Risk in Insurance: Concepts, Measurement, Attitudes and Behavior

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An Overview

- Two concepts of risk—possibility of harm and dispersion of outcomes
  - Both used widely, but overlap only partially with each other
  - Pure and speculative risk in insurance
- Measurement of risk:
  - Tail probability, expected loss, lower semivariance, VaR
  - Variance, standard deviation, covariance and beta
- Human perceptions of risk: discrepancies
- Attitudes towards risk:
  - Aversion to pure risk (possibility of harm) follows from its definition
  - Attitudes to dispersion risk could vary across individuals and groups; however, attempts to document these attitudes have encountered major challenges over the recent decades
- Observed behavior: unresolved challenges
  - Limited or low predictive content of theories based on dispersion risk
  - Multiplicity of measures of hazard risk
  - Can we find alternative concepts, measures of, and human attitudes toward, risk which have greater predictive content?
Concepts of Risk

• Two primary concepts of risk
  – Possibility of harm or loss
  – Dispersion of outcomes
  – They overlap partially
  – Depending on the context to distinguish between the two works some times, but can also create confusion

• Insurance literature and practice
  – Pure risk
  – Speculative risk
Relationship between Expected Loss vs. Standard Deviation

121 Lotteries with uniform distribution with different parameters

121 Lotteries on (-0.5, 0.5) with beta distribution with different parameters
Risk as Possibility of Harm or Loss

• Possibility of undesirable outcome(s); used in
  – Engineering (component failure)
  – Medicine (heart disease)
  – Public health (epidemic)
  – Sports (injury)
  – Environment (drinking water contamination)
  – Regulation (fraud)
  – Credit (default, liquidity)
  – Insurance (accident, fire, death, etc.)

• Probability of a negative outcome, the magnitude/consequences of potential negative outcome, or the negative outcome itself
Risk as Dispersion of Outcomes

• Dispersion of outcomes, as in
• Markowitz’ portfolio theory (variance)
• Capital asset pricing model (beta/covariance)
Pure Risk (in Insurance)

- Only two possibilities: loss or no loss
  - No possibility of a gain
  - Generally insurable
  - Can be pooled
  - Generally arise in the environment, unavoidable except by withdrawal; little control, not result of a conscious decision
  - Closely related to the possibility of harm or loss concept of risk
Speculative Risk (in Insurance)

• Possibility of gain as well as loss
  – Generally not insurable
  – Can be diversified
  – Generally taken on after a deliberate decision to assess the possibilities of losses and gains in controllable circumstances
  – Related to dispersion concept of risk to the extent dispersion considers both gains as well as loss outcomes
Meaning of Risk in Financial Economics

• June 6, 2012 search of SSRN.com database of 345,529 research papers
• The word “risk” appears in the titles of 11,144 (3.3%) of all papers
• Of the ten most frequently downloaded of these finance papers, six use the hazard meaning of risk, three use the dispersion meaning, and one uses both.
Measures of Risk

• Hazard or harm concept
  – Probability (objective or subjective)
  – Expected or maximum magnitude of harm/loss
  – Value at Risk or VaR
  – Negative semi-variance

• Dispersion concept
  – Variance or standard deviation
  – Portfolio covariance (beta)
  – Inter-percentile range
Risk Perception

• Concepts and measurements do not require reference to humans
• Some times measurements can be made from parameters of a process or frequency data (with appropriate assumptions)
• But this is not always possible. How do humans perceive risk?
• Measuring risk may require subjective judgments
• Relationship between such judgments and actual risk (if determinable objectively) is an empirical matter
• Many studies of discrepancies between objective and perceived levels of risk, e.g., risk/odds of dying while traveling by car (1 in 98) vs. airplane (1/7,178) during one’s life in 2008 (National Safety Council, USA)
Attitudes towards Risk

• In the hazard meaning of risk, it is impossible for some one to prefer risk; in the dispersion meaning, like or dislike for risk; concave or convex utility or Bernoulli function over outcomes

