

Beyond Plain Vanilla: Modeling Joint Product Assortment and Pricing Decisions

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Introduction

- Product assortment adjustments important by-product of changes in market structure (due to, e.g., mergers)
 - Affects both marginal and infra-marginal consumers
- Examples
 - Store locations; flight schedules; radio format offerings
- Research questions
 - How do consumer preferences affect equilibrium product assortments?
 - What is the effect of changes in product assortment on market prices and shares?

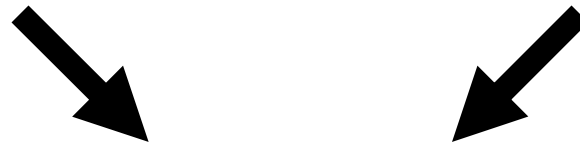
Modeling Assortment Decisions

Structural Demand Models

- Exogenous assortment
- Berry (1994)
- Berry, Levinsohn & Pakes (1995)
- Nevo (2000)

Product Choice Models

- Reduced-form profits
- Bresnahan & Reiss (1991)
- Mazzeo (2002)
- Seim (2006)



This Paper

- Endogenous assortment
- Structural profit function
- Application: Ice cream market

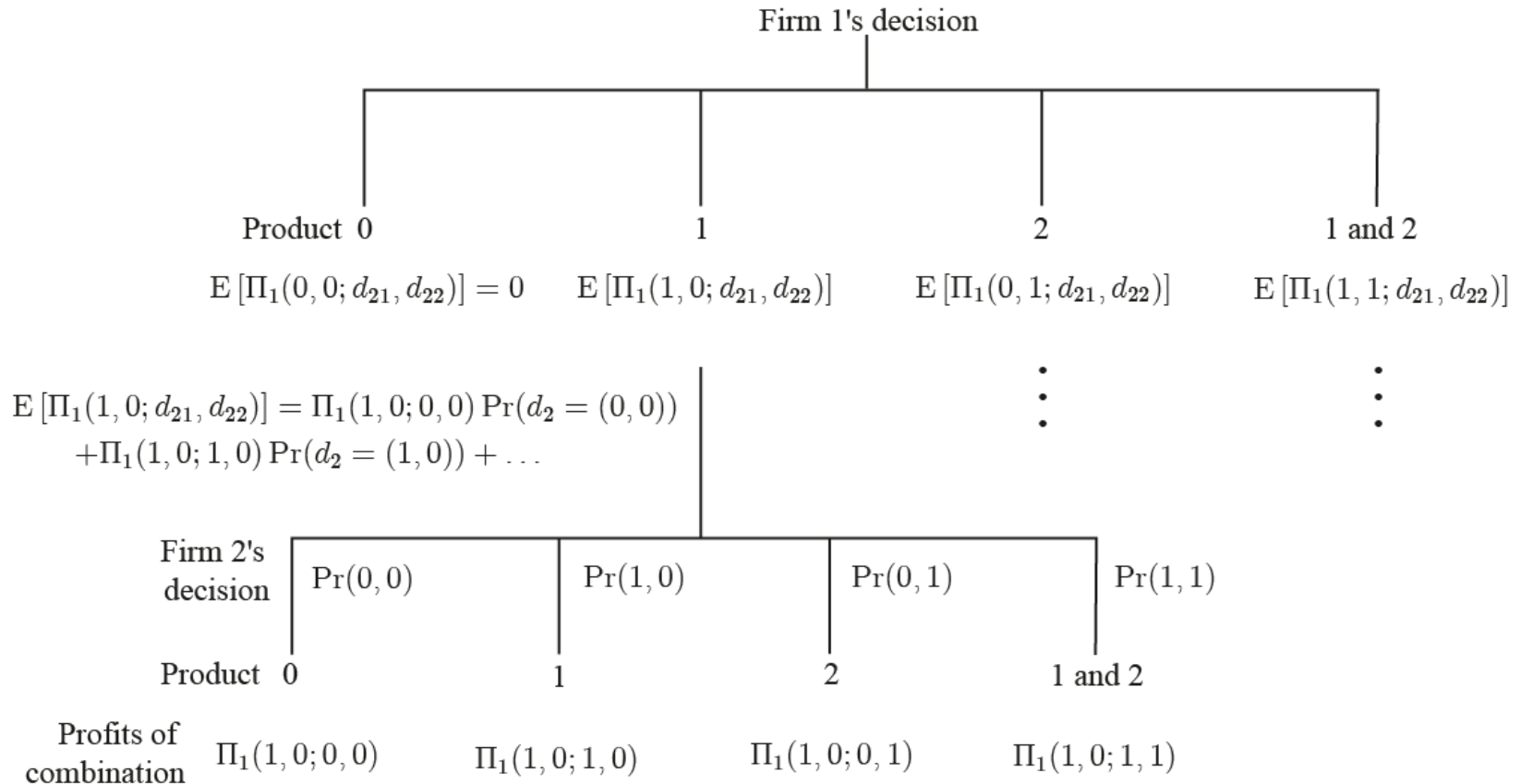
Model Overview

- Two-stage game
 - Stage 1: B brands (firms) decide which flavors (products) to offer
 - Stage 2: conditional on flavor choices, brands set prices
- Demand
 - Discrete choice model to obtain consumer preference parameters based on brand-flavor utility.
 - Random-coefficients specification
 - Logit demand shock
 - Control for unobservable attributes of flavors with market characteristics and time & flavor effects.

Model Overview, II

- Costs
 - Brand-specific marginal costs are common knowledge
 - Fixed costs of offering assortment are private information
 - Flavor-specific; assumed to be distributed log-normal
- Firm strategies
 - Pricing:
 - Bertrand-Nash competition
 - Obtain marginal costs from pricing first-order condition
 - Assortment choices:
 - Perfect Bayesian flavor assortment strategies

Two-firm/Two-flavor Example



Overview of Estimation Algorithm

- For a given set of parameters:
 - Calculate predicted market shares and prices.
 - Recover shocks to marginal cost from shares and prices at observed assortment using pricing FOC.
 - Calculate variable profits for all possible assortments.
 - Compute Perfect Bayesian Nash equilibrium as fixed point in probabilities.
- Combine moment conditions into objective and minimize to update parameters.

