of adjustable air-suspension height.

Toyota Highlander
$29,000
The Highlander, based on the Lexus RX-300, is a practical, smooth riding, seven seater.

Lexus RX-300
$36,000
The RX-300 defined the crossover category and is the top-selling Lexus. Its rear bench seat slides forward and backward.

Buick Rendezvous
$30,000
The Rendezvous' middle seat is removable and the rear seat folds onto the floor. The ride is smooth and the interior large, seating up to seven.
STOC Vol.-Weighted Avg. Price vs. 1st Choice
(8) Crossover Vehicles - SDM's Oct. 20, 2000

\[ r^2 = 0.87 \]
STOC Median Price vs. Top 3 Choices
(8) Crossover Vehicles - SDM October 20, 2000

STOC Median Price

Top 3 Choice

r^2 = 0.80
Students valued BMW and Mercedes STOC highly, even though they “bought” them less frequently.
Which STOC metric is best?

Correlations Between STOC and 1st Choice
(Max - Average - Min for four independent trials)

<table>
<thead>
<tr>
<th>STOC Metric</th>
<th>Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median</td>
<td>0.69</td>
</tr>
<tr>
<td>VWAP</td>
<td>0.69</td>
</tr>
<tr>
<td>Mean</td>
<td>0.55</td>
</tr>
<tr>
<td>Close</td>
<td>0.68</td>
</tr>
<tr>
<td>Min</td>
<td>0.71</td>
</tr>
<tr>
<td>Max</td>
<td>0.45</td>
</tr>
</tbody>
</table>
# STOC Games for Laptop Bags: Tabular vs. Image Stimuli

<table>
<thead>
<tr>
<th>Bag 3</th>
<th>Bag 4</th>
<th>Bag 8</th>
<th>Bag 9</th>
<th>Bag 10</th>
<th>Bag 13</th>
<th>Bag 15</th>
<th>Bag 16</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price</td>
<td>$89</td>
<td>$88</td>
<td>$99</td>
<td>$80</td>
<td>$95</td>
<td>$79</td>
<td>$87</td>
</tr>
<tr>
<td>Size</td>
<td>Medium</td>
<td>Large</td>
<td>Large</td>
<td>Medium</td>
<td>Large</td>
<td>Medium</td>
<td>Large</td>
</tr>
<tr>
<td>Appearance</td>
<td>Black</td>
<td>Red &amp; Black</td>
<td>Black</td>
<td>Black</td>
<td>Red &amp; Black</td>
<td>Red &amp; Black</td>
<td>Black</td>
</tr>
<tr>
<td>Logo</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Handle</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>PDA Holder</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Cell Phone Holder</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Mesh Pocket</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Closure for Sleeve</td>
<td>Full Flap</td>
<td>Velcro Tab</td>
<td>Velcro Tab</td>
<td>Velcro Tab</td>
<td>Full Flap</td>
<td>Velcro Tab</td>
<td>Velcro Tab</td>
</tr>
<tr>
<td>Boot</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Prediction was very bad with the table - better with the larger images.
Will prediction improve if traders consider each attribute independently?
## Nine *Laptop Bag* Attribute Stocks

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Description</th>
<th>Price Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Larger_size</td>
<td></td>
<td>Adds $9</td>
</tr>
<tr>
<td>Red_color</td>
<td></td>
<td>No price change</td>
</tr>
<tr>
<td>Logo</td>
<td></td>
<td>Adds $4</td>
</tr>
<tr>
<td>Handle</td>
<td></td>
<td>Adds $6</td>
</tr>
<tr>
<td>PDA_holder</td>
<td></td>
<td>Adds $6</td>
</tr>
<tr>
<td>Cell_holder</td>
<td></td>
<td>Adds $7</td>
</tr>
<tr>
<td>Mesh_pocket</td>
<td></td>
<td>Adds $4</td>
</tr>
<tr>
<td>Flap_closure</td>
<td></td>
<td>Adds $7</td>
</tr>
<tr>
<td>Bottom_boot</td>
<td></td>
<td>Adds $7</td>
</tr>
</tbody>
</table>

![Image of laptop bag]
### Prior Individual Estimates of Attributes: Laptop Bags

<table>
<thead>
<tr>
<th>Attribute</th>
<th>109 Survey Responses</th>
<th>330 Actual Choices</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Larger size</td>
<td>54% (±19%)</td>
<td>61%</td>
</tr>
<tr>
<td>2. Red color</td>
<td>22% (±20%)</td>
<td>25%</td>
</tr>
<tr>
<td>3. Logo</td>
<td>66% (±22%)</td>
<td>71%</td>
</tr>
<tr>
<td>4. Handle</td>
<td>68% (±19%)</td>
<td>83%</td>
</tr>
<tr>
<td>5. PDA holder</td>
<td>26% (±16%)</td>
<td>25%</td>
</tr>
<tr>
<td>6. Cell holder</td>
<td>33% (±18%)</td>
<td>34%</td>
</tr>
<tr>
<td>7. Mesh pocket</td>
<td>51% (±22%)</td>
<td>58%</td>
</tr>
<tr>
<td>8. Flap closure</td>
<td>43% (±22%)</td>
<td>59%</td>
</tr>
<tr>
<td>9. Bottom boot</td>
<td>49% (±22%)</td>
<td>75%</td>
</tr>
</tbody>
</table>