• This idea (EUT) is widely accepted in the field; theorists devise new parameterized curves (e.g., CPT); experimenters devise protocols to elicit data and estimate the parameters

• Meager empirical harvest: little stability in parameters outside the fitted context; power to predict out of sample poor-to-nonexistent; no convincing victories over naïve alternatives; surprisingly little insight into phenomena outside the lab (insurance, security, labor, forex markets, gambling, business cycles, etc.)
  – Very quick reviews (research through 1960; measuring individual risk preferences; aggregate level evidence from the field)

• Raise doubts; not sure of way forward, some possibilities
  – Alternative meanings/measures of risk
  – Looking for explanatory power in decision makers’ opportunity sets, real options, and net pay-offs, instead of in unobserved curved Bernoulli functions
  – Current work in evolution, learning theory, neuroeconomics, and physiology
Research Through 1960s

- D. Bernoulli’s “Exposition of a New Theory on the Measurement of Risk” (1738): E (log x), not E (x), to explain St. Petersburg paradox (but not gambling)
- Jevons (1871) links Bernoulli to decreasing marginal utility, but he and Marshall had difficulty with gambling
- Soon the ordinal paradigm took over, in which changes in marginal utility were undefined
- John Von Neumann and Oskar Morgenstern’s challenge: Theory of Games and Economic Behavior (1943 [1953]) axiomatization; more general; and empirical procedure to estimate Bernoulli function from choice data over lotteries and certain prospects
- Since then, neoclassical ordinal and VNM’s cardinal utility have co-existed in graduate seminars in economics through mutual non-recognition (F&S denied derivability of their utility curve from riskless choices, p. 464)
Measuring Individual Risk Preferences

• Unambiguous definitions and methods of measurement at the heart of sciences

• John Von Neumann and Oskar Morgenstern’s challenge: *Theory of Games and Economic Behavior* (1943 [1953]) axiomatization; more general; and empirical procedure to estimate Bernoulli function from choice data over lotteries and certain prospects

• Seven decades of attempts to furnish empirical content to VNM theory include:
  – Free form thought experiments (Friedman and Savage 1948, Markowitz 1952), both rejected Bernoulli
Free-Form Thought Experiments

Friedman and Savage 1948
2 points of inflexion

Markowitz 1952
3 points of inflexion

Fig. 3.—Illustration of typical shape of utility curve.

Fig. 5
Empirical Task of Mapping Utilities

- Mosteller and Nogee (1951): elicited data from payoff-motivated choice experiments over sample “poker” hands to construct Bernoulli/VNM utility functions (no statistical estimation)
  - Max EU not unreasonable; Inconsistency in behavior relative to VNM; meager support for F&S; Harvard students “conservative” (i.e., concave), National Guard subjects “extravagant” (i.e., convex)
Mosteller & Nogee 1951
Empirical Task of Mapping Utilities

• Ward Edwards (1955): “Another model, which assumes that Ss choose so as to maximize expected utility, failed to predict choices successfully.” (p. 214)

• Grayson (1960): “Drilling decisions by oil and gas operators” (Howard Raiffa’s graduate student)
Edwards (1955): FIG. 1. Experimentally determined individual utility curves. The 45° line in each graph is the curve which would be obtained if the subjective value of money were equal to its objective value.
Grayson (1960)
Grayson (1960)
Pratt; Diamond, Rothschild, and Stiglitz (1964-74)

• With the work of Pratt; Diamond, Rothschild, and Stiglitz during this decade, EUT with dispersion-based measures of risk (e.g., variance and Arrow-Pratt) were in the driver’s seat
• Coexistence of ordinal (absent risk) and neo-cardinal (under risk) utilities (F&S denied derivability of their utility curve from riskless choices, p. 464)
• Pure vs. speculative risk distinction of insurance theory and industry fell into disuse
• Explosion of interest in EU with analysis of parameterized utility function
• Almost immediately, attempts made to elicit data, and empirically obtain statistical estimates of these parameters using the VNM mapping process, in the hope of explaining and predicting “Economic Behavior” (the second part of the title of the VNM book) beyond non-statistical methods of F&S, Mosteller and Nogee, Markowitz, Edwards, and Grayson
• To what extent did these elicitations yield dependable estimates of a person’s propensity to choose under risk?
Examples of Parametric Estimation from Lab and Field Experiments: Absolute (ARA) and Relative (RRA) Risk Aversion

