Outside options and risk attitude

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Motivation

(Effective) risk attitude: how a decision-maker chooses among risky prospects (=lotteries).

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prospects	outside option
projects	job loss (for manager)
health-insurance plans	public option
occupations	retraining
spouses	divorce
locations	bailout (e.g. FEMA)

Questions

Framework:

$$\text{effective risk att.} \quad = \quad \text{`true' risk att.} \quad + \quad \text{effect of o.o.}$$

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$$\underbrace{\text{effective risk att.}}_{\text{observable}} \quad = \quad \underbrace{\text{`true' risk att.}}_{\text{unobservable}} \quad + \quad \underbrace{\text{effect of o.o.}}_{\text{unobservable}}$$

Identification: what do choices reveal about 'true' risk attitude?

– important for policy / welfare analysis

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- Thm 1(i): 'true' is <u>more risk-averse</u> than effective.

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Specialness: which transform'ns of a decision problem necessarily reduce risk-aversion?

- adding an o.o.: yes by Th'm 1(i)

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Specialness: which transform'ns of a decision problem necessarily reduce risk-aversion?

- adding an o.o.: yes by Th'm 1(i)
- <u>any</u> other transform'n: <u>no</u>! (Th'm 3)

Literature

Th'm 1(i) formalises idea that o.o. increases risk appetite.

An old idea. For example, Adam Smith (1776) argued that limited liability (o.o. = bankruptcy) increases risk-taking.

Details: slide 28. See also e.g. Jensen and Meckling (1976, section 4.1),
Golbe (1981, 1988),
Gollier, Koehl and Rochet (1997).

An important idea, e.g. for financial stability.

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Th'ms 1(ii), 2, 3: no close parallels that we know of.

Broader literature

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Some economic forces that have been studied:

- background risk .... papers: slide 31
- contracts
  - employment .... papers: slide 32
  - financing .... papers: slide 33
- having an audience
  - career concerns .... papers: slide 34
  - disclosure .... Ben-Porath, Dekel and Lipman, 2018
- (in)flexibility .... papers: slide 35
- competition .... papers: slides 36–39

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Setup

Alternatives: $x, y \in X \neq \varnothing$.

Risky prospects / simple lotteries: $p, q \in \Delta^0(X)$

$$:= \left\{ p : X \to [0,1] \ : \ |\mathrm{supp}(p)| < \infty \ \& \ \textstyle\sum_{x \in \mathrm{supp}(p)} p(x) = 1 \right\}$$

Preferences $\succeq, \succeq'$: complete transitive relations on $\Delta^0(X)$.

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$\succeq$ is <u>EU</u> iff $\exists\, u : X \to \mathbf{R}$ s.t. $p \succeq q \iff \int u \mathrm{d}p \geq \int u \mathrm{d}q$.

$\hookrightarrow$ the function u is called <u>risk attitude</u>

$\hookrightarrow$ $\alpha u + \beta$ is identified off $\succeq$ ($\alpha > 0$ & $\beta \in \mathbf{R}$ unknown)

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$\succeq$ is <u>less risk-averse than</u> $\succeq'$ iff $\forall\, x \in X$ & $\forall\, p \in \Delta^0(X)$,

$$x \succeq (\succ)\, p \implies x \succeq' (\succ')\, p.$$

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u is <u>less risk-averse than</u> v iff $\forall\, x \in X$ & $\forall\, p \in \Delta^0(X)$,

$$u(x) \geq (>) \int u \mathrm{d}p \implies v(x) \geq (>) \int v \mathrm{d}p.$$

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For $X \neq \varnothing$ and $u, v : X \to \mathbf{R}$, the following are equivalent:

(A) u is less risk-averse than v.

(B) $\exists$ increasing convex $\phi : \mathrm{co}(v(X)) \to \mathbf{R}$
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(C) The following two properties hold:

(I) $\forall\, x, y \in X,\ u(x) \geq (>)\, u(y) \implies v(x) \geq (>)\, v(y).$

(II) $\forall\, x, y, z \in X,$ if $u(x) < u(y) < u(z),$ then

$$\frac{u(z) - u(y)}{u(y) - u(x)} \geq \frac{v(z) - v(y)}{v(y) - v(x)}.$$

Pratt's theorem (part 2)

If in addition X is an open convex subset of $\mathbf{R}$

& u, v are C^2 with $u' > 0 < v'$, then

u is less risk-averse than v iff $u''/u' \geq v''/v'$.

