READING SEMINAR OF
TEACHER-STUDENT GROUP
"EMPIRICAL DEMAND ESTIMATION"

"A Two-State Model of Purchase Incidence and Brand Choice"

Randolph E. Bucklin and James M. Lattin

Prepared by
Marina O. Tsevileva

26.03.2015

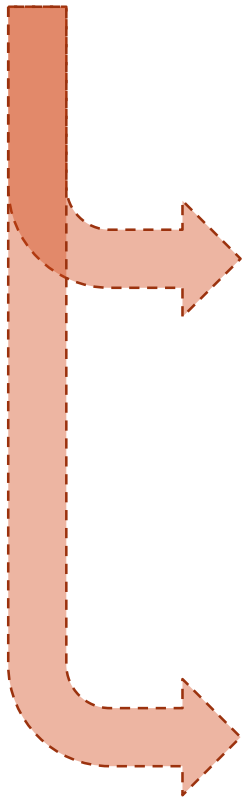
Key Figures

1991 — Was published in **MARKETING SCIENCE**

254 — # of citations according to Academia **GOOGLE SCHOLAR**

101 — # of citations according to **WEB OF SCIENCE**

A probabilistic model of purchase incidence and brand choice



Planned decision State

He or she has
(1) considered a purchase,
(2) made a decision to buy a given brand or not to buy at all.

Show NO response to point-of-purchase promotions.

Opportunistic decision State

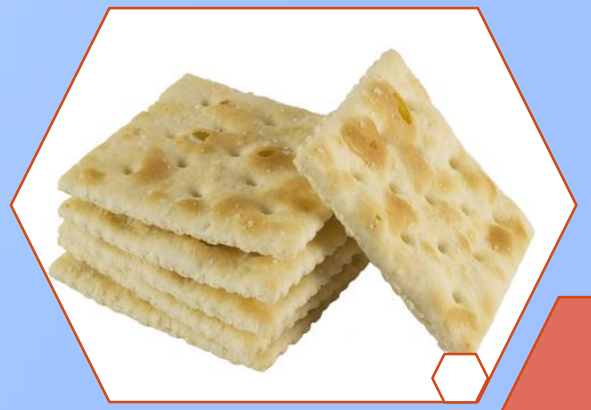
He or she has not considered a purchase or, having considered a purchase, has not decided whether or what to buy.

May be strongly influenced by promotions.

Williamsport, PA, USA 117 000

Williamsport, PA, USA

Photos · Search nearby



Saltine Crackers

Data (IRI scanner data)

In this market there are 10 instrumented stores:

1. regional chain A (stores 107-110), (Brand 2)
2. regional chain B (store 114), (Brand 1)
3. national chain C (stores 115-116),
4. independent chain D (stores 111-113).

The six top selling saltine brands:

Brand	UPC Code	Name	Size	Share
1	06373 05077	SPL1	16 oz	6.8%
2	21662 01482	SPL2	16 oz	31.9%
3	24100 13067	Sunshine	16 oz	7.4%
4	30100 00133	Zesta	16 oz	6.9%
5	44000 00055	Premium1	16 oz	6.4%
6	44000 00057	Premium2	16 oz	26.0%

Data

Price on National Brands

range from $0.70 to $1.50 per one pound box.

Price on Private Labels

range from $0.60 to $0.80 per one pound box.

Promotion Activities

were, on average, about one week in eight.

104 weeks of the data

52-week initialization period

52-week estimation period

Purchase occasions involved the purchase of only one item.

