Producers Valuation of Feeder Cattle Characteristics

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Feeder Cattle

- Young steers, heifers and bulls to be placed in a feedlot, where they are fattened prior to slaughter.

- Purchased at live auction markets

- Price is determined by observable characteristics:
  - Premiums: European breeds, color
  - Discounts: Horns, sex

Hedonic Price

- Feeder cattle price: $r(\mathbf{z}) = r(z_1, \dots, z_m)$

- The effect of cattle characteristics on market prices has been extensively studied:
  ◦ Schroeder et al., 1988
  ◦ Schulz et al., 2015
  ◦ Zimmerman et al., 2012

- Prices reveal nothing about producers' valuations or structural demands.

Price vs. Preferences

Price, WTP, WTA (vertical axis)

$$r(z_1, z_2^* \ldots, z_m^*)$$

Z_1 (horizontal axis)
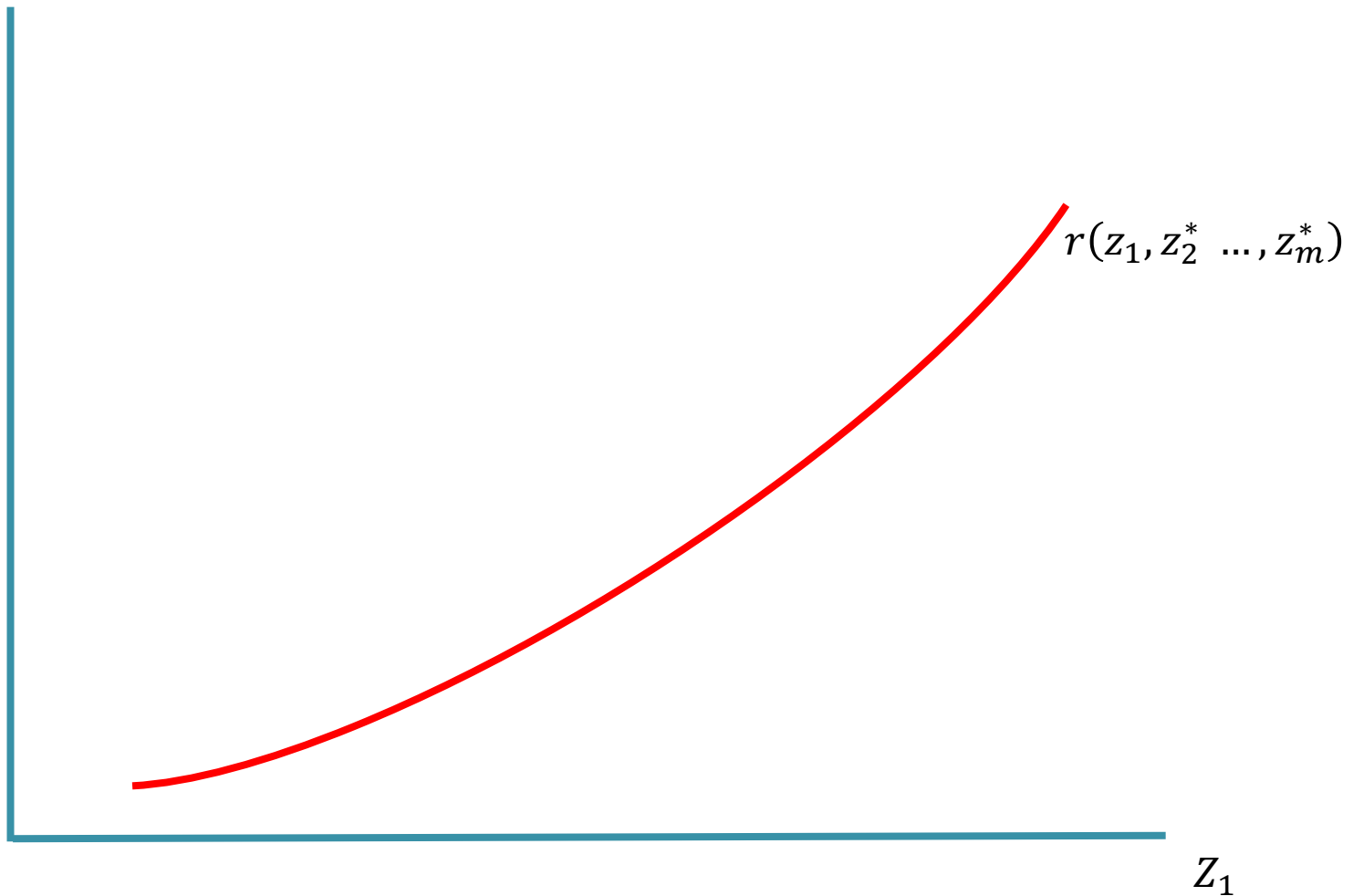
Adapted: Rosen, 1974

