The Status Quo and Beliefs Polarization of Inattentive Agents: Theory and Experiment

Vladimír Novák
CERGE-EI

joint work with
Andrei Matveenko and Silvio Ravaioli
(University of Copenhagen) (Columbia University)

CERGE-EI Brown Bag
October 30th, 2019

Motivation

- Society today is more polarized (McCarty et al. 2006)
  Increase in Polarization Literature
- Information is more easily accessible (lower cost)

Motivation

- Society today is more polarized (McCarty et al. 2006)
  Increase in Polarization Literature
- Information is more easily accessible (lower cost)
- Democratic votes are often binary choices about complex questions - status quo vs. a new policy

Motivation

- Society today is more polarized (McCarty et al. 2006)
  Increase in Polarization Literature
- Information is more easily accessible (lower cost)
- Democratic votes are often binary choices about complex questions - status quo vs. a new policy

Main Question:

How are such binary choices connected with the belief polarization (information selection)

Motivating example

Consider the 2016 Brexit referendum

- Surveys suggest that polarization increased after the 2016 Brexit vote (see e.g. YouGov)

Motivating Example

Setting

Alice and Bob face a choice: vote to Leave or Stay in the EU

- Leave: uncertainty about the outcome of the policy [state s]
- Stay: "safe" choice [status quo]

Motivating Example

Setting

Alice and Bob face a choice: vote to Leave or Stay in the EU

- Leave: uncertainty about the outcome of the policy [state s]
- Stay: "safe" choice [status quo]

	Leave	**Stay**	
s	v_s	R_A	R_B
bad	0	0.45	0.55
medium	0.5	0.45	0.55
good	1	0.45	0.55

- Assume uniform prior $g_s = \frac{1}{3}$ and risk neutrality

Motivating Example

No Learning

Alice and Bob have the same beliefs over s and $EV(\text{Leave})$

- $EV(\text{Leave}) = 0.5$

Motivating Example

No Learning

Alice and Bob have the same beliefs over s and $EV(\text{Leave})$

- $EV(\text{Leave}) = 0.5$

Alice and Bob make different choices

- A chooses Leave as $0.5 = EV(\text{Leave}) > EV(\text{Stay}) = 0.45$
- B chooses Stay as $0.5 = EV(\text{Leave}) < EV(\text{Stay}) = 0.55$

	Leave	**Stay**	
s	v_s	R_A	R_B
bad	0	0.45	0.55
medium	0.5	0.45	0.55
good	1	0.45	0.55

Motivating Example

Learning

- Same problem as before, but now A and B can collect "some" information about the outcome
- Can ask question for a cost $\alpha > 0$:

"Is the realized state i, or is it not? "

Motivating Example

Learning

- Same problem as before, but now A and B can collect "some" information about the outcome
- Can ask question for a cost $\alpha > 0$:

"Is the realized state i, or is it not? "

- Note that we have 2 actions (L/S) and 3 states (b/m/g)
- Alice with one question can receive following partition:

	Leave	**Stay**
s	v_s	R_A
bad	0	0.45
medium	0.5	0.45
good	1	0.45

Motivating Example

How many questions would they ask?

- If they decide to ask at least one question, then they will not ask the second.

What is the optimal question?

- For Alice it *cannot* be optimal to ask if the outcome of Leave is (b/m) or g

	Leave	**Stay**
s	v_s	R_A
bad	0	0.45
medium	0.5	0.45
good	1	0.45

Motivating Example

How many questions would they ask?

- If they decide to ask at least one question, then they will not ask the second.

What is the optimal question?

- For Alice it *cannot* be optimal to ask if the outcome of Leave is (b/g) or m

	Leave	**Stay**
s	v_s	R_A
bad	0	0.45
medium	0.5	0.45
good	1	0.45

Motivating Example

How many questions would they ask?

- If they decide to ask at least one question, then they will not ask the second.

What is the optimal question?

- For Alice it is *sufficient* to ask if the outcome of Leave is (m/g) or b

	Leave	**Stay**
s	v_s	R_A
bad	0	0.45
medium	0.5	0.45
good	1	0.45

Motivating Example

How many questions would they ask?

- If they decide to ask at least one question, then they will not ask the second.

What is the optimal question?

- For Bob it is *sufficient* to ask
  if the outcome of Leave is (b/m) or g

	Leave	**Stay**	
s	v_s	R_A	R_B
bad	0	0.45	0.55
medium	0.5	0.45	0.55
good	1	0.45	0.55

Motivating Example

Beliefs

- If the Leave outcome is good (bad) they agree about the action Leave (Stay)
- But they do not agree about how good (bad) the outcome is
  - Good: $EV_A(L|g) = 0.75 < EV_B(L|g) = 1$
  - Bad: $EV_A(L|b) = 0 < EV_B(L|b) = 0.25$

Motivating Example

Beliefs

- If the Leave outcome is good (bad) they agree about the action Leave (Stay)
- But they do not agree about how good (bad) the outcome is
  - Good: $EV_A(L|g) = 0.75 < EV_B(L|g) = 1$
  - Bad: $EV_A(L|b) = 0 < EV_B(L|b) = 0.25$

- If the outcome is medium they still disagree about the action
- But they also disagree about the expected outcome of Leave
  - Alice chooses Leave: $EV_A(L|m) = 0.75$
  - Bob chooses Stay: $EV_B(L|m) = 0.25$

Motivating Example

Direction of updating - richer space of questions

- If the realized state is medium then for Alice

$$\mathbb{E}_i[\mathbb{E}(v|i)|s=m)] = \frac{1}{2}v_m + \frac{1}{2}v_g.$$

$$i \in \{\text{leaving the EU}, \text{staying in the EU}\}$$

Motivating Example

Direction of updating - richer space of questions

- If the realized state is medium then for Alice

$$\mathbb{E}_i[\mathbb{E}(v|i)|s = m)] = \frac{1}{2}v_m + \frac{1}{2}v_g.$$

$$i \in \{\text{leaving the EU}, \text{staying in the EU}\}$$

Interestingly, if $\mathbb{E}V_L - \alpha > \mathbb{E}V_{NL} > v_m$, the following inequality holds:

$$\mathbb{E}_i[\mathbb{E}(v|i)|s = m)] > \mathbb{E}V_{NL} > v_m.$$

Alice's conditional expected posterior belief about the outcome of the Leave [new policy] is higher than the prior expected belief and as the true outcome.

Motivating Example

Summary

- Alice and Bob have the same prior beliefs
- But they have different valuation of **the status quo** option
- The introduction of **endogenous information collection** created disagreement about outcome of the new policy

Motivating Example

Summary

- Alice and Bob have the same prior beliefs
- But they have different valuation of **the status quo** option
- The introduction of **endogenous information collection** created disagreement about outcome of the new policy
- Stock/bond investment, Referendum vote (e.g. Brexit), etc.

Motivating Example

Summary

- Alice and Bob have the same prior beliefs
- But they have different valuation of **the status quo** option
- The introduction of **endogenous information collection** created disagreement about outcome of the new policy
- Stock/bond investment, Referendum vote (e.g. Brexit), etc.

Definition

- **State pooling**: agents avoid redundant information and "pool together" states associated with the same action

Our Theoretical Approach and Contribution

- Agent's are modelled to be **rationally inattentive**
  - Rational endogenous information acquisition
  - We do not assume exogenous biases
  - Can receive any information
  - Information is costly

Our Theoretical Approach and Contribution

- Agent's are modelled to be **rationally inattentive**
  - Rational endogenous information acquisition
  - We do not assume exogenous biases
  - Can receive any information
  - Information is costly

- Impact of the current situation - **Status quo**
- Disciplined model - evolution of the disagreement in different environments
- **Multiple states** environment

- Impact of **increased information availability** on polarization e.g. internet, social networks

Our Theoretical Results

- Polarization as **a result of inattentiveness**
- Polarization even for people with **the same prior belief**
- Polarization in **expectations**

Our Theoretical Results

- Polarization as **a result of inattentiveness**
- Polarization even for people with **the same prior belief**
- Polarization in **expectations**

- **Status quo** importance
- Endogenous **state pooling** effect

Our Theoretical Results

- Polarization as **a result of inattentiveness**
- Polarization even for people with **the same prior belief**
- Polarization in **expectations**

- **Status quo** importance
- Endogenous **state pooling** effect

- **Cheaper** information $\implies$ **more polarized** society
- **Policy lesson:**
  focus on the valuation of the status quo

Our Experimental Contribution

Can we observe belief polarization
and identify its drivers in a lab experiment?

Our Experimental Contribution

Can we observe belief polarization and identify its drivers in a lab experiment?

This question can be divided into three smaller ones:

1. **How do agents evaluate and choose information sources?**
   We replicate well-known results in multiple states design (compression of WTP wrt optimal value, preference for certainty)
2. **Do we observe (preference for) state pooling?**
   Yes, we report new evidence of preference for "state pooling" and "extreme" information
3. **Do we observe belief polarization (by changing status quo)?**
   Yes, a change in the safe option generates "information switch" as predicted, and creates belief polarization

Previous literature

Polarization - exogenous biases

- Rabin and Schrag (1999) - signal misreading,
  Klayman and Ha (1987) - positive test strategy,
  Ortoleva and Snowberg (2015) - correlation neglect, ...