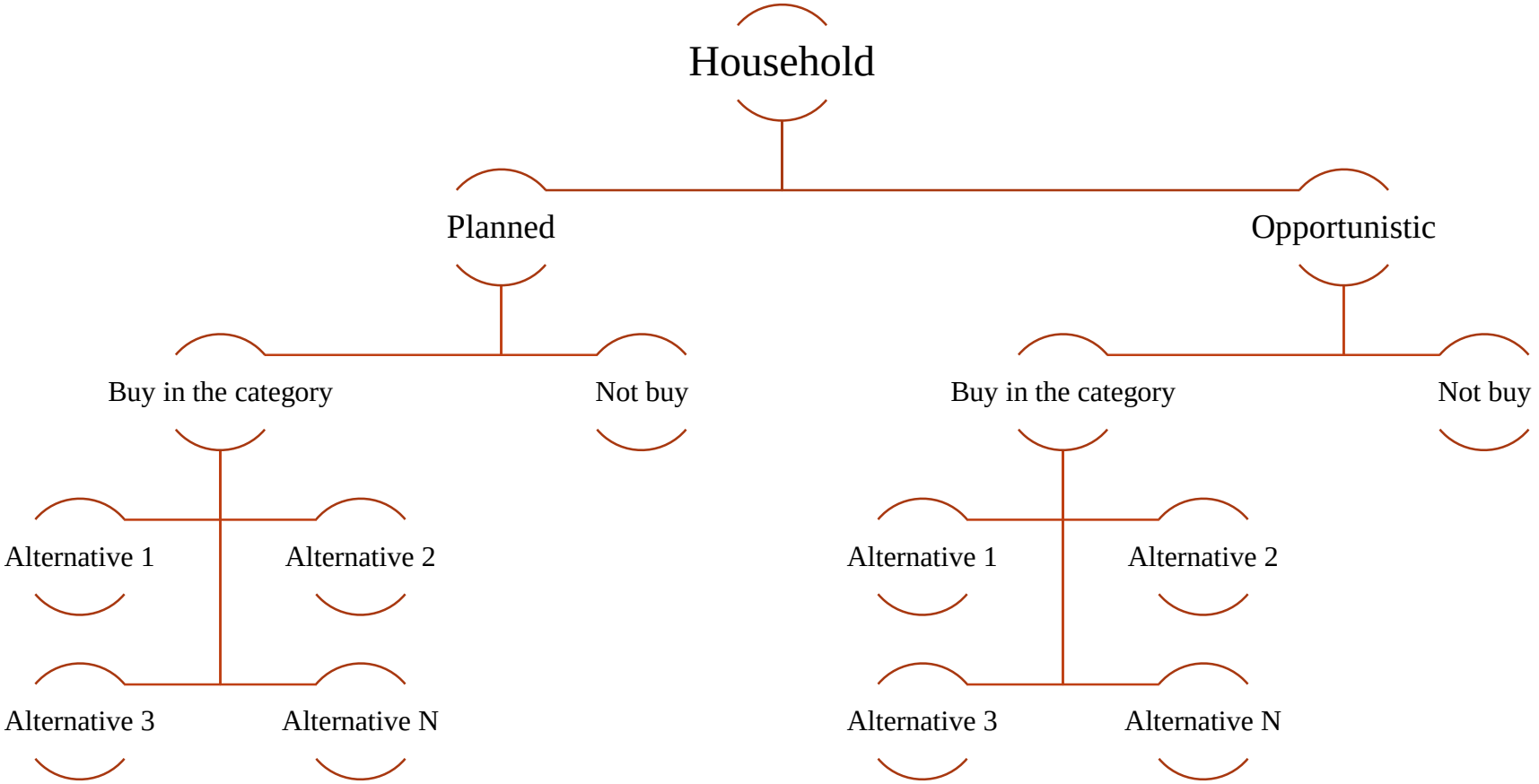
95%

7

The Two-state Model
A NESTED LOGIT

Discrete Choice Model

Conceptual Framework



$$P_t^h(i) = P_t^h(plan) \cdot P_t^h(inc|plan) \cdot P_t^h(i \mid inc\&plan) + P_t^h(opp) \cdot P_t^h(inc|opp) \cdot P_t^h(i \mid inc\&opp)$$

The First Level

Planned State

Opportunistic State

$$P_t^h(plan) = \frac{\exp(W)}{1 + \exp(W)}$$

$$W = \beta_0 + \beta_1 \cdot DL^h + \beta_2 \cdot SL_t^h + \beta_3 \cdot INV_t^h$$

$$P_t^h(opp) = 1 - P_t^h(plan)$$

$$INV_t^h = INV_{t-1}^h + Q_{t-1}^h - CR^h \cdot I_{t-1;t}$$

CR^h - average weekly consumption of saltines in pounds by household *h* ***(initialization period).***

Store Loyalty = proportion of household h's total expenditures made in the store being visited on occasion t,

Deal Loyalty = proportion of household h's purchases made **in the initialization period** when the brand purchased was being promoted.

