"*It's all relative*" Reference Points in Choice Experiments

University of Missouri-Columbia Seminar
Dept. of Agricultural and Applied Economics
October 30, 2015

Glynn Tonsor
Dept. of Agricultural Economics
Kansas State University

Motivational Example - #1

Motivational Example - #2

- 4WD, 2015 Chevy Silverado's MPG:
  - 16 city,
  - 22 highway,
  - 18 combined (Low = 15, High = 19)

    - *Which statistic do people think about when buying a vehicle?*

Motivational Example - #3

- Stocker producers buying 500 lb steers for past 10 years.

➢ *Which do producers think about when buying cattle?*

- *Worst, average, or best ADG experience?*

Situational Background

- Many examples in literature of prospect theory (loss-gain) > expected utility theory in explaining economic decision making
  - Most assessments done with general public (consumers)
  - Few assessments done using choice experiments
  - Some have involved uncertain issues/attributes
  - Few consider alternative reference points

➢ Limited application to agricultural producers making decisions with substantial uncertain components

Situational Background

- Limited application to agricultural producers making decisions in economically significant and uncertain situations
  - Consider stocker producer in Oct. purchasing 500 lb steers for 120 days of grazing & Feb. sale plans
    - Realized prices (buy & sell), ADG, and COG drive profits
      - Producer expectations underlie their purchasing decisions – yet expectations are unobserved to analysts

Classical View: Symmetry of Expected Utility Approach

- If ExpADG =2.0 & producer WTP=$280/cwt
  - Then when ExpADG=2.2 (1.8), WTP = $300/cwt ($260/cwt)

➢ While symmetric valuation & lack of loss aversion is commonly assumed it may not be appropriate.

➢ Moreover, HOW ExpADG is formulated is far from clear.

➢ ***So how does alternative presentations and modeling of uncertain ADG impact economic conclusions?***

Roadmap Summary

- Do Producers Use Reference Points
  - If yes, which one?
- How do alternative methods of presenting risky attributes impact producer decisions and hence research conclusions?
- Who cares? What are implications?

Alternative Choice Experiment Designs

- **Design A** (vary prob, hold ADG ranges same across scenarios)

Treatment 1, 1st scenario					
	Lot A		Lot B		Option C
Purchase Price ($/cwt)	$257		$257		
ADG (lbs/day)	40%	Chance: under 1.7	20%	Chance: under 1.7	
Outcome	40%	Chance: 1.7 to 2.5	60%	Chance: 1.7 to 2.5	
	20%	Chance: over 2.5	20%	Chance: over 2.5	
I would choose:	_____		_____		_____

- Symmetric lower (0 - 1.7) & upper (2.5 - 4.2) ranges:
  - ExpADG of LotA (Profile 1) = 1.85
  - ExpADG of LotB (Profile 2) = 2.10
  - ExpADG of Profile 3 (20,40,40%; not in Scenario 1) = 2.35

= 30 lbs ending wt. difference (120*0.25)

Alternative Choice Experiment Designs

- **Design B** (vary ADG ranges, hold prob same across scenarios)

Treatment 2, 1st scen			
	Lot A	Lot B	Option C
Purchase Price ($/cwt)	$257	$257	
ADG (lbs/day)	20% Chance: under 1.5	20% Chance: under 1.7	
Outcome	60% Chance: 1.5 to 2.3	60% Chance: 1.7 to 2.5	
	20% Chance: over 2.3	20% Chance: over 2.5	
I would choose:	_____	_____	_____

- Symmetric lower & upper ranges:
  - ExpADG of LotA (Profile 1) = 1.90
  - ExpADG of LotB (Profile 2) = 2.10
  - ExpADG of Profile 3 (1.9/2.7 thresholds;not in Scen 1)= 2.30

= 24 lbs ending wt. difference (120*0.20)

Alternative Choice Experiment Designs

- Design A & B share common Profile 2

Treatment 1, 1st scenario			
	Lot A	Lot B	Option C
Purchase Price ($/cwt)	$257	$257	
ADG (lbs/day)	40% Chance: under 1.7	20% Chance: under 1.7	
Outcome	40% Chance: 1.7 to 2.5	60% Chance: 1.7 to 2.5	
	20% Chance: over 2.5	20% Chance: over 2.5	
I would choose:	_____	_____	_____