Previous literature

Polarization - exogenous biases

- Rabin and Schrag (1999) - signal misreading,
  Klayman and Ha (1987) - positive test strategy,
  Ortoleva and Snowberg (2015) - correlation neglect, ...

Persistent polarization

- Bayesian agents would converge over time - Savage (1954), Blackwell and Dubins (1962)
- Bimodality of preferences - Dixit and Weibull (2007)
- Inattentiveness - Nimark and Sundaresan (2019)

Previous literature

Polarization - exogenous biases

- Rabin and Schrag (1999) - signal misreading,
  Klayman and Ha (1987) - positive test strategy,
  Ortoleva and Snowberg (2015) - correlation neglect, ...

Persistent polarization

- Bayesian agents would converge over time - Savage (1954), Blackwell and Dubins (1962)
- Bimodality of preferences - Dixit and Weibull (2007)
- Inattentiveness - Nimark and Sundaresan (2019)

Laboratory experiments

- Masatlioglu, Orhun and Raymond (2017) - preference for skewed information
- Charness, Oprea and Yuksel (2018) - choices between biased info
- Ambuehl and Li (2018) - demand for information

Related Literature: Rational Inattention Bayes Update

Today's Presentation

- **The Model**

- **Laboratory Experiment**
  - Design
  - Results

The Model

Model

- An agent faces a discrete binary choice problem

$$i \in \{1, 2\} = \{\underbrace{\text{new policy}}_{\text{leaving EU}}, \underbrace{\text{status quo}}_{\text{staying in EU}}\}$$

- New policy
  - value v_s, where $s \in S = \{1, \ldots, n\}$
  - states are labeled, such that $v_1 < v_2 < ... < v_n$

Model

- An agent faces a discrete binary choice problem

$$i \in \{1, 2\} = \{\underbrace{\text{new policy}}_{\text{leaving EU}}, \underbrace{\text{status quo}}_{\text{staying in EU}}\}$$

- New policy
  - value v_s, where $s \in S = \{1, \dots, n\}$
  - states are labeled, such that $v_1 < v_2 < ... < v_n$
    e.g. consequent GDP growth $-10\% < -9\% < \cdots < 5\%$

Model

- An agent faces a discrete binary choice problem

$$i \in \{1, 2\} = \{\underbrace{\text{new policy}}_{\text{leaving EU}}, \underbrace{\text{status quo}}_{\text{staying in EU}}\}$$

- New policy
  - value v_s, where $s \in S = \{1, \ldots, n\}$
  - states are labeled, such that $v_1 < v_2 < ... < v_n$
    e.g. consequent GDP growth $-10\% < -9\% < \cdots < 5\%$

- Status quo
  - known value R (e.g. GDP growth 2%)
  - Assumption: $v_1 < R < v_n$

Model

- Prior beliefs about realized state $\mathbf{g} = [g_1 \quad g_2 \quad \dots \quad g_n]$
- Agent is rationally inattentive (Sims, 2003, 2006)
  - Can acquire information about the state
  - Information acquisition is costly ($\propto$ uncertainty reduction)

Model

- Prior beliefs about realized state $\mathbf{g} = [g_1 \quad g_2 \quad \dots \quad g_n]$
- Agent is rationally inattentive (Sims, 2003, 2006)
  - Can acquire information about the state
  - Information acquisition is costly ($\propto$ uncertainty reduction)

$$\max_{\text{Information strategy}} \{\mathbb{E}(U) - \text{cost of information}\}$$

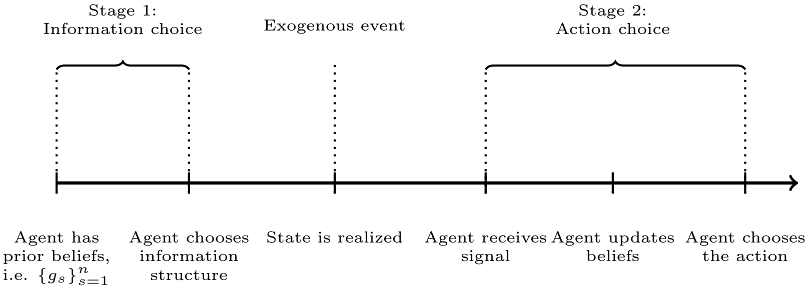
Model

- Prior beliefs about realized state $\mathbf{g} = [g_1 \quad g_2 \quad \dots \quad g_n]$
- Agent is rationally inattentive (Sims, 2003, 2006)
  - Can acquire information about the state
  - Information acquisition is costly ($\propto$ uncertainty reduction)

$$\max_{\text{Information strategy}} \{\mathbb{E}(U) - \text{cost of information}\}$$

Agent's Problem

Agent's Problem with Rational Inattention



Our work vs. previous RI models
e.g. Sims (2003), Matějka and McKay (2015):
State-dependent precision/pooling

Agent's problem

$$\max_{\{\mathcal{P}(i|s)|i=1,2;\ s\in S\}} \left\{ \sum_{s=1}^{n} \left(v_s \mathcal{P}\left(i=1|s\right) + R\mathcal{P}(i=2|s) \right) g_s - \lambda\kappa \right\},$$

subject to

$$\forall i:\ \mathcal{P}(i|s) \geq 0 \qquad \forall s \in S\ ,$$

$$\sum_{i=1}^{2} \mathcal{P}(i|s) = 1 \qquad \forall s \in S\ ,$$

and

$$\kappa = \underbrace{-\sum_{i=1}^{2} \mathcal{P}(i) \log \mathcal{P}(i)}_{\text{prior uncertainty}} - \sum_{s=1}^{n} \left(\underbrace{-\left(\sum_{i=1}^{2} \mathcal{P}(i|s) \log \mathcal{P}(i|s) \right)}_{\text{posterior uncertainty in state } s} g_s \right).$$

Main idea: Evolution of Beliefs

We are interested in updating of expectations

$$\Delta(s^*) = \underbrace{\mathbb{E}_i[\mathbb{E}(v|i)|s^*]}_{\text{Posterior expected mean}} - \underbrace{\mathbb{E}_g[v]}_{\text{Prior mean}}$$

Main idea: Evolution of Beliefs

We are interested in updating of expectations

$$\Delta(s^*) = \underbrace{\mathbb{E}_i[\mathbb{E}(v|i)|s^*]}_{\text{Posterior expected mean}} - \underbrace{\mathbb{E}_g[v]}_{\text{Prior mean}}$$

where

$$\mathbb{E}_i[\mathbb{E}(v|i)|s^*] = \sum_{i=1}^{2} \left(\sum_{s=1}^{n} v_s \mathcal{P}(s|i) \right) \mathcal{P}(i|s^*),$$

where option $i \in \{1, 2\} = \{\text{new policy}, \text{status quo}\}$

Main idea: Evolution of Beliefs

We are interested in updating of expectations

$$\Delta(s^*) = \underbrace{\mathbb{E}_i[\mathbb{E}(v|i)|s^*]}_{\text{Posterior expected mean}} - \underbrace{\mathbb{E}_g[v]}_{\text{Prior mean}}$$

Main idea: Evolution of Beliefs

We are interested in updating of expectations

$$\Delta(s^*) = \underbrace{\mathbb{E}_i[\mathbb{E}(v|i)|s^*]}_{\text{Posterior expected mean}} - \underbrace{\mathbb{E}_g[v]}_{\text{Prior mean}}$$

Proposition 1

Given that the agent is in a learning area $(0 < \mathcal{P}(i = 1) < 1)$ and that the realized state of the world is s^*,

Main idea: Evolution of Beliefs

We are interested in updating of expectations

$$\Delta(s^*) = \underbrace{\mathbb{E}_i[\mathbb{E}(v|i)|s^*]}_{\text{Posterior expected mean}} - \underbrace{\mathbb{E}_g[v]}_{\text{Prior mean}}$$

Proposition 1

Given that the agent is in a learning area $(0 < \mathcal{P}(i = 1) < 1)$
and that the realized state of the world is s^*,
the sign of the change in the mean of beliefs $\boldsymbol{\Delta}(\mathbf{s}^*)$
about the payoff of the new policy

Main idea: Evolution of Beliefs

We are interested in updating of expectations

$$\Delta(s^*) = \underbrace{\mathbb{E}_i[\mathbb{E}(v|i)|s^*]}_{\text{Posterior expected mean}} - \underbrace{\mathbb{E}_g[v]}_{\text{Prior mean}}$$

Proposition 1

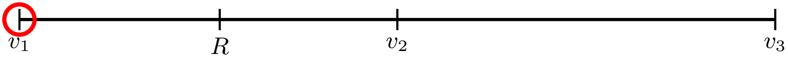
Given that the agent is in a learning area $(0 < \mathcal{P}(i = 1) < 1)$ and that the realized state of the world is s^*, **the sign of the change** in the mean of beliefs $\boldsymbol{\Delta(s^*)}$ about the payoff of the new policy **is the same as the sign of** $(\mathbf{v_{s^*} - R})$.