- Certainty equivalent (Dillon and Scandizzo 1978)
- Lottery choice from menu (Binswanger 1980)
- Auctions
- Becker-DeGroot-Marschak procedure
- Holt-Laury procedure
- Pie Chart procedures
- Physiological measurements
- Payment methods
- BDM vs. auctions
- Small and large stakes
- Problem solving ability
- Perception of institutions
- Heuristics
Binswanger’s Field Work in India

- Binswanger 1980 used lottery choice and certainty equivalent elicitation methods
- Different results from two methods
- Only F is inconsistent with risk aversion
- Landlord RA > tenants
- No high stakes effect
- “Luck” was best explanation
- Farming investment decisions “cannot be explained by differences in their attitudes…”
- Ditto Jacobson and Petrie 2007

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<td>190</td>
</tr>
<tr>
<td>F</td>
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Auctions

• Vickrey 1961 independent value first price sealed bid auction: empirical work yields overbidding relative to risk neutral prediction

• CRRAM (Cox et al. 1988): modification to allow for risk aversion as explanation of overbidding: mixed results

• Kagel and Levin 1993: third price sealed bid auction to estimate coefficient of relative risk aversion: risk aversion with n = 5; risk seeking for n = 10
Becker-DeGroot-Marschak (1964) Procedure

- A special case of second-price auction pitting a lottery-endowed single subject (who submits an ask) against a robotic bidder generating random bids
- If bid exceeds the ask, subject sells at the bid price
- Otherwise, subject plays the lottery
- Harrison 1986, James 2011, Kachelmeier and Shehata 1992: different implementations and institutions yield estimated coefficients that imply risk aversion or risk seeking behavior
Holt-Laury Procedure

- Choose left or right column in each row
- Should switch only once (row 5 if risk neutral; above risk seeking)
- But 28% multiple switches (in Laury-Holt 2008)
- Bosch-Domenech Silvestre 2006: estimate depends on # of rows
- Levy-Garbboua et al. 2012 and Taylor 2013: dependence of results on various procedural details

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<td>1/10 of $3.85, 9/10 of $0.10</td>
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<td>10/10 of $3.85, 0/10 of $0.10</td>
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Pie Chart Procedures

• Lotteries shown as pie charts, more transparent and intuitive

• Inconsistent results from Becker-DeGroot-Marschak and pie chart procedures Lichtenstein and Slovic 1971; Grether and Plott 1979

• Hey and Orne 1994: Inconsistent choices

• Results depend on the number of pie charts presented to subjects; Engle-Warnick et al. 2006
Physiological Measurements: Hormones

• Harlow and Brown 1990: bidding behavior related to enzyme MAO for men, not women
• Sapienza et al. 2009: relationship between Holt-Laury estimates and salivary testosterone levels is highly conditional on gender and background hormone levels
• Mixed results from various other studies of risky choice and various hormones (cortisol, estradiol, progesterone), often mutually inconsistent
• Effect of pre-natal exposure to testosterone revealed in 2D:4D ratio: inconsistent results
• Biometric data tends to vary with time, raising new questions about interpretation of preferences and their stability and usefulness for prediction
Payment Methods

• Frustration with obtaining consistent measurements of risk attitudes from observational data drew attention to details of how subjects are paid
• Monetary, consumable, hypothetical?
• Paid for all rounds or randomly selected subset of rounds
• Single or multiple rounds
• Paid each round, or paid sum at the end
• Payment in public or private
• Whole literature on payments methods influencing the estimates
• Generally, everything seems to matter some of the time; no general results
Becker-DeGroot-Marschak vs. Auctions

• Isaac and James 2000: Estimated risk coefficients from different elicitation methods are not only different, they are not even rank-preserving
• Subjects identified to be far risk averse by one method of elicitation tend to be far risk seeking from the other method
• Difficulty of reconciling the results with extant models
Math/Problem Solving Ability

• Frederick 2005: could problem solving skills and learning during the task affect the estimates?

