Willingness-to-pay for Warnings: Pilot Results

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Summary

- Subjects underweight both the prior probability and the signal (consistent with all the tasks using signals)
- Subjects tend to approach tasks independently
- Subjects's WTP underreact to false positive rates for low priors and overreact for high probabilities
- The oppositve is true for false negative rates
- WTP is overly sensitive to false positive and false negative rates

WTP for signals: Determinants

Table: WTP for Information (Discrepancy)

	(1)	(2)	(3)	(4)	(5)	(6
FP costs	.251*	.305**	.0991	.136	.404**	.43
	(0.1)	(0.1)	(0.2)	(0.2)	(0.2)	(0.
FN costs	.356***	.292***	.397***	.348***	.425***	.375
	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.
Risk-averse			.0046	-.154		
			(0.3)	(0.4)		
Risk-averse × FP costs			.187	.227		
			(0.2)	(0.3)		
Risk-averse × FN costs			-.066	-.118		
			(0.2)	(0.1)		
Accur. beliefs					.212	.33
					(0.3)	(0.
Accur. beliefs × FP costs					-.361	-.3
					(0.2)	(0.
Accur. beliefs × FN costs					-.143	-.1
					(0.1)	(0.
Constant	-.233	.288	-.237	.336	-.331	.14
	(0.2)	(0.2)	(0.3)	(0.3)	(0.2)	(0.
Prior dummies	No	Yes	No	Yes	No	Ye

WTP for signals: Heterogeneity with respect to priors

Table: WTP for Information (Discrepancy, by prior)

	(1)	(2)	(3)	(4)
	0.1	0.2	0.3	0.5
FP costs	.472***	.585***	.0821	-.326
	(0.2)	(0.2)	(0.2)	(0.3)
FN costs	-.609**	.192	.26**	.379***
	(0.2)	(0.1)	(0.1)	(0.1)
Constant	.412*	-.715***	-.968***	.671**
	(0.2)	(0.2)	(0.2)	(0.3)
Observations	162	153	162	153
Adjusted R^2	0.04	0.05	0.01	0.09

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

WTP heterogeneity: one simple explanation

- Theory: false-negative costs increase with prior probabilities, false-positive costs decrease with priors
- Subjects do not take it into account in stated WTP:
  - Pay more for signals with higher prior probabilities
  - Pay less for signals with high FP/FN rates
  - Do not account for the **interaction** between the prior and FP/FN rates
- Next table illustrates this pattern

Accounting for Heterogeneity

	(1) WTP	(2) Value
model		
Prior>0.2	.916***	.754***
	(0.2)	(0.1)
FP rate	-2.47***	-4.27***
	(0.8)	(0.3)
Prior>0.2 × FP rate	-1.28	1.55***
	(1.1)	(0.4)
FN rate	-2.63***	-2.25***
	(0.8)	(0.3)
Prior>0.2 × FN rate	-.967	-3.75***
	(1.1)	(0.4)
Constant	2.02***	2.23***
	(0.2)	(0.1)
sigma		
Constant	1.91***	.691***
	(0.1)	(0.0)
Observations	630	630
Adjusted R^2		
Standard errors in parentheses		

Alternative Explanations for Heterogeneity

1. Subjects react to signals of no value which introduces extra sensitivity to (high) false-positive and false-negative rates
2. Loss aversion
3. Subjects do not update correctly: base-rate neglect or signal underweighting
4. Probability weighting (part of cumulative prospect theory, rank-dependent EU, etc)

Potential Explanations: Reacting to Low-quality Signals

- The signal's value for a risk-neutral agent is bounded below at zero:

$$b^* = \max[0, \min(\pi L, c) - \pi P(s = 0|\omega = 1)L - P(s = 1)c]$$

- It is easy to prove that any signal with zero value $\pi P(s = 0|\omega = 1)L + P(s = 1)c \leq \min(\pi L, c)$ generates either too low posterior probabilities to respond to any color or too high to not respond to any color
- Potential issue: subjects are sensitive to signal's quality even for worthless signals