Extreme states

Updating towards the realized state

$$\underbrace{\text{sign } \Delta(s^*)}_{\text{change in mean of beliefs}} \quad = \quad \underbrace{\text{sign } (v_{s^*} - R)}_{\text{true payoff}-\text{status quo}}$$

State $s^* = 1$

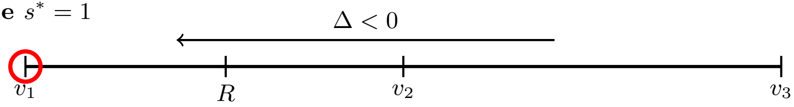


Extreme states

Updating towards the realized state

$$\underbrace{\text{sign } \Delta(s^*)}_{\text{change in mean of beliefs}} = \underbrace{\text{sign } (v_{s^*} - R)}_{\text{true payoff}-\text{status quo}}$$

State $s^* = 1$

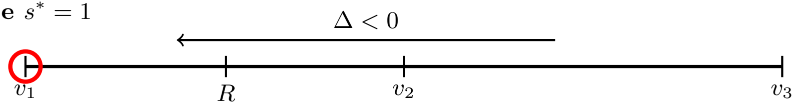


Extreme states

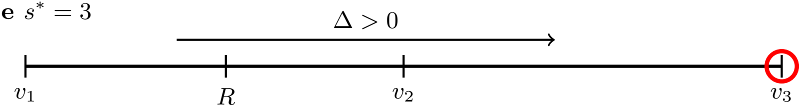
Updating towards the realized state

$$\underbrace{\text{sign } \Delta(s^*)}_{\text{change in mean of beliefs}} = \underbrace{\text{sign } (v_{s^*} - R)}_{\text{true payoff}-\text{status quo}}$$

State $s^* = 1$

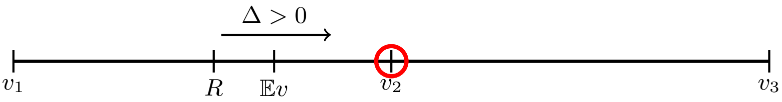


State $s^* = 3$



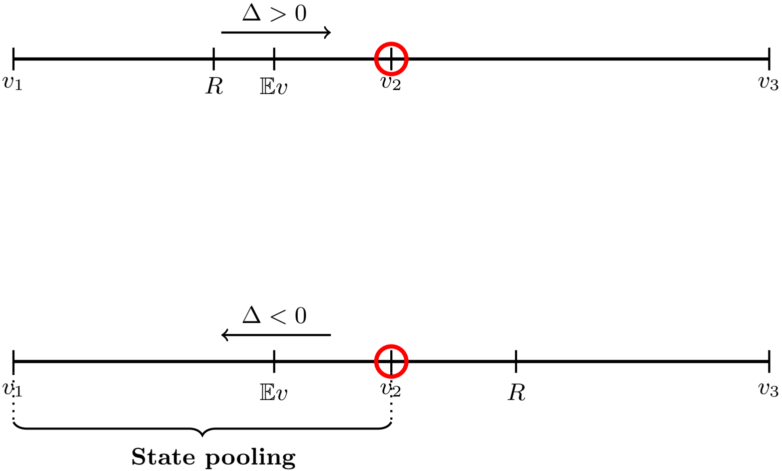
Updating away from the realized state

State $s^* = 2$



Updating away from the realized state

State $s^* = 2$



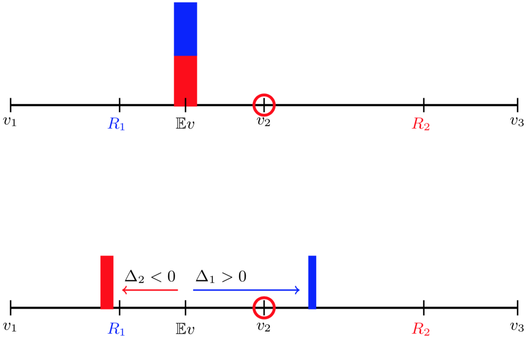
Polarization result

Proposition

Agents $j = 1, 2$ are **polarized**, i.e. exists such $(R_j, \mathbb{E}_g^j[v])$ that

- Posterior expected beliefs are further away than the prior
- Agents update in opposite directions

are satisfied.



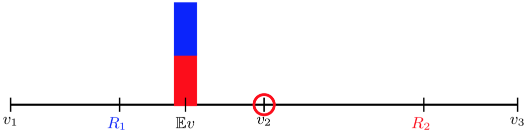
Polarization result

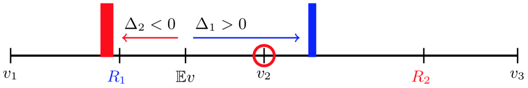
Definition

Agents $j = 1, 2$ are **polarized**, i.e. exists such $(R_j, \mathbb{E}_g^j[v])$ that

- $\left|\mathbb{E}_i^1[\mathbb{E}(v|i)|s^*] - \mathbb{E}_i^2[\mathbb{E}(v|i)|s^*]\right| > \left|\mathbb{E}^1 v - \mathbb{E}^2 v\right|$.
- $\Delta_1(s^*) \cdot \Delta_2(s^*) < 0$.

are satisfied.





Other Results

Convergence of beliefs Convergence

Monotonicity of $\Delta(s^*)$ Monotonicity

Divergence while updating in the same direction Divergence

Comparative statics Comparative statics

- **Cheaper** information might lead to **higher** polarization

Laboratory Experiment

Laboratory Experiment

- **How do agents evaluate and choose information sources?**
- **Do we observe (preference for) state pooling?**
- **Do we observe belief polarization (by changing Safe)?**

Laboratory Experiment

- **How do agents evaluate and choose information sources?**
- **Do we observe (preference for) state pooling?**
- **Do we observe belief polarization (by changing Safe)?**

- Stage 1: choose or "hire" an advisor (experiment)
- Observe signal realization
- Stage 2: select an action [risky/safe]

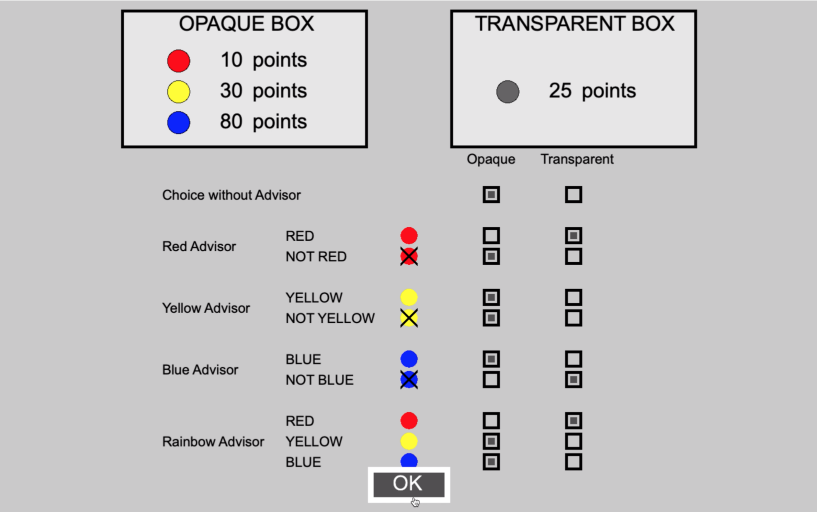
- We collect separately
  - Choices over sources of information (advisors)
  - Action (conditional on realized signals)
  - Elicited beliefs (signal probability and posterior)
  - Willingness to pay for signal structures

Laboratory Experiment

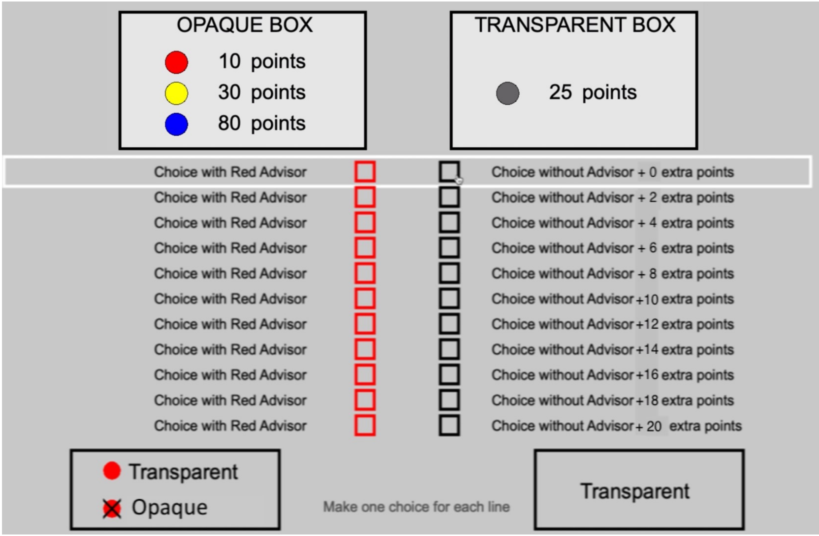
- Experiment conducted at Columbia in August-September 2019
- 85 participants (undergraduate and graduate students)
- Average time 80 minutes, Average payment ~$25
  - Show-up fee ($10)
  - Main experiment, 4 parts (probability points, $15 prize)
  - Risk attitude (Holt-Laury, $0.10-$4.00)
  - Intelligence (Raven's Progressive Matrices, 5 x $0.50)
  - Unrewarded questionnaire (strategy, LOT-R, demographics)

