Expected Utility, Risk, and Marketing Behavior: Theory and Evidence from the Fed Cattle Market

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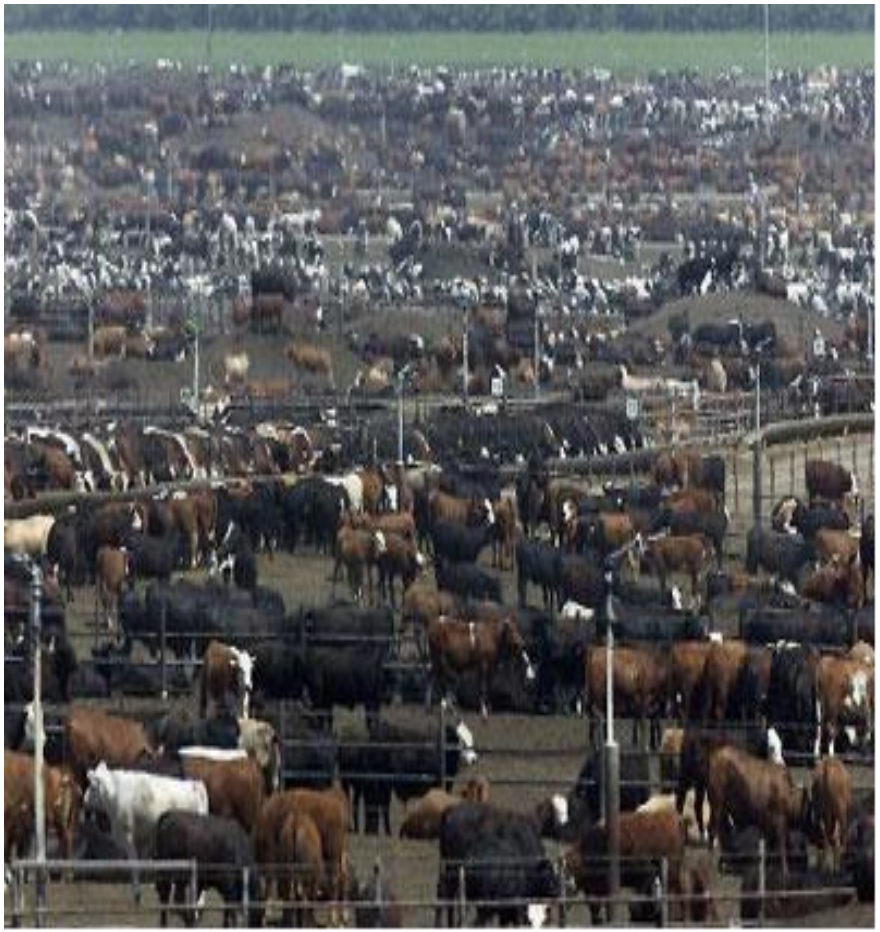
Slaughter Cattle Market



The Fed Cattle Market

1. In the U.S., 34 million cattle were slaughtered in 2011. Fed steer and heifer slaughter totaled a little over 27 million.
2. Buyers and sellers negotiate with respect to a transaction mechanism and the selection of a pricing mechanism.
3. Slaughter cattle sales do occur across multiple transaction mechanisms (AMAs) in the Cash and Contract markets.

Pricing Mechanisms in the Cash Market

4. About 80% of cash transactions are negotiated at a pen level average (fixed) price quoted as a live-weight or dressed-weight price.
5. The alternative is to price each animal as an individual. Final price is based on carcass characteristics determined by USDA graders at slaughter. This is referred to as grid pricing.
6. Pen and Grid cash transactions occur on a live weight or dressed weight basis.

The Price Mechanism Conundrum

7. GIPSA has conducted numerous studies on if the fed cattle market is competitive.
8. Regardless of which pricing mechanism is selected for the transaction, the market value of derived products from any specific animal is unaffected by the pricing mechanism.
9. Given these two stylized facts, the coexistence of multiple pricing mechanisms seems to be redundant.
10. We suggest that price mechanism informational differences about carcass quality generates uncertainty. Uncertainty explains the coexistence of pricing mechanisms (Fausti-Feuz 1995; Feuz, Fausti, and Wagner 1993 and 1995).