The Second Level

Planned State

$$P_t^h(inc|plan) = \frac{\exp(V_{plan})}{1+\exp(V_{plan})}$$

$$V_{plan} = \alpha_0 + \alpha_1 \cdot CR^h + \alpha_2 \cdot INV_t^h + \alpha_3 \cdot CV_{plan}$$

Opportunistic State

$$P_t^h(inc|opp) = \frac{\exp(V_{opp})}{1+\exp(V_{opp})}$$

$$V_{opp} = \alpha_4 + \alpha_1 \cdot CR^h + \alpha_2 \cdot INV_t^h + \alpha_5 \cdot CV_{plan}$$

$$CV_{plan} = \ln\left(\sum_k \exp(U_{k|plan})\right) \Leftarrow P_t^h(i|inc\&plan) = \frac{\exp(U_{i|plan})}{\sum_k exp(U_{k|plan})}$$

Category Value – inclusive value; category attractiveness.

The Third Level

Planned State

$$P_t^h(i|inc\&plan) = \frac{\exp(U_{i|plan})}{\sum_k exp(U_{k|plan})}$$

$$U_{i|plan} = \alpha_i + \theta_1 \cdot LOY_i^h + \theta_2 \cdot LPP_{it}^h$$

Opportunistic State

$$P_t^h(i|inc\&opp) = \frac{\exp(U_{i|opp})}{\sum_k exp(U_{k|opp})}$$

$$U_{i|opp} = \gamma_i + \theta_1 \cdot LOY_i^h + \theta_3 \cdot Price_{it} + \theta_4 \cdot Promo_{it} + \theta_5 \cdot (Price_{it} \cdot Promo_{it})$$

$Promo_{it}$ = 1 if brand i is featured or displayed on occasion t and 0 otherwise,

$$LOY_i^h = \frac{(1/k + \#\text{ of purchases of } i \text{ by } h)}{(1 + \#\text{ of purchases of all brands by } h)}$$

it is a Bayesian estimate based on equally likely priors with an equivalent sample size of one.

Calibration

456 households buy saltines

Calibration sample

52 households make
943 purchases of saltines in
15,023 store visits.

Validation sample

100 households make
612 saltine purchases in
9,999 store visits.

$$LL = \sum_h \sum_t \left[\sum_i y_{it}^h \ln\left(P_t^h(i)\right) + \left(1 - \sum_i y_{it}^h\right) \ln\left(1 - \sum_i P_t^h(i)\right) \right] \rightarrow \text{MAX}$$

Estimated Simultaneously

13

RESULTS

	Brand Choice			
	$P_i^h(i \mid \text{inc\&plan})$		$P_i^h(i \mid \text{inc\&opp})$	
Store Private Label 1	α_1	−2.124	γ_1	1.412
		(−2.67)[a]		(3.08)
Store Private Label 2	α_2	−2.198	γ_2	1.427
		(−3.29)		(4.24)
Sunshine	α_3	−0.549	γ_3	−0.621
		(−1.28)		(−2.04)
Zesta	α_4	−0.260	γ_4	0.455
		(−0.55)		(1.85)
Premium 1	α_5	−1.021	γ_5	−0.394
		(−1.91)		(−1.35)
LOY_i^h (Loyalty)	β_1	3.268	β_1	3.268[b]
		(10.71)		(10.71)
LP_{it}^h (Last Purchase)	β_2	1.896	—	—
		(11.04)		
$PRICE_{it}$	—	—	β_3	−17.020
				(−3.99)
$PROMO_{it}$	—	—	β_4	−6.859
				(−2.68)
$PRICE_{it} \times PROMO_{it}$	—	—	β_5	11.204
				(3.00)

