Preferences over Menus

Eddie Dekel and Bart Lipman

March 19 2008

Model: Expected value

$V(\beta) = E(\beta)$, $\beta \in \Delta(B)$

- *Concerns*: Violates evidence. Ignores important behavioral features (risk).

Model: Expected value

$V(\beta) = E(\beta)$, $\beta \in \Delta(B)$

- *Concerns*: Violates evidence. Ignores important behavioral features (risk).
- "*Solution*": assume expected utility, a particular functional form of preferences over lotteries. Could even assume particular functional forms, e.g. ln.

Assuming EU

- *What's wrong*? Perhaps nothing. But we do want to understand this representation of preferences:

Assuming EU

- *What's wrong*? Perhaps nothing. But we do want to understand this representation of preferences:
  - How can we test it?

Assuming EU

- *What's wrong*? Perhaps nothing. But we do want to understand this representation of preferences:
  - How can we test it?
  - What environment is rich enough to obtain revealed preference/elicitation.

Assuming EU

- *What's wrong*? Perhaps nothing. But we do want to understand this representation of preferences:
  - How can we test it?
  - What environment is rich enough to obtain revealed preference/elicitation.
  - Normative: Understand why people should/might behave this way?

Assuming EU

- *What's wrong*? Perhaps nothing. But we do want to understand this representation of preferences:
  - How can we test it?
  - What environment is rich enough to obtain revealed preference/elicitation.
  - Normative: Understand why people should/might behave this way?
  - How unique it is, so as to give behavioral content to the functional form.

Assuming EU

- *What's wrong*? Perhaps nothing. But we do want to understand this representation of preferences:
    - How can we test it?
    - What environment is rich enough to obtain revealed preference/elicitation.
    - Normative: Understand why people should/might behave this way?
    - How unique it is, so as to give behavioral content to the functional form.
        - DARA,, CARA, comparing among different preferences risk aversion

Assuming EU

- *What's wrong*? Perhaps nothing. But we do want to understand this representation of preferences:
  - How can we test it?
  - What environment is rich enough to obtain revealed preference/elicitation.
  - Normative: Understand why people should/might behave this way?
  - How unique it is, so as to give behavioral content to the functional form.
    - DARA,, CARA, comparing among different preferences risk aversion
  - Want to be able to relate it to alternative functional forms.

Assuming EU

- *What's wrong*? Perhaps nothing. But we do want to understand this representation of preferences:
  - How can we test it?
  - What environment is rich enough to obtain revealed preference/elicitation.
  - Normative: Understand why people should/might behave this way?
  - How unique it is, so as to give behavioral content to the functional form.
    - DARA,, CARA, comparing among different preferences risk aversion
  - Want to be able to relate it to alternative functional forms.
  - Basically want to study connection between behavior and representations

Assuming EU

- *What's wrong*? Perhaps nothing. But we do want to understand this representation of preferences:
  - How can we test it?
  - What environment is rich enough to obtain revealed preference/elicitation.
  - Normative: Understand why people should/might behave this way?
  - How unique it is, so as to give behavioral content to the functional form.
    - DARA,, CARA, comparing among different preferences risk aversion
  - Want to be able to relate it to alternative functional forms.
  - Basically want to study connection between behavior and representations
  - Viewing this as a restriction on revealed preferences can helps; axioms help understand the restriction.

Assuming EU

- *What's wrong*? Perhaps nothing. But we do want to understand this representation of preferences:
  - How can we test it?
  - What environment is rich enough to obtain revealed preference/elicitation.
  - Normative: Understand why people should/might behave this way?
  - How unique it is, so as to give behavioral content to the functional form.
    - DARA,, CARA, comparing among different preferences risk aversion
  - Want to be able to relate it to alternative functional forms.
  - Basically want to study connection between behavior and representations
  - Viewing this as a restriction on revealed preferences can helps; axioms help understand the restriction.
- *Better(?) approach...*

- Focus on the space of objects $\Delta(B)$ and study preferences.

Model: Expected utility

vN-M

- Focus on the space of objects $\Delta(B)$ and study preferences.
- *Representation*: $U(\beta) = \int u(b)\, d\beta(b)$

Model: Expected utility

- Focus on the space of objects $\Delta(B)$ and study preferences.
- *Representation*: $U(\beta) = \int u(b)\, d\beta(b)$
- *Elicitation idea:* What mixture between b^* and b_* (best and worst outcomes) is indifferent to any b.

- Focus on the space of objects $\Delta(B)$ and study preferences.
- *Representation*: $U(\beta) = \int u(b)\, d\beta(b)$
- *Elicitation idea:* What mixture between b^* and b_* (best and worst outcomes) is indifferent to any b.
- *Interpretations:*

Model: Expected utility

vN-M

- Focus on the space of objects $\Delta(B)$ and study preferences.
- *Representation*: $U(\beta) = \int u(b)\, d\beta(b)$
- *Elicitation idea:* What mixture between b^* and b_* (best and worst outcomes) is indifferent to any b.
- *Interpretations:*
  - Normative: Internal consistency: People want to satisfy these axioms, so they will behave *as if* this representation holds;

Model: Expected utility

vN-M

- Focus on the space of objects $\Delta(B)$ and study preferences.
- *Representation*: $U(\beta) = \int u(b)\, d\beta(b)$
- *Elicitation idea:* What mixture between b^* and b_* (best and worst outcomes) is indifferent to any b.
- *Interpretations:*
  - Normative: Internal consistency: People want to satisfy these axioms, so they will behave *as if* this representation holds;
  - Normative: "advice" If you want to satisfy these axioms, you may want to use probabilities and utilities;

Model: Expected utility

vN-M

- Focus on the space of objects $\Delta(B)$ and study preferences.
- *Representation*: $U(\beta) = \int u(b)\, d\beta(b)$
- *Elicitation idea:* What mixture between b^* and b_* (best and worst outcomes) is indifferent to any b.
- *Interpretations:*
  - Normative: Internal consistency: People want to satisfy these axioms, so they will behave *as if* this representation holds;
  - Normative: "advice" If you want to satisfy these axioms, you may want to use probabilities and utilities;
  - Modeling: We want to know if this is a good model so the axioms and revealed preference approach help test it and elicit the utility function.

Model: Expected utility

vN-M

- Cannot tell if this is "as if" or actual. People may use a mental process with utilities (or construct them based on our advice) or have preferences that happen to coincide with these and never think about utilities, or have rules of thumb that yield the same behavior.