Potential Explanations: Reacting to Low-quality Signals

- Suppose the signal is low quality $b^* \leq 0$
- $\Longrightarrow$ theoretical sensiivity to FP or FN is zero for any signal's deterioration
- If WTP sensitivity is still non-zero (negative) - the difference has **negative** sensitivity
- If the prior is low ($\pi L < c$) - most bad signals have high FP, so high negative sensitivity to FP
- If the prior is high ($\pi L \geq c$) -most bad signals come from FN, so high negative sensitivity to FN
- This prediction goes contrary to the observed pattern in which extra-negative sensitivity to FN emerges for low probs and vice versa
- Dropping obs with zero theoretical value or "forgetting" about bounds does not explain away the pattern

Potential Explanations: Biased Belief Updating

- A standard Bayesian agent does:

$$P(B|S) = \frac{P(S|B)P(B)}{P(S|W)P(W) + P(S|B)P(B)}$$

- More generally, consider an agent updating as a quasi-Bayesian:

$$\mu(B|S) = \frac{P(S|B)^{\alpha}P(B)\beta}{P(S|W)^{\alpha}P(W)^{\beta} + P(S|B)^{\alpha}P(B)^{\beta}}$$

- You can estimate it as:

$$\log\left(\frac{\mu(B|S)}{1-\mu(B|S)}\right) = \alpha\log\left(\frac{P(S|B)}{P(S|W)}\right) + \beta\log\left(\frac{P(B)}{P(W)}\right)$$

- Base-rate neglect is when $0 < \beta < 1$ and $0 < \alpha < 1$ is the signal underweighting

Belief Updating: Decomposition

	(1) OLS	(2) FE	(3) OLS	(4) FE	(5) OLS	(6) FE
Prior	.246***	.202***	.175***	.191**	.14**	.0403
	(5.5)	(4.0)	(3.1)	(2.5)	(2.3)	(0.6)
Signal	.43***	.43***	.327***	.327***	.539***	.539***
	(6.3)	(6.3)	(3.2)	(3.2)	(5.3)	(5.3)
Good quiz × Prior			.143*	.0207		
			(1.7)	(0.2)		
Good quiz × Signal			.193	.193		
			(1.4)	(1.4)		
Stat. class × Prior					.162*	.264***
					(1.9)	(2.8)
Stat. class × Signal					-.166	-.166
					(-1.2)	(-1.2)
Observations	280	280	280	280	280	280
Adjusted R^2	0.31	0.31	0.33	0.32	0.32	0.32

Decomposition works only for imperfect signals

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Discussion: Belief Updating

- Observe: base-rate neglect $\beta < 0.3$ and the signal underweighting $0.3 < \alpha < 0.6$
- Signal underweighting is much smaller
- These findings are consistent with the meta-analysis in Benjamin (2018)
- How does it affect WTP?
- Posterior probs do not enter the equation for the signal's value, but posteriors affect signal's responses
- Approach: estimate posterior probs using the estimated quasi-bayesian equation above, find optimal responses and calculate the value of information for risk-neutral subject based on that

WTP difference: accounting for belief updating

	(1)	(2)	(3)	(4)
	0.1	0.2	0.3	0.5
FP costs	.28*	.0421	-.495**	-.547
	(0.2)	(0.2)	(0.2)	(0.3)
FN costs	.0622	1.55***	1.23***	.457***
	(0.3)	(0.2)	(0.1)	(0.1)
Constant	.467*	-.359	-.605**	.811***
	(0.2)	(0.2)	(0.3)	(0.3)
Observations	162	153	162	153
Adjusted R^2	0.00	0.25	0.31	0.13

Standard errors in parentheses

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Alternative: Probability weighting

- In EU framework subject weight outcome by their probabilities (or their beliefs)
- In the prob. weighting framework the probabilities are rescaled towards the middle:
- Example (Tversky and Kahneman, 1992):

$$\pi(\mu) = \frac{\mu^\gamma}{[\mu^\gamma + (1-\mu)^\gamma]^{1/\gamma}}, 0 < \gamma \leq 1$$

- Difference: base-rate neglect affect only probabilities not given directly, probability weighting affects all the probabilities

Results: Probability weighting

- Reweighting all the probabilities (blind protection included):