**Aggregate Opinions**

- Improve prediction

**Trader Pre-Survey vs. Actual Choice of Each Attribute**

- Group $r^2 = 0.72$, $\rho = 0.85$
- Mean individual $r^2 = 0.33$, $\rho = 0.49$

What % of 330 first year Sloanies (in 2000) bought each of the nine upgrades?
Can traders predict each attribute independently? **YES!**
STOC for Vehicle Attributes: *Crossover Vehicles*

- **7 Seats**
- **Tow 5000**
- **Fast 0-60**
- **Large Cargo**
- **240 hp**
- **MPG**

$\textit{STOC Close}$

$r^2 = 0.85$

Actual User Design vs. STOC Close

- **Tow 5000**
- **Large Cargo**
- **Fast 0-60**
- **240 hp**
- **MPG**

Graph with data points showing correlation.
STOC for Ski Resort attributes

- 2001 Actual
- Mean Prior
  \( r^2 = 0.67 \) group, 0.53 indiv.
- STOC \( r^2 = 0.58 \)
We let 241 people design their ideal PDA/Cell phone device.

Each feature was traded off against price, weight, & battery.
The (14) Features were then traded as (14) “Stocks” in a game.

<table>
<thead>
<tr>
<th>Feature</th>
<th>Upgrade</th>
<th>Price</th>
<th>Weight</th>
<th>Battery</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIZE</td>
<td>compact</td>
<td>$10</td>
<td>3.0 oz</td>
<td>-</td>
</tr>
<tr>
<td>COLOR</td>
<td>monochrome</td>
<td>$99/149</td>
<td>-</td>
<td>-20%</td>
</tr>
<tr>
<td>MEMORY</td>
<td></td>
<td>$25</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>MEMORY</td>
<td></td>
<td>$50</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>OS</td>
<td>Palm</td>
<td>$40</td>
<td>-</td>
<td>-5%</td>
</tr>
<tr>
<td>CELL</td>
<td>cell</td>
<td>$99</td>
<td>1.0 oz</td>
<td>-</td>
</tr>
<tr>
<td>HANDSFREE</td>
<td></td>
<td>$50</td>
<td>-</td>
<td>-5%</td>
</tr>
<tr>
<td>BATTERY</td>
<td></td>
<td>$99/149</td>
<td>0.5 oz</td>
<td>+300%</td>
</tr>
<tr>
<td>WIRELESS</td>
<td></td>
<td>$99/149</td>
<td>0.5 oz</td>
<td>-10%</td>
</tr>
<tr>
<td>BLUETOOTH</td>
<td></td>
<td>$49</td>
<td>$</td>
<td>-5%</td>
</tr>
<tr>
<td>KEYBOARD</td>
<td>Thumb keyboard</td>
<td>$25</td>
<td>$</td>
<td>-10%</td>
</tr>
<tr>
<td>CF SLOT</td>
<td></td>
<td>$15</td>
<td>0.5 oz</td>
<td>-5%</td>
</tr>
<tr>
<td>SD SLOT</td>
<td></td>
<td>$15</td>
<td>$</td>
<td>-</td>
</tr>
<tr>
<td>GPS</td>
<td></td>
<td>$129</td>
<td>1.0 oz</td>
<td>-10%</td>
</tr>
</tbody>
</table>

Stock price = % of respondents who bought each feature
Student STOC trading agreed quite well with the original survey.
How did Executives do with *PDA/Cell* attributes?

![Graph showing the STOC Trading of 14 PDA Attributes](image)

- **STOC Trading of 14 PDA Attributes**
- **CEB Traders on April 18, 2002**
- **$r^2 = 0.87$**

- **STOC Closing Prices**
  - Wireless
  - Color
  - Cell
  - Battery
  - CF
  - Pocket PC
  - Bluetooth
  - 64MB
  - 32MB
  - Large
  - Hands free
  - GPS
  - SD
  - Keyboard

Source: Ely Dahan, MIT, April 18, 2002

CEB Executives did even **better than students!**
How do individual traders rank? *(laptop bag attributes)*

High market-priced portfolios don’t always identify “accurate” traders.
Order Effect: Bottom stocks get traded less, at lower prices

Vol.-Weighted Avg. Price
Position v. Price $r^2 = 0.41$
$\rho = -0.64$

VOLUME
Position v. Volume $r^2 = 0.14$
$\rho = -0.38$

ACTUAL
Position v. Actual $r^2 = 0.03$
$\rho = +0.18$

This suggests a need to have stocks randomly ordered by trader
Do STOC sellers rank concepts lower than buyers?

STOC Traded Vehicles Are Close in Rank

(n = 165 transaction pairings)

62% of trades are in the "right" direction
Conclusions about STOC

• Functions well with informed traders
• Is accurate at identifying winners
• Measures preferences in the aggregate
• Traders behave heterogeneously, learn
• Predicts well for many product categories
• Can be effective with concepts AND attributes
• Real outcomes are not absolutely necessary
Thank you.

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