Treatment 2, 1st scen			
	Lot A	Lot B	Option C
Purchase Price ($/cwt)	$257	$257	
ADG (lbs/day)	20% Chance: under 1.5	20% Chance: under 1.7	
Outcome	60% Chance: 1.5 to 2.3	60% Chance: 1.7 to 2.5	
	20% Chance: over 2.3	20% Chance: over 2.5	
I would choose:	_____	_____	_____

Data Collection

- National stocker producer survey
  - Sept-Nov 2014, Mailed 2,000 surveys
    - 554 returned (27.7% response rate)
      - 327 used in this particular analysis
  - *BEEF* magazine subscribers: "*operations with any cattle sold as a stocker/grower, backgrounder, or preconditioner*"
  - Split-sample CE application

Conceptual Models
Expected Utility Theory

- Traditional Dummy Coding (Opt Out Base)

$$U_{ij} = \alpha_j P_j + \beta_j^{ADG1} ADG1_j + \beta_j^{ADG2} ADG2_j + \beta_j^{ADG3} ADG3_j + \varepsilon_{ij}$$

- Effects Coding (ADG Profile 2 Base)

$$U_{ij} = \alpha_j P_j + \beta_j^{ADG1\_EC} ADG_j^{1\_EC} + \beta_j^{ADG3\_EC} ADG_j^{3\_EC} + \delta_j + \varepsilon_{ij}$$

Conceptual Models
Prospect Theory

- Traditional Dummy Coding (Opt Out Base)

$$U_{ij} = \alpha_j P_j + \beta_j^{ADG1}\left(ADG_j^1 - R_{ij}\right)G_{ij} +$$
$$\beta_j^{ADG2}\left(ADG_j^2 - R_{ij}\right)G_{ij} + \beta_j^{ADG3}\left(ADG_j^3 - R_{ij}\right)G_{ij} +$$
$$\lambda_j^{ADG1}\left(ADG_j^1 - R_{ij}\right)L_{ij} + \lambda_j^{ADG2}\left(ADG_j^2 - R_{ij}\right)L_{ij} +$$
$$\lambda_j^{ADG3}\left(ADG_j^3 - R_{ij}\right)L_{ij} + \varepsilon_{ij}$$

Rij -- Reference Point
Gij -- =1 if Gain
Lij -- =1 if Loss

Empirical Analysis

- MNL (& RPL) Models
  - Exp. Utility & Prospect Theory (*within* each CE design)
    - Compare AIC & %Correct Predictions
    - Compare alternative reference points
  - Split sample CE approach
    - Test key hypotheses *across* CE designs

Hypotheses & Tests of Focus

- Tests across CE Designs A & B
  - ADG Profile 2 valuations equal?
  - Opt Out (Reservation $) valuations equal?
  - Loss aversion ratios equal?

  - Same reference point significance (vs. Exp. Utility)?
  - Same selection of reference point (worst, average, best)?

Current Work – Summary Statistics

Table 1. Summary Statistics, by Choice Experiment Version	Treatment A				Treatment B			
Variable	*Mean*	*SD*	*Min*	*Max*	*Mean*	*SD*	*Min*	*Max*
	Versions 5 and 6 (N=172)				**Versions 7 and 8 (N=155)**			
Operator and Operation Characteristics								
Male	0.99	0.11	0.00	1.00	0.96	0.18	0.00	1.00
Age	57.00	12.48	24.00	87.00	56.69	12.53	24.00	85.00
Bachelor's College Degree	0.47	0.50	0.00	1.00	0.45	0.50	0.00	1.00
Cows Sold in 2013	65.08	225.04	0.00	2,000.00	89.99	290.65	0.00	2,000.00
Calves Sold in 2013	253.38	903.28	0.00	9,000.00	237.21	871.43	0.00	8,000.00
Yearlings Sold in 2013	1,781.84	2,709.43	0.00	20,000.00	1,419.01	1,846.18	0.00	12,000.00
Perceived ADG of placing 500 lbs steers in October for about 120 days								
Average ADG across all lots/groups over the past 10 years	1.90	0.66	0.00	3.75	1.86	0.72	0.00	3.50
ADG in the worst lot/group over the past 10 years	1.18	0.59	0.00	2.70	1.12	0.60	0.00	2.10
ADG in the best lot/group over the past 10 years	2.49	1.01	0.00	4.50	2.45	1.02	0.00	4.10
CE Understanding and Selection Confidence - V56								
Easy and straight-forward; Confident in Selections	0.48				0.47			
Easy and straight-forward; Not confident in Selections	0.18				0.16			
Not easy and straight-forward; Confident in Selections	0.17				0.19			
Not easy and straight-forward; Not confident in Selections	0.18				0.18			