	(1)	(2)	(3)	(4)
	0.1	0.2	0.3	0.5
FP costs	.495***	.548***	-.198	-.275
	(0.2)	(0.2)	(0.2)	(0.4)
FN costs	1.65***	1.52***	1.04***	.535***
	(0.2)	(0.1)	(0.1)	(0.1)
Constant	-.77***	-1.2***	-.547**	.493*
	(0.2)	(0.2)	(0.2)	(0.3)
Observations	162	153	162	153
Adjusted R^2	0.14	0.29	0.25	0.17

Standard errors in parentheses

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Results: Probability weighting

- Reweighting only the probabilities not given directly (informed protection posterior probs but not blind protection):

	(1)	(2)	(3)	(4)
	0.1	0.2	0.3	0.5
FP costs	.418***	.656***	.72***	.694***
	(0.0)	(0.0)	(0.0)	(0.1)
FN costs	.94***	1.68***	1.53***	.817***
	(0.1)	(0.1)	(0.0)	(0.0)
Constant	-.799***	-2.36***	-3.08***	-2.56***
	(0.0)	(0.0)	(0.0)	(0.0)
Observations	162	153	162	153
Adjusted R^2	0.63	0.85	0.89	0.85

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Informed Protection: Correlation

Table: Informed Protection

	(1) All	(2) All	(3) Good quiz	(4) Good quiz
Informed protection				
Posterior prob.	2.15***	.662***	2.26***	.638***
	(19.1)	(3.3)	(17.7)	(3.0)
Prior prob.		1.13***		1.17***
		(4.1)		(3.8)
Gremlin says Black		1.34***		1.46***
		(8.8)		(8.8)
Constant	-.662***	-1.03***	-.717***	-1.1***
	(-14.2)	(-11.2)	(-14.2)	(-10.9)
Observations	1487	1487	1259	1259
AIC	1467.25	1394.01	1211.48	1137.59

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Informed Protection: Determinants

Table: Informed Protection: Response to Reported Beliefs

	(1) All	(2) All	(3) Good quiz
Informed protection			
Belief	2.18***	2.62***	2.8***
	(18.5)	(18.2)	(17.0)
Belief error		1.52***	1.41***
		(11.5)	(9.3)
Constant	-.762***	-.881***	-.963***
	(-14.3)	(-15.7)	(-15.9)
Observations	1487	1487	1259
AIC	1566.82	1413.23	1146.78

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Informed Protection: Do Subject's Beliefs Matter?

Table: Informed Protection: Response to Reported Beliefs

	(1) All	(2) All	(3) Good quiz
Informed protection			
Belief	2.18***	2.62***	2.8***
	(18.5)	(18.2)	(17.0)
Belief error		1.52***	1.41***
		(11.5)	(9.3)
Constant	-.762***	-.881***	-.963***
	(-14.3)	(-15.7)	(-15.9)
Observations	1487	1487	1259
AIC	1566.82	1413.23	1146.78

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Belief Updating: Correlation

Table: Belief Elicitation: Belief vs Posterior

	(1) All	(2) Good quiz	(3) Dishonest greml
Posterior prob.	.644***	.693***	.524***
	(37.5)	(39.2)	(21.8)
Constant	.175***	.15***	.236***
	(21.7)	(19.8)	(23.4)
Observations	1488	1260	992
Adjusted R^2	0.53	0.60	0.38

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

What Affects Beliefs?

Table: Belief Elicitation: Discrepancy

	(1)	(2)	(3)	(4)	(5)
False neg. rate	-.0101	-.0101	.05	.05	.0886
	(0.0)	(0.0)	(0.1)	(0.1)	(0.1)
False pos. rate	-.606***	-.606***	-.75***	-.749***	-.664***
	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)
Good quiz			-.0299	-.0538	
			(0.0)	(0.0)	
Good quiz × False neg. rate			-.102	-.102	
			(0.1)	(0.1)	
Good quiz × False pos. rate			.269**	.266**	
			(0.1)	(0.1)	
Stat. class					.0203
					(0.0)
Stat. class × False neg. rate					-.172*
					(0.1)
Stat. class × False pos. rate					.104
					(0.1)
Constant	.0616***	.0279	.0779***	.0566	.0499**
	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)
Prior prob dummies	No	Yes	No	Yes	No

WTP for signals

- Higher average WTP for more valuable signals