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The outside-option model

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The outside-option model

Decision-maker has

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Decision-maker's valuation of alternative $x \in X$ if o.o. worth k:

$$\max\{v(x), k\}$$

(Compare realised o.o. with x; if better, exercise.)

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Decision-maker's valuation of alternative $x \in X$:

$$\int \max\{v(x), k\} F(\mathrm{d}k) \quad = \quad F(v(x))v(x) + \int_{(v(x),+\infty)} kF(\mathrm{d}k).$$

(Compare realised o.o. with x; if better, exercise.)

Where do outside options come from?

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Physical o.o. $\sim \mu \in \Delta(Y \cup \{\varnothing\})$, ‘$\varnothing$’ means ‘unavailable’

payoff f'n $w : Y \to \mathbf{R}$ convention: $w(\varnothing) := -\infty$

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Special case: X-valued o.o., i.e. $Y = X$ & $w = v$.

- Implies F concentrated on $v(X) \cup \{-\infty\}$.
- Conversely, any ECDF F concentrated on $v(X) \cup \{-\infty\}$ arises via $(\star)$ from some X-valued o.o. $\mu \in \Delta(X \cup \{-\infty\})$.
- (Detail: above makes sense provided $v(X)$ is Borel.)

(skip to slide 21)

Behavioural implications

Say that (v, F) is <u>o.o. representation</u> of $\succeq$ iff

$$p \succeq q \quad \Longleftrightarrow \quad \begin{cases} \displaystyle\int \left(\int \max\{v(x), k\} F(\mathrm{d}k) \right) p(\mathrm{d}x) \\ \\ \displaystyle\geq \int \left(\int \max\{v(x), k\} F(\mathrm{d}k) \right) q(\mathrm{d}x). \end{cases}$$

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$$p \succeq q \qquad \Longleftrightarrow \qquad \left\{ \begin{aligned} & \int \underbrace{\left(\int \max\{v(x), k\} F(\mathrm{d}k) \right)}_{=\alpha u(x)+\beta} p(\mathrm{d}x) \\ \geq & \int \overbrace{\left(\int \max\{v(x), k\} F(\mathrm{d}k) \right)} q(\mathrm{d}x). \end{aligned} \right.$$

Note: (v, F) o.o. rep'n of $\succeq$

$\Longrightarrow$ $\succeq$ is EU with risk att. u where $\exists\ \alpha > 0$ & $\beta \in \mathbf{R}$ s.t.

$\alpha u(x) + \beta = \int \max\{v(x), k\} F(\mathrm{d}k) \quad \forall x \in X.$

$\hookrightarrow$ u is decision-maker's <u>effective</u> risk attitude.

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Corollary: $\succeq$ admits an o.o. representation iff $\succeq$ is EU.

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How an o.o. shapes risk attitude

Question: how do properties of o.o. dist'n F shape divergence of effective risk att. u from 'true' risk att. v ?

How an o.o. shapes risk attitude

Proposition 1. For $X \neq \varnothing$, $u, v : X \to \mathbf{R}$
& ECDF F,
the following are equivalent:

(i) $\exists\ \alpha > 0$ & $\beta \in \mathbf{R}$ such that

$$\alpha u(x) + \beta = \int \max\{v(x), k\} F(\mathrm{d}k) \qquad \forall\ x \in X.$$

(ii) $\int_{(0,+\infty)} kF(\mathrm{d}k) < +\infty$, and
$\exists\ \phi : \mathrm{co}(v(X)) \to \mathbf{R}$ s.t. $u = \phi \circ v$,
ϕ is abs. cont's & $\phi' \propto F$.