• Higher CRT scores related to lower risk aversion

• Differences in numeracy could be the common cause of the variability of risk coefficients estimated from observed choice data
Subject Perception of Institution

• The choice of the format in which the data and the task are presented to the subjects alter the estimated risk coefficients
Where Are We Now?

• Different ways of eliciting risk parameters in cash-motivated controlled economics experiments yield different results

• Little evidence that EU (and its variations), based on elicited preferences, predict individual choice better than naïve alternatives
  – Estimation procedures applied to any choice data necessarily yield a risk coefficient; but exhibit little stability outside contexts

• **Perhaps the failure to find stable results *is* the result**

• Let us look if Bernoulli functions to represent attitudes towards risk may help us understand aggregate phenomena and furnish some consilience across macro domains
Are Aggregate Level Phenomena in the Field Explained Better by Bernoulli Functions?

- Health, medicine, sports, illicit drugs
- Gambling
- Engineering
- Insurance
- Real estate
- Bond markets
- Stock markets
- Uncovered interest rate parity
- Equity premium
- Aggregate model calibrations
  - Labor markets
  - Social/unemployment insurance
  - Central bank reserves
Health and medicine, illicit drugs

- Dispersion meaning of risk almost absent; risk factors for:
  - **Drug addiction**: family history of addiction, being male, having another psychological problem, peer pressure, lack of family involvement, anxiety, depression, loneliness, and taking a highly addictive drug
  - **Heart disease**: old, male, family history of heart disease, post-menopausal, non-Caucasian race, smoking, high level of low density lipoprotein, hypertension, obesity, diabetes, high level of C-reactive protein, sedentary lifestyle, and stress
  - No mention of expectation of a Bernoulli function, or dispersion of outcomes
Engineering

• NASA: Engineering Reliability Analysis quantifies system risks through a combination of probabilistic analyses, physics-based simulations of key risk factors, and failure timing and propagation models. ERA develops dynamic, integrated risk models to not only quantify the \textit{probabilities of individual failures}, but also to learn about the specific systems, identify the driving risk factors, and guide designers toward the most effective strategies for reducing risk.

• No mention of dispersion measure of risk
Gambling

- NRC 1999: $550b wagered in US alone
- Attempts to explain by convex Bernoulli functions (F&S 1948)
- Markowitz 1952 and Marshall 1984: Optimal bet is implausibly large
- Alternatives: entertainment, thrill, bluff, arousal, competition, auto-erotic,
- Variable ratio form of Skinnerian conditioning
- Design of state lotteries not explainable by Bernoulli functions
Insurance

• Industry size in 2011: $4.6t in premiums; best case for risk aversion

• Almost all have negative actuarial value to policy holders; textbook example of widespread aversion to risk; but
  – Marketing emphasizes loss/harm/injury, not dispersion risk
  – Other explanations: policy as a put option, cuts costs of contingency planning
  – Some versions of EUT specify convexity in losses; inconsistent with insurance
  – Lack of universality of insurance suggests social learning, marketing, and legal requirements may play roles
  – Einav et al. (2012): correlations among individual risk attitudes obtained from various domains of insurance vary widely (0.06-0.55); but their subjective ordinal measures of risk unrelated to Arrow-Pratt
Bond Markets

• Moody’s and S&P ratings define credit risk as likelihood of default and associated financial loss

• No mention of dispersion of outcomes or concave Bernoulli functions

• Fisher 1959: Chances of default and marketability of bonds explained 75% variation in yield