Model: Expected utility

vN-M

- Cannot tell if this is "as if" or actual. People may use a mental process with utilities (or construct them based on our advice) or have preferences that happen to coincide with these and never think about utilities, or have rules of thumb that yield the same behavior.
- Do we care?

- Cannot tell if this is "as if" or actual. People may use a mental process with utilities (or construct them based on our advice) or have preferences that happen to coincide with these and never think about utilities, or have rules of thumb that yield the same behavior.
- Do we care?
  - When we treat these as preferences, we are saying something about the process.

- Cannot tell if this is "as if" or actual. People may use a mental process with utilities (or construct them based on our advice) or have preferences that happen to coincide with these and never think about utilities, or have rules of thumb that yield the same behavior.
- Do we care?
  - When we treat these as preferences, we are saying something about the process.
  - We do treat them preferences when we try to use them to explain the world or improve it.

Model: Expected utility

vN-M

- Cannot tell if this is "as if" or actual. People may use a mental process with utilities (or construct them based on our advice) or have preferences that happen to coincide with these and never think about utilities, or have rules of thumb that yield the same behavior.
- Do we care?
    - When we treat these as preferences, we are saying something about the process.
    - We do treat them preferences when we try to use them to explain the world or improve it.
    - That's still not saying the process has to be right.

- Cannot tell if this is "as if" or actual. People may use a mental process with utilities (or construct them based on our advice) or have preferences that happen to coincide with these and never think about utilities, or have rules of thumb that yield the same behavior.
- Do we care?
  - When we treat these as preferences, we are saying something about the process.
  - We do treat them preferences when we try to use them to explain the world or improve it.
  - That's still not saying the process has to be right.
  - But we seem to like SOSD as a definition of risk aversion in part at least because it relates nicely to the representation. So we must think the representation means something. Why not define risk of a lottery by variance? Or, if we thought risk aversion evolved from winner-take-all games, it would be probability of getting highest outcomes, which isn't even transitive.

- *Concerns:*

- *Concerns:*
  - Useless: Where do utilities come from?

- *Concerns:*
  - Useless: Where do utilities come from?
  - Incomplete: What if probabilities aren't objective.

- *Concerns:*
  - Useless: Where do utilities come from?
  - Incomplete: What if probabilities aren't objective.
- "*Solution*": people have them in their mind and we can just assume vN-M with subjective probabilities.

- *Concerns:*
    - Useless: Where do utilities come from?
    - Incomplete: What if probabilities aren't objective.
- "*Solution*": people have them in their mind and we can just assume vN-M with subjective probabilities.
- What is "wrong" with this answer? Same as before....

- *Concerns:*
    - Useless: Where do utilities come from?
    - Incomplete: What if probabilities aren't objective.
- "*Solution*": people have them in their mind and we can just assume vN-M with subjective probabilities.
- What is "wrong" with this answer? Same as before....
- *Better(?) approach...*

- *Enrich the space*: $(\Delta(B))^S$ [Why not B^S? Not rich enough to pin down probabilities]

- *Enrich the space*: $(\Delta(B))^S$ [Why not B^S? Not rich enough to pin down probabilities]
- *Representation*: $\int U(\beta(s))\,d\mu(s)$, state dependent: $\int U(\beta(s), s)\,d\mu(s)$

Model: Subjective expected utility

A-A / Savage

- *Enrich the space*: $(\Delta(B))^S$ [Why not B^S? Not rich enough to pin down probabilities]
- *Representation*: $\int U(\beta(s))\, d\mu(s)$, state dependent: $\int U(\beta(s), s)\, d\mu(s)$
- *Elicitation idea:* What certain outcome β is indifferent to 1 in state s, 0 elsewhere.

Model: Subjective expected utility

- *Enrich the space*: $(\Delta(B))^S$ [Why not B^S? Not rich enough to pin down probabilities]
- *Representation*: $\int U(\beta(s))\, d\mu(s)$, state dependent: $\int U(\beta(s), s)\, d\mu(s)$
- *Elicitation idea:* What certain outcome β is indifferent to 1 in state s, 0 elsewhere.
- On uniqueness: Complaint about state dependent—probabilities aren't pinned down.

Model: Subjective expected utility

- *Enrich the space*: $(\Delta(B))^S$ [Why not B^S? Not rich enough to pin down probabilities]
- *Representation*: $\int U(\beta(s))\, d\mu(s)$, state dependent: $\int U(\beta(s), s)\, d\mu(s)$
- *Elicitation idea:* What certain outcome β is indifferent to 1 in state s, 0 elsewhere.
- On uniqueness: Complaint about state dependent—probabilities aren't pinned down.
- Do we care?

- *Enrich the space*: $(\Delta(B))^S$ [Why not B^S? Not rich enough to pin down probabilities]
- *Representation*: $\int U(\beta(s))\, d\mu(s)$, state dependent: $\int U(\beta(s), s)\, d\mu(s)$
- *Elicitation idea:* What certain outcome β is indifferent to 1 in state s, 0 elsewhere.
- On uniqueness: Complaint about state dependent—probabilities aren't pinned down.
- Do we care?
  - Under "as if" approach, why should we? People behave as if they have one.

Model: Subjective expected utility

- *Enrich the space*: $(\Delta(B))^S$ [Why not B^S? Not rich enough to pin down probabilities]
- *Representation*: $\int U(\beta(s))\, d\mu(s)$, state dependent: $\int U(\beta(s), s)\, d\mu(s)$
- *Elicitation idea:* What certain outcome β is indifferent to 1 in state s, 0 elsewhere.
- On uniqueness: Complaint about state dependent—probabilities aren't pinned down.
- Do we care?
    - Under "as if" approach, why should we? People behave as if they have one.
    - Even in state independence case it's only a normalization.

Model: Subjective expected utility

- *Enrich the space*: $(\Delta(B))^S$ [Why not B^S? Not rich enough to pin down probabilities]
- *Representation*: $\int U(\beta(s))\, d\mu(s)$, state dependent: $\int U(\beta(s), s)\, d\mu(s)$
- *Elicitation idea:* What certain outcome β is indifferent to 1 in state s, 0 elsewhere.
- On uniqueness: Complaint about state dependent—probabilities aren't pinned down.
- Do we care?
  - Under "as if" approach, why should we? People behave as if they have one.
  - Even in state independence case it's only a normalization.
  - But as a mental process uniqueness seems more important.

