Revealed Attention

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Limited Attention

▷ People do not pay attention to *all* products because

- Information Overload,
- Unawareness,
- Or both.

Breakfast Cereal

Breakfast Cereal

Consideration Sets

The consideration set is made up of the brands that are taken seriously by the consumer in his or her purchase decision.

Marketing, Finance and Psychology Literatures: Alba et al 1991, Chiang et al 1999, Goeree 2008, Hauser and Wernerfelt 1990, Howard and Sheth 1969, Nedungadi 1990, Punj and Brookes 2001, Roberts and Lattin 1991, Roberts and Nedungadi 1995, Shocker et al. 1991, Swait et al. 2002, Wright and Barbour 1977.

Cars

Cars

In USA car market, you can find (Kelly Blue Book)

SUV	Sedan	Minivan	Total
170	296	68	567

- The median number of cars considered by U.S. consumers is 8.1 (Hauser et al 1983)
- 22% of new-car buyers looked only one brand (Lapersonne et al 1995).

The Purpose of the Talk

- How can we deduce preferences and consideration sets from choice data with Limited Attention?

- How do decision makers with limited attention differ behaviorally from standard economic agents?

Notation

- X: finite set of all alternatives
- $S \subset X$: the feasible set
- c is a choice function ($c(S) \in S$)
- $\Gamma(S) \subset S$ is consideration set under S
    - Deterministic
    - Only depend on the set of alternatives

Choice by Limited Consideration (CLC)

$$c(S) = \max_{\succ} S$$

$$c(S) = \max_{\succ} \Gamma(S)$$

- $\Gamma(S)$ - Consideration set under S
- $\succ$ - Preference Relation

- Observables: $c(S)$
- Unobservables: $\Gamma(S)$ and $\succ$

Attention Filter

Her consideration set is unchanged when an alternative to which she does not pay attention becomes unavailable:

$$x \notin \Gamma(S) \;\Rightarrow\; \Gamma(S) = \Gamma(S \setminus x)$$

Attention Filter

$\Gamma(\cdot)$ is an attention filter if $x \notin \Gamma(S) \;\Rightarrow\; \Gamma(S) = \Gamma(S \setminus x)$

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$\Gamma(\cdot)$ is an attention filter if $x \notin \Gamma(S) \;\Rightarrow\; \Gamma(S) = \Gamma(S \setminus x)$

(Normatively Appealing) This property is satisfied when

- Standard Theory ($\Gamma(S) = S$)
- Unawareness
- Ultra-Rational (based on cost-benefit analysis)

Some Heuristics

(Descriptively Appealing) Some decision heuristics are used in consideration set formation:

- Top N Rule
- Top on Each Criterion
- Most popular category
- Satisficing
- Iterative Neighborhood Search

Identifying the Preference

Observation: There might be multiple preferences representing the same choice data.

S	xyz	xy	yz	xz
$c(S)$	x	x	y	z

Preference	Attention Filter			
	xyz	xy	yz	xz
$x \succ y \succ z$	xyz	x	yz	z
$z \succ x \succ y$	xy	xy	y	xz
$x \succ y$	xy	x	y	z

Revealed Preferences, Attention and Inattention

Need for a new definition of revealed preference and revealed attention !!!

Assume that there are multiple pairs of a preference $\succ$ and an attention filter Γ explaining her choice:

$$(\succ_1, \Gamma_1), (\succ_2, \Gamma_2), (\succ_3, \Gamma_3), \ldots (\succ_k, \Gamma_k)$$

Definition

- x is **revealed to be preferred** to y if $\succ_i$ ranks x above y for all i,
- x is **revealed to attract attention** at S if $\Gamma_i(S)$ includes x for all i,
- x is **revealed *not* to attract attention** at S if $\Gamma_i(S)$ excludes x for all i.

An illustration for Revealed Preference

$$c(xyz) = x \text{ and } c(xz) = z$$

- Her attention span changes when y is removed,
- Then she pays attention to y at $\{x, y, z\}$,
  - $y \in \Gamma(xyz)$ - - Revealed Attention
- Since she chooses x, x must be better than y,
  - $x \succ y$ - - Revealed Preference

Revealed Preference

If $x = c(S) \neq c(S \setminus y)$,
then x is *directly* revealed to be preferred to y

If $x = c(S) \neq c(S \setminus y)$ and $y = c(T) \neq c(T \setminus z)$,
then x is *indirectly* revealed to be preferred to z

Revealed Preference

Definition

xPy if there exists S such that

$$x = c(S) \neq c(S \setminus y).$$

Let P_R be the transitive closure of P.