Price vs. Preferences

Price, WTP, WTA

$$\phi^2(z_1, z_2^* \dots, z_m^*; \pi_2^*)$$

$$r(z_1, z_2^* \dots, z_m^*)$$

$$\phi^1(z_1, z_2^* \dots, z_m^*; \pi_1^*)$$

$$\theta^2(z_1, z_2^* \dots, z_m^*; \pi_2^*)$$

$$\theta^1(z_1, z_2^* \dots, z_m^*; \pi_1^*)$$

Z_1
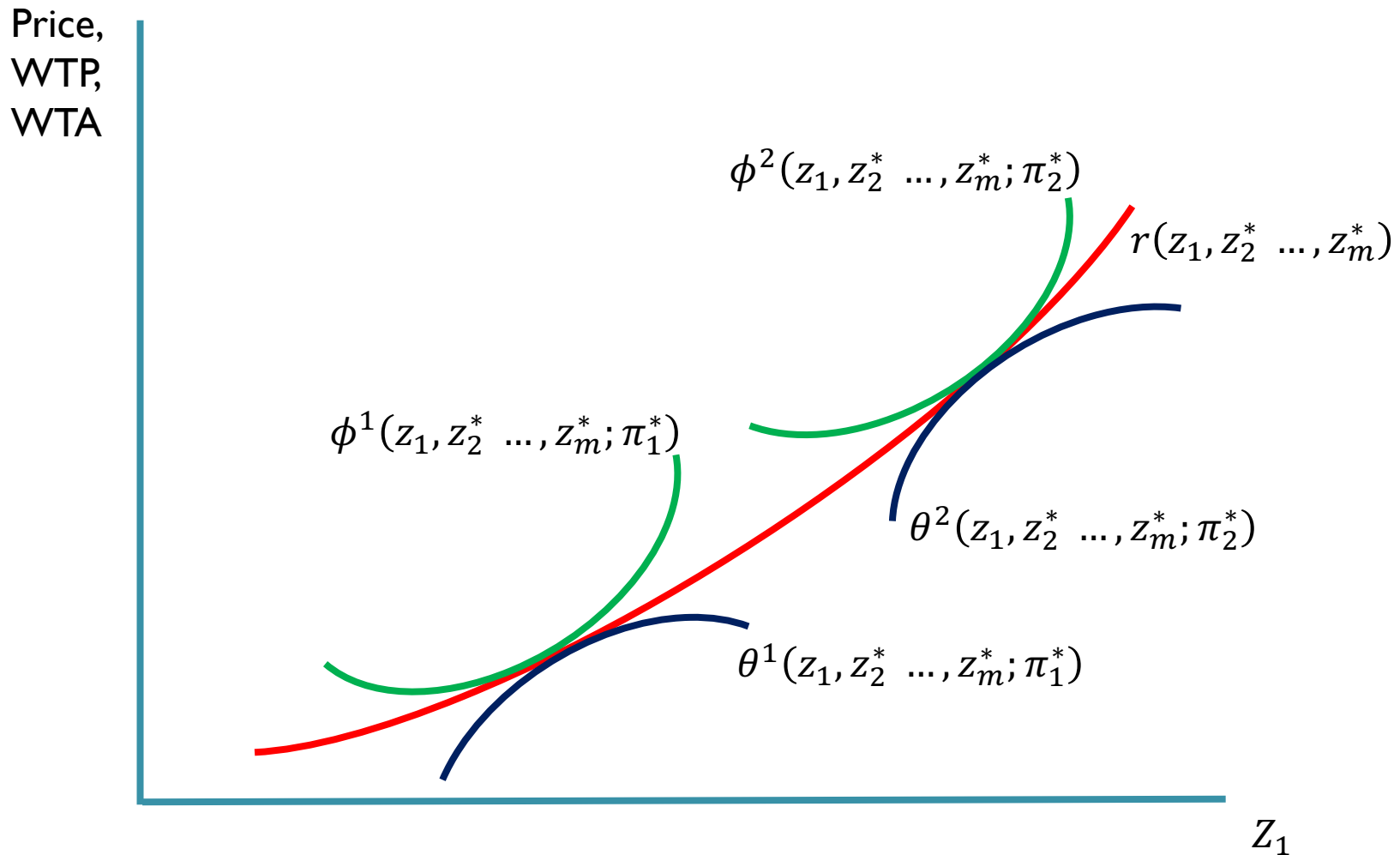
Adapted: Rosen, 1974

Objectives

- Estimate the underlying valuation functions behind observed prices.

- Develop better marketing, management and educational programs for feeder cattle producers.

Outline

- Motivations
- Theoretical Framework
- Data
- Model Estimation
- Preliminary Results

Theoretical Framework

Theoretical Model

- Two input types:
  - Heterogeneous: Feeder cattle
  - Homogenous: Composite

- Output quality is a function of the quantity and quality of the inputs used.
  - $q \leq \mathbf{\Gamma}(X, \boldsymbol{z}, \boldsymbol{\lambda})$ *(quality constraint)*
  - $p(\boldsymbol{q}) = p(q_1, \dots, q_k)$ *(price)*

- Objective of producers (buyers) is to maximize profit:
$$\max_{\boldsymbol{q},\boldsymbol{z}} \pi = p(\boldsymbol{q}) - c(r, \boldsymbol{z}, \boldsymbol{q}, \boldsymbol{\lambda})$$

- Producers' valuation of heterogeneous input ($\boldsymbol{z}$):
  - $WTP = \theta(\boldsymbol{z}; \pi, \boldsymbol{q}, \boldsymbol{\lambda})$
  - $\pi = p(\boldsymbol{q}) - c(\theta, \boldsymbol{z}, \boldsymbol{q}, \boldsymbol{\lambda})$

- Optimal choice of $\boldsymbol{q}$ and $\boldsymbol{z}$:
  - $p_i(\boldsymbol{q}) = \dfrac{\partial c}{\partial q_i} = c_{q_i}, \quad i = 1, \dots, k$
  - $\theta_{z_i} = -\dfrac{\partial c}{\partial z_i} = -c_{z_i}, \quad i = 1, \dots, m$

- Thus, profit is maximized when
  - $\theta(\boldsymbol{z}^*; \pi^*, \boldsymbol{q}^*, \boldsymbol{\lambda}) = r(\boldsymbol{z}^*)$
  - $\theta_{z_i}(\boldsymbol{z}^*; \pi^*, \boldsymbol{q}^*, \boldsymbol{\lambda}) = r_i(\boldsymbol{z}^*), \quad i = 1, \dots, m$

Data

Data Collection

- 5,092 obs. collected at 8 livestock auction facilities across Southeast Texas during 2014-2017.
  - County Extension Agents
  - Standardized data collection process
  - Individual animals rather than lots

- Gathered information includes

• Price	• Fill	• Dehorn status
• Color	• Body condition	• Weight
• Sex	• Muscle score	• Date
• Frame size	• Brahman influence	

Summary Statistics

Variable	Proportion (%)	Variable	Proportion (%)
Hide Color/Pattern		Condition	
Black	29.59	Average	79.29
Red Brindle	5.62	Fleshy	13.10
Brown	5.05	Thin	7.61
Black with white Face (BWF)	8.48	Muscle Score	
Dun	10.17	1	4.12
Gray	4.99	2	55.12
Red	12.80	3	40.76
Red with white Face (RWF)	7.91	Brahman Influence	
Smokey	4.16	0%	24.43
Spots	2.06	25%	35.31
White	9.18	50%	25.33
Sex		75%	12.50
Bull	31.12	100%	2.43
Heifer	40.72	Horns Status	
Steer	28.16	Dehorned	69.02
Frame		Horned	30.98
Medium	63.40		
Large	32.08		Mean (S.E.)
Small	4.52	Weight (CWT)	5.40 (0.02)
Fill		Price ($/CWT)	177.11 (0.86)
Average	71.64		
Full	25.93		
Shrunk	2.43		