Model: Subjective expected utility

A-A / Savage

- *Enrich the space*: $(\Delta(B))^S$ [Why not B^S? Not rich enough to pin down probabilities]
- *Representation*: $\int U(\beta(s))\, d\mu(s)$, state dependent: $\int U(\beta(s), s)\, d\mu(s)$
- *Elicitation idea:* What certain outcome β is indifferent to 1 in state s, 0 elsewhere.
- On uniqueness: Complaint about state dependent—probabilities aren't pinned down.
- Do we care?
  - Under "as if" approach, why should we? People behave as if they have one.
  - Even in state independence case it's only a normalization.
  - But as a mental process uniqueness seems more important.
  - But perhaps if we want to make assumptions like common priors.

- *Enrich the space*: $(\Delta(B))^S$ [Why not B^S? Not rich enough to pin down probabilities]
- *Representation*: $\int U(\beta(s))\,d\mu(s)$, state dependent: $\int U(\beta(s), s)\,d\mu(s)$
- *Elicitation idea:* What certain outcome β is indifferent to 1 in state s, 0 elsewhere.
- On uniqueness: Complaint about state dependent—probabilities aren't pinned down.
- Do we care?
  - Under "as if" approach, why should we? People behave as if they have one.
  - Even in state independence case it's only a normalization.
  - But as a mental process uniqueness seems more important.
  - But perhaps if we want to make assumptions like common priors.
    - Perhaps not–should find "revealed preference" test for that.

- *Concerns*:

Model: Subjective expected utility

- *Concerns*:
  - Useless: Where does the prior come from? (And same complaint about u as before.)

- *Concerns*:
  - Useless: Where does the prior come from? (And same complaint about u as before.)
  - Incomplete: What if states aren't objective. E.g. unforeseen contingencies.

- *Concerns*:
    - Useless: Where does the prior come from? (And same complaint about u as before.)
    - Incomplete: What if states aren't objective. E.g. unforeseen contingencies.
- "*Solution*": Subjective states / indescribable states / un-contractible states.

- *Concerns*:
  - Useless: Where does the prior come from? (And same complaint about u as before.)
  - Incomplete: What if states aren't objective. E.g. unforeseen contingencies.
- "*Solution*": Subjective states / indescribable states / un-contractible states.
- Not only of abstract theoretical interest: contract incompleteness, control rights = flexibility.

- *Concerns*:
  - Useless: Where does the prior come from? (And same complaint about u as before.)
  - Incomplete: What if states aren't objective. E.g. unforeseen contingencies.
- "*Solution*": Subjective states / indescribable states / un-contractible states.
- Not only of abstract theoretical interest: contract incompleteness, control rights = flexibility.
- Note again the (lack of) difference between interpretations in the "solution": in one people have preferences but cannot describe the contingencies vs. people have in mind contingencies but we cannot observe them. We cannot tell these apart. Do we care?

Model: Subjective expected utility

A-A / Savage

- *Concerns*:
  - Useless: Where does the prior come from? (And same complaint about u as before.)
  - Incomplete: What if states aren't objective. E.g. unforeseen contingencies.
- "*Solution*": Subjective states / indescribable states / un-contractible states.
- Not only of abstract theoretical interest: contract incompleteness, control rights = flexibility.
- Note again the (lack of) difference between interpretations in the "solution": in one people have preferences but cannot describe the contingencies vs. people have in mind contingencies but we cannot observe them. We cannot tell these apart. Do we care?
- *Better(?) approach...*

Model: Subjective states

Kreps (1979)

- *Enrich the state space*: $2^B - \emptyset$, consider menus.

Model: Subjective states

Kreps (1979)

- *Enrich the state space*: $2^B - \emptyset$, consider menus.
  - *assume* monotonicity

Model: Subjective states

Kreps (1979)

- *Enrich the state space*: $2^B - \emptyset$, consider menus.
  - *assume* monotonicity
  - $x \sim x \cup x'$ implies $x \cup x'' \sim x \cup x' \cup x''$: no menu effects – adding x' isn't valuable given x, so adding x'' doesn't change that. (frog's legs on menu can change preferences between steak and salad)

Model: Subjective states

Kreps (1979)

- *Enrich the state space*: $2^B - \emptyset$, consider menus.
    - *assume* monotonicity
    - $x \sim x \cup x'$ implies $x \cup x'' \sim x \cup x' \cup x''$: no menu effects – adding x' isn't valuable given x, so adding x'' doesn't change that. (frog's legs on menu can change preferences between steak and salad)
- *Representation*: $V(x) = \int_S \max_{b \in x} u(b, s)\, d\mu(s)$

Model: Subjective states

Kreps (1979)

- *Enrich the state space*: $2^B - \emptyset$, consider menus.
  - *assume* monotonicity
  - $x \sim x \cup x'$ implies $x \cup x'' \sim x \cup x' \cup x''$: no menu effects – adding x' isn't valuable given x, so adding x'' doesn't change that. (frog's legs on menu can change preferences between steak and salad)
- *Representation*: $V(x) = \int_S \max_{b \in x} u(b, s)\, d\mu(s)$
- *Elicitation idea*: Strict preference of $\{b, b'\}$ over $\{b\}$ and over $\{b'\}$ indicates two states, one where each is preferred.

Model: Subjective states

Kreps (1979)

- *Enrich the state space*: $2^B - \emptyset$, consider menus.
  - *assume* monotonicity
  - $x \sim x \cup x'$ implies $x \cup x'' \sim x \cup x' \cup x''$: no menu effects – adding x' isn't valuable given x, so adding x'' doesn't change that. (frog's legs on menu can change preferences between steak and salad)
- *Representation*: $V(x) = \int_S \max_{b \in x} u(b,s)\, d\mu(s)$
- *Elicitation idea*: Strict preference of $\{b, b'\}$ over $\{b\}$ and over $\{b'\}$ indicates two states, one where each is preferred.
- Remark: Menus are acts, specifically incentive compatible acts where in each state (not observed) the person chooses their preferred outcome. So "just like" Savage/A-A (except not rich enough so far)

Model: Subjective states
Kreps (1979)

- *Concerns*:

Model: Subjective states

Kreps (1979)

- *Concerns*:
  - Useless: Where do subjective states come from? (Plus same complains about u and μ as before.) Actually, the subjective states do have a natural interpretation, but the probabilities become even harder to assess.

