Risk 101 and decision Making in the face of uncertainty

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Any decision on power sector capacity planning involves **trading** one risk for another

Planning for small probability catastrophic events is hard

- How low is the probability?
- How bad can be the losses?
- Actions can be directed towards
  - Reducing the probability of the events
  - Reducing the losses when the events occur
- But these actions…
  - Are not unique
  - Require large & irreversible investments
    - Divert economic and institutional resources from other needs
      - Reduce the ability to hedge against other risks
  - Lead to uncertain outcomes
    - May create path dependencies
      - Decisions today determine the availability of future choices

How much do we value this reduction of risk ?

Who should pay ?

Who is in charge ?

Example: National Academies Consensus 2017:
nobody has a primary responsibility for building resilience to LLD-outages

Discussing about these risks and any related decisions

may be more productive if

we make an effort to share our understanding of uncertainty, risk and the tools to manage it

What is risk?

An individual is jumping from an airplane without a parachute? Does he face a risk?

We take one ball from a black urn and look at its color. Do we face a risk?

A risk implies both:

- Exposure to an undesirable outcome

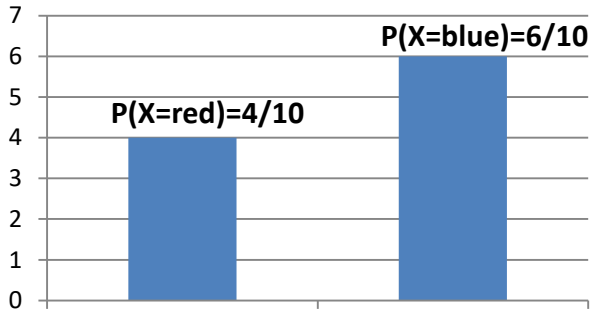
To understand risks it is necessary to characterize both!!

- Uncertainty about the chances of its occurrence

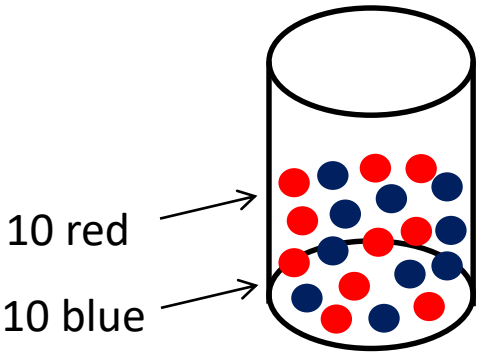
Characterizing Uncertainty

1. Define **random variable**
2. Enumerate all possible outcomes
3. Determine probabilities of outcomes

Take one ball with your eyes closed



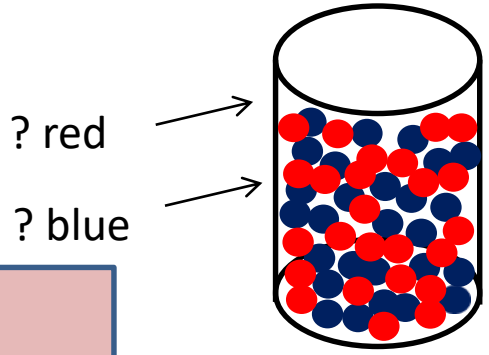
Frequentist view:
"Probability of an event is the **frequency** with which it occurs in a long sequence of similar trials"



1. X = color of ball picked up at random
2. X may be blue or red
3. Probability that X is blue is 50%
   Probability that X is red is 50%

Uncertainty

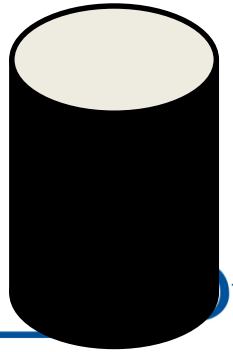
Electricity demand per household in Augusta, on a Sunday in July 2015 when temperature is <80F



1.X = color of ball picked up at random
2. X may be blue or red
3. Probability that X is blue is ?%
   Probability that X is red is ?%

Deep uncertainty

Repeat experiment several times and try to ***infer*** the probability



1.X = color of ball picked up at random
2. X may be blue, red, yellow, green, ..
3. Probability that X is blue is ?%
   Probability that X is red is ?%
   Probability that X is yellow is ?