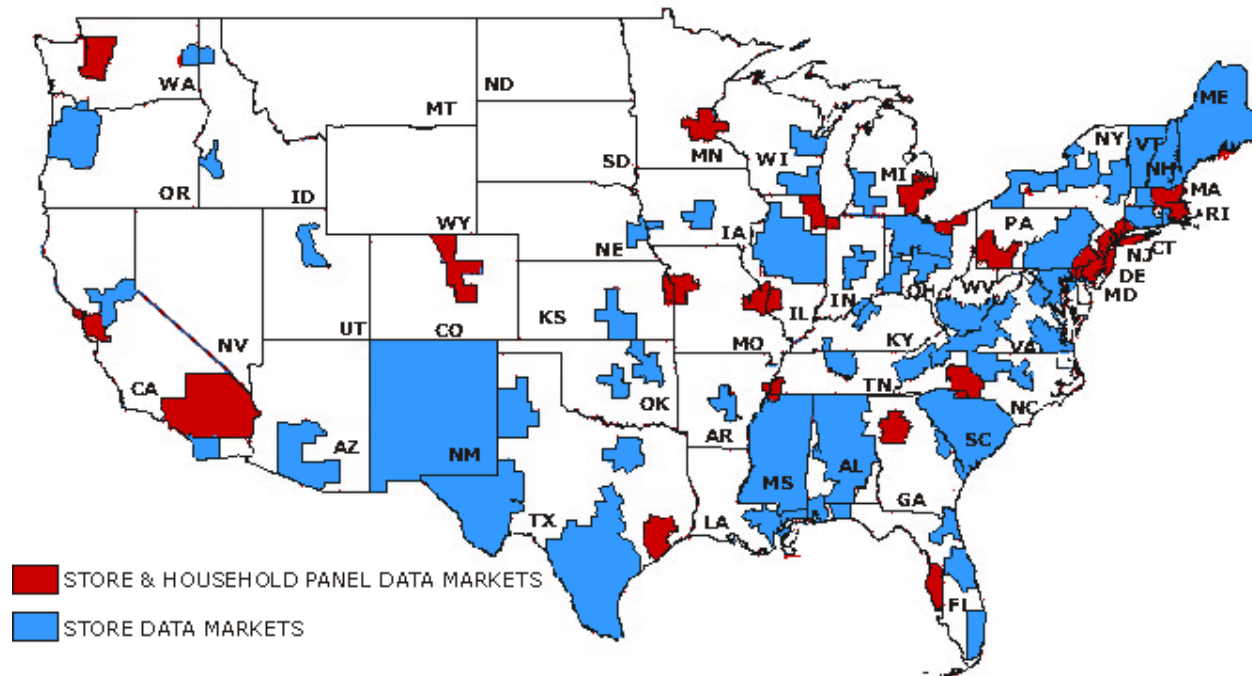
Monte Carlo Simulation

	truth	mean	bias	std. dev.	RMSE
<i>Mean</i>					
brand 1, flavor 1	0.0100	0.0086	-1.36E-03	6.32E-03	6.47E-03
brand 1, flavor 2	0.0250	0.0220	-2.95E-03	1.65E-02	1.68E-02
brand 2, flavor 1	0.0100	0.0110	1.01E-03	7.14E-03	7.22E-03
brand 2, flavor 2	0.0200	0.0170	-3.05E-03	1.24E-02	1.27E-02
<i>Standard deviation</i>					
brand 1, flavor 1	0.1000	0.1061	6.13E-03	4.22E-02	4.26E-02