Model: Subjective states

Kreps (1979)

- *Concerns*:
  - Useless: Where do subjective states come from? (Plus same complains about u and μ as before.) Actually, the subjective states do have a natural interpretation, but the probabilities become even harder to assess.
  - Non uniqueness (that is hard to understand and troublesome for comparative statics);

Model: Subjective states

Kreps (1979)

- *Concerns*:
  - Useless: Where do subjective states come from? (Plus same complains about u and μ as before.) Actually, the subjective states do have a natural interpretation, but the probabilities become even harder to assess.
  - Non uniqueness (that is hard to understand and troublesome for comparative statics);
  - Monotonicity implies that the only unforeseen contingencies are those where I am in control. What about concerns about states where the wrong thing happens?

Examples of issues with Kreps' model

Additivity

- $V(x) = \int_S \max_{b \in x} u(b, s)\, d\mu(s)$ or $V(x) = w(\max_{b \in x} u(b, s))$, $w : \mathbf{R}^S \to \mathbf{R}$.

Examples of issues with Kreps' model

Additivity

- $V(x) = \int_S \max_{b \in x} u(b,s)\, d\mu(s)$ or $V(x) = w(\max_{b \in x} u(b,s))$, $w : \mathbf{R}^S \to \mathbf{R}$.
-

$$\begin{array}{rcl} u(b,s) & = & \begin{array}{cccc} & s_1 & s_2 & s_3 \\ c & 2 & 1 & 1 \\ f & 1 & 2 & 1 \\ v & 1 & 1 & 2 \end{array} \\ w(a_1, a_2, a_3) & = & a_1 a_2 + a_3 \end{array}$$

Examples of issues with Kreps' model

Additivity

- $V(x) = \int_S \max_{b \in x} u(b,s)\, d\mu(s)$ or $V(x) = w(\max_{b \in x} u(b,s))$, $w : \mathbf{R}^S \to \mathbf{R}$.
- $$\begin{array}{rcl} & & \begin{array}{cccc} & s_1 & s_2 & s_3 \end{array} \\ u(b,s) & = & \begin{array}{cccc} c & 2 & 1 & 1 \\ f & 1 & 2 & 1 \\ v & 1 & 1 & 2 \end{array} \\ w(a_1, a_2, a_3) & = & a_1 a_2 + a_3 \end{array}$$
- This aggregator is "truly" nonadditive in the sense that there is no monotonic transformation which makes it additive.

- $V(x) = \int_S \max_{b \in x} u(b,s)\, d\mu(s)$ or $V(x) = w(\max_{b\in x} u(b,s))$, $w : \mathbf{R}^S \to \mathbf{R}$.
-

$$u(b,s) = \begin{array}{cccc} & s_1 & s_2 & s_3 \\ c & 2 & 1 & 1 \\ f & 1 & 2 & 1 \\ v & 1 & 1 & 2 \end{array}$$

$$w(a_1, a_2, a_3) = a_1 a_2 + a_3$$

- This aggregator is "truly" nonadditive in the sense that there is no monotonic transformation which makes it additive.
- $\{c, f, v\} \succ \{c, f\} \succ \{c, v\} \sim \{f, v\} \succ \{c\} \sim \{f\} \sim \{v\}$.

- We get the same ranking if we use an additive aggregator and a state space of

	s_1'	s_2'	s_3'
c	3	0	4
f	0	3	4
v	1	1	5

Examples of issues with Kreps' model

Additivity

- We get the same ranking if we use an additive aggregator and a state space of

	s_1'	s_2'	s_3'
c	3	0	4
f	0	3	4
v	1	1	5

- Similar to subjective probabilities: are we bothered by on-uniqueness? Does this example cast doubt on using additive model? "As if" or real?

Examples of issues with Kreps' model

- Can't identify how many states are "bad" and how many are "good".

Examples of issues with Kreps' model

- Can't identify how many states are "bad" and how many are "good".
-

	s_1	s_2	s_3	s_4	s_5
c	0	1	0	1	0
f	1	0	0	2	2
v	2	0	1	0	1
μ_1	2	5	-3	1	0
μ_2	-1	6	0	0	3

Examples of issues with Kreps' model

- Can't identify how many states are "bad" and how many are "good".
-

	s_1	s_2	s_3	s_4	s_5
c	0	1	0	1	0
f	1	0	0	2	2
v	2	0	1	0	1
μ_1	2	5	-3	1	0
μ_2	-1	6	0	0	3

- So $S_1 = \{s_1, s_2, s_3, s_4\}$ and $S_2 = \{s_1, s_2, s_5\}$. Both yield the preferences

$$\{c, f\} \succ \{c, f, v\} \succ \{c, v\} \succ \{c\} \succ \{f\} \succ \{f, v\} \succ \{v\}$$

Examples of issues with Kreps' model

- Can't identify how many states are "bad" and how many are "good".
-

	s_1	s_2	s_3	s_4	s_5
c	0	1	0	1	0
f	1	0	0	2	2
v	2	0	1	0	1
μ_1	2	5	-3	1	0
μ_2	-1	6	0	0	3

- So $S_1 = \{s_1, s_2, s_3, s_4\}$ and $S_2 = \{s_1, s_2, s_5\}$. Both yield the preferences

$$\{c, f\} \succ \{c, f, v\} \succ \{c, v\} \succ \{c\} \succ \{f\} \succ \{f, v\} \succ \{v\}$$

- In both cases the signs of the coefficients are determined holding fixed the state space.

Examples of issues with Kreps' model

- Can't identify how many states are "bad" and how many are "good".
-

	s_1	s_2	s_3	s_4	s_5
c	0	1	0	1	0
f	1	0	0	2	2
v	2	0	1	0	1
μ_1	2	5	-3	1	0
μ_2	-1	6	0	0	3

- So $S_1 = \{s_1, s_2, s_3, s_4\}$ and $S_2 = \{s_1, s_2, s_5\}$. Both yield the preferences

$$\{c, f\} \succ \{c, f, v\} \succ \{c, v\} \succ \{c\} \succ \{f\} \succ \{f, v\} \succ \{v\}$$

- In both cases the signs of the coefficients are determined holding fixed the state space.
- Identify the signs with fixed state space, but changing the state space *forces* the signs to change.

Subjective states with random lotteries and without monotonicity

DLR (2001)

- *Enrich the state space*: $2^{\Delta(B)} - \emptyset$. Drop monotonicity.

Subjective states with random lotteries and without monotonicity

DLR (2001)

- *Enrich the state space*: $2^{\Delta(B)} - \emptyset$. Drop monotonicity.
  - With $\Delta(B)$ menus are A-A acts. But a subset.