Carcass Quality Risk and Pricing Mechanisms

11. Generalized version of additive grid.
12. $\boldsymbol{P_G = P_B + P_M - P_D}$.
13. Pen price is known at time of transaction, grid price is not known until after grading.
14. Packer assumes carcass quality risk for pen transactions. Producer assumes carcass quality risk for grid transactions.
15. Seller Live Weight Pricing Decision:

$$\boldsymbol{P_L * LW_i \; or \; E[P_{G,i}] * LW_i}.$$

April 14, 1997 Price Grid

Table 1. Prices from AMS Grid System ($/cwt)

	Yield Grade							
Quality Grade	*Less than YG 2.0*	*Greater than YG 2.0*	*Greater than YG 2.5*	*Greater than YG 3.0*	*Greater than YG 3.5*	*Greater than YG 4.0*	*Greater than YG 5.0*	*Carcass Weight*
Prime	98.37	97.55	97.55	96.52	96.37	84.37	79.22	
Choice	92.64	91.84	91.84	90.81	90.64	78.64	73.52	Less than
Select	87.36	86.54	86.54	85.51	85.36	73.36	68.22	500 lbs.
Standard	78.22	77.40	77.40	76.37	76.22	64.22	59.08	
Prime	102.64	101.84	101.84	100.81	100.64	88.64	83.52	
Choice	96.95	96.13	96.13	95.10	94.95	82.95	77.81	500-550
Select	91.65	90.83	90.83	89.80	89.65	77.65	72.51	lbs.
Standard	82.51	81.69	81.69	80.64	80.51	68.51	63.37	
Prime	118.64	117.84	117.84	116.81	116.64	104.64	99.52	
Choice	112.95	112.13	112.13	111.24	110.95	98.95	93.81	550-950
Select	107.65	106.83	106.83	105.80	105.65	93.65	88.51	lbs.
Standard	98.51	97.69	97.69	96.64	96.51	84.51	79.37	
Prime	105.09	104.27	104.27	103.24	103.09	91.09	85.95	
Choice	99.38	98.56	98.56	97.53	97.38	85.38	80.24	950-1000
Select	94.08	93.26	93.26	92.23	92.08	80.08	74.94	lbs.
Standard	84.94	84.12	84.12	83.09	82.94	70.94	65.80	
Prime	100.80	99.98	99.98	98.95	98.80	86.80	81.66	
Choice	95.09	94.27	94.27	93.24	93.09	81.09	75.95	Greater than
Select	89.79	88.97	88.97	87.94	87.79	75.79	70.65	1000 lbs.
Standard	80.65	78.83	79.83	78.80	78.65	66.65	61.51	

Theoretical Framework

16. We assume grid (P_G) and pen (P_L) transactions occur in the cash market for live weight cattle.
17. The seller has a carcass quality expectation but is uncertain about the quality of cattle to be sold.
18. We assume the j^{th} seller forms a subjective probability(γ_j) for the average grid price (P_G) being greater than or less than P_L.
19. The seller's expectation is that $E[P_G]$ falls within the interval: $P_2 > P_L > P_1$. P_2 and P_1 denote the market value of high and low quality cattle, respectively.

Theoretical Framework

20. $E_j(P_G) = \gamma_j P_1 + (1-\gamma_j)P_2$.
21. Hence, γ can be interpreted as degree of pessimism about the ex-post grid price being lower than P_L.
22. The expected utility function for seller j when selling on a grid is defined as:
23. $E_j[U_j(P_G)] = \gamma_j U_j(P_1) + (1-\gamma_j)U_j(P_2)$.

Theoretical Framework

24. We assume that buyer and seller make an unbiased assessment of carcass quality in the cash market for live weight cattle.
25. This implies that $\boldsymbol{P_L} = \boldsymbol{E}[\boldsymbol{P_G}]$.
26. The seller's decision to market on a grid or at an average price can be discussed within the Expected Utility framework.