brand 1, flavor 2	0.2500	0.2758	2.58E-02	1.47E-01	1.49E-01
brand 2, flavor 1	0.1000	0.1052	5.19E-03	4.77E-02	4.80E-02
brand 2, flavor 2	0.2000	0.2133	1.33E-02	9.76E-02	9.85E-02

- 100 runs, 256 simulated markets
- Estimation recovers fixed cost parameters

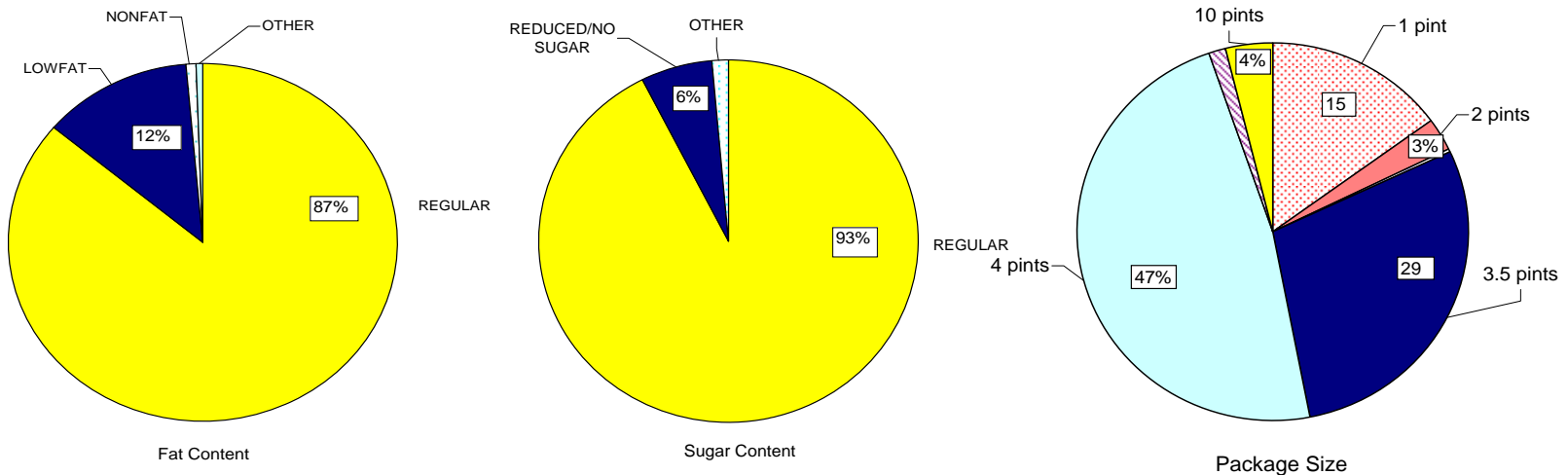
Data Sources

- Price and quantity data by UPC
 - IRI Infoscan, 2003-2005, 64 metropolitan areas