Task 1

Task 1 - Choice screen

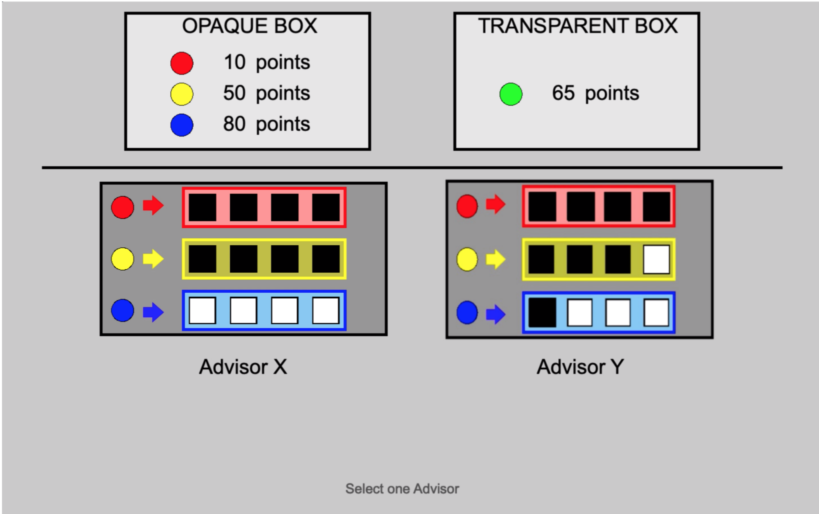


Task 1 - Hiring screen

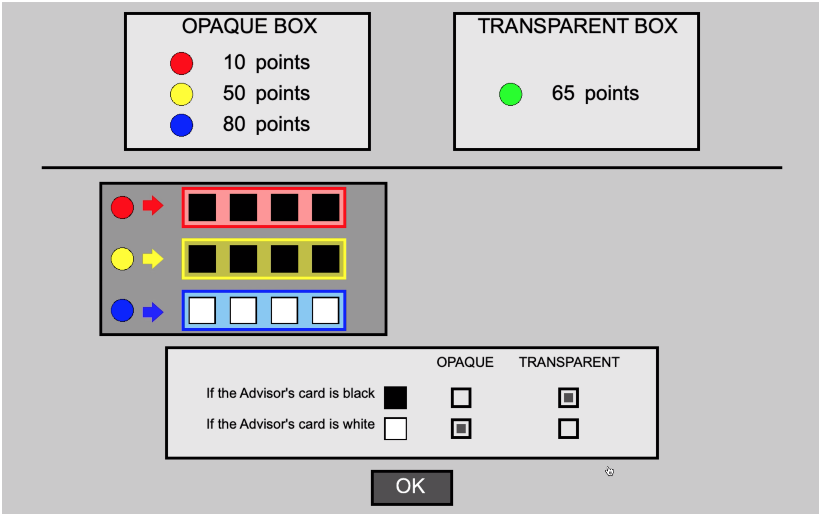


Task 2

Task 2 - Hiring screen

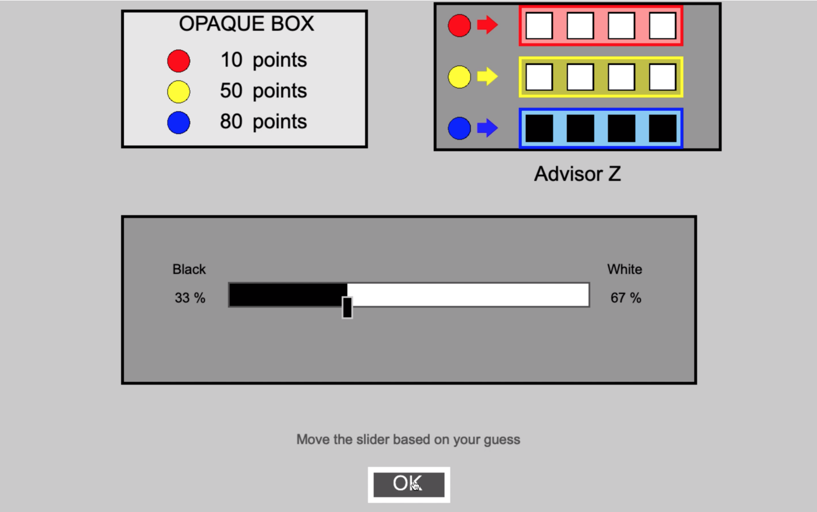


Task 2 - Choice screen



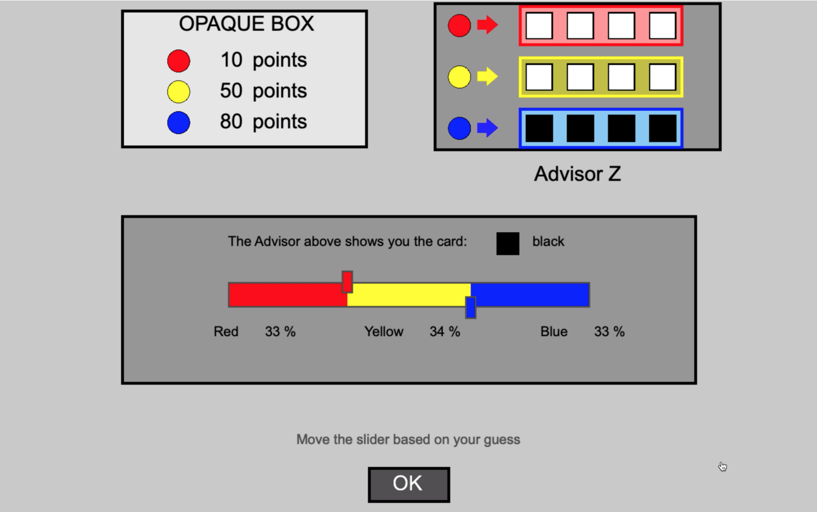
Task 3

Task 3 - Belief elicitation



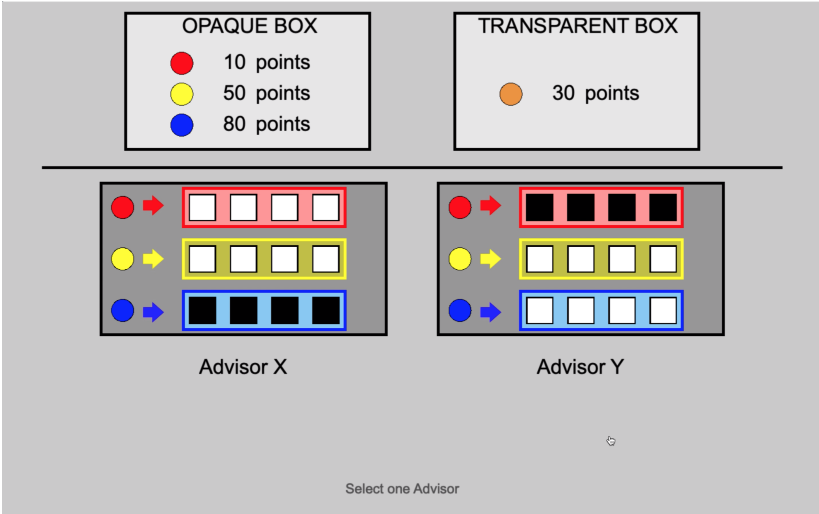
Task 4

Task 4 - Belief elicitation

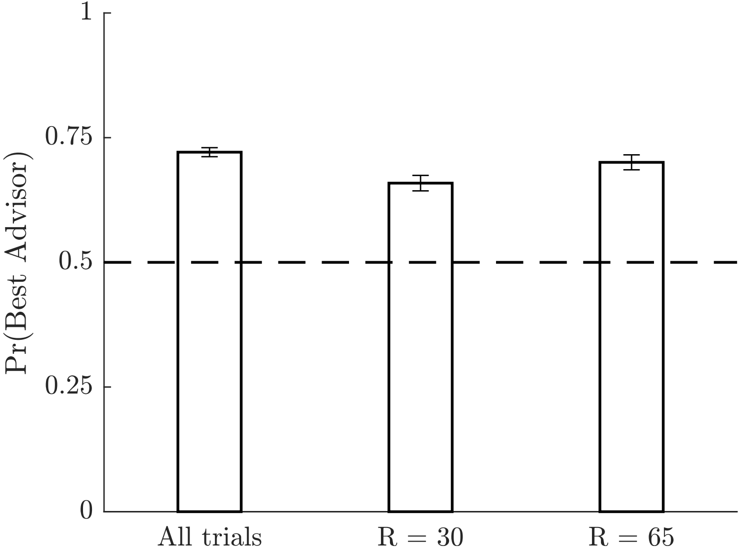


Experimental Results

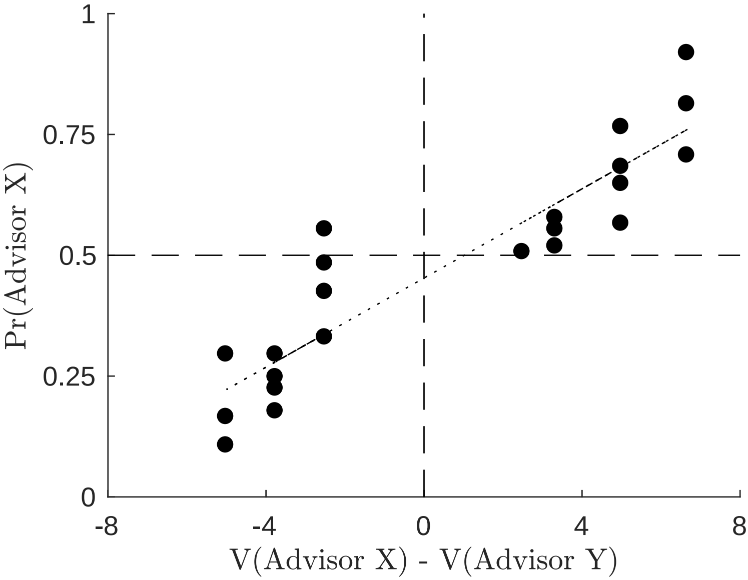
Task 2 - How did we design the pairs of advisor?