	Purchase Incidence				*Decision State*		
	$P_i^h(\text{inc} \mid \text{plan})$		$P_i^h(\text{inc} \mid \text{opp})$		$P_i^h(\text{plan})$		
Intercept	θ_0	−3.968	Intercept	θ_4	4.893	Intercept	δ_1 −0.750
		(−13.30)			(2.77)		(−2.12)
CR^h	θ_1	2.837	CR^h	θ_1	2.837[c]	DL^h	δ_2 −1.813
		(9.14)			(9.14)		(−3.63)
INV_i^h	θ_2	−0.516	INV_i^h	θ_2	− 0.516[c]	SL_i^h	δ_3 2.463
		(−11.01)			(−11.01)		(7.00)
CV_{plan}	θ_3	0.260	CV_{opp}	θ_5	0.689	INV_i^h	δ_4 0.361
		(4.22)			(6.29)		(2.63)

Model Validation

The one-state nested logit model

Consumers are always opportunistic

$$P_t^h(i) = P_t^h(\text{inc})P_t^h(i|\text{inc}),$$

$$P_t^h(i|\text{inc}) = \frac{\exp(U_i)}{\sum_k \exp(U_k)},$$

$$U_i = \alpha_i + \beta_1 \text{LOY}_i^h + \beta_2 \text{LP}_{it}^h + \beta_3 \text{PRICE}_{it} + \beta_4 \text{PROMO}_{it} + \beta_5(\text{PRICE}_{it} \times \text{PROMO}_{it}),$$

$$P_t^h(\text{inc}) = \frac{\exp(V)}{1 + \exp(V)},$$

$$V = \theta_4 + \theta_1 \text{CR}^h + \theta_2 \text{INV}_t^h + \theta_5 \text{CV}, \quad \text{and}$$

$$\text{CV} = \ln\left(\sum_k \exp(U_k)\right).$$

Was calibrated following the maximum likelihood procedure described by Guadagni and Little (1987)