Theorem 1

Suppose c is a CLC with an attention filter.
x is revealed to be preferred to y if and only if xP_Ry.

Revealed Preference

- Our revealed preference analysis is a model-based approach,
- Bernheim and Rangel (2009) propose a model-free approach (Behavioral Welfare Economics),
  - if x is never chosen while y is present,
    and y is chosen at least once when x is available,
    then y should be strictly welfare improving over x.
- Next example illustrates their intuition might deceive us.

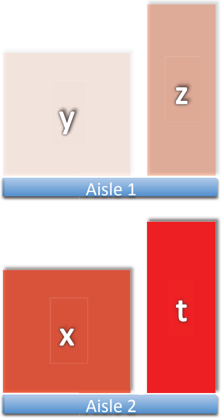
Example

- A (hypothetical) supermarket with two aisles and four products x, y, z and t,
  - two products for each aisle,
  - x and y in big boxes,
  - The first aisle has priority
  - y and z have priorities for the first aisle,

- A customer with preference $t \succ x \succ z \succ y$ (not observable)
  - visits the first aisle (not observable)
  - picks her most preferred in the first aisle

Example

- two products for each aisle,
- x and y in big boxes,
- The first aisle has priority
- y and z in the first aisle,



If all products are available,

Example

- two products for each aisle,
- x and y in big boxes,
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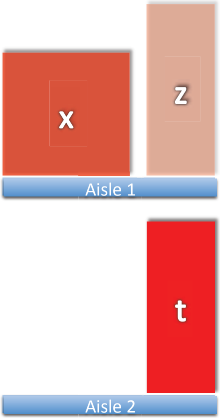
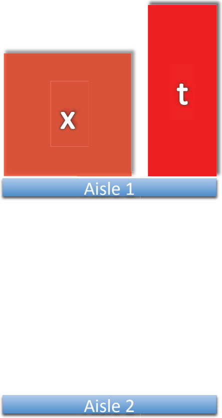


If x, z, t are available,

Example

- two products for each aisle,
- x and y in big boxes,
- The first aisle has priority
- y and z in the first aisle,



If x, t are available,

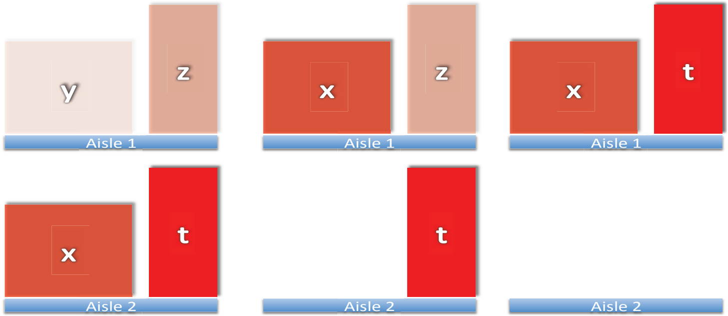
Example

- Since x never appears in the first aisle when y is available
- x is never chosen when y is available
- y is chosen when only x and y are available
- Bernheim and Rangel (2009) conclude that y is welfare improving over x
- opposite to her true preference $(x \succ y)$!!!!!!!

Example

- ▷ Assume we do not know true preference,
- ▷ Choices are observable,
- ▷ What does Theorem 1 say?
- ▷ Is Theorem 1 applicable?
- ▷ Yes, since her consideration set mapping is an attention filter,
- ▷ Let see what Theorem 1 says !!!!

Example



$c(\{x, y, z, t\}) = \{z\}$ $c(\{x, z, t\}) = \{x\}$ $c(\{x, t\}) = \{t\}$

Example

Now we assume that only choice data are observable and we do not know what the decision-maker does or pays attention to:

$c(\{x, y, z, t\}) = \{z\} \quad c(\{x, z, t\}) = \{x\} \quad c(\{x, t\}) = \{t\}$

We infer her preferences from these choices by using Theorem 1:

- $c(\{x, y, z, t\}) \neq c(\{x, z, t\}) \to z \succ y$
- $c(\{x, z, t\}) \neq c(\{x, t\}) \to x \succ z$
- Hence $x \succ z \succ y$

Wrap-up

This example highlights the importance of knowledge about the underlying choice procedure when we conduct welfare analysis.

Welfare analysis is more delicate task than it looks.