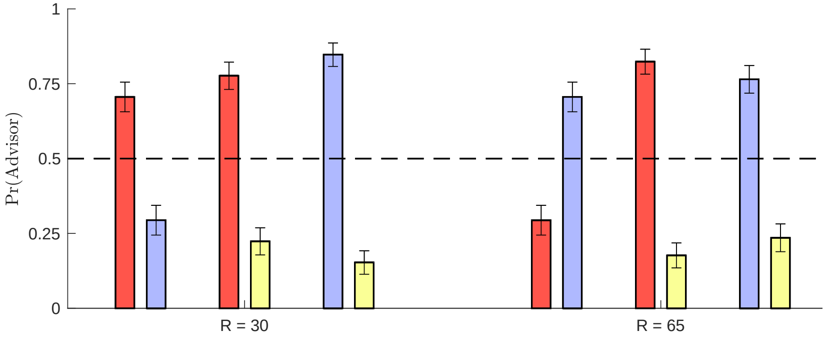
Most of participants "switch" advisor optimally



Accuracy depends on the stakes

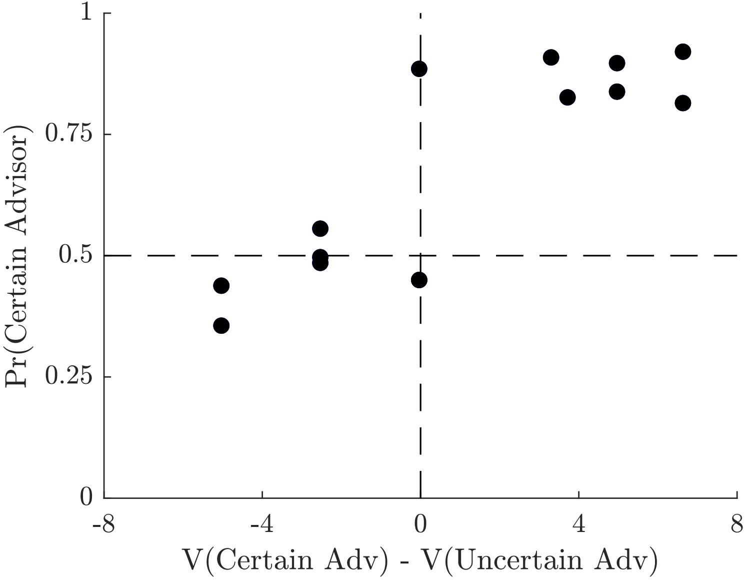


Simple Advisors: Certainty vs Certainty

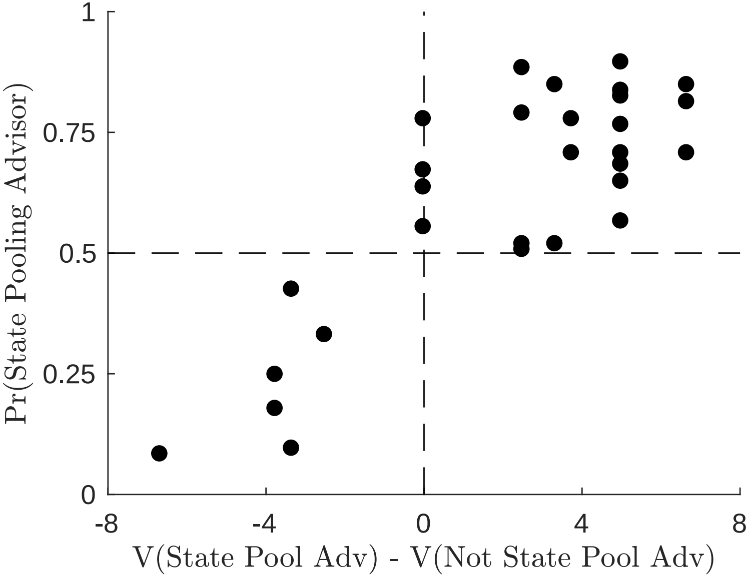


- Each advisor “pools” two states out of three
- These trials are easy to interpret
- Participants switch in the red/blue choice...
- ...but they switch only when it is valuable to do so

Certainty vs Uncertainty



State Pooling vs Not Pooling



Aggregate Valuation of Advisors - Logit Regression

	(1)
v_I^{Bayes}	0.210***
	(0.0346)
Best Advisor	0.106
	(0.143)
Certainty	
State Pooling	
Certainty $\times$ SP	
Trials	All
Observations	3,400

The significance levels concern the hypothesis that the coefficient is 0.
Notation: *** p<0.01, ** p<0.05, * p<0.1

Aggregate Valuation of Advisors - Logit Regression

	(1)	(2)
v_I^{Bayes}	0.210***	0.236***
	(0.0346)	(0.0110)
Best Advisor	0.106	
	(0.143)	
Certainty		0.1876***
		(0.0708)
State Pooling		
Certainty × SP		
Trials	All	All
Observations	3,400	3,400

The significance levels concern the hypothesis that the coefficient is 0.
Notation: *** p<0.01, ** p<0.05, * p<0.1

Aggregate Valuation of Advisors - Logit Regression

	(1)	(2)	(3)
v_I^{Bayes}	0.210***	0.236***	0.2108***
	(0.0346)	(0.0110)	(0.0113)
Best Advisor	0.106		
	(0.143)		
Certainty		0.1876***	
		(0.0708)	
State Pooling			0.742***
			(0.0757)
Certainty $\times$ SP			0.488***
			(0.0825)
Trials	All	All	All
Observations	3,400	3,400	3,400

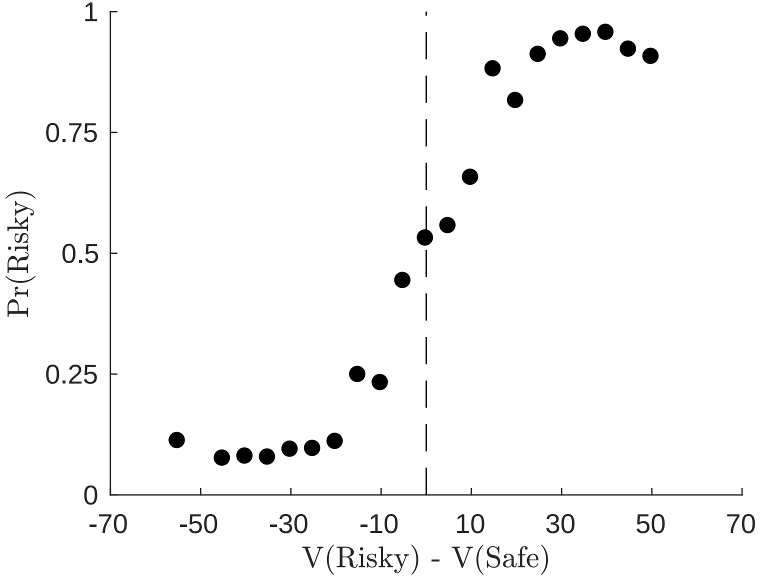
The significance levels concern the hypothesis that the coefficient is 0.
Notation: *** p<0.01, ** p<0.05, * p<0.1

Aggregate Valuation of Advisors - Logit Regression

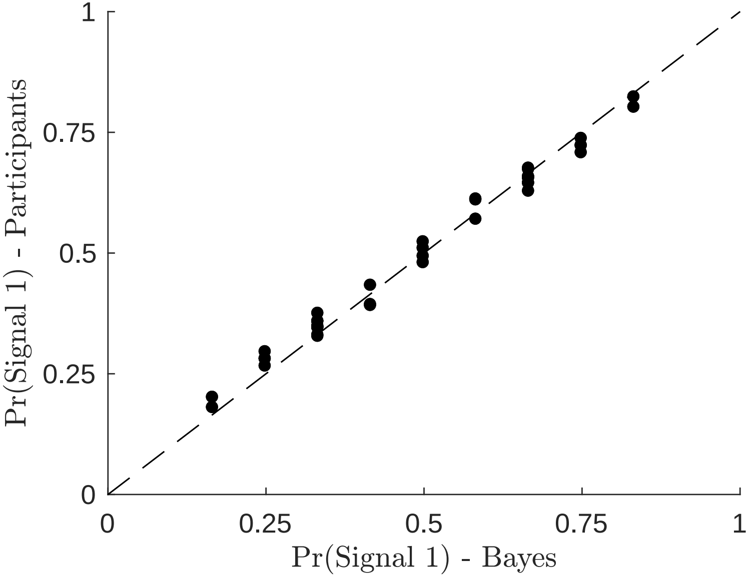
	(1)	(2)	(3)	(4)
v_I^{Bayes}	0.210***	0.236***	0.2108***	0.253***
	(0.0346)	(0.0110)	(0.0113)	(0.0358)
Best Advisor	0.106			-0.186
	(0.143)			(0.149)
Certainty		0.1876***		0.596***
		(0.0708)		(0.154)
State Pooling			0.742***	1.041***
			(0.0757)	(0.111)
Certainty × SP			0.488***	-0.0601
			(0.0825)	(0.164)
Trials	All	All	All	All
Observations	3,400	3,400	3,400	3,400