Subjective states with random lotteries and without monotonicity

DLR (2001)

- *Enrich the state space*: $2^{\Delta(B)} - \emptyset$. Drop monotonicity.
  - With $\Delta(B)$ menus are A-A acts. But a subset.
- Axioms: weak order, independence (on menus!), continuity

Subjective states with random lotteries and without monotonicity

DLR (2001)

- *Enrich the state space*: $2^{\Delta(B)} - \emptyset$. Drop monotonicity.
  - With $\Delta(B)$ menus are A-A acts. But a subset.
- Axioms: weak order, independence (on menus!), continuity
  - Independence: $x \succeq y \iff px + (1-p)z \succeq py + (1-p)z$

Subjective states with random lotteries and without monotonicity

DLR (2001)

- *Enrich the state space*: $2^{\Delta(B)} - \emptyset$. Drop monotonicity.
  - With $\Delta(B)$ menus are A-A acts. But a subset.
- Axioms: weak order, independence (on menus!), continuity
  - Independence: $x \succeq y \iff px + (1-p)z \succeq py + (1-p)z$
  - $px + (1-p)z = \{\beta \in \Delta(B) : \beta = p\alpha + (1-p)\gamma,\ \alpha \in x, \gamma \in z\}$.

Subjective states with random lotteries and without monotonicity

DLR (2001)

- *Enrich the state space*: $2^{\Delta(B)} - \emptyset$. Drop monotonicity.
  - With $\Delta(B)$ menus are A-A acts. But a subset.
- Axioms: weak order, independence (on menus!), continuity
  - Independence: $x \succeq y \iff px + (1-p)z \succeq py + (1-p)z$
  - $px + (1-p)z = \{\beta \in \Delta(B) : \beta = p\alpha + (1-p)\gamma, \alpha \in x, \gamma \in z\}$.
  - Why independence? $x \succeq y \iff px \oplus (1-p)z \succeq py \oplus (1-p)z$ $\iff px + (1-p)z \succeq py + (1-p)z$

Subjective states with random lotteries and without monotonicity

DLR (2001)

- *Enrich the state space*: $2^{\Delta(B)} - \emptyset$. Drop monotonicity.
  - With $\Delta(B)$ menus are A-A acts. But a subset.
- Axioms: weak order, independence (on menus!), continuity
  - Independence: $x \succeq y \iff px + (1-p)z \succeq py + (1-p)z$
  - $px + (1-p)z = \{\beta \in \Delta(B) : \beta = p\alpha + (1-p)\gamma, \alpha \in x, \gamma \in z\}$.
  - Why independence? $x \succeq y \iff px \oplus (1-p)z \succeq py \oplus (1-p)z$ $\iff px + (1-p)z \succeq py + (1-p)z$
  - First one is like standard two stage argument. Second is like standard reduction of compound lotteries.

Subjective states with random lotteries and without monotonicity

DLR (2001)

- *Enrich the state space*: $2^{\Delta(B)} - \emptyset$. Drop monotonicity.
  - With $\Delta(B)$ menus are A-A acts. But a subset.
- Axioms: weak order, independence (on menus!), continuity
  - Independence: $x \succeq y \iff px + (1-p)z \succeq py + (1-p)z$
  - $px + (1-p)z = \{\beta \in \Delta(B) : \beta = p\alpha + (1-p)\gamma, \alpha \in x, \gamma \in z\}$.
  - Why independence? $x \succeq y \iff px \oplus (1-p)z \succeq py \oplus (1-p)z$
    $\iff px + (1-p)z \succeq py + (1-p)z$
  - First one is like standard two stage argument. Second is like standard reduction of compound lotteries.
- *Representation*: $V(x) = \int_S \max_{\beta \in x} U(\beta, s)\, d\mu(s)$, μ signed measure, S "unique", μ is not.

Subjective states with random lotteries and without monotonicity

DLR (2001)

- *Enrich the state space*: $2^{\Delta(B)} - \emptyset$. Drop monotonicity.
  - With $\Delta(B)$ menus are A-A acts. But a subset.
- Axioms: weak order, independence (on menus!), continuity
  - Independence: $x \succeq y \iff px + (1-p)z \succeq py + (1-p)z$
  - $px + (1-p)z = \{\beta \in \Delta(B) : \beta = p\alpha + (1-p)\gamma, \alpha \in x, \gamma \in z\}$.
  - Why independence? $x \succeq y \iff px \oplus (1-p)z \succeq py \oplus (1-p)z$ $\iff px + (1-p)z \succeq py + (1-p)z$
  - First one is like standard two stage argument. Second is like standard reduction of compound lotteries.
- *Representation*: $V(x) = \int_S \max_{\beta \in x} U(\beta, s)\, d\mu(s)$, μ signed measure, S "unique", μ is not.
- *Elicitation idea*: Like A-A lotteries pin things down; preferring $\{b\}$ and $\{b'\}$ to $\{b, b'\}$ indicates a concern about a state where the wrong thing is chosen.

- *Concerns*:

- *Concerns*:
  - Difficult to interpret negative states.

- *Concerns*:
    - Difficult to interpret negative states.
    - Too general.

- *Concerns*:
    - Difficult to interpret negative states.
    - Too general.
- *Solution*: study special cases to capture specific behavioral issues and explain why the "wrong" thing is chosen?

- *And more concerns:*

Solution: drop EU and/or weaken independence.

- *And more concerns:*
  - Too restrictive: Independence rules too much out (risk/uncertainty-ambiguity) but also new implications of those. Do menus add reasons to be concerned with reduction?

Solution: drop EU and/or weaken independence.

- *And more concerns:*
  - Too restrictive: Independence rules too much out (risk/uncertainty-ambiguity) but also new implications of those. Do menus add reasons to be concerned with reduction?
    - Rules out menu effects.

Solution: drop EU and/or weaken independence.

- *And more concerns:*
  - Too restrictive: Independence rules too much out (risk/uncertainty-ambiguity) but also new implications of those. Do menus add reasons to be concerned with reduction?
    - Rules out menu effects.
    - Rules out ambiguity-based violations of independence on lotteries (singleton menus).

Solution: drop EU and/or weaken independence.