Market Definition

- Vanilla flavors
- Regular premium ice cream
- Family size (3.5 or 4 pt)



Market Presence of Vanilla Brands

	Market- month obs.	# flavors	# markets	% of market-months in which # of flavors is offered						
				0	1	2	3	4	5	6
				Breyers	1600	4	64	-	-	0.5
Dreyers	1600	6	64	0.2	0.1	2.6	15.8	34.4	42.7	4.2
Wells Blue Bunny	700	4	28	0.1	-	0	27.7	72.1	-	-
Friendly	375	3	15	-	-	14.9	85.1	-	-	-
Turkey Hill	350	3	14	-	-	2	98	-	-	-
Prairie Farms	300	3	12	1	-	9.7	89.3	-	-	-
Mayfield	300	4	12	-	-	1.7	6	92.3	-	-
Deans	275	4	11	-	-	66.9	24	9.1	-	-
Pet	275	3	11	1.8	-	0.7	97.5	-	-	-
Kemps	250	6	10	3.2	4.0	22.8	10	11.6	20.8	27.6
United Dairy	250	4	10	-	1.6	16.4	80.4	1.6	-	-
Hood	200	3	8	-	-	24	76	-	-	-
Hiland	175	6	7	0.6	2.3	2.3	5.1	46.9	18.3	24.6
Yarnells	125	4	5	10.4	1.6	4.8	36.8	46.4	-	-
Tillamook	75	2	3	-	-	100	-	-	-	-

Motivation

Model

Estimation

Data

Results

Conclusion

Our Focus

- Demand is modeled for all brands in the market.
- Decisions of Breyers and Dreyers considered in the product choice stage.
- Offering of optional flavors versus staples.

Demand Estimates

	Homogeneous Logit Model		Random Coefficients Logit Model	
	Estimate	Std. Error	Estimate	Std. Error
<i>Demand – Inside flavors</i>				
Price	-0.5019	0.0209	-0.5070	0.0264
Price SD			0.0623	0.0158
Breyers constant			0.7958	0.1853
Breyers SD			0.1081	0.0813
Dreyers constant			-0.5733	0.1791
Dreyers SD			0.1455	0.1280
<i>Demand – Outside option</i>				
Temperature	0.0009	0.0011	0.0087	0.0018
January dummy	-0.0080	0.0448	0.0048	0.0088
February dummy	0.0880	0.0384	0.0544	0.0591
March dummy	0.1193	0.0441	-0.0765	0.0603
April dummy	0.0762	0.0448	-0.2425	0.0466
May dummy	0.1198	0.0496	-0.2559	0.0608
June dummy	0.1121	0.0560	-0.3904	0.0643
July dummy	0.1134	0.0545	-0.4421	0.0674
August dummy	0.1306	0.0641	-0.2518	0.0719
September dummy	0.0745	0.0580	-0.3650	0.0666
October dummy	0.0689	0.0479	-0.1748	0.0546
November dummy	-0.0747	0.0453	-0.0227	0.0363
Northeast dummy	0.6097	0.0449	-0.5940	0.0483
Midwest dummy	0.3090	0.0365	-0.4844	0.0371
South dummy	0.4451	0.0418	-0.4895	0.0505
% African American	-1.1401	0.1566	-0.1863	0.1614
% Male	-9.6801	1.7030	-21.3949	0.5949
% 18-24 old	-4.4395	1.4749	1.6635	1.5779
% 25-44 old	-3.7634	1.5196	-3.6254	1.2495
% 45-64 old	-2.9410	1.3352	-2.2134	1.3165
% 65 and older	-8.0026	0.9295	-1.7608	0.8625
Average household size	0.2340	0.1461	-0.7608	0.0955
Per capita income	-0.0001	1.1E-05	0.0001	6.7E-06
Wal-Mart	0.0015	0.0007	-0.0041	0.0009