Current Work - Expected Utility MNLs

Table 2. Base Multinomial Logit Models Estimates

Parameter	TA	TA	TB	TB
Price	-0.0271	-0.0271	-0.0318	-0.0318
ADG Profile 1	6.4803		7.6575	
ADG Profile 2	8.1037		8.5951	
ADG Profile 3	7.9072		8.7439	
Opt Out		-7.4971		-8.3321
ADG Profile 1		-1.0168		-0.6747
ADG Profile 3		0.4101		0.4117
Log-Likelihood	-421.0014	-421.0014	-461.4865	-461.4865
AIC	850.00280	850.00280	930.97291	930.97291
Percent Correct	0.6589	0.6589	0.6445	0.6445
McFadden's LRI	0.2573	0.2573	0.1796	0.1796

- Every coefficient significant (1% level).

Current Work - Expected Utility MNLs

Table 3. Base Multinomial Logit Models, WTP Estimates

Parameter	TA	TA	TB	TB	*p-value* [a]
ADG Profile 1 (Vs. Opt Out)	$ 238.84		$ 240.54		0.3987
ADG Profile 2 (Vs. Opt Out)	$ 298.68		$ 269.99		0.0041
ADG Profile 3 (Vs. Opt Out)	$ 291.43		$ 274.66		0.0645
Opt Out		$ (276.32)		$ (261.73)	0.0451
ADG Profile 1 (vs. 2)		$ (74.95)		$ (42.38)	0.0022
ADG Profile 3 (vs. 2)		$ 30.23		$ 25.87	0.3120
Loss Aversion Ratio		2.4793		1.6386	0.0509

- Every presented WTP estimate ($/cwt) is statistically different than $0 and both loss aversion ratios are statistically different from 1.0 at the 1% level.
- *p-values* report results of one-sided tests of differences in measures across TA and TB (Poe, Giraud, and Loomis (2005) complete combination tests).
- Stated WTP Context: KS 500 lb steers averaged $282/cwt in Sept-Oct 2014

Current Work - Expected Utility MNLs

Table 3. Base Multinomial Logit Models, WTP Estimates

Parameter	TA	TA	TB	TB	*p -value* [a]
ADG Profile 1 (Vs. Opt Out)	$ 238.84		$ 240.54		0.3987
ADG Profile 2 (Vs. Opt Out)	$ 298.68		$ 269.99		0.0041
ADG Profile 3 (Vs. Opt Out)	$ 291.43		$ 274.66		0.0645
Opt Out		$ (276.32)		$ (261.73)	0.0451
ADG Profile 1 (vs. 2)		$ (74.95)		$ (42.38)	0.0022
ADG Profile 3 (vs. 2)		$ 30.23		$ 25.87	0.3120
Loss Aversion Ratio		2.4793		1.6386	0.0509

- **Significant CE Design Impacts:**
  - WTP for ADG Profile 2,
  - WTP Opt Out, and
  - Loss Aversion (driven by loss frame differences)
    - TA: vary probabilities, hold ADG ranges same across scenarios
    - TB: vary ADG ranges, hold probabilities same across scenarios

Current Work - Exp Utility, ***SO WHAT***

- Treatment A
  - 30 lb difference across ADG profiles in Exp ending weight
  - Effects Coded MNL, WTP values suggest:
    - » $1.01/lb PREMIUM for expected increase in Profile 3 vs. Profile 2
    - » $2.50/lb DISCOUNT for expected decrease in Profile 1 vs. Profile 2
- Treatment B
  - 24 lb difference across ADG profiles in Exp ending weight
  - Effects Coded MNL, WTP values suggest:
    - » $1.08/lb PREMIUM for expected increase in Profile 3 vs. Profile 2
    - » $1.77/lb DISCOUNT for expected decrease in Profile 1 vs. Profile 2

