Outline

Innovation dilemma: Definition and examples.

Severe uncertainty:
- The idea of an info-gap.
- Shackle-Popper indeterminism.

Info-gap robust satisficing:
Resolving the dilemma.

Example: Monetary policy selection.

Example: The innovation dilemma of rural poverty.
Innovation dilemma: The Idea

Choose between 2 options:

**Option 1: (paradigm: new technology)**
- New and innovative.
- Very promising.
- Higher uncertainty.

**Option 2: (paradigm: standard procedure)**
- State of the art.
- Less promising.
- Lower uncertainty.

Dilemma due to uncertainty.
Innovation dilemma: Examples

Automobile steering and collision control:
- Autonomous sensor-based computer control (innov).
- Human steering and foot-break system (SotA).

Monetary policy:
- New tools for new situations (innov).
- “A little stodginess at the CB” (Blinder) (SotA).

Peace or War:
- Bold diplomatic initiative (Sadat to Jerusalem, ‘77) (innov).
- Conventional diplomatic-military cycle (SotA).

Risk taking or avoiding:
- Nothing ventured, nothing gained (innov).
- Nothing ventured, nothing lost (SotA).
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Probabilistic risk
or
Knightian “true uncertainty”
### Probabilistic Risk

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<th>Probability</th>
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<td>Drought</td>
<td>Stochastic process</td>
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<td>Industrial accident</td>
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<tr>
<td>Deception, scam</td>
<td>Sociological data</td>
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**Risk is:**
- Structured: known event space
- Modeled with probability
- Manageable (but still risky)
Frank Knight’s “true uncertainty”

“The uncertainties which persist ... are **uninsurable** because there is no objective measure of the probability”. 

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**Diagram:**
- Fukushima
- Arab Spring
- Russia-Crimea
- ESP
- Diagnostic lens
- 3-d printed car

**Surprise**
“We live on an island of knowledge surrounded by a sea of ignorance. As our island of knowledge grows, so does the shore of our ignorance.”

John A. Wheeler
Non-probabilistic true uncertainty

D  Discovery

- America
- Nuclear fission
- Martians (not yet?)
Non-probabilistic true uncertainty

**D** Discovery

**I** Invention/Innovation

- Printing press: material invention.
- Ecological responsibility: conceptual innovation.
- French revolution: social innovation.
Non-probabilistic true uncertainty

**D** Discovery

**I** Invention/Innovation

**S** Surprise (Asymmetric uncertainty)

- Ambush
- Competitor’s innovation
- Natural catastrophe
Non-probabilistic true uncertainty

D  Discovery

I  Invention/Innovation

S  Surprise (Asymmetric uncertainty)

What’s the next D  I or S  ???

Knightian uncertainty:

• Unstructured: unknown event space.
• Indeterminate: no laws.
• Barely manageable.
Info-gap uncertainty: examples

• Transcendental probability.
• ECB interest rate.
• Phillips curve.
• Many more (info-gap.com).
Carroll's Transcendental Probability

Riddle from *Pillow Problems*:
“A bag contains 2 counters, as to which nothing is known except that each is either black or white. Ascertain their colours without taking them out of the bag.”

**Answer:** “One is black, and the other white.”
ECB Interest rate after 9/11

Rate fairly constant through Aug 2001. After 9/11 ECB will reduce the rate.

Info-gaps:

• By how much will ECB reduce interest?
• What is ECB decision model?
Phillips Curve

Linear? Quadratic?

**Info-gaps:** data, processes, functional relations.

Inflation vs unemployment
US, ’61–’67.

Inflation vs unemployment
US, ’61–’93.
What is an info-gap?

Info-gap:
Disparity between what one does know and what one needs to know in order to make a responsible decision.

Two elements: uncertainty and consequence.

Distinct from probability.
What is an info-gap?

Role a fair dice:
- Equal probabilities of 1, 2, ..., 6.
- Known event space; known likelihoods.

Response to next financial crisis. The event space?
- 2 events: Either collapse or not.
- 8 events: collapse or not, short or long, local or global.
- More possibilities.
- Rolling an N-sided dice, but:
  *Unknown event space; unknown likelihoods.*
What is an info-gap?

Probabilistic thinking sometimes useful:

• Israel 1984 inflation: 450% and growing.
• Moda’i/Bruno 5-point consensus plan: Budget cuts, wage and price control, ILS devalued and forex rigid, no ILS printing.
• Stabilization likely.
• Hence “No stabilization” unlikely.

Binary logic:

• Proposition either true or false.
• Excluded middle: proposition can’t be both T and F.

Probability applies excluded middle to uncertainty:
Proposition can’t be both ‘likely’ and ‘unlikely’.
What is an info-gap?