How an o.o. shapes risk attitude

Proposition 1. For $X \neq \varnothing$, $u, v : X \to \mathbf{R}$
& ECDF F that is C^1 with $F > 0$ on $(\inf v(X), +\infty)$,
the following are equivalent:

(i) $\exists\ \alpha > 0$ & $\beta \in \mathbf{R}$ such that

$$\alpha u(x) + \beta = \int \max\{v(x), k\} F(\mathrm{d}k) \qquad \forall\ x \in X.$$

(ii′) $\int_{(0,+\infty)} k F(\mathrm{d}k) < +\infty$, and
$\exists\ \phi : \mathrm{co}(v(X)) \to \mathbf{R}$ s.t. $u = \phi \circ v$,
ϕ is C^2 & $\phi''/\phi' = F'/F$.

Monetary alternatives

Suppose alternatives & o.o. are monetary:

- X is an open convex subset of $\mathbf{R}$
- u, v are C^2 with $u' > 0 < v'$
- $F = G \circ v^{-1}$ for ECDF G concentrated on $X \cup \{-\infty\}$.

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Then (ii) on previous slide is equivalent to

(ii″) $\int_{(0,+\infty)} v \mathrm{d}G < +\infty$ and

$u''/u' = v''/v' + G'/G.$

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Revealed risk attitude

Question: what can be learned about v from observing choice among lotteries?

Revealed risk attitude

Question: what can be learned about v from $\alpha u + \beta$?

Revealed risk attitude

Theorem 1. For $X \neq \varnothing$ and bounded-above $u, v : X \to \mathbf{R}$ with u Lipschitz w.r.t. v,* the following are equivalent:

(a) u is less risk-averse than v.

Revealed risk attitude

Theorem 1. For $X \neq \varnothing$ and bounded-above $u, v : X \to \mathbf{R}$ with u Lipschitz w.r.t. v,[*] the following are equivalent:

(a) u is less risk-averse than v.

(b) $\exists\ \alpha > 0,\ \beta \in \mathbf{R}$ & an ECDF F such that

$$\alpha u(x) + \beta = \int \max\{v(x), k\} F(\mathrm{d}k) \quad \text{for every } x \in X$$

& $F > 0$ on $(\underline{\inf}\, v(X), +\infty)$.[†]

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[*] $\exists\, L \geq 0 \quad \text{s.t.} \quad \forall\, x, y \in X, \quad |u(x) - u(y)| \leq L|v(x) - v(y)|.$

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---

*$\exists\ L \geq 0$ s.t. $\forall\ x, y \in X$, $|u(x) - u(y)| \leq L|v(x) - v(y)|$.

†Ordinarily $\underline{\inf}\, A \coloneqq \inf A$. The exception:
$\underline{\inf}\, A \coloneqq \inf(A \setminus \{\inf A\})$ if $\inf A < \inf(A \setminus \{\inf A\}) \notin A$.

(Non-)identification of the o.o. dist'n

Question: what can be learned about F from observing choice among lotteries?

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(Non-)identification of the o.o. dist'n

Question: what can be learned about F from $\alpha u + \beta$?

Answer: essentially nothing. (details: slide 30)

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Comparative statics

Question: how does effective risk att. u vary with (v, F)?

Comparative statics

Theorem 2. Fix $X \neq \varnothing$, $u, v : X \to \mathbf{R}$, ECDF F with $F > 0$ on $(\underline{\inf}\, v(X), +\infty)$. Suppose $\exists\ \alpha > 0$ & $\beta \in \mathbf{R}$ such that

$$\alpha u(x) + \beta = \int \max\{v(x), k\} F(\mathrm{d}k) \qquad \forall x \in X.$$

Assume ($v(X)$ Borel and) F concentrated on $v(X) \cup \{-\infty\}$.

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Theorem 2. Fix $X \neq \varnothing$, $\widehat{u}, \widehat{v} : X \to \mathbf{R}$, ECDF $\widehat{F}$ with $\widehat{F} > 0$ on $(\underline{\inf}\, \widehat{v}(X), +\infty)$. Suppose $\exists\ \widehat{\alpha} > 0$ & $\widehat{\beta} \in \mathbf{R}$ such that

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Assume ($\widehat{v}(X)$ Borel and) $\widehat{F}$ concentrated on $\widehat{v}(X) \cup \{-\infty\}$.

(a) Sps $\widehat{v} = v$. Then $\widehat{u}$ is less risk-averse than u iff $\widehat{F}$ is better than F in the RHRO on $v(X) \setminus \{\sup v(X)\}$.