March 2015 FC Contract = +/- $225 in Sept-Oct of 2014

Current Work – Prospect Theory MNLs

Table 4. Multinomial Logit Models Estimates, Alternative Reference Points

Reference Point	Average	Worst	Best	Average	Worst	Best
CE Treatment	TA	TA	TA	TA	TA	TA
Parameter						
Price	-0.0282	-0.0266	-0.0288	-0.0282	-0.0266	-0.0288
ADGProf1_BtTSaTI	7.1473	6.5079	6.7568	-1.3552	-1.5743	-1.8580
ADGProf2_BtTSaTI	8.5889	8.0938	8.6315			
ADGProf3_BtTSaTI	8.3120	7.9312	8.1051	-0.1371	-0.1464	-0.5036
ADGProf1_WtTI	6.6284	5.7927	6.8915	-1.7350	-2.1742	-1.7067
ADGProf2_WtTI	8.1081	7.5258	8.5927			
ADGProf3_WtTI	8.0196	6.7886	8.4951	-0.2303	-1.0488	-0.1004
Opt Out				-8.3993	-8.0634	-8.6001
Log-Likelihood	-387.3428	-372.7529	-368.8986	-389.1534	-373.1899	-368.9048
AIC	788.68560	759.50585	**751.79715**	790.30674	758.37970	**749.80968**
Percent Correct	0.6577	0.6681	**0.6724**	0.6619	0.6660	**0.6724**
McFadden's LRI	0.2730	0.2735	0.2810	0.2696	0.2726	0.2810

Best (PT) > Worst (PT) > Avg (PT) > *Exp. Utility*

Current Work – Prospect Theory MNLs

Table 4. Multinomial Logit Models Estimates, Alternative Reference Points

Reference Point	Average	Worst	Best	Average	Worst	Best
CE Treatment	TB	TB	TB	TB	TB	TB
Parameter						
Price	-0.0323	-0.0310	-0.0311	-0.0323	-0.0310	-0.0311
ADGProf1_BtTSaTI	7.9336	7.6715	7.2564	-0.9019	-0.9021	-1.0776
ADGProf2_BtTSaTI	8.8440	8.5735	8.1693			
ADGProf3_BtTSaTI	9.1138	8.7197	8.9467	0.2826	0.1461	0.5190
ADGProf1_WtTI	7.8641	7.1526	7.5794	-0.9622	-1.4209	-0.9173
ADGProf2_WtTI	8.8046	#	8.5289			
ADGProf3_WtTI	8.3574	#	8.5716	-0.4606	#	0.0615
Opt Out				-8.8285	-8.5735	-8.4895
Log-Likelihood	-408.3208	-388.8638	-407.2526	-408.3334	-388.8638	-407.6387
AIC	830.64164	**787.72758**	828.50524	828.66687	**787.72758**	827.27731
Percent Correct	0.6328	**0.6446**	0.5903	0.6436	0.6446	**0.6498**
McFadden's LRI	0.1973	0.1937	0.1835	0.1972	0.1937	0.1827

Worst (PT) >? Best (PT)
> Avg (PT) > *Exp. Utility*

Current Work – Prospect Theory Implementation Challenges

	Treatment A			
Perceived ADG of placing 500 lbs steers in October for about 120 days	*Mean*	*SD*	*Min*	*Max*
Average ADG across all lots/groups over the past 10 years	1.90	0.66	0.00	3.75
ADG in the worst lot/group over the past 10 years	1.18	0.59	0.00	2.70
ADG in the best lot/group over the past 10 years	2.49	1.01	0.00	4.50
	Treatment B			
	Mean	*SD*	*Min*	*Max*
Average ADG across all lots/groups over the past 10 years	1.86	0.72	0.00	3.50
ADG in the worst lot/group over the past 10 years	1.12	0.60	0.00	2.10
ADG in the best lot/group over the past 10 years	2.45	1.02	0.00	4.10