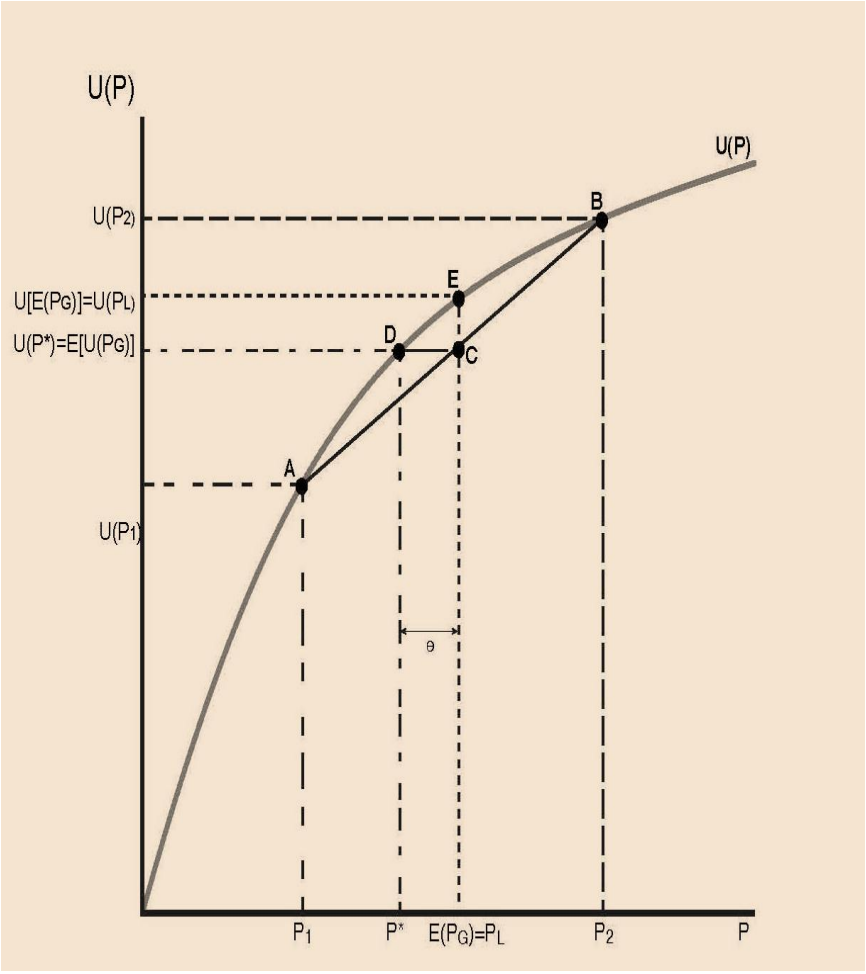
Theoretical Framework

27. $\theta_j = \frac{1}{2}\left[\frac{-U_j''(P_G)}{U_j'(P_G)}\right]\ \sigma_j^2(P_G) = \frac{1}{2}\alpha_j\sigma_j^2(P_G)$

28. S ∋ $\left\{(U_j, \theta_j)\ \middle|\ \theta_j = \frac{1}{2}\left[\frac{-U_j''(P_G)}{U_j'(P_G)}\right]\ \sigma_j^2(P_G)\right\}$