$\hookrightarrow$ RHRO (reverse hazard rate order) on $K \subseteq \mathbf{R}$: $F(\ell)\widehat{F}(k) \leq F(k)\widehat{F}(\ell)$ for all $k < \ell$ in K.

Comparative statics

Theorem 2. Fix $X \neq \varnothing$, $\widehat{u}, \widehat{v} : X \to \mathbf{R}$, ECDF $\widehat{F}$ with $\widehat{F} > 0$ on $(\underline{\inf}\,\widehat{v}(X), +\infty)$. Suppose $\exists\ \widehat{\alpha} > 0$ & $\widehat{\beta} \in \mathbf{R}$ such that

$$\widehat{\alpha}\widehat{u}(x) + \widehat{\beta} = \int \max\{\widehat{v}(x), k\}\widehat{F}(\mathrm{d}k) \qquad \forall x \in X.$$

Assume ($\widehat{v}(X)$ Borel and) $\widehat{F}$ concentrated on $\widehat{v}(X) \cup \{-\infty\}$.

(a) Sps $\widehat{v} = v$. Then $\widehat{u}$ is less risk-averse than u iff $\widehat{F}$ is better than F in the RHRO on $v(X) \setminus \{\sup v(X)\}$.

(b) Sps $F \circ v = \widehat{F} \circ \widehat{v}$. Then $\widehat{u}$ is less risk-averse than u iff $\widehat{v}$ is less risk-averse than v.

$\hookrightarrow$ $F \circ v = \widehat{F} \circ \widehat{v}$ means utility units change $(v \rightsquigarrow \widehat{v})$ but physical o.o. dist'n $\mu \in \Delta(X \cup \{\varnothing\})$ held fixed.

(recall slide 12)

Comparative statics

Theorem 2. Fix $X \neq \varnothing$, $\widehat{u}, \widehat{v} : X \to \mathbf{R}$,
ECDF $\widehat{F}$ with $\widehat{F} > 0$ on $(\underline{\inf}\, \widehat{v}(X), +\infty)$.
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Plan

Setup and background

The outside-option model

How an o.o. shapes risk attitude (Proposition 1)

Identification (Theorem 1)

Comparative statics (Theorem 2)

What is special about o.o.? (Theorem 3)

Idea

Adding an o.o. to a decision problem transforms it
by replacing each $x \in X$ with an x-contingent lottery.
(Viz. lottery which returns x or the o.o., whichever is better.)

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Another example of such transform'n: adding background risk.

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Question: which transformations decrease risk-aversion?

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(Viz. lottery which returns x or the o.o., whichever is better.)

Another example of such transform'n: adding background risk.

Question: which transformations decrease risk-aversion?

- adding o.o.: yes, by Th'm 1.
- adding background risk: no, not in general.

Idea

Adding an o.o. to a decision problem transforms it
by replacing each $x \in X$ with an x-contingent lottery.
(Viz. lottery which returns x or the o.o., whichever is better.)

Another example of such transform'n: adding background risk.

Question: which transformations decrease risk-aversion?

Answer: <u>only</u> transform'ns that amount to adding an o.o.

The question, formally

Transform'n: replace each x with draw from measure μ_x on X.

'True' risk att. $v : X \to \mathbf{R} \quad \rightsquigarrow \quad$ effective risk att. $x \mapsto \int v \mathrm{d}\mu_x$.

The question, formally

Transform'n: replace each x with draw from measure μ_x on X.

'True' risk att. $v : X \to \mathbf{R}$ $\quad\rightsquigarrow\quad$ effective risk att. $x \mapsto \int v \mathrm{d}\mu_x$.

Question: given rich class $\mathcal{V}$ of possible 'true' risk attitudes,
which families $(\mu_x)_{x \in X}$ have the property that
$\forall\, v \in \mathcal{V}, \quad x \mapsto \int v \mathrm{d}\mu_x$ is less risk-averse than v?

The question, reformulated

Question: given rich class $\mathcal{V}$ of possible 'true' risk attitudes, which families $(\mu_x)_{x\in X}$ have the property that $\forall\ v \in \mathcal{V}, \quad x \mapsto \int v \mathrm{d}\mu_x$ is less risk-averse than v?