In economics we can’t always exclude the middle.
Example: Policy based on regressing inflation vs employment.

- Theory-based structural trade off.  
  Historical evidence. **Likely** basis for policy success.
- Lucas critique: 
  Agents’ responds to policy.  
  Agents’ response uncertain.  
  **Unlikely** basis for policy success.

The policy maker faces an info-gap.
What is an info-gap?

Ignorance or ambiguity or potential for surprise.

Two elements: **uncertainty** and **consequence**.

Distinct from probability.

In human affairs, info-gaps result from **Shackle-Popper indeterminism**.
Shackle-Popper indeterminism

GLS Shackle, 1903-1992

Karl Popper, 1902-1994
Intelligence:
What people know, influences how they behave.

Discovery:
What will be discovered tomorrow can’t be known today.

Indeterminism:
Tomorrow’s behavior can’t be fully modelled today.

- Info-gaps, indeterminism: unpredictable.
- Ignorance is not probabilistic.
✓ Innovation dilemma: Definition and examples.

✓ Severe uncertainty:
  • The idea of an info-gap.
  • Shackle-Popper indeterminism.

Info-gap robust satisficing:
Resolving the dilemma.

Example: Monetary policy selection.

Example: The innovation dilemma of rural poverty.
Robust Satisficing

Two questions for decision makers:

1. What are our goals?
2. How much error/surprise can we tolerate?
Robust Satisficing

Two questions for decision makers:
1. What are our goals?
2. How much error/surprise can we tolerate?

   - Essential goals.
   - Worst acceptable outcomes.
   - Modest or ambitious.
Robust Satisficing

Two questions for decision makers:
1. What are our goals?
2. How much error/surprise can we tolerate?


2. Robustness: Greatest tolerable error.
   • Immunity to ignorance.
   • Greatest tolerable error or surprise.
Robust Satisficing

Two questions for decision makers:

1. What are our goals?
2. How much error/surprise can we tolerate?

2. Robustness: Greatest tolerable error.

Optimize robustness; satisfice goals:

Procedural (not substantive) optimization.
Outline

✓ Innovation dilemma: Definition and examples.

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Monetary policy selection

Collaborators:

- Maria Demertzis (Bruegel).
- Jan Willem Van den End (DNB).

The question:
Include financial stability objectives in monetary policy?
Or
Leave financial stability to macro-prudential policy?

Method: Info-gap robustness analysis.
Monetary policy selection

Model of economic dynamics, $M$:

- Inflation gap, $\pi_t$.
- Output gap, $y_t$.
- Other variables.
- Loss function $L(\pi_t, y_t)$.
- 4 Policy rules:
  - R0: benchmark. Standard macro, aggregate demand, Phillips curve, traditional Taylor rule.
  - R1: R0 + monetary policy reacts to financial stress.
  - R2: R0 + financial imbalance and debt in demand curve.
  - R3: full model; all of the above.
Monetary policy selection

Uncertainties:

• Model coefficients, $c$.
• Shock amplitudes, $\varepsilon_t$.
• Shock times, $t_s$.

Info-gap model of uncertainty, $U(h)$:

• Unbounded family of nested sets of $c$, $\varepsilon_t$, $t_s$.
• No known worst case. Unbounded horizon of uncertainty.
• No probabilistic information.
Monetary policy selection

Robustness combines:

• **Performance requirement:** loss, $L$, acceptably small.
• **System model** of economic dynamics, $M$.
• **Uncertainty model**, $U(h)$.

Robustness. **Maximum tolerable uncertainty**:

Maximum horizon of uncertainty, $h$, such that

**Performance requirement** on $L$ satisfied by

**System model** $M$ for all realizations in

**Uncertainty model** $U(h)$. 
Monetary policy selection

Robustness curve (R3):

• **Performance requirement:**
  Horizontal axis.

• **Robustness:** vertical axis.

• **Trade off (pessimist’s thm):**
  Robustness vs performance.

• **Zeroing:**
  No robustness at predicted outcome.

• **Time horizon:**
  reduces robustness.
Monetary policy selection

Robustness: 4 policy rules.

- **Trade off, zeroing:** all 4 rules.
- **R0 Robust dominant** at $t_1 + 1$...
- **Robustness decreases with time.**
- **Innovation dilemma** at $t_1$:
  - Preference reversal of R0, R2.
- **Resolution of innov. dilemma:**
  - Maximize robustness.
  - Satisfice loss.
Conclusions:

- **R0 more robust at** $t_1 + 1...$:
  Less true; less vulnerable to error.
  Simple rule more robust (usually).

