Sales of Handloom Saris

An Application of Logistic Regression

Objectives

- Illustrate importance of interpretation, domain insights from managers for interpretation and implementation
- Relevance to situations where too many products (or services) but can define more stable underlying characteristics of products (or services)
- Logistic Regression as a tool that parallels multiple linear regression in practice. Powerful analysis in a spreadsheet

Handloom Industry in India

- Decentralized, traditional, rural, co-ops
- Direct employment of 10 million persons
- Accounts for 30% of total textile production

Co-optex (Tamilnadu State)

- Large: 700 outlets; $30million; 400,000 looms
- Strengths:
  - Design variety, short run lengths
  - Majority sales through co-op shops
- Weaknesses:
  - Competing with mills difficult
  - Large inventories, high discount sales

Study Question

- Improve feedback of market to designs through improved product codes
- Assess economic impact of proposed code
- Pilot restricted to saris
  - Most difficult
  - Most valuable

A Consumer-oriented Code for Saris

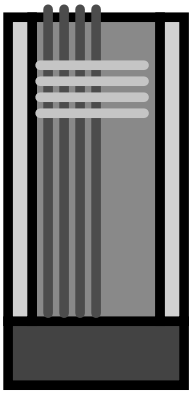
- Developed with National Institute of Design

Sari components

Body

Border

Pallav



Sari Code

Body: Warp Color & Shade (WRPC, WRPS)

Weft Color & Shade (WFTC, WFTS)

Body Design (BODD)

Border: Color, Shade, Design, Size (BRDC, BRDS, BRDD, BRDZ)

Pallav: Color, Shade, Design, Size (PLVC, PLVS, PLVD, PLVZ)

Code Levels

- Color (Warp, weft, border, pallav)
  10 levels:0=red, 1=blue, 2=green, etc.
- Shade (Warp, weft, border, pallav)
  - 4 levels: 0=light, 1=medium, 2=dark, 3=shiny;
- Design (Body, border, pallav)
  - 23 levels: 0=plain, 1=star buttas, 2=chakra buttas, etc.
- Size (Border, pallav)
  - 3 levels: 0= broad, 1=medium, 2=narrow

Assessing Impact

Major Marketing Experiment

- 14 day high season period selected
- 18 largest retail shops selected
- 20,000 saris coded, sales during period recorded
- Logistic Regression models developed for Pr(sale of sari during period) as function of coded values.

Example data (Plain saris)

Sari#	WrpCl	BrdClr	WftClr	PlvClr	WrpS	BrdSh	WftSh	PlvSh	BrdDs	PlvDs	BrdSz	PlvSz	Response
1	2	2	2	2	2	3	2	3	0	1	0	2	1
2	0	2	0	2	2	3	2	3	0	1	0	0	1
3	0	2	0	2	2	3	2	3	0	1	1	2	1
4	1	2	1	2	0	3	0	3	0	1	1	2	1
5	1	2	1	8	1	3	1	3	0	1	0	1	1
6	4	2	4	8	2	3	2	3	0	1	0	1	1
7	0	1	3	2	0	2	2	3	0	1	0	1	0
8	1	2	1	2	2	3	2	3	0	1	0	1	1
9	1	2	1	2	0	3	0	3	1	1	2	2	1
10	4	2	2	2	1	3	1	3	1	1	2	2	1
11	1	1	1	2	0	2	0	3	0	1	0	2	1

Logistic Regression Model

- Odds(Sale)

$$=\exp(ß_0 + ß_1 WRPC\_1 + ß_2 WRPC\_2 + ß_3 WRPC\_3 + ß_4 WRPC\_4 + ß_5 PLVD\_1 + ß_6 BRDZ\_1 + ß_7 BRDZ\_2)$$

Coefficient Estimates

Variable	Coeff	Odds
Constant	-0.698	
WrpCl_1	0.195	1.215
WrpCl_2	-2.220	0.109
WrpCl_3	-2.424	0.089
WrpCl_4	-0.072	0.931
PlvDs_1	1.866	6.462
BrdSz_1	-0.778	0.459
BrdSz_2	-0.384	0.681

Confusion Table

(Cut-off probability = 0.5)

Actual

Predicted	Sale	No Sale	Total
Sale	15	5	20
No Sale	5	32	37
Total	20	37	57

Impact

- Producing only saris that have predicted probability > 0.5 will reduce slow-moving stock substantially. In the example, slow-moving stock will go down from 65% of production to 25% of production
- Even cut-off probability of 0.2 reduces slow stock to 49% of production

Insights

- Certain colors and combinations sold much worse than average but were routinely produced (e.g. green, border widths-body color interaction)
- Converse of above (e.g. plain designs, light shade body)
- Above adjustments possible within weavers' skill and equipment constraints
- Huge potential for cost savings in silk saris
- Need for streamlining code, training to code.

Reasons for versatility of Logistic Regression Models in Applications

- Derivable from random utility theory of discrete choice
- Intuitive model for choice-based samples and case-control studies
- Derivable from latent continuous variable model
- Logistic Distribution indistinguishable from Normal within ±2 standard deviations range
- Derivable from Normal population models of discrimination (pooled covariance matrix)
- Fast algorithms
- Extends to multiple choices (polytomous regression)
- Small sample exact analysis useful for rare events (e.g. fraud, accidents, lack of relevant data, small segment of data)