Marginal Cost Estimates

	Homogeneous Logit Model		Random Coefficients Logit Model	
	Estimate	Std. Error	Estimate	Std. Error
Breyers constant	5.2320	0.9258	4.5881	0.9104
Dreyers constant	4.8952	0.9254	4.2710	0.9099
Transportation cost	0.0002	3.2E-05	0.0002	3.2E-05
Sugar price	-0.0027	0.0252	-0.0057	0.0244
Wage	-0.0037	0.0014	-0.0040	0.0013
Commercial paper	-0.0108	0.0600	-0.0035	0.0587
Cream II price	-0.1180	0.0512	-0.1180	0.0503
Dry milk price	-0.2712	0.2043	-0.2916	0.2031
Distributor employment	0.4236	0.0584	0.4578	0.0583
Population per distributor	-2.0E-06	1.8E-07	-2.0E-06	1.8E-07
Fuel cost	0.0029	0.0007	0.0031	0.0007

Fixed Cost Estimates – Implied Moments

Parameter	Estimate	Confidence Interval*	
<i>Mean</i>			
Breyers Homemade Vanilla	3340.9	1759.8	6353.6
Dreyers Natural Vanilla	28447.0	15959.2	46020.1
Dreyers Vanilla Custard	2302.1	1103.1	4844.8
<i>Standard deviation</i>			
Breyers Homemade Vanilla	83533.0	8510.6	256505.2
Dreyers Natural Vanilla	188332.6	54739.4	407440.3
Dreyers Vanilla Custard	44679.3	7990.0	107313.2
<i>Median</i>			
Breyers Homemade Vanilla	252.2	137.6	413.7
Dreyers Natural Vanilla	4653.4	3395.3	5741.7
Dreyers Vanilla Custard	167.2	130.7	209.5

Merger Analysis

	All Flavors & Firms		
	Duopoly	Merged Firm	
		Fixed Products	Endog. Choices
Price, Breyers	3.785	3.846	3.846
Price, Dreyers	3.427	3.530	3.530
Total profits, Breyers	8.379	8.392	8.392
Total profits, Dreyers	4.721	4.723	4.723
Industry total profits	13.101	13.115	13.115
Profits, opt. flavors, Breyers	4.392	4.408	4.231
Profits, opt. flavors, Dreyers	7.497	7.518	7.452
Number of flavors	1.999	1.999	1.980
Share of time offered:			
Natural Vanilla	0.865	0.865	0.862
Homemade Vanilla	0.628	0.628	0.619
Vanilla Custard	0.507	0.507	0.498
Consumer surplus	14.730	14.651	14.628

Small effects due to:

- Share of vanilla (and especially optional vanilla) flavors small in potential ice cream market
- Relatively low cost of offering flavor

Merger Analysis – Alt. Scenarios

	Breyers & Dreyers' Optional Flavors Only					
	Estimated Fixed Cost			High Fixed Cost		
	Duopoly	Merged Firm		Duopoly	Merged Firm	
Fixed Products		Endog. Choices	Fixed Products		Endog. Choices	
Price, Breyers	4.549	6.329	6.283	4.763	5.980	5.761
Price, Dreyers	4.842	6.027	6.003	4.764	5.552	5.508
Total profits, Breyers	3.260	3.348	3.394	2.174	2.240	2.330
Total profits, Dreyers	5.307	6.480	6.461	3.790	4.438	4.540
Industry total profits	8.567	9.828	9.855	5.964	6.678	6.871
Profits, opt. flavors, Breyers	3.260	3.348	3.394	2.174	2.240	2.330
Profits, opt. flavors, Dreyers	5.307	6.480	6.461	3.790	4.438	4.540
Number of flavors	2.550	2.550	2.483	1.581	1.581	1.435
Share of time offered:						
Natural Vanilla	0.975	0.975	0.951	0.611	0.611	0.535
Homemade Vanilla	0.869	0.869	0.841	0.587	0.587	0.553
Vanilla Custard	0.706	0.706	0.691	0.384	0.384	0.347
Consumer surplus	14.906	14.074	14.055	14.048	13.662	13.657

Conclusion

- Model allows us to evaluate empirically both price and product variety effects of mergers.
- Value of jointly modeling product market competition and entry decisions:
 - Consumer surplus changes represents net effect of price and assortment effects.
 - Under reasonable conditions, consumer welfare increases because of increased variety.
- Future work:
 - Here, assortment choices driven by cost considerations
 - Alternative model focuses on selection