- *And more concerns:*
  - Too restrictive: Independence rules too much out (risk/uncertainty-ambiguity) but also new implications of those. Do menus add reasons to be concerned with reduction?
    - Rules out menu effects.
    - Rules out ambiguity-based violations of independence on lotteries (singleton menus).
    - But rules out more: min max type preferences over sets

$$V(x) = \min_{\mu \in M} \int_S \max_{\beta \in x} U(\beta, s) \, d\mu(s)$$

would satisfy IR: $x \sim \mathrm{conv}(x)$. But if have "hedging" desire over unforeseen contingencies then might strictly prefer $\mathrm{conv}(x)$.

Solution: drop EU and/or weaken independence.

- *And more concerns:*
  - Too restrictive: Independence rules too much out (risk/uncertainty-ambiguity) but also new implications of those. Do menus add reasons to be concerned with reduction?
    - Rules out menu effects.
    - Rules out ambiguity-based violations of independence on lotteries (singleton menus).
    - But rules out more: min max type preferences over sets

$$V(x) = \min_{\mu \in M} \int_S \max_{\beta \in x} U(\beta, s)\, d\mu(s)$$

    would satisfy IR: $x \sim \text{conv}(x)$. But if have "hedging" desire over unforeseen contingencies then might strictly prefer $\text{conv}(x)$.

  - Independence rules out contemplation costs: $px \oplus (1-p)\, y \succeq px + (1-p)\, y$.

Solution: drop EU and/or weaken independence.

- *And more concerns:*
  - Too restrictive: Independence rules too much out (risk/uncertainty-ambiguity) but also new implications of those. Do menus add reasons to be concerned with reduction?
    - Rules out menu effects.
    - Rules out ambiguity-based violations of independence on lotteries (singleton menus).
    - But rules out more: min max type preferences over sets

$$V(x) = \min_{\mu \in M} \int_S \max_{\beta \in x} U(\beta, s)\, d\mu(s)$$

      would satisfy IR: $x \sim \mathrm{conv}(x)$. But if have "hedging" desire over unforeseen contingencies then might strictly prefer $\mathrm{conv}(x)$.
  - Independence rules out contemplation costs: $px \oplus (1-p)\, y \succeq px + (1-p)\, y$.
  - Uniqueness assumes and relies upon EU; while lotteries are necessary for uniqueness, EU should not be.

Solution: drop EU and/or weaken independence.

- *Representations*:

Interpreting Negative states: Temptation

Gul-Pesendorfer (2001)

- *Representations*:
- costly self control

$$V(x) = \max_{\beta \in x} \left(U(\beta) + V(\beta) \right) - \max_{\beta \in x} \left(V(\beta) \right)$$

$$\begin{aligned} V(x) &= \max_{\beta \in x} (U(\beta) - c(\beta, x)) \\ c(\beta, x) &= \max_{\gamma \in x} V(\beta) - V(\gamma) \end{aligned}$$

Interpreting Negative states: Temptation

Gul-Pesendorfer (2001)

- *Representations*:
- costly self control

$$
\begin{aligned}
V(x) &= \max_{\beta \in x} (U(\beta) + V(\beta)) - \max_{\beta \in x} (V(\beta)) \\
V(x) &= \max_{\beta \in x} (U(\beta) - c(\beta, x)) \\
c(\beta, x) &= \max_{\gamma \in x} V(\beta) - V(\gamma)
\end{aligned}
$$

- **Axiom**: Add set betweenness: $x \succeq y \Rightarrow x \succeq x \cup y \succeq y$

- Overwhelming temptation

$$
\begin{aligned}
V(x) &= \max_{\beta \in \arg\max_{\beta' \in x} v(\beta')} U(\beta) \\
&= \max_{\beta \in B_v(x)} U(\beta), \qquad\qquad B_v(x) \equiv \arg\max_{\beta' \in x} v(\beta')
\end{aligned}
$$

$$
\lim_{k \to \infty} \max_{\beta \in x} \left(U(\beta) + kV(\beta) \right) - \max_{\beta \in x} \left(kV(\beta) \right)
$$

- Overwhelming temptation

$$
\begin{aligned}
V(x) &= \max_{\beta \in \arg\max_{\beta' \in x} v(\beta')} U(\beta) \\
&= \max_{\beta \in B_v(x)} U(\beta), \qquad\qquad B_v(x) \equiv \arg\max_{\beta' \in x} v(\beta')
\end{aligned}
$$

$$
\lim_{k \to \infty} \max_{\beta \in x} \left(U(\beta) + kV(\beta) \right) - \max_{\beta \in x} \left(kV(\beta) \right)
$$

- *Complaints:* Too restrictive; misses interesting forms of temptation.

- $$\{b\} \succ \{b, c\}, \{b, p\} \succ \{b, c, p\}.$$

  broccoli, candy, potato chips

- $$\{b\} \succ \{b, c\}, \{b, p\} \succ \{b, c, p\}.$$

  broccoli, candy, potato chips
- Two snacks worse because unsure what temptation will strike, or because lots of snacks make it hard to resist.

Temptation

Multiple temptations

- $$\{b\} \succ \{b, c\}, \{b, p\} \succ \{b, c, p\}.$$

  broccoli, candy, potato chips
- Two snacks worse because unsure what temptation will strike, or because lots of snacks make it hard to resist.
- The latter can be due to regret (more on that later) or due to menu effects. E.g., broccoli, ice cream, frozen yogurt:

  $$\{b\} \sim \{b, f\} \sim \{b, i\} \succ \{b, f, i\} \sim \{f, i\} \;\tilde{}\; \{f\} \succ \{i\}$$

  We assume no menu effects (follows from independence axiom) and that menus don't tempt.

Temptation

Multiple temptations

- $$\{b\} \succ \{b, c\}, \{b, p\} \succ \{b, c, p\}.$$

  broccoli, candy, potato chips

- Two snacks worse because unsure what temptation will strike, or because lots of snacks make it hard to resist.
- The latter can be due to regret (more on that later) or due to menu effects. E.g., broccoli, ice cream, frozen yogurt:

  $$\{b\} \sim \{b, f\} \sim \{b, i\} \succ \{b, f, i\} \sim \{f, i\} \,\tilde{}\, \{f\} \succ \{i\}$$

  We assume no menu effects (follows from independence axiom) and that menus don't tempt.