Deeper uncertainty

Example random variable

Z = Price of natural gas in the U.S. in January 2030

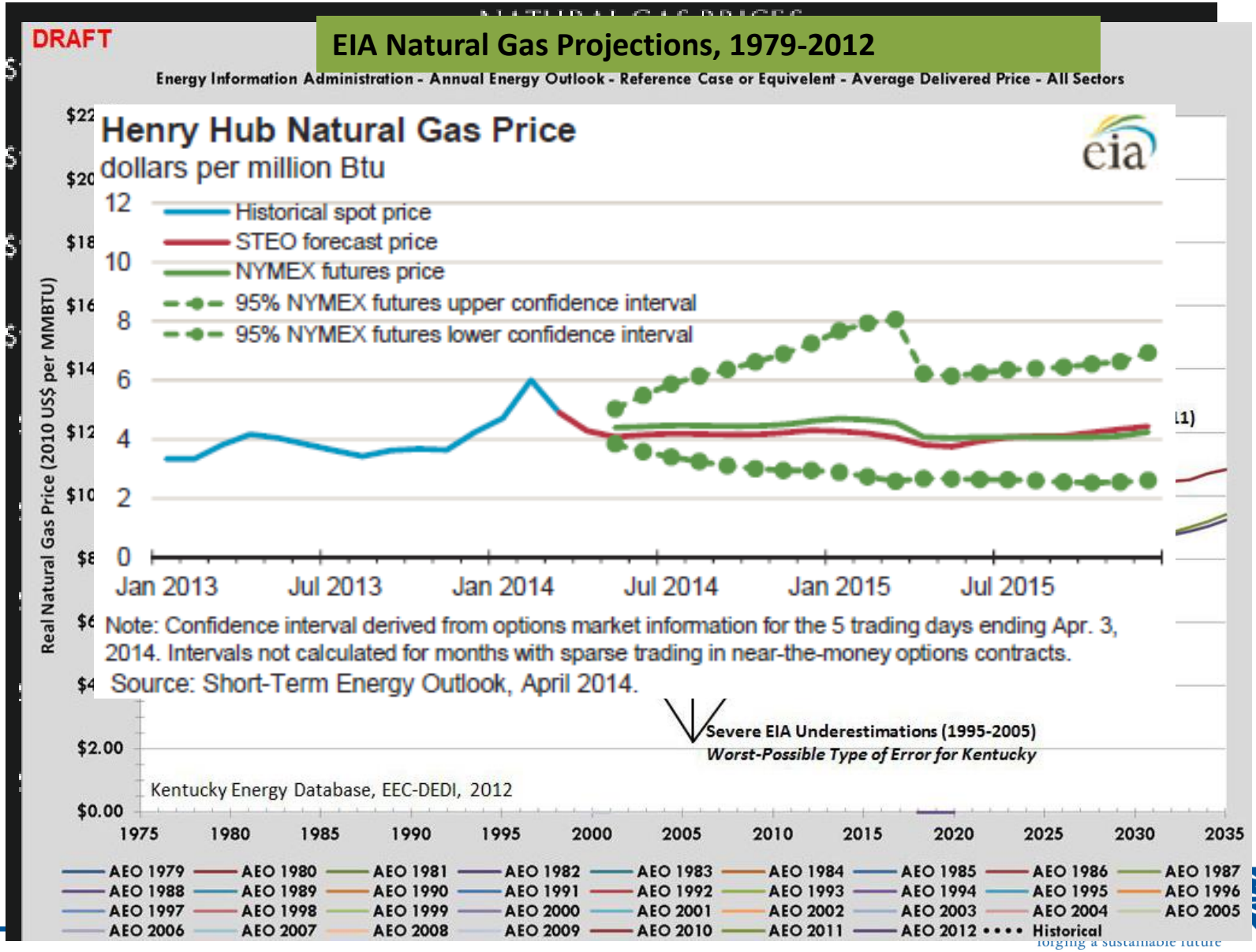
1. What kind of random variable is this?
2. What is the probability that it will be <$20/MMBtu?
3. What is the probability that it will be <$5/MMBtu?
4. Can we use the **frequentist** approach to find a probability?

There is no experiment we can conduct to infer the probability

Bayesian view:
"Probability of an event is the **degree of a belief a person has that it will occur"**

We can develop a model that explains NG prices as a function of other thousand variables but…

EIA Natural Gas Projections, 1979-2012



How to deal with risk?

- Assess risk
  - What is the risk of an large area outage of long duration next year?
    - Define possible causes of LLD outages
    - Assess probabilities of those causes
    - Estimate area affected
    - Estimate duration

*Unless completely deterministic, refrain from point estimates

*Estimate as ranges or probability distributions

- Assess opportunities for risk reduction
  - What are possible "insurance" alternatives
    - To reduce the probability of occurrence
    - To reduce the area affected
    - To reduce the duration of the outage
- Assess costs of risk reduction
  - What is the cost of the different alternatives
  - What are associated alternatives
- Assess your own attitudes towards risk
  - Are you comfortable paying a premium to reduce risk?

Are you risk averse?

Let's see!