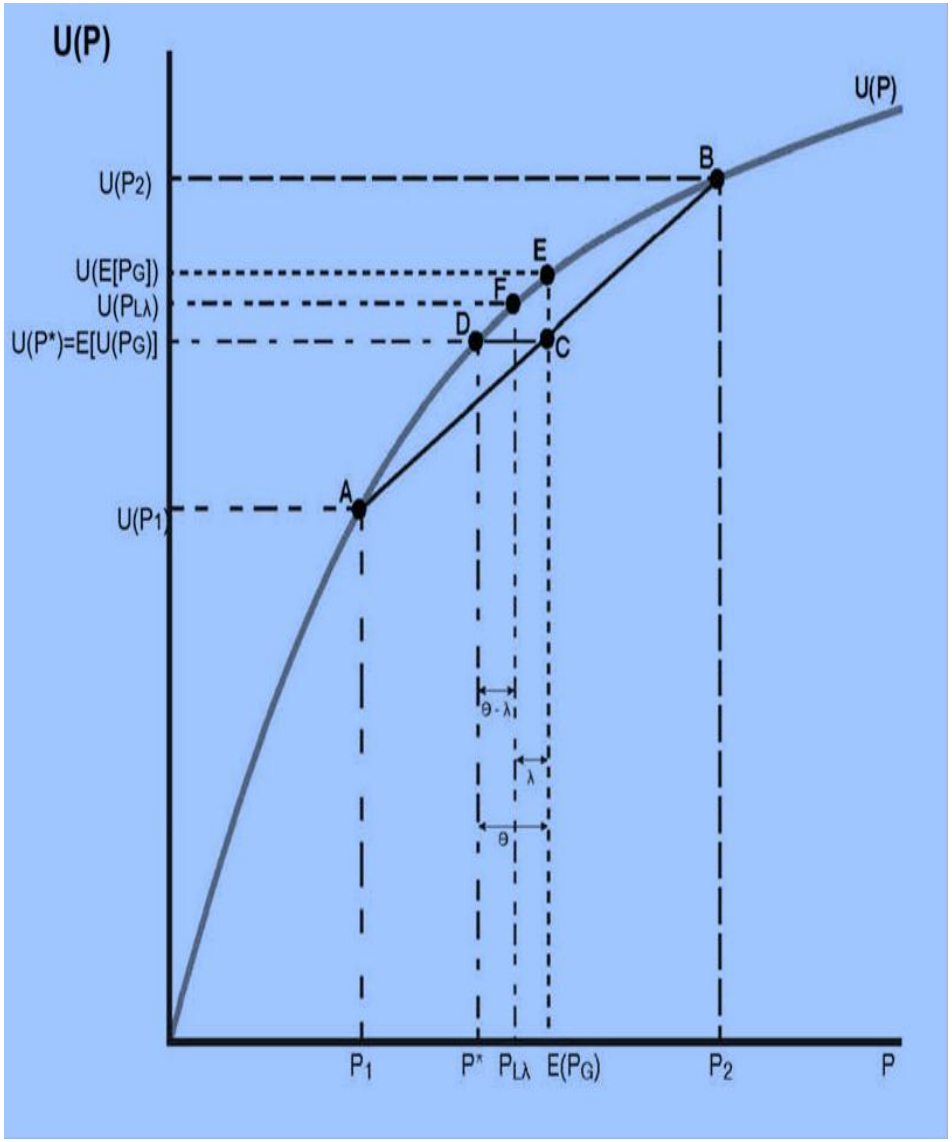
29. The market contains a set of producers (ordered set S) and each producer has a unique correspondence of risk preference (U_j) to risk premium (θ_j).

Figure 1: The Seller's Decision and The Puzzle



- a) if $E(P_G) = P_L$, then a risk-averse seller will only sell cattle by the pen, at a live weight price, and
- b) as the representative seller becomes less risk-averse, i.e., as U'' approaches zero, the limit of the risk premium "θ" approaches zero.