TA

- Exp[ADGP1]=1.85
- Exp[ADGP2]=2.10
- Exp[ADGP3]=2.35

TB

- Exp[ADGP1]=1.90
- Exp[ADGP2]=2.10
- Exp[ADGP3]=2.30

Current Work – Prospect Theory MNLs

Table 5. WTP Estimates, Alternative Reference Points

Reference Point	Average	Worst	Best	Average	Worst	Best
CE Treatment	TA	TA	TA	TA	TA	TA
Parameter						
ADGProf1_BtTSaTI	$ 253.56	$ 244.49	$ 234.60	$ (96.19)	$ (118.27)	$ (129.01)
ADGProf2_BtTSaTI	$ 304.70	$ 304.07	$ 299.70			
ADGProf3_BtTSaTI	$ 294.88	$ 297.96	$ 281.42	$ (9.73)	$ (11.00)	$ (34.97)
ADGProf1_WtTI	$ 235.15	$ 217.62	$ 239.28	$ (123.15)	$ (163.34)	$ (118.50)
ADGProf2_WtTI	$ 287.65	$ 282.73	$ 298.35			
ADGProf3_WtTI	$ 284.50	$ 255.03	$ 294.96	$ (16.34)	$ (78.79)	$ (6.97)
Opt Out				$ (298.09)	$ (302.89)	$ (298.57)

TA, Exp. Utility WTPs:
ADG P1 = $239/cwt
ADG P2 = $299/cwt
ADG P3 = $291/cwt

TA, Exp. Utility:
ADG P1 DISCOUNT= $75/cwt
ADG P3 PREMIUM = $30/cwt

Current Work – Prospect Theory MNLs

Table 5. WTP Estimates, Alternative Reference Points

Reference Point	Average	Worst	Best	Average	Worst	Best
CE Treatment	TB	TB	TB	TB	TB	TB
Parameter						
ADGProf1_BtTSaTI	$ 245.99	$ 247.08	$ 233.23	$ (55.93)	$ (58.11)	$ (69.30)
ADGProf2_BtTSaTI	$ 274.22	$ 276.14	$ 262.57			
ADGProf3_BtTSaTI	$ 282.58	$ 280.84	$ 287.55	$ 17.52	$ 9.41	$ 33.38
ADGProf1_WtTI	$ 243.83	$ 230.37	$ 243.61	$ (59.66)	$ (91.53)	$ (58.99)
ADGProf2_WtTI	$ 273.00	#	$ 274.13			
ADGProf3_WtTI	$ 259.13	#	$ 275.50	$ (28.56)	#	$ 3.96
Opt Out				$ (273.73)	$ (276.14)	$ (272.99)

TB, Exp. Utility WTPs:
ADG P1 = $241/cwt
ADG P2 = $270/cwt
ADG P3 = $275/cwt

TB, Exp. Utility:
ADG P1 DISCOUNT= $42/cwt
ADG P3 PREMIUM = $26/cwt

Current Work – Initial Conclusions

- Reference points exist in producer decisions
- *Which* RP producers use remains unclear
  - Is not Average experience
- Varying how uncertain ADG is shown impacts:
  - Best or Worst RP conclusions
  - Reservation value (& hence market shares)
  - Valuation of base ADG (Profile 2)
  - Magnitude of loss aversion

Why Does this Work Matter?

- Broadly – Ongoing expanded use of CEs
  - Need insight on *HOW* to apply prospect theory
    - Key to most accurate estimates for economic assessments
  - Several LCM applications have "no observable" membership covariates explaining heterogeneity
    - What about reference points?
  - Many other CE issues (hypo. bias, cues, etc.) already studied, nearly all in traditional expected utility space…

Why Does this Work Matter?

- Livestock Industry
  - Economically important industry
  - Ongoing interest in producer decision-making in risky & uncertain settings
  - Industry progress on efficiency is tied to WTP seedstock/cow-calf producers for genetic investments
  - *Is this germane to "justification" for land-grants?*
    - Will producers only pay for "superior" cattle, corn, etc. genetics once they "experience" it?
      - Is consistent w/ BEST reference point & with seed corn trials/plots throughout the cornbelt…

Why Does this Work Matter?

- Matters to Tonsor
  - Recall NE MO swine farm…
  - Integrated R&E Program @ KSU
    - Germane economic issue
    - Pure research methodology knowledge gaps
      - Fits with past work on cues, cheap talk, etc. in CE applications
    - Combined = multiple outputs and impacts should materialize

More information available at:

This presentation will be available in PDF format at:
http://www.agmanager.info/about/contributors/individual/tonsor.asp

Glynn T. Tonsor
Associate Professor
Dept. of Agricultural Economics
Kansas State University
Email: gtonsor@ksu.edu
Twitter: @TonsorGlynn