The significance levels concern the hypothesis that the coefficient is 0.
Notation: *** $p<0.01$, ** $p<0.05$, * $p<0.1$

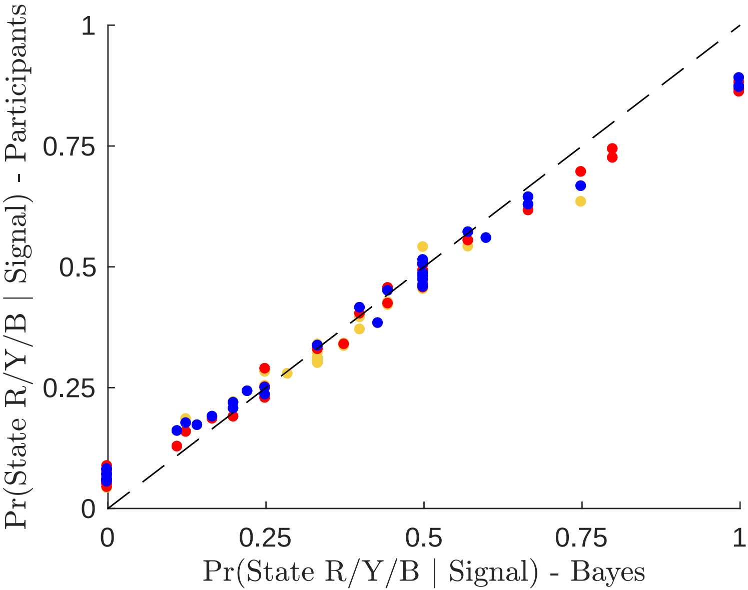
Action Selection



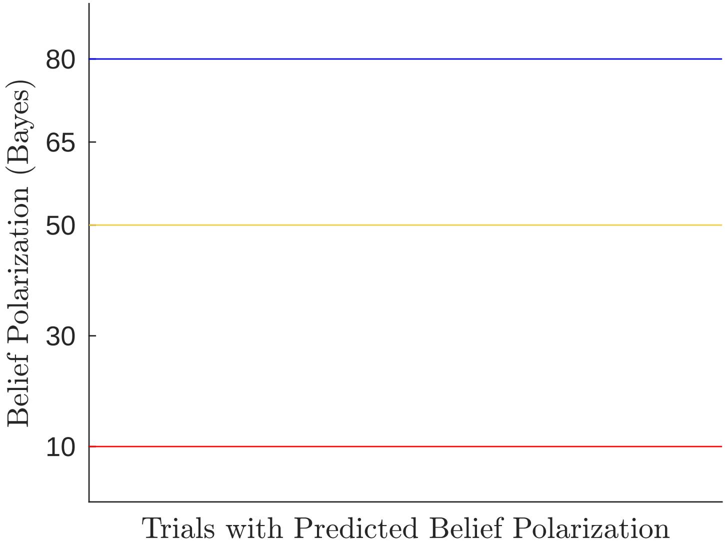
Elicited Beliefs - Card color



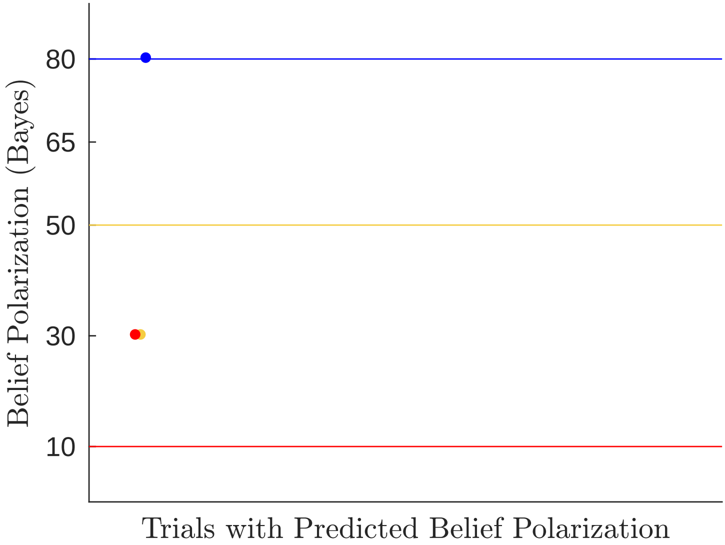
Elicited Beliefs - Ball color



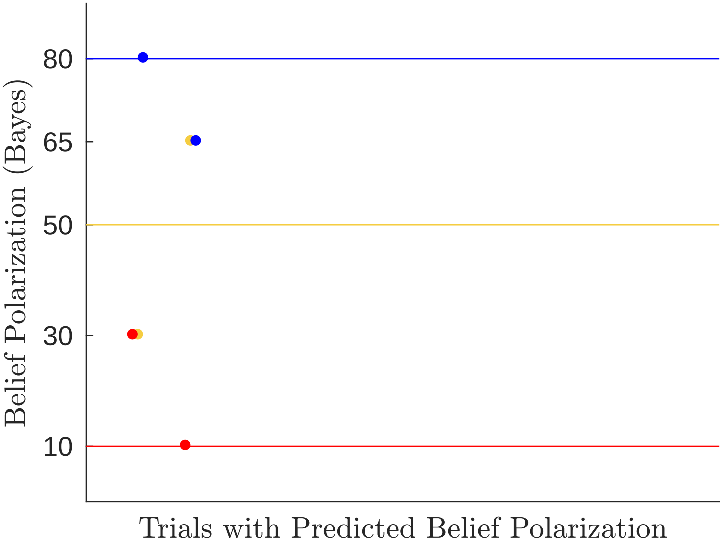
Beliefs Polarization - Predictions



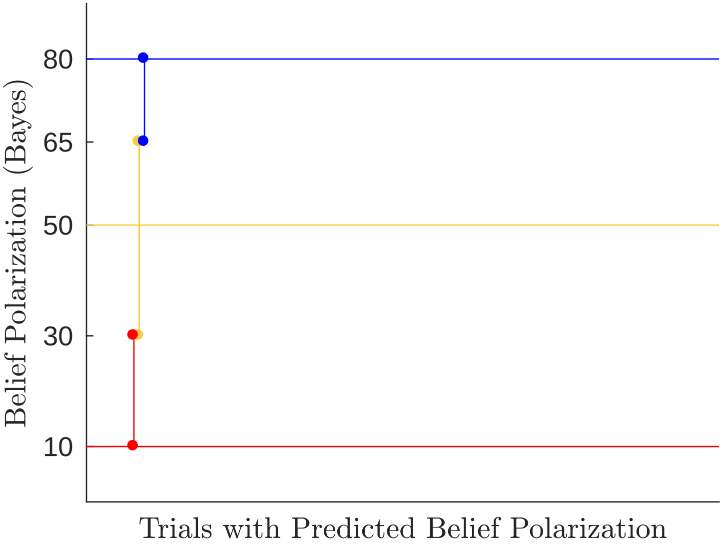
Beliefs Polarization - Predictions



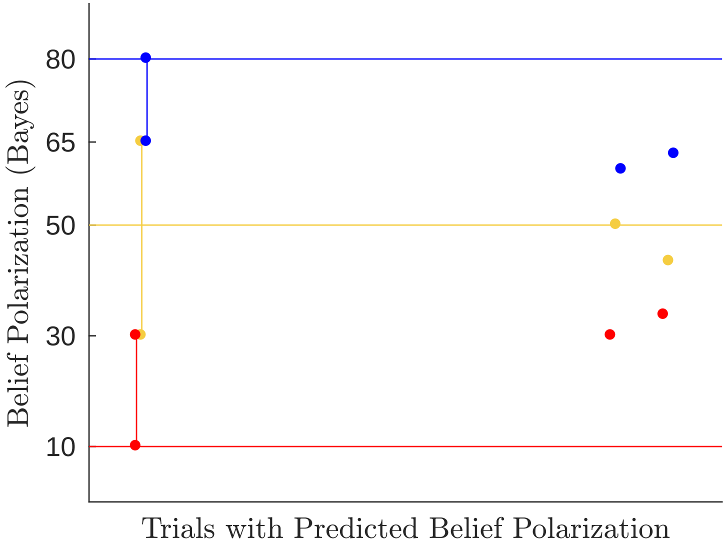
Beliefs Polarization - Predictions



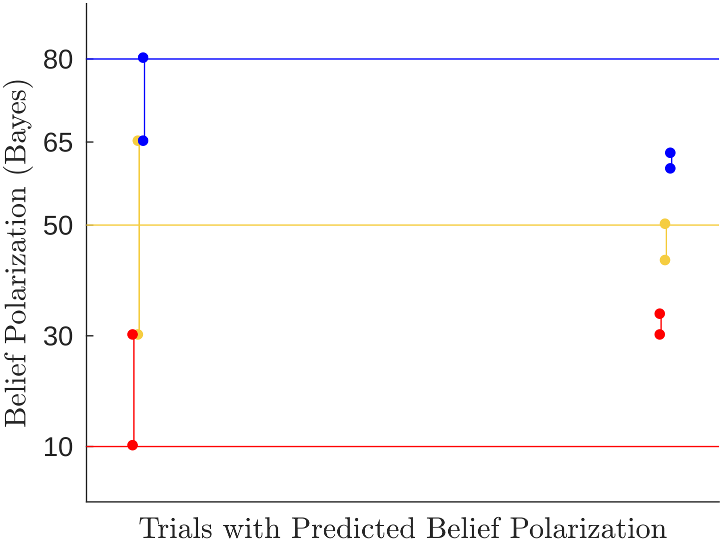
Beliefs Polarization - Predictions



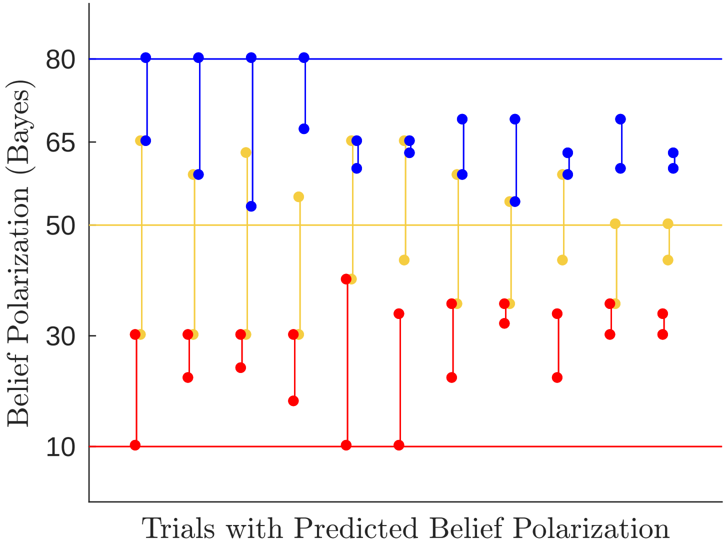
Beliefs Polarization - Predictions



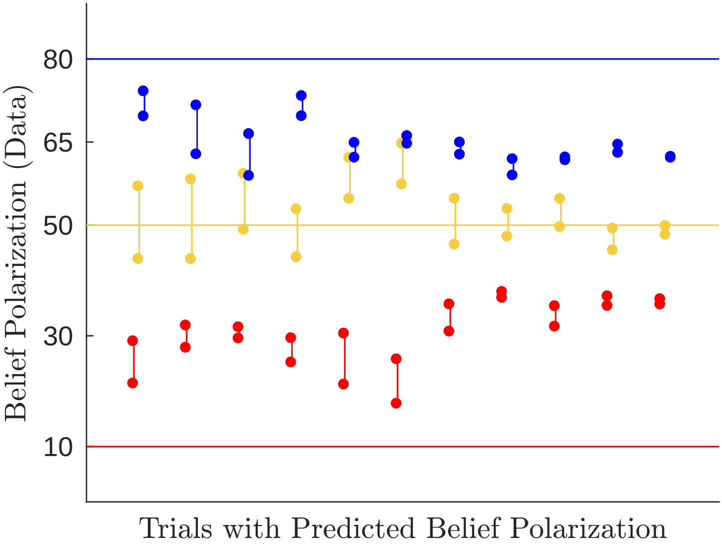
Beliefs Polarization - Predictions



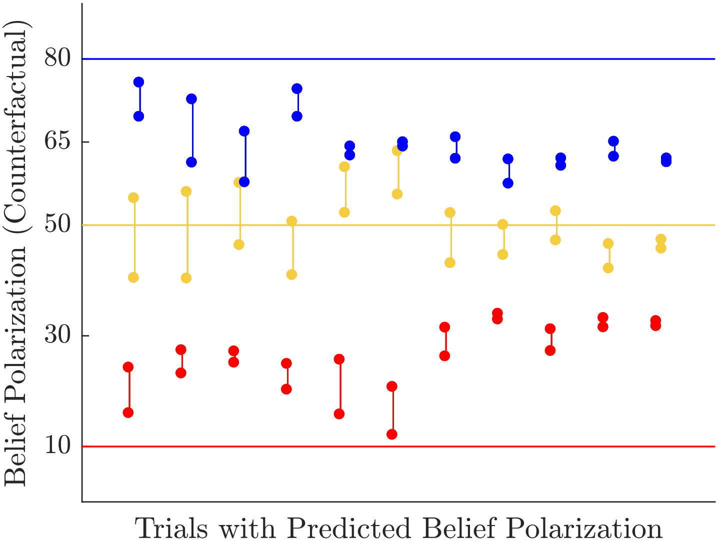
Beliefs Polarization - Predictions



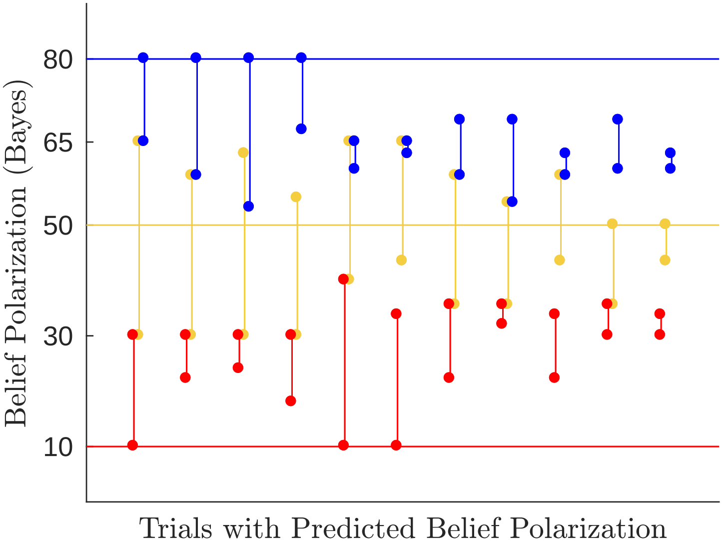
Beliefs Polarization - Data



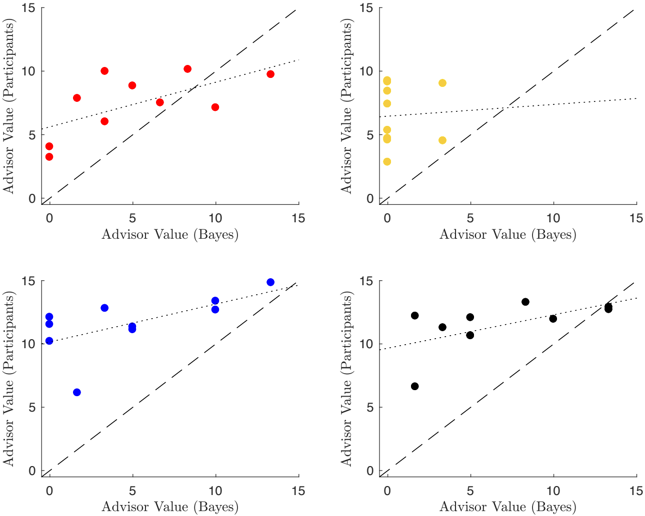
Beliefs Polarization - Counterfactual



Beliefs Polarization - Predictions



Compression in the WTP for Advisors in Task 1



Questionnaire - Strategies

State Pooling

- If low ball in transparent box, pick advisor most likely to reveal blue or yellow, vice versa
- I chose based on whichever advisor's information could tell me more about the single ball I either really did or did not want to pick

Other strategies