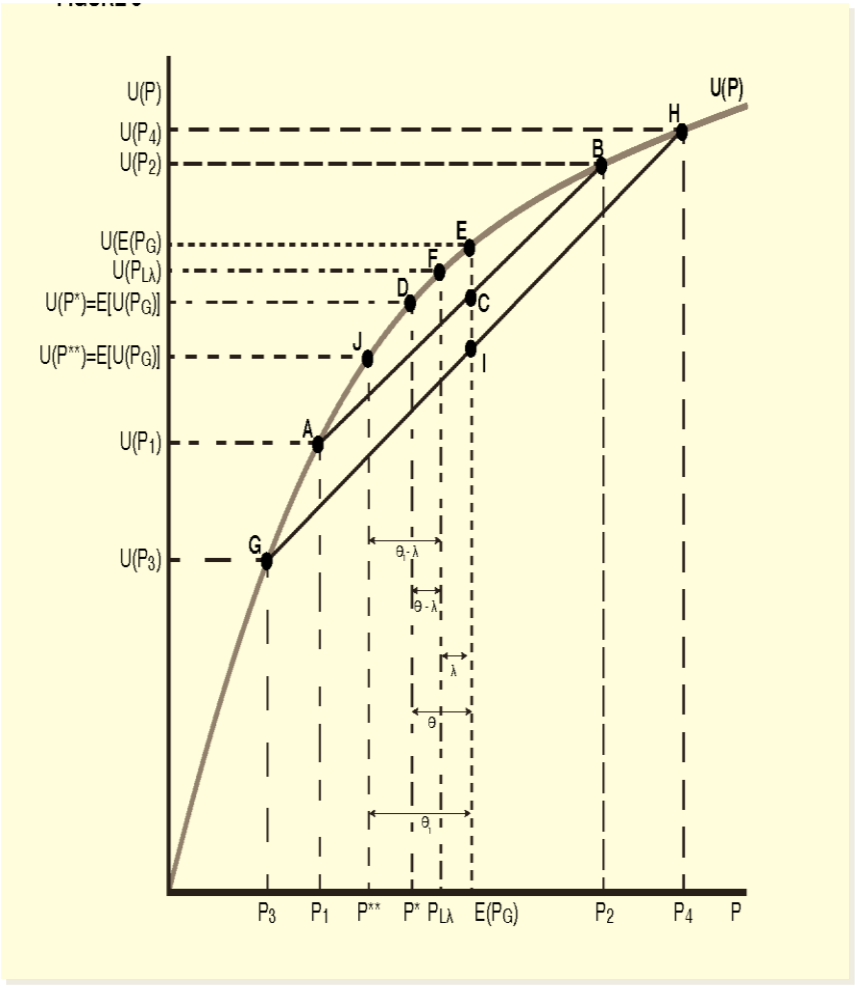
Figure 2



- a) Lambda "λ" is the risk premium the packer charges producers when purchasing live weight. It is exogenous to the model. Theta "θ" is the risk premium producers require packers to pay to switch from marketing live weight to selling on a grid.
- b) Now the producer's marketing decision is dependent on: if $\theta > \lambda$, then the producer markets live weight by the pen. If $\theta < \lambda$, then the producer sells on a grid.
- C) So the producer's decision comes down to if the risk premium required by the producer for selling on a grid (θ) is greater than or less than (λ) the risk premium the packer will charge the producer if the producer sells live weight. What about $\theta = \lambda$? Packer increases λ !

30. The economic implications in Figure 2 for the risk-averse seller are:
31. if all sellers have identical risk preferences and $\theta-\lambda > 0$, then only the live weight marketing channel will exist,
32. if all sellers have identical risk preferences and $\theta-\lambda < 0$, then only the grid marketing channel will exist ($P^* > P_{L\lambda}$),
33. a risk-averse seller will be indifferent between the grid and live weight marketing alternatives when $\theta=\lambda$ ($P^* = P_{L\lambda}$),
34. in set S, as producer "j" becomes less risk-averse, i.e., as U" approaches zero, the risk premium "$\theta-\lambda$" this producer requires to sell on a grid approaches $-\lambda$. This implies a risk-neutral seller would be willing to pay up to λ to market on the grid rather than sell live weight, and
35. the existence of λ in conjunction with varying degrees of risk aversion among producers explains the coexistence of multiple pricing alternatives for slaughter cattle

Figure 3



- Figure 3 depicts the comparative static result of an increase in carcass quality uncertainty that is reflected in the high versus low carcass quality price spread.
- The symmetric increase in risk is reflected by the shift in the Expected Utility Function downward from $\overline{AB}$ to $\overline{GH}$. Increased risk raises the producer's required risk premium for marketing on a grid from θ-λ to θ_1 – λ.
- As a result, holding producers' risk preferences constant, a producer who was indifferent between marketing live versus grid prior to the symmetric increase in risk will now only sell by the pen.