Data Considerations

- Cattle attributes:
  - Continuous: Weight
  - Discrete (S levels): Color – black, white, spots, etc.,

- Hedonic literature is based on continuous attributes.
  - Profit maximization implies: $\theta_{z_j} = r_j$
  - No FOC for discrete attributes

- The true valuation of discrete characteristics is not directly observed
  - Revealed preference choices imply: $\theta_{z_{ks}} \geq r_{ks}$

Model Estimation

1. Hedonic Price

- Hedonic price function: $r(\mathbf{z}) = r(z_1, \ldots, z_m)$
  - Random Effects: $r(\mathbf{z}) = \mathbf{z}'\boldsymbol{\beta} + \mathbf{z}'\boldsymbol{\gamma}$

- Marginal implicit prices
  - Continuous: $\dfrac{\partial r}{\partial z_i}$
  - Discrete: $r(\mathbf{z}|z_{ks} = 1) - r(\mathbf{z}|z_{ks} = 0)$

- The hedonic price is estimated for each auction location to avoid potential identification problems (*Brown and Rosen, 1982*).

- Marginal prices are inferred for each observation $(\hat{r}_i)$.

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2. Producers' Valuation

- Theory: $r_i = \theta_{z_i} = -c_{z_i}$

- A functional cost function could be used to estimate θ_{z_i}
  - Theoretical properties of $c(r, \boldsymbol{z}, \boldsymbol{q}, \boldsymbol{\lambda})$?
  - $-c_{z_i} \approx V_{z_i} + u_i$
  - $V_{z_i} = f(r, \boldsymbol{z}, \boldsymbol{q}, \boldsymbol{\lambda}) = f(\boldsymbol{x}; \boldsymbol{\alpha})$

- Marginal valuation functions
  - Continuous: $\hat{r}_i = \boldsymbol{x}'\boldsymbol{\alpha} + u_i$
  - Discrete: $\hat{r}_{ks} \leq \boldsymbol{x}'\boldsymbol{\alpha} + u_{ks}$

Preliminary Results

Price Differentials

Variable	Weighted Mean (SE)	Variable	Weighted Mean (SE)
Hide Color/Pattern		Condition	
Black	-	Average	-
Red Brindle	2.81 (0.53)	Fleshy	-1.52 (0.24)
Brown	-5.44 (0.32)	Thin	-1.35 (0.75)
Black with white Face (BWF)	6.55 (0.45)	Muscle Score	
Dun	4.27 (0.33)	1	-2.31 (0.81)
Gray	-0.35 (0.59)	2	-
Red	-5.58 (0.19)	3	2.57 (0.14)
Red with white Face (RWF)	1.02 (0.21)	Brahman Influence	
Smokey	2.27 (0.73)	0%	-0.004 (0.20)
Spots	-16.27 (2.05)	25%	-
White	-0.26 (0.41)	50%	5.96 (0.16)
Sex		75%	3.00 (0.38)
Bull	-	100%	2.46 (1.57)
Heifer	-1.92 (0.14)	Horns Status	
Steer	6.68 (0.21)	Dehorned	-
Frame		Horned	-2.10 (0.21)
Medium	-	Weight (CWT)	-11.70 (0.35)
Large	0.07 (0.16)	Trend	-0.06 (0.004)
Small	2.85 (0.85)		
Fill			
Average	-		
Full	0.12 (0.32)		
Shrunk	-14.16 (2.57)		

Future Work

- Estimate valuation function:
  - $V_{z_i} = f(r, \boldsymbol{z}, \boldsymbol{q}, \boldsymbol{\lambda})$
  - Input price: *hedonic price, corn futures*
  - Quality: *feeder cattle attributes*
  - Production parameters: *location, time*

- Develop educational programs for feeder cattle producers
  - Identify buyer preferences
  - Price vs. valuation

Thank you!

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