Since u less risk-averse than $v \implies u, v$ ordinally equivalent, restrict to $\mathcal{V}$s whose members are mutually ordinally equivalent.

The question, reformulated

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No other restrictions $\implies \mathcal{V}$ is an ordinal equivalence class.

Given such $\mathcal{V}$, fix $v_0 \in \mathcal{V}$ & embed X in $\mathbf{R}$ via $x \mapsto v_0(x)$. Then $X \subseteq \mathbf{R}$ & $\mathcal{V}$ is the set of all str. incr. f'ns $X \to \mathbf{R}$.

The question, reformulated

Question: given rich class $\mathcal{V}$ of possible 'true' risk attitudes, which families $(\mu_x)_{x\in X}$ have the property that $\forall\ v \in \mathcal{V}, \quad x \mapsto \int v \mathrm{d}\mu_x$ is less risk-averse than v?

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Given such $\mathcal{V}$, fix $v_0 \in \mathcal{V}$ & embed X in $\mathbf{R}$ via $x \mapsto v_0(x)$. Then $X \subseteq \mathbf{R}$ & $\mathcal{V}$ is the set of all str. incr. f'ns $X \to \mathbf{R}$.

Question′: which families $(G_x)_{x\in X}$ of CDFs concentr'd on X have the property that $\forall$ str. incr. $v : X \to \mathbf{R}$, $x \mapsto \int v \mathrm{d}G_x$ is less risk-averse than v?

The answer

Theorem 3. For non-empty Borel $X \subseteq \mathbf{R}$ with $\sup X \notin X$ & family $(G_x)_{x \in X}$ of CDFs concentrated on X, the following are equivalent:

(a) $\forall$ bounded str. incr. $v : X \to \mathbf{R}$,
$x \mapsto \int v \mathrm{d} G_x$ is less risk-averse than v.

The answer

Theorem 3. For non-empty Borel $X \subseteq \mathbf{R}$ with $\sup X \notin X$ & family $(G_x)_{x \in X}$ of CDFs concentrated on X, the following are equivalent:

(a) $\forall$ bounded str. incr. $v : X \to \mathbf{R}$, $x \mapsto \int v \mathrm{d}G_x$ is less risk-averse than v.

(b) $\exists$ ECDF G $\begin{Bmatrix} \text{concentrated on } X \cup \{-\infty\}, \\ \text{with } G > 0 \text{ on } (\inf X, +\infty) \end{Bmatrix}$ such that

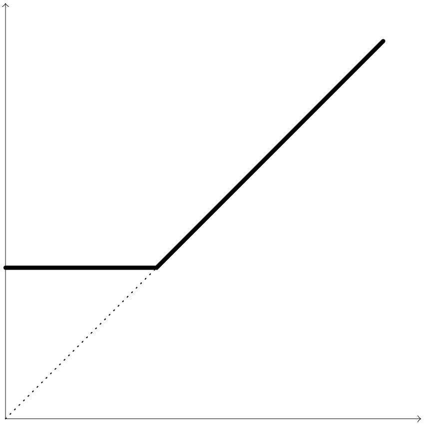
$\forall$ bounded str. incr. $v : X \to \mathbf{R}$,

$\exists\, \alpha > 0$ & $\beta \in \mathbf{R}$ such that

$$\alpha \int v \mathrm{d}G_x + \beta = \int \max\{v(x), v(y)\} G(\mathrm{d}y) \quad \text{for every } x \in X,$$

where by convention $v(-\infty) := -\infty$.

Thanks!



Adam Smith on limited liability and risk-taking

From the *Wealth of Nations:*[3]

> *In a private copartnery, each partner is bound for the debts contracted by the company to the whole extent of his fortune. In a joint stock company, on the contrary, each partner is bound only to the extent of his share. This total exemption from trouble and from risk, beyond a limited sum, encourages many people to become adventurers in joint stock companies, who would, upon no account, hazard their fortunes in any private copartnery.*

(back to slide 4)

[3] Pages. 740–1 in the Glasgow edition (Smith, 1776/1976).