- **Robustness decreases with time.**

- **Innovation dilemma at** $t_1$:
  Preference reversal of R0, R2.
  Simple rule not always more robust.
Innovation dilemma of poverty

Rural poverty:
• Low agricultural productivity.
• High mortality/morbidity.
• Resentment and suspicion of government and NGOs.
• Local barons or warlords.

Innovative hi-tech proposal:
• New strains of plants.
• Better irrigation.
• Better fertilizers.
• Mechanization of field work.
Innovation dilemma of poverty

Potential gains from innovation:

• Higher agricultural productivity.
• Higher standard of living.
• Less arduous field work.

Potential losses from innovation:

• Failure of innovative crops, causing starvation.
• Social reorganization and upheaval.
• Rapid population growth, canceling gains (Malthus).

Dilemma: Innovation could be much better, or much worse. How to choose?
Innovation dilemma of poverty

Basic questions:
• What are the goals?
• What is our knowledge?
• What are the uncertainties?

Robustness of an option:
Maximum tolerable uncertainty.

The knowledge-bifurcation. Is your knowledge:
• Quantitative: data and equations?
• Qualitative: mainly insight and understanding, (perhaps with some numbers)?

We will consider both situations.
Poverty dilemma: quantitative

Field study of traditional State of the Art:
• Survival requirement: 1171 kg wheat/ha.
• Probability dist. of productivity well known.
• Survival probability: 0.95 (known).
• Survival catastrophe return-time: 20 years (known).

Knowledge about innovative option:
• Probability distribution of productivity estimated, uncertain.
• Survival probability: 0.9967 (estimate).
• Survival catastrophe return-time: 303 years (estimate).

The choice is clear?
Uncertainty of innovative option:
- Prob. distribution of productivity: estimated.
- True tail (rare but bad): **highly uncertain**.
- Survival probability & catastrophe return-time may be **much worse than for SotA**.

Robustness of an option: How much error can we tolerate?
Greatest **uncertainty** at which current **knowledge** satisfies the survival **requirement**.

Robust prioritization: Innovation or SotA?
- Maximize robustness, satisfice outcome.
- Don’t try to optimize the outcome.
Poverty dilemma: quantitative

Robustness of innovative option:

Pessimist’s thm. Trade off:
Higher survival prob \(\iff\) lower robustness

Zeroing: No robustness at estimated survival probability.

Robustness of SotA:

- **Unbounded** for survival probability up to 0.95.
- **Zero** for survival probability above 0.95.

Decision: Choose by robustly satisfying the requirement.
Poverty dilemma: quantitative

Summary of quantitative analysis of innov. dilemma:

- **Zeroing**: no robustness at estimated survival prob.
- **Optimizer’s fallacy**: Prioritize by estimates.
- **Trade off**: robustness vs survival probability.
- **Preference reversal**: Resolution of dilemma.
Poverty dilemma: qualitative

Now for the hard part:

Qualitative analysis of robustness.

Robustness:

• We can’t evaluate it quantitatively.
• Assess it qualitatively with proxies for robustness:
  – Resilience: rapid recovery of critical functions.
  – Redundancy: multiple alternative solutions.
  – Flexibility: rapid modification of tools and methods.
  – Adaptiveness: adjust goals and methods online.
  – Comprehensiveness: interdisciplinary system-wide coherence.
Poverty dilemma: qualitative

Basic questions:

• What are the goals?
• What is our knowledge?
• What are the uncertainties?

Bernard Amadei: girl water carriers.

• Goal: more potable water.
• Knowledge: Abundant fuel. Pump tech. Local culture.
• Uncertainties:
  – Long-term maintenance? Catastrophe if not.
  – Stable fuel supply?
  – Social response: what happens to the girls?
Poverty dilemma: qualitative

Robust solution:

• **Satisfice** the goal. Don’t try to maximize. (Exploit trade off)
• **Co-design**: local involvement in all stages (comprehensive).
• **Train** locals in pump maintenance (resilience, flexibility).
• **Transition period** of dual supply (redundancy).
• **Long-term contact** for emergency support (adaptiveness).
• **Education** for girls (and boys) (comprehensiveness).
• **Quantitative** analysis where possible.
Poverty dilemma: qualitative

Methodological re-cap:

• **Trade off**: higher ambition = lower robustness.
  Ambitions: Yes. Wishful thinking: No.

• **Zeroing**: Best-estimated outcomes have no robustness.

• **Satisfice** your goals. **Optimize** your robustness.
  Don’t try to maximize the outcome.

• **Preference reversal**: sub-optimal may be more robust.
  Wood burning steam pump more robust to uncertainty than solar electric technology.
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**Questions?**