Parameter Estimates for the One-State Nested Logit Reference Model

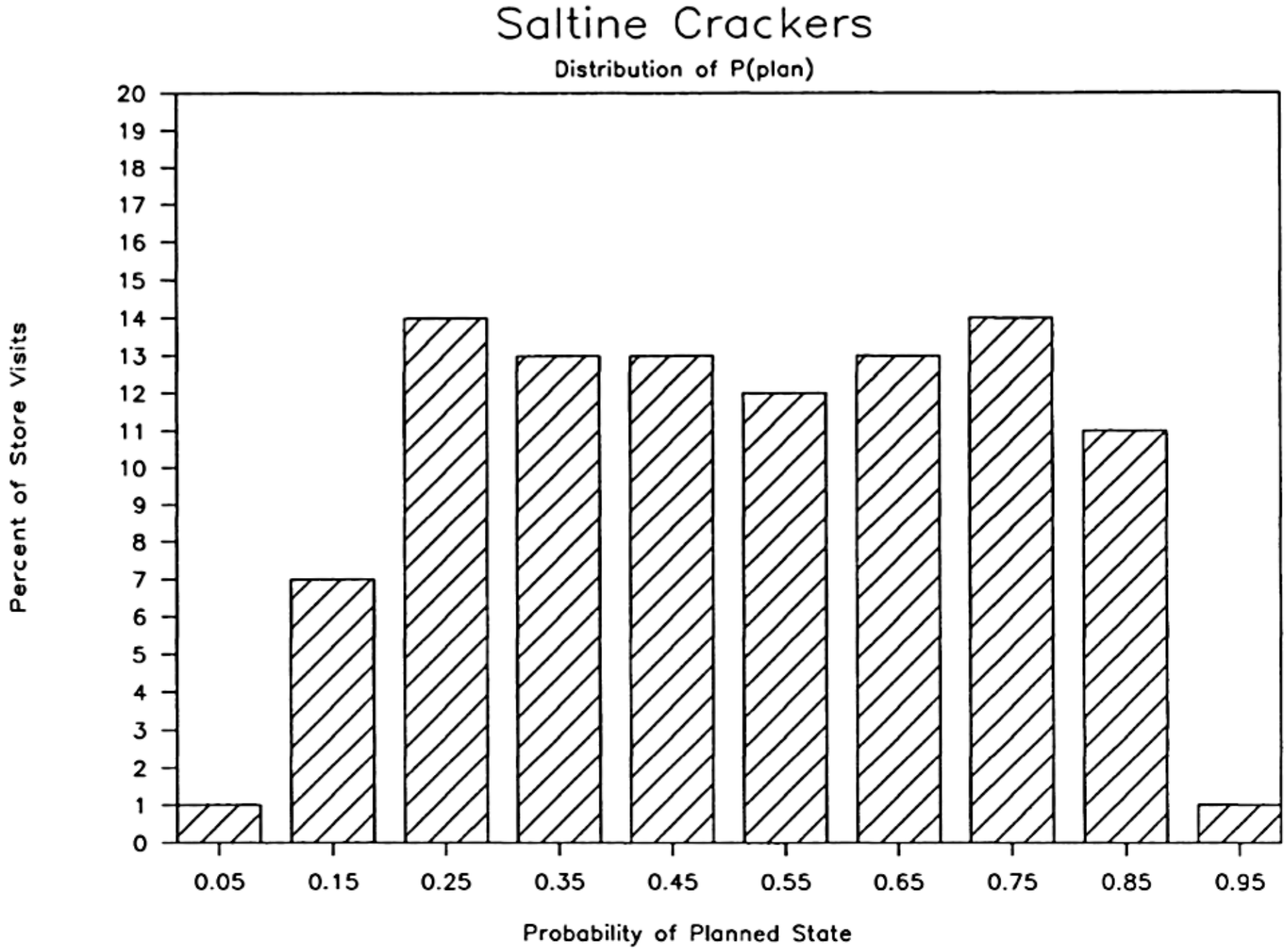
$P_t^h(i\|\text{inc})$		Hold-out sample	$P_t^h(\text{inc})$		
Store Private Label 1	α_1	1.073	Intercept	θ_4	−4.350
		(2.63)[a]			(−41.66)
Store Private Label 2	α_2	0.837	CR^h	θ_1	2.629
		(2.14)			(9.24)
Sunshine	α_3	−0.209	INV_t^h	θ_2	−0.446
		(−1.06)			(−11.51)
Zesta	α_4	0.450	CV	θ_3	0.398
		(2.54)			(14.06)
Premium 1	α_5	−0.259			
		(−1.18)			
LOY_t^h Loyalty)	β_1	3.058			
		(14.23)			
LP_{it}^h (Last Purchase)	β_2	1.476			
		(12.05)			
$PRICE_{it}$	β_3	−1.001			
		(−1.68)			
$PROMO_{it}$	β_4	1.603			
		(2.51)			
$PRICE_{it} \times PROMO_{it}$	β_5	0.022			
		(0.04)			

