Rational Inattention

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Introduction

> *"A **wealth of information** creates a **poverty of attention** and a need to allocate that attention efficiently among the overabundance of information sources that might consume it." - Herbert A. Simon (1971)*

Key Idea: attention, like physical goods, is a scarce resource.

How to allocate it?

Introduction

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Rational Inattention: when information processing is costly/limited, how to choose:

1. How much information to process?
2. What type of information to process?

$\Longrightarrow$ information sets are endogenous choice variables

Note: for a thorough lit review see Maćkowiak et al (JEL forthcoming)

General Problem

For action y and unknown state x:

$$\max_{f_{sx}, f_{ys}} \mathbb{E}\left[\mathbb{E}U(y, x)|s\right] - C\left(f_{sx}(s|x)\right)$$

1. **Information Strategy:** $f_{sx}(s|x)$. What kind of signal distribution? More precise signals $\Rightarrow$ greater cost $C(\cdot)$ (see next slide).

2. **Action Strategy:** $f_{ys}(y|s)$. Standard choice under uncertainty using posterior beliefs from the signal.

The Cost of Information

Cost of signal is proportional to Shannon mutual information:

$$C\big(f_{sx}(s|x)\big) = \lambda \cdot \underbrace{I(x;s)}_{\text{Shannon mutual information}} = \lambda \Big[\underbrace{H(x)}_{\text{prior entropy}} - \mathbb{E}\big[\underbrace{H(x|s)}_{\text{posterior entropy}} \big] \Big]$$

Intuition: a signal contains more information, so costs more, if in expectation it implies a large reduction in belief dispersion from prior to posterior.

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λ?

- Constant marginal cost of info: fixed λ.
- Fixed info capacity κ: $\lambda =$ Lagrange multiplier on $I(x;s) \leq \kappa$.

Two Special Cases

1) Discrete Choice: Matějka & McKay (2015)

$$f(y|x) = \frac{\mathcal{P}(y)\exp(U(y,x)/\lambda)}{\sum_k \mathcal{P}(k)\exp(U(k,x)/\lambda)}$$

Multinomial Logit choice with endogenous shifters $\mathcal{P}(y)$, $\implies$ endogenous consideration sets (Caplin et al, 2019).

Two Special Cases

2) LQG: Sims(2003), Maćkowiak & Wiederholt (2009)

$$\text{If } U(y,x) = -a(x-y)^2, \quad \text{prior } g(x) \sim N(\mu, \sigma^2)$$

$$\implies \text{optimal signal is } s = x + \varepsilon, \quad \varepsilon \sim N(0, \sigma_\varepsilon^2)$$

Standard Kalman filter problem, with endogenously chosen noise variance.

Dynamic versions of both are available (Steiner et al, 2017; Maćkowiak et al, 2018)

Applications: what is information endogenous to?

1) Variable distributions

- Exogenous (Maćkowiak & Wiederholt, 2009; Kohlhas & Walther, 2019).
- Due to actions of others (Hellwig & Veldkamp, 2009) or policy choices (Afrouzi & Yang, 2021).

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2) And...

- Costs of information (Lei, 2019; Mihet, 2021; Haldane et al, 2021)
- Wealth (Broer et al, 2021; Macaulay, 2021)
- Macro conditions (Macaulay, 2022a; Song & Stern, 2021; Flynn & Sastry, 2021)
- Subjective models (Ellison & Macaulay, 2021; Macaulay, 2022 JMP)

Existing Evidence

1) Observational data consistent with RI

- Expectations: Coibion & Gorodnichenko (2015), etc. etc., Macaulay & Moberly (2022)
- Actions: Kacperczyk et al (2016), Macaulay (2022a)
- Revealed Preference: Caplin & Dean (2015)

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2) Experiments

- Laboratory: Khaw et al (2017), Dean & Neligh (2019), Matveenko et al (2021)
- Survey: Fuster et al (2019), Roth & Wohlfart (2020), Roth et al (2021)

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3) Direct measures of attention

- Survey questions: Link et al (2022), Macaulay (2022 JMP)
- Google trends: Mondria et al (2010), Chavaz & Slutzky (2021)

Open Question 1: equilibrium attention?

RI models **demand** for information

- Infinite set of possible signals to choose from, including $s = x$.
- Exogenously given cost function.

Appropriate in some situations.

But is information **supply** always unlimited? Is the price ever endogenous?

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How does RI interact with...

- Information production? (Fajgelbaum et al, 2017; Farboodi & Veldkamp, 2021)
- Communication policies (Haldane et al, 2021)? Persuasion (Matysková & Montes, 2021)?

Open Question 1b: measurement?

If attention is an equilibrium object, are we sure existing empirics is only picking up demand effects?

- Experiments: ✓
- Observational data: ??

Can we do better? Disentangle demand from supply? Is it ever possible to observe the price?

Open Question 2: information $\iff$ subjective models?

Macaulay (2022 JMP): aggregate shock transmission depends on cross-sectional Cov(information, subjective model).

- **Intuition:** shock amplified if **information** on the shock is concentrated among those who **update other expectations** the most in response to it.

- **Implication:** two-way feedback information $\iff$ subjective models implies rich aggregate dynamics.

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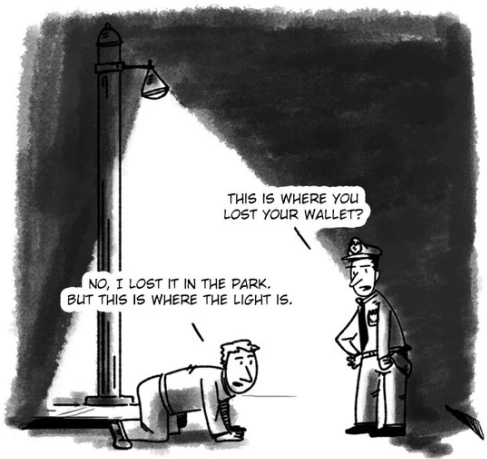
Typical assumption: agents perfectly understand **true equilibrium laws of motion.** Observed information $\not\Rightarrow$ subjective models. Plausible?

Question(s): how does rational inattention interact with:

- Learning (Evans & Honkapohja, 2001)? Robust control (Hansen & Sargent, 2008)? Diagnostic expectations (Bordalo et al, 2018)? Narratives (Eliaz & Spiegler, 2020)?

Bonus Open Question: what happens outside the special cases?



What does RI imply when e.g.:

- agents face occasionally-binding constraints (non-quadratic payoffs)?
- shocks have fat tails (non-Gaussianity)?
- inaction regions?

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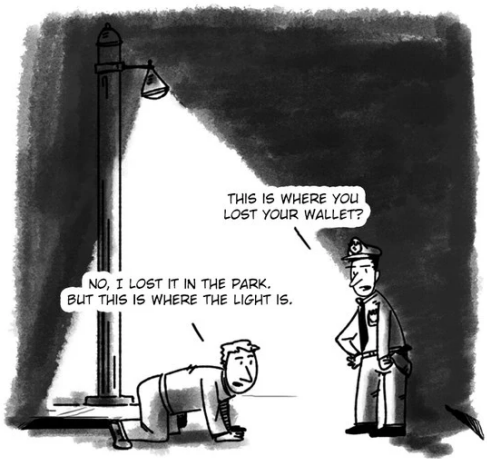

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- inaction regions?

In general:

- optimal s_t restricts agent to discrete actions from continuous choice sets (Matějka, 2016; Stevens, 2019; Ellison & Macaulay, 2021).
- decisions become **lumpy**.

Implications in specific situations? Evidence?

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