• Altman 1989: Realized yields net of defaults increase with lower rating for all except B and CCC bonds; not explained by dispersion measure of risk
Stock markets

• Markowitz 1952/1959 presented variance as a measure of risk, tentatively, because of familiarity, convenience, and computability
• Sharpe 1964 and Lintner 1965: Linear equilibrium relationship between expected return and covariance risk
• Intensive research on empirical evidence on CAPM and diversification
• Fama and French 1992: “Our tests do not support the most basic predictions of the SLB model, that average stock returns are positively related to market betas.”
• Fama and French 2004: “Unfortunately, the empirical record of the model is poor — poor enough to invalidate the way it is used in applications. . . . In the end, we argue that whether the model’s problems reflect weaknesses in the theory or in its empirical implementation, the failure of the CAPM in empirical tests implies that most applications of the model are invalid.”
Stock Markets (2)

• Brealey and Myers 2003: “There is no doubt that the evidence on the CAPM is less convincing than scholars once thought. But it will be very hard to reject the CAPM beyond all reasonable doubt. Since data and statistics are unlikely to give final answers, the plausibility of the CAPM will have to be weighed along with the empirical ‘facts’”
Diversification implication of risk aversion?

• Worthington 2009 on household diversification: “Australian household portfolios have very low levels of asset diversification . . . household portfolios appears to bear little relation to the central predictions of classic portfolio theory.
• Similar results for other economies (U.S., France, the Netherlands, U.K., Germany, and India). Guiso et al. 2000: “The country studies find that the extent of diversification between and within risk categories is typically quite limited.”
• Why aren’t (dispersion) risk averse households partake of almost “free lunch” of diversification?
• Holderness 2009 on distribution of corporate ownership: “Given that 96% of a representative sample of CRSP and Compustat firms have large shareholders and these shareholders on average own 39% of the common stock (Table 1), it is now clear that atomistic ownership is the exception, not the rule, in the United States.”
Uncovered interest parity

• Li et al. 2012: “Uncovered interest parity (UIP) is one of the most important theoretical relations used in analytical work in both international finance and macroeconomics. It is also a key assumption in many of the models of exchange rate determination.”

• \( \text{Exch. Rate Appreciation} = a + b*\text{InterestDifferential} + \text{error} \)
• \( \text{Where } a = 0 \text{ and } b = 1 \text{ and error has mean zero.} \)
• Froot and Thaler 1990 meta study: most estimates of \( b \) have wrong sign, average = - 0.88!

• Li et al. 2012: data from 10 countries, mixed results; estimates vary widely by currency pairs and over time

• Concave Bernoulli functions have not helped resolve the puzzle; “…hard to explain the failure of UIP even using a sophisticated measure of risk” (p. 168).
Equity Premium Puzzle

• Difficulties in reconciling empirical estimates of the market risk premium $P_M = E(R_M) - R_f$ with its theoretical determinants

• Mehra and Prescott 1985: assuming plausible levels of CRRA, risk premium should be 0.4%;

• But, over 1889-1978 realized risk premium was about 15 times (6%)

• Fernandez et al. 2012 survey: 2223 answers from US ranged over 1.5-15%; mean 5.5%

• After reviewing dozens of attempts over quarter century to resolve the puzzle, Mehra 2008 states: “The puzzle cannot be dismissed lightly because much of our economic intuition is based on the very class of models that fall short so dramatically when confronted with financial data. It underscores the failure of paradigms central to financial and economic modeling to capture the characteristic that appears to make stocks comparatively riskier.” (emphasis added).