Extended CDFs

<u>Extended CDF:</u> $k \mapsto \mathbf{P}(K \leq k)$ for a
$[-\infty, +\infty)$-valued random variable K.

Observation: $F : \mathbf{R} \to [0,1]$ is an ECDF iff
increasing, right-continuous, $\lim_{k \nearrow +\infty} F(k) = 1$.

Expectation of meas'ble $g : [-\infty, +\infty) \to \mathbf{R}$ w.r.t. ECDF F:

$$\int g \mathrm{d}F := \Big(\lim_{k \searrow -\infty} F(k) \Big) g(-\infty) + \int_{\mathbf{R}} g \mathrm{d}F.$$

(back to slide 11)

(Non-)identification of the o.o. dist'n: details

Proposition 2. For $X \neq \varnothing$, $u : X \to \mathbf{R}$ & ECDF F, the following are equivalent:

(I) $\int_{(0,+\infty)} kF(\mathrm{d}k) < +\infty$, and

if $\int_{(-\infty,0]} kF(\mathrm{d}k) > -\infty$ then u is bounded below.

(Non-)identification of the o.o. dist'n: details

Proposition 2. For $X \neq \varnothing$, $u : X \to \mathbf{R}$ & ECDF F, the following are equivalent:

(I) $\int_{(0,+\infty)} kF(\mathrm{d}k) < +\infty$, and
if $\int_{(-\infty,0]} kF(\mathrm{d}k) > -\infty$ then u is bounded below.

(II) $\exists\ \alpha > 0$, $\beta \in \mathbf{R}$, & $v : X \to \mathbf{R}$ such that

$$\alpha u(x) + \beta = \int \max\{v(x), k\} F(\mathrm{d}k) \quad \forall\ x \in X.$$

(back to slide 19)

Forces shaping risk att.: background risk

E.g. Ross (1981), Kihlstrom, Romer and Williams (1981), Pratt and Zeckhauser (1987), Kimball (1993), Eeckhoudt, Gollier and Schlesinger (1996), Gollier and Pratt (1996), Pomatto, Strack and Tamuz (2020) and Mu, Pomatto, Strack and Tamuz (2024).

(back to slide 5)

Forces shaping risk att.: employment contracts

E.g. Wilson (1969), Ross (1974), Amihud and Lev (1981), Lambert (1986), Hirshleifer and Suh (1992), Diamond (1998), Garicano and Rayo (2016) and Barron, Georgiadis and Swinkels (2020).

(back to slide 5)

Forces shaping risk att.: financing contracts

E.g. Galai and Masulis (1976), Jensen and Meckling (1976), Stiglitz and Weiss (1981), Green (1984) and Hébert (2018).

(back to slide 5)

Forces shaping risk att.: career concerns

E.g. Holmström (1982/1999), Hirshleifer and Thakor (1992), Hermalin (1993) and Chen (2015).

(back to slide 5)

Forces shaping risk att.: flexibility

E.g. Drèze and Modigliani (1966/1972), Mossin (1969), Spence and Zeckhauser (1972), Machina (1982, 1984), Bodie, Merton and Samuelson (1992), Gollier (2005), Chetty and Szeidl (2007) and Postlewaite, Samuelson and Silverman (2008).

(back to slide 5)

Forces shaping risk att.: R&D races

E.g. Dasgupta and Stiglitz (1980), Klette and de Meza (1986), Dasgupta and Maskin (1987), Cabral (2003) and Anderson and Cabral (2007).

(back to slide 5)

Forces shaping risk att.: competition for status

E.g. Robson (1992), Rosen (1997), Becker, Murphy and Werning (2005), Ray and Robson (2012) and Hopkins (2018).

(back to slide 5)

Forces shaping risk att.: competition generally

E.g. Hvide (2002), Hvide and Kristiansen (2003), Taylor (2003), Kräkel and Sliwka (2004), Seel and Strack (2013, 2016), Nutz and Zhang (2022) and Fang et al. (2025).

(back to slide 5)

Forces shaping risk att.: competition in banking

Surveys: Beck (2008), Carletti (2008), Vives (2016) and Berger, Klapper and Turk-Ariss (2017).

(back to slide 5)

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