Revealed Inattention

- x is revealed to be preferred to y but y is chosen from S
  $\Rightarrow$ She must not pay attention to x at S

Revealed Attention

When can we conclude she pays attention to x at S?

- Removing x from S changes the choice $\Rightarrow$ x must be in $\Gamma(S)$.

- Removing x from T changes the choice
  $\Rightarrow$ x must be in $\Gamma(T)$.

  - All elements in T but not in S are revealed to be preferred to $c(T)$.
    $\Rightarrow$ they must not be in $\Gamma(T)$
    $\Rightarrow$ it must be $\Gamma(T) = \Gamma(S \cap T)$

  - All elements in S but not in T are revealed to be preferred to $c(S)$.
    $\Rightarrow$ it must be $\Gamma(S) = \Gamma(S \cap T)$

Revealed Attention and Inattention

Theorem 2

Suppose c is a CLC with an attention filter.

i) x is revealed *not* to attract attention at S if and only if x is revealed to be preferred to $c(S)$.

ii) x is revealed to attract attention at S if and only if there exists T such that:

- $c(T) \neq c(T \setminus x)$
- For all $y \in T \setminus S$, y is revealed to be preferred to $c(T)$.
- For all $y \in S \setminus T$, y is revealed to be preferred to $c(S)$.

Characterization

The assumption of classical choice theory:

WARP

For any nonempty S, there exists $x^* \in S$ such that

$$\text{if } x^* \in T \text{ and } c(T) \in S \text{ then } c(T) = x^*$$

Characterization

WARP with Limited Attention

For any nonempty S, there exists $x^* \in S$ such that

$$\text{if} \quad x^* \in T \text{ and } c(T) \in S \quad \text{then } c(T) = x^*$$
$$\text{and } c(T \setminus x^*) \neq c(T)$$

The additional requirement guarantees that she pays attention to x^* at T.

Characterization

Theorem 3

A choice function c is a CLC with an attention filter

if and only if

c satisfies WARP(LA).

Choice Anomalies

Choice Reversals

x is sometimes chosen when y is available but y is selected over x in some other occasion.

- Attraction Effect,
  - Huber et al. (1982), Huber and Puto (1983), ...
- Choice Cycle,
  - Tversky (1969), Loomes et al. (1991), ...
- Choosing Pairwise Unchosen Alternative,
  - Shafir and Tversky (1992), Sethi-Iyengar et al. (2004), ...

OTHER FILTERS

Full Attention in Binary Comparisons
If her inattention is because of abundance of alternatives, she will consider all alternatives more likely in small decision problems.

$$\Gamma(S) = S \text{ whenever } |S| = 2$$

Attention Grabbers

If the decision maker pays attention to an alternative in a larger set, then she will pay attention to it in a smaller set.

$$\text{if } x \in \Gamma(S) \text{ then } x \in \Gamma(T) \quad \text{for all} \quad T \subset S$$

Full Attention in Binary Comparisons

If her inattention is because of abundance of alternatives, she will consider all alternatives more likely in small decision problems. As a benchmark case,

$$\Gamma(S) = S \text{ whenever } |S| = 2$$

Full Attention in Binary Comparisons

Revealed Preference

$$xP^*y \text{ if } c(\{x, y\}) = x$$

Full Attention in Binary Comparisons

Pairwise Consistency: *P^* is a strict linear order.*

Weak Contraction: *If $c(S) \neq c(S \setminus x)$ then $c(S) = c(\{x, c(S)\})$.*

Theorem

A choice function satisfies PC and WC if and only if it is a CLC with an attention filter where there is full attention in binary sets.

Related Literature

- Sequentially Rationalizable Choice
  - Manzini and Marriotti (2007)
  - Apesteguia and Ballester (2010)
- Categorization
  - Manzini and Marriotti (2010)
- Rationalization
  - Cherepanov, Feddersen, and Sandroni (2010)
- When More is Less
  - Lleras, Masatlioglu, Nakajima and Ozbay (2010)

Related Literature

- Iterative Search (Masatlioglu and Nakajima (2010))
  - Consideration sets evolve dynamically
- Choosing the Two Finalists (Eliaz, Richter, and Rubinstein (2009))
  - Characterize only the first stage

Conclusion

- Boundedly rational choice model where agents are rational except they cannot pay attention to all available alternatives.
- Seemingly irrational behaviors are explained.
- Provide several simple characterizations
- Revealed Preference, Attention, and Inattention.

THANK YOU