- Violates SB: $\{b, c, p\}$ is strictly worse than $\{b, c\}$ and $\{b, p\}$

Uncertain temptations

DLR (2001), Stovall (2007)

	u	v_1	v_2
b	3	2	2
c	0	0	6
p	0	6	0

Uncertain temptations

DLR (2001), Stovall (2007)

	u	v_1	v_2
b	3	2	2
c	0	0	6
p	0	6	0

- $$\begin{aligned} V(x) &= \frac{1}{2}\Sigma_{i=1}^{2} \max_{\beta \in x}[u(\beta) - c_i(\beta, x)] \\ c_i(\beta, x) &= \max_{\beta' \in x} v_i(\beta') - v_i(\beta). \end{aligned}$$

Uncertain temptations

DLR (2001), Stovall (2007)

-

	u	v_1	v_2
b	3	2	2
c	0	0	6
p	0	6	0

-

$$
\begin{aligned}
V(x) &= \frac{1}{2}\Sigma_{i=1}^{2} \max_{\beta \in x}[u(\beta) - c_i(\beta, x)] \\
c_i(\beta, x) &= \max_{\beta' \in x} v_i(\beta') - v_i(\beta).
\end{aligned}
$$

- **Axiom**: Weak set betweenness: If $\forall \alpha \in x, \beta \in y$ $\alpha \succeq \beta$ then $x \succeq x \cup y \succeq y$

Uncertain costly temptations and overwhelming temptations

- $$\begin{aligned} V(x) &= \int \left(\max_{\beta \in x} \left[u(\beta) + v_s(\beta) \right] - \max_{\beta \in x} v_s(\beta) \right) d\mu(s) \\ & \int \left(\max_{\beta \in x} \left[u(\beta) + K v_s(\beta) \right] - \max_{\beta \in x} K v_s(\beta) \right) d\mu(s) \\ &\rightarrow \int \max_{\beta \in B_{v_s}(x)} u(\beta) \, d\mu(s) \end{aligned}$$

- But in fact for all μ there exists $\hat{\mu}$ st.

$$\begin{aligned} & \int \left(\max_{\beta \in x} \left[u\left(\beta\right) + v_s\left(\beta\right) \right] - \max_{\beta \in x} v_s\left(\beta\right) \right) d\mu\left(s\right) \\ = & \int \max_{\beta \in B_{v_s}\left(x\right)} u\left(\beta\right) d\hat{\mu}\left(s\right) \end{aligned}$$

- But in fact for all μ there exists $\hat{\mu}$ st.

$$\int \left(\max_{\beta \in x} \left[u(\beta) + v_s(\beta) \right] - \max_{\beta \in x} v_s(\beta) \right) d\mu(s)$$

$$= \int \max_{\beta \in B_{v_s}(x)} u(\beta)\, d\hat{\mu}(s)$$

- Implication:

- But in fact for all μ there exists $\hat{\mu}$ st.

$$\begin{aligned} & \int \left(\max_{\beta \in x} \left[u(\beta) + v_s(\beta) \right] - \max_{\beta \in x} v_s(\beta) \right) d\mu(s) \\ = & \int \max_{\beta \in B_{v_s}(x)} u(\beta) \, d\hat{\mu}(s) \end{aligned}$$

- Implication:
  - choice from menu matters

- But in fact for all μ there exists $\hat{\mu}$ st.

$$\begin{aligned} & \int \left(\max_{\beta \in x} \left[u(\beta) + v_s(\beta) \right] - \max_{\beta \in x} v_s(\beta) \right) d\mu(s) \\ = & \int \max_{\beta \in B_{v_s}(x)} u(\beta)\, d\hat{\mu}(s) \end{aligned}$$

- Implication:
  - choice from menu matters
  - If all we care about is "as if", doesn't matter

- But in fact for all μ there exists $\hat{\mu}$ st.

$$\int \left(\max_{\beta \in x} \left[u(\beta) + v_s(\beta) \right] - \max_{\beta \in x} v_s(\beta) \right) d\mu(s)$$

$$= \int \max_{\beta \in B_{v_s}(x)} u(\beta)\, d\hat{\mu}(s)$$

- Implication:
  - choice from menu matters
  - If all we care about is "as if", doesn't matter
  - If we think of GP as representing a new "behavioral" feature—costs to resisting temptation—we see that they lead to same (commitment) behavior as uncertain overwhelming temptation. This suggests differences less inherent to this feature. Also may suggest comparative statics on which to focus and dynamic models for overwhelming temptation.

- $$\{b, y\} \succ \{y\} \text{ and } \{b, c, y\} \succ \{b, c\}.$$

  Rather have a chance of sticking to her diet rather than committing herself to violating it so $\{b, y\} \succ \{y\}$.
  But if the temptation of the ice cream is unavoidable, it's better to also have the frozen yogurt around.

- $$\{b, y\} \succ \{y\} \text{ and } \{b, c, y\} \succ \{b, c\}.$$

  Rather have a chance of sticking to her diet rather than committing herself to violating it so $\{b, y\} \succ \{y\}$.
  But if the temptation of the ice cream is unavoidable, it's better to also have the frozen yogurt around.
- This violates a more subtle combination of set betweenness and independence.

-

	u	v
b	6	0
i	0	8
y	4	6

$$V(x) = \frac{1}{2}\max_{\beta\in x}[u(\beta) - c(\beta, x)] + \frac{1}{2}\max_{\beta\in x} u(\beta).$$

	u	v
b	6	0
i	0	8
y	4	6

  $$V(x) = \frac{1}{2} \max_{\beta \in x} [u(\beta) - c(\beta, x)] + \frac{1}{2} \max_{\beta \in x} u(\beta).$$

- Desire for commitment: $\exists \alpha \in x,\ \alpha \succeq x$

Uncertain temptations

Uncertain strength of temptation

	u	v
b	6	0
i	0	8
y	4	6

$$V(x) = \frac{1}{2}\max_{\beta \in x}[u(\beta) - c(\beta, x)] + \frac{1}{2}\max_{\beta \in x} u(\beta).$$

- Desire for commitment: $\exists \alpha \in x$, $\alpha \succeq x$
- Negative set betweenness: $x \succeq y \Rightarrow x \cup y \succeq y$.

- A different interpretation of negative states.

Regret

Sarver (2007)

- A different interpretation of negative states.
- $$V(x) = \max_{\beta \in x} \left[(1+K) \sum u(\beta, s) p(s) \right] - K \sum \max_{\beta \in x} u(\beta, s) p(s)$$

Regret
Sarver (2007)

- A different interpretation of negative states.
- $$V(x) = \max_{\beta \in x} \left[(1+K) \sum u(\beta, s) \, p(s) \right] - K \sum \max_{\beta \in x} u(\beta, s) \, p(s)$$
- **Axiom**: *Dominance:* If $\{\alpha\} \succeq \{\beta\}$ and $\alpha \in x$ then $x \succeq x \cup \{\beta\}$

Contemplation costs

Ergin, Ergin and Sarver

- Instead of taking costly information as objective, there is a subjective derivation of costs and information.