Empirical Test

Table 1. Summary Statistics: April 11, 2004 – March 4, 2012					
Variable	No. of Obs.	Mean	Standard Deviation	Minimum	Maximum
Heifer Live Price	**413**	**93.15**	**11.33**	**78.20**	**129.33**
Steer Live Price	**413**	**93.09**	**11.34**	**78.27**	**129.37**
Heifer Grid % Share	**413**	**33.45**	**5.16**	**20.23**	**49.95**
Steer Grid % Share	**413**	**43.25**	**5.41**	**28.88**	**61.22**

Empirical Test

Table 2. Difference in Population Means: Matched Pairs Test					
Variable	No. of Obs.	Mean	Standard Deviation	Range	p-value
Steer minus Heifer Live wt. ($ cwt.)	**413**	**-0.059**	**0.156**	**1.19**	**.0001**
Steer minus Heifer %Grid Market Share	**413**	**9.79**	**4.29**	**26.25**	**.0001**

Heterogeneous Subjective Probability

36. To maintain tractability of the EUT model we allowed risk preferences across sellers to vary but held constant γ.
37. The assumption is now reversed.
38. Similar to the case with risk aversion, there exists a critical value of γ^* that solves $\theta = \lambda$ for which the two marketing channels are indifferent to sellers.

Heterogeneous Subjective Probability

39.

$$\theta_j = \frac{1}{2}\left[\frac{-U_j''(E(P_G))}{U_j'(E(P_G))}\right] \sigma^2_{E(P_G)} = \frac{1}{2}\left[\frac{-U_j''(f(\gamma_j;.))}{U_j'(f(\gamma_j;.))}\right] \sigma^2\left(f\left(\gamma_j;.\right)\right) = \lambda$$

40.

$$\gamma^* = \frac{1 \pm \sqrt{1 - \frac{8\lambda / \alpha}{(P_1 - P_2)^2}}}{2}$$

SEU Comparative Static Result

41. We can conclude that sellers with a high degree of certainty of having either high quality cattle ($\gamma<\underline{\gamma}^*$) or low quality cattle ($\gamma>\overline{\gamma}^*$) will decide to market their cattle on the grid, because sellers' risk premium is less than buyers' risk premium ($\theta<\lambda$) in such a region. Vice versa, sellers with a low degree of certainty $\underline{\gamma}^*<\gamma<\overline{\gamma}^*$ will choose to market live weight by the pen, because sellers' risk premium is higher than buyers' risk premium ($\theta>\lambda$) in this region.

42. A higher degree of certainty (a lower σ^2) results in a lower θ.

Implications for Marketing Behavior

43. Our results suggest that increased information due to incorporating value-based production methods will reduce carcass quality uncertainty.
44. Lowering carcass quality uncertainty will increase grid market share.
45. This result validates the symbiotic relationship between value based pricing and production technology.

Summary

46. We have demonstrated that varying levels of producer preference for risk and producer perception of carcass quality risk are plausible explanations for:
47. the coexistence of multiple pricing methods (live weight, dressed weight, and grid) for slaughter cattle,
48. the grid market share differential between steer and heifer slaughter volume, and
49. the variability in market share of slaughter volume across alternative marketing channels and pricing mechanisms for slaughter cattle.

Policy Implication

50. Box 1 indicates: a) that producers who tend to be less risk averse and have more information on cattle quality sell on a grid; and b) that producers who tend to be more risk averse and have less information on cattle quality tend to sell by the pen at an average price. This finding is consistent with Muth et al (2007), who report a four to one ratio of large feedlot producers to small producers marketing on a grid.

Box I: Seller Decision Criteria

Sale on a Grid	Sale by the Pen
$\alpha_j < \alpha_j^*$	$\alpha_j > \alpha_j^*$
$\gamma_j < \underline{\gamma_j^*}$ or $\gamma_j > \overline{\gamma_j^*}$	$\underline{\gamma_j^*} < \gamma_j < \overline{\gamma_j^*}$