- CERTAINTY - I would choose the advisor which had the same color of cards for each color ball
- BLUE - To make sure if it is blue
- RED - I chose the advisor of the ball I didn't want to get on the opaque box, and if that was the color that was on the box, I went with the transparent box
- TALKATIVE - Probability

Conclusion

- **Endogenously arising rational** theory of polarization with multiple states
- Role of **the status quo for information acquisition**
- Endogenous **state pooling effect**
- **Cheaper** information leading to **more** polarized society

Lab experiment:

- A change in the safe option generates "advisor switches" as predicted...
- ... and creates (mitigated) belief polarization.
- We replicate well-known results (compression, preference for certainty) in a new setup with 3 states...
- ... and we report novel evidence: preference for "state pooling" and "extreme states" advisors.

The Status Quo and Beliefs Polarization of Inattentive Agents: Theory and Experiment

Vladimír Novák

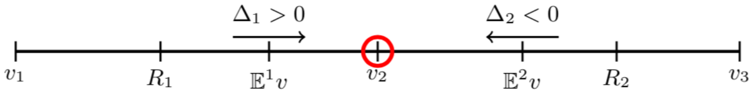
CERGE-EI

joint work with
Andrei Matveenko and Silvio Ravaioli
(University of Copenhagen) (Columbia University)

CERGE-EI Brown Bag
October 30th, 2019

Thank you for your attention

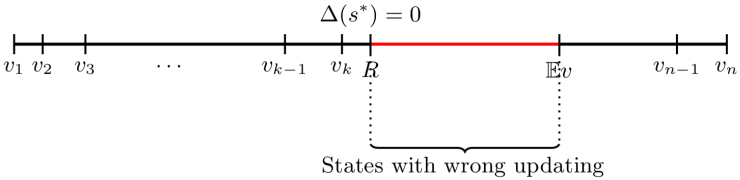
Convergence



Back

Monotonicity of $\Delta(s^*)$

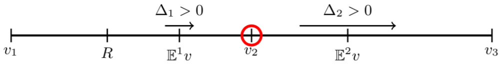
Proposition Change in mean of beliefs $\Delta(s^*)$ is an increasing function of s^*.