Contemplation costs

Ergin, Ergin and Sarver

- Instead of taking costly information as objective, there is a subjective derivation of costs and information.
- Formally they use menus, but the interpretation (like that of independence) involves lotteries of menus.

Contemplation costs

Ergin, Ergin and Sarver

- Instead of taking costly information as objective, there is a subjective derivation of costs and information.
- Formally they use menus, but the interpretation (like that of independence) involves lotteries of menus.
- **Axiom:** *Aversion to contingent planning:* $x \succeq y \Rightarrow x \succeq \alpha x + (1 - \alpha) y$.

Contemplation costs

Ergin, Ergin and Sarver

- Instead of taking costly information as objective, there is a subjective derivation of costs and information.
- Formally they use menus, but the interpretation (like that of independence) involves lotteries of menus.
- **Axiom:** *Aversion to contingent planning:* $x \succeq y \Rightarrow x \succeq \alpha x + (1 - \alpha) y$.
  - Interpret $\alpha x + (1 - \alpha) y$ as resolving after choice and "requiring" contingent choice, and contrast this with a lottery over menus, $\alpha \circ x \oplus (1 - \alpha) \circ y$ resolving after choice, that does not require contemplation. The latter is better, and it is also reasonable to assume it is no better than x since $x \succeq y$. (They do this to avoid explicitly introducing lotteries over menus.) Here we have a subjective states space S, state-dependent utility functions u, possible subjective information partition about the state, $\mathcal{G} \in \mathbf{G}$, and a cost function over information partitions. (Independence forces indifference to contingent planning.)

Contemplation costs

Ergin, Ergin and Sarver

- $$V(x) = \max_{\mathcal{G} \in \mathbf{G}} \left(\sum_{E \in \mathcal{G}} \left[\max_{\beta \in x} \sum_{s \in E} u(\beta, s)\, \mu(s|E) \right] \mu(E) - c(\mathcal{G}) \right)$$

  A drawback to this representation is its lack of uniqueness; they show that there is a more refined notion of a costly contemplation model that is pinned down.

DLR too restrictive

Extend choice domain

- Too restrictive: Independence rules out (risk/uncertainty-ambiguity) and new implications of those.

DLR too restrictive

Extend choice domain

- Too restrictive: Independence rules out (risk/uncertainty-ambiguity) and new implications of those.
- Epstein and Kopylov enrich the choice set: menus of acts.

DLR too restrictive

Extend choice domain

- Too restrictive: Independence rules out (risk/uncertainty-ambiguity) and new implications of those.
- Epstein and Kopylov enrich the choice set: menus of acts.
- Yields subjective "beliefs" over states, and decision maker suffers the temptation is to use wrong beliefs later. They get "cold feet". Knowing this decision maker commits ahead of time.

$$
\begin{aligned}
V(\xi) &= \max_{f\in\xi}\left(p\cdot u(f) + k\min_{q\in Q}(q\cdot u(f))\right) \\
&\quad - \max_{f\in\xi} k\left(\min_{q\in Q}(q\cdot u(f))\right) \\
, p &\in Q
\end{aligned}
$$

DLR too restrictive

Extend choice domain

- Uniqueness assumes and relies upon EU; while lotteries are necessary for uniqueness, EU is not.

DLR too restrictive

Extend choice domain

- Uniqueness assumes and relies upon EU; while lotteries are necessary for uniqueness, EU is not.
- Epstein, Marinacci and Seo, and Epstein and Seo consider lotteries of menus (of lotteries).

DLR too restrictive

Extend choice domain

- Uniqueness assumes and relies upon EU; while lotteries are necessary for uniqueness, EU is not.
- Epstein, Marinacci and Seo, and Epstein and Seo consider lotteries of menus (of lotteries).
- This yields a more robust notion of uniqueness, not relying on EU.

- Uniqueness assumes and relies upon EU; while lotteries are necessary for uniqueness, EU is not.
- Epstein, Marinacci and Seo, and Epstein and Seo consider lotteries of menus (of lotteries).
- This yields a more robust notion of uniqueness, not relying on EU.
- This approach also can be used to characterize

$$W(P) = \int_X \left(\int_{2^S} \max_{\beta \in x} \min_{s \in \sigma} u(\beta, s)\, d\mu(\sigma) \right) dP(x),$$

μ a probability over sets of states

Menus

- Choice from menus enables eliciting and identifying preferences with subjective states,

Menus

- Choice from menus enables eliciting and identifying preferences with subjective states,
    - yielding a model of unforeseen contingencies that mimics exactly a standard model with the additional assumption that states can not be contracted (as they are subjective).

Menus

- Choice from menus enables eliciting and identifying preferences with subjective states,
  - yielding a model of unforeseen contingencies that mimics exactly a standard model with the additional assumption that states can not be contracted (as they are subjective).
  - It also yields models that capture behavioral features such as temptation, contemplation costs, regret, anticipation,...

Menus

- Choice from menus enables eliciting and identifying preferences with subjective states,
  - yielding a model of unforeseen contingencies that mimics exactly a standard model with the additional assumption that states can not be contracted (as they are subjective).
  - It also yields models that capture behavioral features such as temptation, contemplation costs, regret, anticipation,...
  - costs to resisting temptation and uncertain overwhelming temptation have same commitment behavior

Menus

- Choice from menus enables eliciting and identifying preferences with subjective states,
  - yielding a model of unforeseen contingencies that mimics exactly a standard model with the additional assumption that states can not be contracted (as they are subjective).
  - It also yields models that capture behavioral features such as temptation, contemplation costs, regret, anticipation,...
  - costs to resisting temptation and uncertain overwhelming temptation have same commitment behavior
- In the overwhelming representation the problem facing a decision maker with negative states is exactly a principle-agent problem, and in that sense this class of models can be analyzed using standard techniques to identify the form of commitments that will be chosen and what arrangements a seller would offer (Della Vigna and Melamdier, Eliaz and Spiegler, ...Amador, Werning and Angeletos use a version to study decision makers facing a temptation to over consume with a concern that flexibility might be necessary).