• Down in the Wall Street world of traders and financiers, Investopedia dispenses this wisdom: “Equity premium puzzle is a mystery to financial academics.”
Aggregate model calibrations

• Besides equity premium puzzle, calibrated models of aggregate consumption are used in labor and business cycle theory
• Kydland and Prescott 1982 and Mehra and Prescott 1985 and use $1 < r < 2$, rule out assuming extreme risk aversion
• Kydland and Prescott 1991 tighten to $r = 2$
• Ljungqvist and Sargent 2004: $r < 2$ or $3$
• Resolving the EPP requires $r > 10$
• Chetty 2006: 33 sets of wage and income elasticities imply $r$ in range 0.15-1.78, mean 0.71. “… Hence, one interpretation of the result is that it provides new evidence against canonical expected utility theory as a descriptive model of choice uncertainty”
• Unemployment insurance puzzle: $r = 2$ CRRA consumption model yields 0-20% of wage compared to 50% observed in the field (Baily 1978 and Gruber 1997)
• Central banks’ international reserve levels yield $r = 2$ (CRRA) for Latin America, about 10 for Asia
Aggregate Level Evidence From the Field on Attitudes towards Risk

• The hope that curved Bernoulli functions, combined with dispersion concept of risk, might yield insights into a variety of socio-economic phenomena in the field waits to be fulfilled.

• Surprisingly little aggregate level insights or consilience across domains populated by the same agents: credit, insurance, corporate equity, real estate, currency markets, gambling, labor, and business cycles.

• Academic literature often assumes curved Bernoulli functions, but attempts to tie the resulting models to data often lead to wildly different, and mutually inconsistent, implied innate preferences in specified populations.

• Parameter $r$ for the same population has to vary from $0.15$ to $14$ (by about two orders of magnitude) to explain observations in various domains of our lives.
What is next on Attitudes towards Risk?

• Alternative meanings/measures of risk
• Looking for explanatory power in decision makers’ observable opportunity sets, real options, and net pay-offs, instead of in unobserved curved Bernoulli functions
• Current work in evolution, learning theory, and neuroeconomics
Context as an Opportunity Set

• Stigler and Becker (1977): suggest holding preferences constant across people and time and focus on how contexts (opportunity sets) affect what we observe.

• Risk aversion and risk preference is the first in their list of future applications, and that agenda can now be implemented.

• Risks change opportunity sets of DMs in observable ways, yielding testable predictions (versus unobservable BFs and probability weights).

• Rich applications of real options (Dixit and Pindyck 1994).
Potential Observable Opportunity Sets

- Revealed preferences reflect intrinsic preferences as well as the circumstances
- Consider a shift in perspective and explanatory burden:
  - From treating circumstances as a nuisance variable in recovering intrinsic preferences (white vase)
  - To circumstances/context as the determining factor in risky choice within neoclassical constrained optimization of simple (linear) utility (black profiles); they are potential source of regularities in risky choices
  - If successful, may not need to estimate curved Bernoulli functions
  - Similar to Stigler-Becker “De Gustibus...”, and unlike much of behavioral econ emphasis on individual taste
Concave Revealed Preferences from Linear Intrinsic Preferences

• Household: credit card, mortgage, rent, utility and car debt penalties
• Firms: payroll, debt service, bond indentures
• Biology: calories needed to maintain normal activity, survival
Convex Revealed Preferences from Linear Intrinsic Preferences

- Tournament incentives
- Decisions under possibility of bailout
Mixed Revealed Preferences from Linear Intrinsic Preferences

- Means-tested subsidy
- Friedman & Savage
- Marshall 1984
- Masson 1972
- Chetty 2012
Real Options

- Insurance: Other explanations: policy as a put option, cuts costs of contingency planning
- Real estate: But higher uncertainty also increases the option value from waiting to sink typically irreversible construction costs
- Bulan et al. 2009: analysis of 1214 condominium projects in Vancouver Canada during 1979-98 finds that empirical evidence supports the risk-neutral predictions of real options theory.
- We should explore how far linear utility of net payoffs combined with careful analysis of opportunity sets and embedded real options will take us.
- Perhaps farther than curved but unobservable BF s have
Brain Science

• Many studies on neurological responses to stimuli to study risky choices of humans and animals (e.g., Preuschoff et al.’s “Markowitz in the Brain” 2008)

• Interpretations are disputed; possibility of protocol effects, caution for now
Linking Theory and Observation