What is your preference when trading **risk** and **expected return ?**

Which lottery do you prefer? We will toss a fair coin

1. You get $28 if tails, $28 if heads

2. You get $24 if tails, $36 if heads

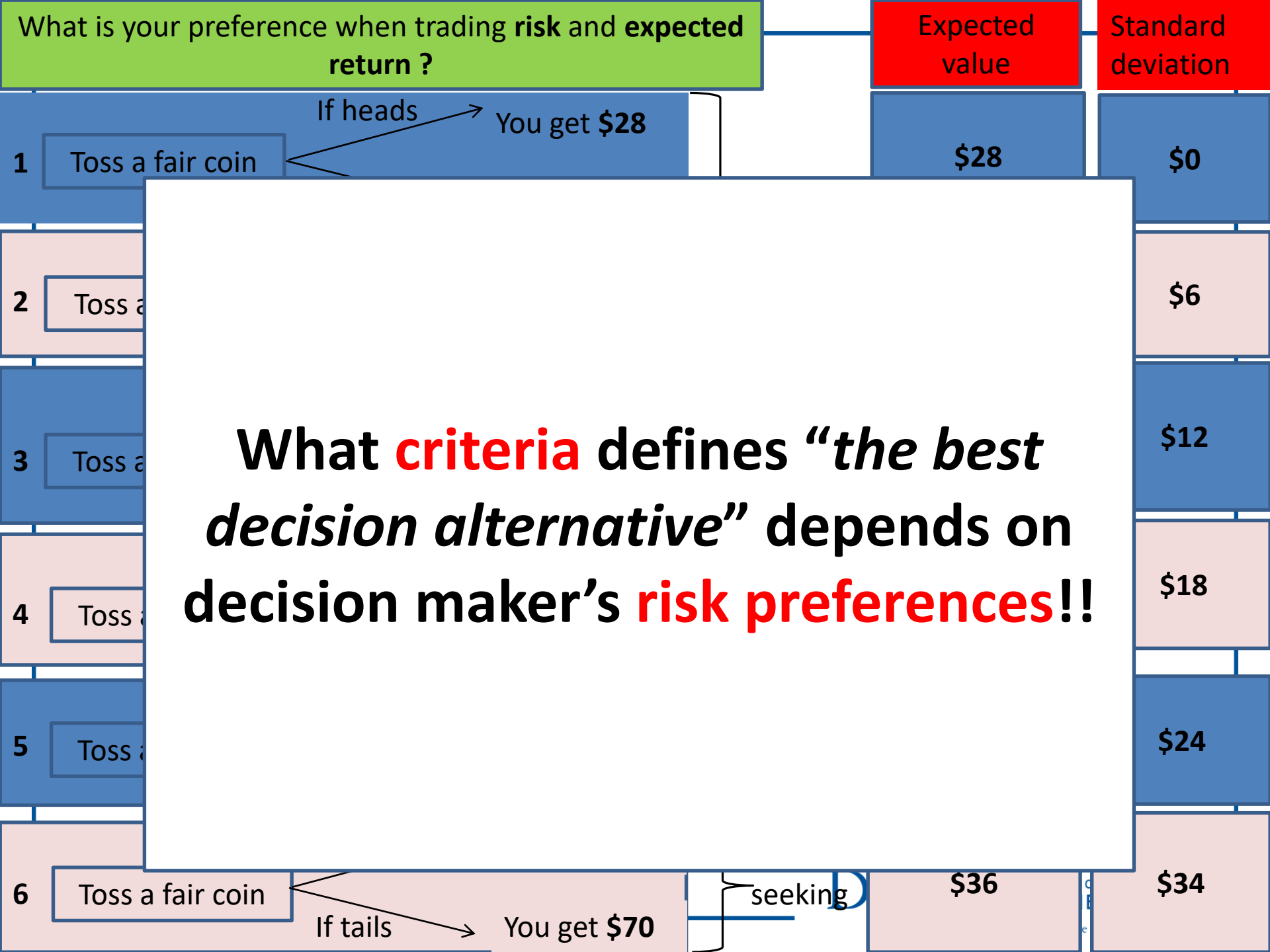
3. You get $20 if tails, $44 if heads

4. You get $16 if tails, $52 if heads

5. You get $12 if tails, $60 if heads

6. You get $2 if tails, $70 if heads


What is your preference when trading **risk** and **expected return ?**
Expected value
Standard deviation
$0
$6
$12
$18
$24
$34


What is your preference when trading **risk** and **expected return ?**
Expected value
Standard deviation
If heads
You get **$28**
1
Toss a fair coin
$28
$0
2
$6
3
$12
4
$18
5
$24
6
Toss a fair coin
If tails
You get **$70**
seeking
$36
$34
What **criteria** defines "*the best decision alternative*" depends on decision maker's **risk preferences**!!

We have different preferences

We choose different tradeoffs between risk and expected value of return

How should these choices be made on behalf of the public ?

Hard question because the option of "not playing the lottery" (i.e., not making a decision) is not available !

Need to use tools of risk analysis

- to think better about the choices
- to inform a deliberative-participatory process

Tools of risk analysis teach us we should:

1. Determine uncertainties and formulate probabilities
2. Use this uncertainty characterization and find the strategy that:

   -Minimizes risk without exceeding allocated budge

   Or

   -Minimizes cost for a desired level or risk-reduction
3. Iterate over 1 and 2
4. Identify strategies that although may not be optimal under any one scenario, are acceptable under all of them

Replacing uncertainty with the average or most likely value leads to suboptimal choices

Not easy to agree on the risk measure, or the approach but we must try

Because probabilities are "subjective beliefs"

ROBUST strategies !!

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forging a sustainable future

Thank you!

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