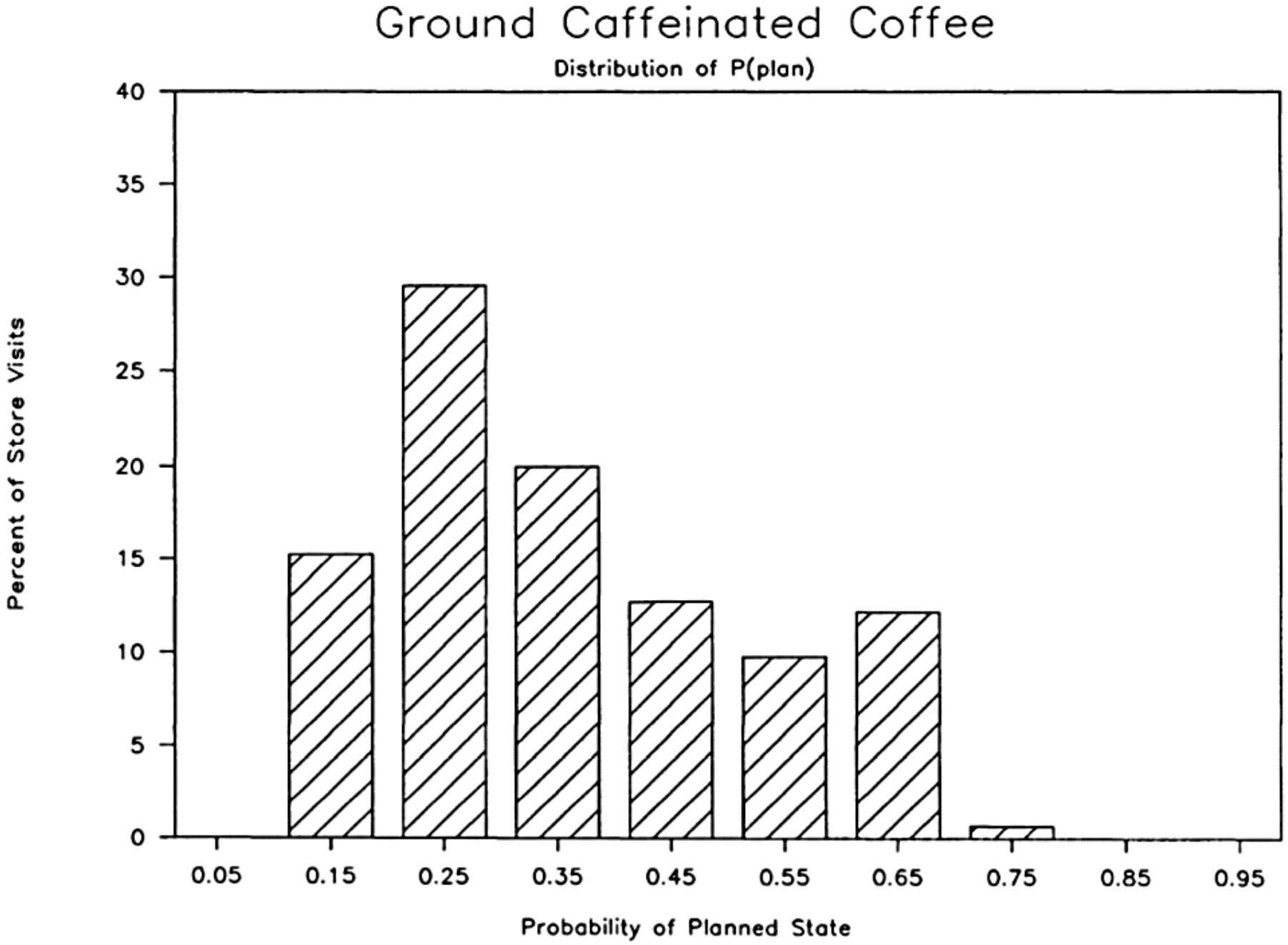
Calibration sample

	Two-State	One-State
Log Likelihood	−3696.4	−3803.4
Akaike Information Criterion	−3721.4	−3817.4
U^2	0.207	0.184

Hold-out sample

	Two-State	One-State
Log Likelihood	−2397.4	−2441.2


Saltine Crackers
Distribution of P(plan)
Percent of Store Visits
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
0.05
0.15
0.25
0.35
0.45
0.55
0.65
0.75
0.85
0.95
Probability of Planned State


Ground Caffeinated Coffee
Distribution of P(plan)
Percent of Store Visits
40
35
30
25
20
15
10
5
0
0.05
0.15
0.25
0.35
0.45
0.55
0.65
0.75
0.85
0.95
Probability of Planned State

THANK YOU FOR YOUR ATTENTION! ☺

Any questions?