• Consequences of unsupported widely-held belief in explanatory/predictive usefulness of Bernoulli functions has consequences
  – Efforts to find new curved Bernoulli functions
  – Insufficient careful attention to opportunity sets of decision makers
  – Increasingly complex theory without benefit of better explanatory power

• Prospects for a better theory to replace curved functions
  – Within orthodox economics, seek explanatory power in potentially observable opportunity sets instead of unobservable preferences (considering bankruptcy, taxes, penalties and other frictions); real options; risk as exposure to harm
  – Possibilities of combining process-based understanding of risky choice: brain science and heuristics (Gigrenzer) with opportunity set focused decision theory
Risk Management

• In hazard concept of risk
  – Identifying
  – Measuring,
  – Controlling, and
  – Minimizing uncertainties about outcome of a system

• In dispersion/speculative concept: not used often, except
  – To balance the possibilities of losses and gains
  – In light of perceptions and attitudes of decision makers

• Case of error-prone perceptions
• Problem of reliably identifying attitudes
Risk and Insurance

• Actuarial science developed for hazard concept; economics/behavioral sciences have little to add
• When risk (hazard or dispersion) is misperceived (see table), opportunities arise
  – To educate to correct misperceptions
  – To arbitrage and benefit from misperceptions (e.g., sell high-priced insurance)
• What do we do with hard-to-identify stable attitudes to (dispersion) risk?
  – Possibility of demographic tables of risk attitudes to target sale of investments?
Lifetime odds of death for selected causes, United States, 2010
(Source: National Safety Council)

- Heart disease and cancer 1 in 7
- Lower respiratory dis. 1 in 29
- Intentional self-harm 1 in 103
- Motor vehicle incidents 1 in 112
- Poisoning 1 in 119
- Falls 1 in 152
- Assault by firearm 1 in 356
- Car occupant 1 in 492
- Pedestrian 1 in 723
- Motorcycle rider 1 in 922
- Drowning 1 in 1,043
- Fire, flames, or smoke 1 in 1,418
- Choking ingestion 1 in 3,649
- Pedalcyclist 1 in 4,974
- Firearms discharge 1 in 6,509
- Excessive natural heat 1 in 8,321
- Air transport 1 in 8,357
- Electric curr., radiation, temp., pressure 1 in 12,174
- Sharp objects 1 in 37,565
- Heat/hot substances 1 in 62,608
- Hornets, wasps, bees 1 in 75,852
- Cataclysmic storm 1 in 83,922
- Legal execution 1 in 96,203
- Bitten by dog 1 in 103,798
- Lightning 1 in 136,011
Recap

- Two concepts of risk—possibility of harm and dispersion of outcomes
  - Both used widely, but overlap only partially with each other
  - Pure and speculative risk distinction in insurance

- Measurement of risk:
  - Tail probability, expected loss, lower semi-variance, value-at-risk (VaR)
  - Variance, standard deviation, covariance and beta

- Human perceptions of risk: discrepancies are common

- Attitudes towards risk:
  - Aversion to pure risk (hazard) follows from its definition
  - Attitudes to dispersion risk could vary across individuals and groups; attempts to document these attitudes have encountered major challenges over the recent decades
  - Aversion to dispersion risk has provided little help in organizing macro data from various domains of our lives
Recap

• Observed behavior:
  – Hazard: perceptual discrepancies
  – Dispersion risk: unresolved challenge of limited or low predictive content in economic domains. Do we attribute this difficulty to
    • Error in choosing the dispersion concept of risk,
    • Errors in measurement of risk,
    • identification of attitudes to risk, Why not use other variables to explain observed behavior

• Perhaps it is time for a careful examination if alternative approaches might be more useful:
  – Common sense (hazard, loss or danger) meaning of risk
  – Real option theory
  – Looking for explanations in observable opportunity sets instead of unobservable utility functions
  – May require us to dwell on the traditional idea of pure risk in insurance
Thank You.

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