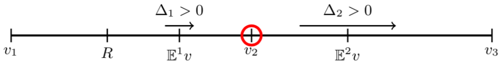
$$W = \begin{cases} \{s \mid R < v_s < \mathbb{E}v\}, & \text{if } \mathbb{E}v > R \\ \{s \mid \mathbb{E}v < v_s < R\}, & \text{otherwise} \end{cases}$$

Back

Divergence while updating in the same direction



Divergence while updating in the same direction



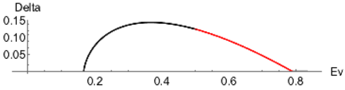


Figure: $\Delta(s^* = 2)$ as a function of $\mathbb{E}v$ for R_1 and λ_2. The red area depicts the region of wrong updating.

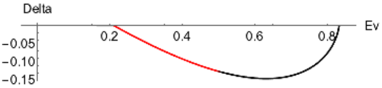


Figure: $\Delta(s^* = 2)$ as a function of $\mathbb{E}v$ for R_2 and λ_2. The red area depicts the region of wrong updating.

Parameters Back

Comparative statics

Cheaper information ($\lambda_2 < \lambda_1$) might lead to higher polarization

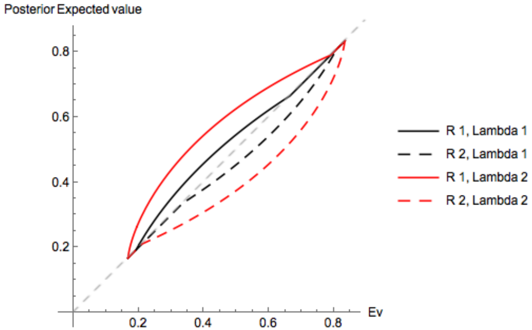


Figure: $\mathbb{E}_i[\mathbb{E}(v|i)|s^*]$ as a function of $\mathbb{E}v$ for different levels of R and λ. The solid lines are the case with R_1 and dashed with R_2. Black corresponds to cases with λ_1 and red is used for λ_2.

Back

Increase in polarization

- Political polarization (e.g., Boxwell, Gentzkow and Shapiro, 2017)
- Disagreement about objective truths
(e.g., McCright and Dunlap, 2011)
- Polarization as a backlash to events: globalization, etc.
(e.g., Pástor and Veronesi, 2018)

Back

Related literature:

1. **Persistent disagreement of the Bayesian agents with exogenous info.**
   - Blackwell and Dubins (1962), Gerber and Green (1999); Dixit and Weibull (2007), and many other
2. **Persistent disagreement with endogenous info.**
   - Su (2015); Nimark and Sundaresan (2019)
3. **Reference based preferences**
   - Koszegi and Rabin (2006, 2007); Bordalo, Gennaioli and Shleifer (2012); Genicot and Ray (2017)
4. **Empirical literature**
   - Charness, Oprea and Yuksel (2018); Ambuehl and Li (2018); Masatlioglu, Orhun and Raymond (2017)

Back

Related literature Rational Inattention

- **Discrete choice**
  - Matejka and McKay (2015); Steiner, Stewart, Matejka (2017)
- **Macroeconomics**
  - Linear-Quadratic
    - Sims (1998,2003,2006); Mackowiak and Wiederholt (2009,2011, 2015); Afrouzi (2017)
    - Sims(2006), Woodford(2009,2015), Matejka(2010), Matejka and Sims(2010)
  - RI Kalman filter
    - Mackowiak, Matejka and Wiederholt (2018)
- **Political economics**
  - Matejka and Tabellini (2017)
- **Finance**
  - Van Nieuwerburgh, Veldkamp(2008); Mondria(2009); Peng (2005); Kacperczyk, Van Nieuwerburgh and Veldkamp (2016)

Back

Bayesian Updating

Realized state

$$X \sim \mathcal{N}(\mu_0, \sigma_X^2)$$

Signal

$$S = X + \epsilon,\ \epsilon \sim \mathcal{N}(0, \sigma_\epsilon^2)$$

where ϵ and X are independent.

Conditional on realization of X posterior mean $\bar{\mu}$ is a weighted average of μ_0 and X

That is, the direction of updating on average is **towards** the realized state.

Back

Agent's problem

$$\max_{\mathcal{P}=\{\mathcal{P}(i|s)|i=1,2;\ s=1,\ldots,n\}} \left\{ \sum_{i=1}^{2} \sum_{s=1}^{n} v_s \mathcal{P}(i|s) g_s - \lambda\kappa \right\},$$

subject to

$$\begin{aligned} \forall i:\ \mathcal{P}(i|s) &\geq 0 \qquad && \forall s = 1, \ldots, n\ , \\ \sum_{i=1}^{2} \mathcal{P}(i|s) &= 1 \qquad && \forall s = 1, \ldots, n\ , \end{aligned}$$

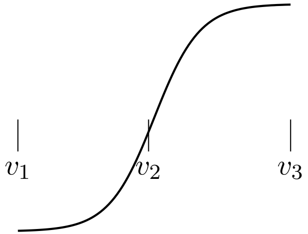
and

$$\kappa = \underbrace{-\sum_{i=1}^{2} \mathcal{P}(i) \log \mathcal{P}(i)}_{\text{prior uncertainty}} - \underbrace{\left(-\sum_{s=1}^{n} \left(\sum_{i=1}^{2} \mathcal{P}(i|s) \log \mathcal{P}(i|s) \right) g_s \right)}_{\text{posterior uncertainty}}.$$

Back

Solution

$\mathcal{P}(i|s)\ \forall i, s$ - characterize information strategy due to consistency of prior and posterior beliefs

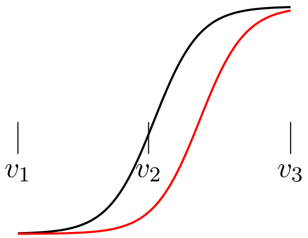


$\mathcal{P}(i|s)$ - logit

Back

Solution

$\mathcal{P}(i|s)\ \forall i, s$ - characterize information strategy due to consistency of prior and posterior beliefs



$\mathcal{P}(i|s)$ - logit

Back

Lemma 1: Solution

Conditional on the realized state of the world s^*

$$\mathcal{P}(\text{new policy } |s^*) = \mathcal{P}(i=1|s^*) = \frac{\mathcal{P}(i=1)e^{\frac{v_{s^*}}{\lambda}}}{\mathcal{P}(i=1)e^{\frac{v_{s^*}}{\lambda}} + (1-\mathcal{P}(i=1))e^{\frac{R}{\lambda}}} \quad \text{a.s.,}$$

$$\mathcal{P}(\text{status quo } |s^*) = \mathcal{P}(i=2|s^*) = \frac{(1-\mathcal{P}(i=1))e^{\frac{R}{\lambda}}}{\mathcal{P}(i=1)e^{\frac{v_{s^*}}{\lambda}} + (1-\mathcal{P}(i=1))e^{\frac{R}{\lambda}}} \quad \text{a.s.,}$$

$\mathcal{P}(i=1)$ - unconditional probability of choosing a new unknown policy

$\lambda = 0$ chooses the option with the highest value with probability one

Back

Description of Evolution of Beliefs

- Agent's prior expected value of the new policy is:

$$\mathbb{E}v = \sum_{s=1}^{n} v_s g_s$$

we **fix the state** of the nature: it is s^*

- Observer sees agent's updated expected belief:

$$\begin{aligned}\mathbb{E}_i[\mathbb{E}(v|i)|s^*] = \mathcal{P}(\text{status quo}|s^*)\mathbb{E}(v|\text{status quo}) + \\ + \mathcal{P}(\text{new policy}|s^*))\mathbb{E}(v|\text{new policy}),\end{aligned}$$

Theorem 1 Back

Theorem 1

The expected posterior value of the new policy given s^*, for $i \in \{\text{new policy, status quo}\} = \{1, 2\}$ is:

$$\mathbb{E}_i[\mathbb{E}(v|i)|s^*] = \sum_{s=1}^{n} v_s g_s \frac{\mathcal{P}(i=1|s^*)e^{\frac{v_s}{\lambda}} + (1-\mathcal{P}(i=1|s^*))e^{\frac{R}{\lambda}}}{\mathcal{P}(i=1)e^{\frac{v_s}{\lambda}} + (1-\mathcal{P}(i=1))e^{\frac{R}{\lambda}}}.$$

Back

Description of Evolution of Beliefs

Corollary $\Delta(s^*) = 0$ holds if at least one of the following conditions is satisfied:

(a) $v_{s^*} = R$

(b) the agent is not acquiring any information, $\exists\, i : \mathcal{P}(i) = 1$.

Back

Parameters

v_1	v_2	v_3	g_1	g_2	g_3	R_1	R_2	λ_1	λ_2	λ_3	λ_4
0	$\frac{1}{2}$	1	$g \in (0, \frac{2}{3})$	$\frac{1}{3}$	$\frac{2}{3} - g$	$\frac{3}{8}$	$\frac{5}{8}$	$\frac{1}{8}$	$\frac{1}{4}$	$\frac{3}{8}$	1

Table: Parameters used in this section

Back