

The Analysis of a Contingency Table: the Pattern of Car Switching

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Summary

The data concern the make of car newly-bought in a given year and the make previously owned, in four coded years in the 1980's in both France and Britain. Our analytic approach was iterative data analysis and informed modelling. It has led to simple and transparent results, together with some explanatory theory.

Switching between car makes can be closely described by a one-parameter model which depends only on each make's market share. The parameter can be given one general value, .5, and four specific ones ranging from .3 to 4.0 for particular sub-markets. The values are the same over the 4 years and in both countries.

Repeat-buying of each make is high, with a Double Jeopardy trend from over 60% to less than 40%. It is largely predictable from the switching model, without having to make any explicit assumptions about a make having hard-core loyal buyers (Colombo and Morrison 1989).

Switching between Car Makes

The main pattern becomes much clearer when the raw counts are re-expressed as rounded percentages of switching from the previously-owned to the newly-bought make and are also ordered by market share (e.g. Ehrenberg 1975, 1982). The pattern is that switching to a make generally varies with that make's share of the market. Switching between Luxury makes is however higher. This and other submarkets, as for instance in Table B, emerged from the analysis of deviations.

The observed switching patterns can largely be modelled by the one-parameter Duplication of Purchase Law $p_{j/i} = Dp_j$ (see Ehrenberg 1972, Part V), where $p_{j/i}$ is the proportion of previous owners of make i who buy make j , and p_j is the proportion of all new car buyers who buy make j , i.e. its market share.

D is a constant for particular sub-markets and can be estimated as the average of the relevant switching percentages divided by the average of the relevant market shares. It is about .5 for most of the market including the three (local) "Domestic" makes in each country, so that the percent switching to make j generally equals half its market share.

Table A
Make Newly Purchased by Make Previously Owned: FRANCE 198d
(With Overall Duplication Model: .5 x Share)

FRANCE		NEW PURCHASE (198d)														
		Domestic			European							Luxury				
PREVIOUS	100	Ren	Peu	Cit	Ford	VW	Fiat	GM	Rov	Seat	Lada	Alfa	BMW	Merc	Volvo	Saab
Domestic	%															
Renault	29	% (63)	12	4	4	4	4	3	1	1	0	0	1	0	0	0
Peugeot	19	% 15	(59)	5	4	4	3	3	1	1	1	0	1	1	0	0
Citroen	12	% 14	14	(55)	3	3	4	2	1	1	1	0	0	0	0	0
European																
Ford	5	% 11	9	3	(53)	5	4	6	2	2	1	0	1	1	1	0
VW	5	% 8	13	4	5	(55)	4	4	1	2	0	1	1	1	1	0
Fiat	4	% 13	11	6	4	7	(45)	4	2	1	1	0	0	0	0	0
GM	3	% 11	10	3	7	6	3	(51)	1	2	1	0	1	1	1	0
Rover	1	% 13	9	5	9	12	7	1	(34)	2	2	1	1	0	1	0
Seat	1	% 21	7	9	8	10	7	8	2	(26)	0	1	0	0	0	0
Lada	1	% 9	14	7	6	4	7	7	2	1	(38)	0	0	0	0	0
Alfa	1	% 13	10	7	5	6	7	3	2	2	0	(36)	2	1	1	0
Luxury																
BMW	1	% 11	10	5	4	8	2	2	2	1	0	1	(44)	5	1	1
Mercedes	1	% 5	2	2	2	2	2	1	2	0	0	1	8	(65)	1	1
Volvo	1	% 10	5	7	2	10	3	4	1	2	0	1	2	2	(46)	1
Saab	0	% 0	0	2	1	12	7	0	2	0	0	4	8	8	5	(50)
Av. Switching*	%	11	9	5	5	7	5	3	2	1	1	0	2	1	1	0
.5 Share	%	15	11	6	4	3	3	2	1	1	0	1	1	1	0	0
Market Share (198d)	%	30	22	12	7	7	6	5	2	1	1	1	1	1	1	0

* Excluding repeat-buying %

Three other sub-markets have been identified by analysing the deviations from $p_{ji} = .5p_j$, with higher switching within each, namely (other) European with D about .8, Japanese (in Britain only) with D about 1.4, and Luxury makes with D about 3.8. Switching from Luxury makes (and Japanese makes in Britain) to Domestic ones or vice versa is however low, with an observed D of only about .3. These D-values are highly consistent across the four years and two countries, as is shown in Table B.

Table B Duplication Coefficients by Submarket, Country, and Year

(Local D estimate = average relevant average p_{ij} /average p_i)

Previous Purchase	NEW PURCHASE																			
	Domestic				European				Japanese				Luxury							
		'8a	'8b	'8c	'8d	'8a	'8b	'8c	'8d	'8a	'8b	'8c	'8d	'8a	'8b	'8c	'8d			
Domestic	Fr	.5	.5	.5	.5	.6	.6	.6	.6	--	--	--	--	.5	.5	.4	.4			
	Br	.5	.5	.4	.6	.50	.5	.5	.5	.5	.55	.5	.4	.5	.5	.48	.3	.3	.2	.3
European	Fr	.4	.5	.5	.5	.8	.9	.9	.9	--	--	--	--	.8	.8	.7	.6			
	Br	.5	.4	.4	.4	.45	.9	.7	.7	.7	.81	.6	.6	.5	.5	.55	.6	.6	.5	.6
Japanese	Fr	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--			
	Br	.4	.3	.4	.3	.35	.6	.6	.6	.6	.60	1.2	1.8	1.3	1.4	1.42	.5	.4	.4	.6
Luxury	Fr	.2	.3	.2	.2	.6	.5	.6	.8	--	--	--	--	3.2	4.3	3.7	4.7			
	Br	.3	.3	.5	.3	.29	.6	.6	.6	.6	.61	.4	1.1	.5	.6	.65	3.2	3.5	4.4	3.8

The model has been simplified by heavily rounding the D-parameters to either .5 or four other values ranging from .3 to 4.0, as shown in Table C.

Table C D-Values: A Parsimonious Simplification

(France and Britain, '8a to '8d - From table 5)

<u>PREVIOUS</u> <u>PURCHASE</u>	<u>NEW PURCHASE</u>			
	Domestic	European	Japanese	Luxury
Domestic	.5	.5	.5	0.3
European	.5	0.8	.5	.5
Japanese*	.5	.5	1.4	.5
Luxury	0.3	.5	.5	4.0

* Britain only

Table D for Britain shows that switching from Japanese to Domestic makes in Britain is greatly overpredicted (the observed D-value of .35 in Table B was markedly over-rounded in Table C), and that Nissan behaves more like a European make. Otherwise the discrepancies between the average observed and simplified predictions in both countries average at about half a percentage point, with an overall correlation of .95.

Repeat-Buying

The observed repeat-buying percent for each make as shown in Table A and E at between 30% to 65% appear high, compared with the switching percentages. They show a Double Jeopardy trend with market shares (e.g. Ehrenberg et al. 1990).

The repeat-buying proportions p_{ji} can largely be accounted for by the switching model. This implies that $p_{ji} = 1 - D(1-p_j)$, or $50\% + \frac{1}{2} \times$ market share for $D=.5$. Some small makes however

have lower repeat-buying than this, especially in France. No ad hoc assumptions of hard-core loyal buyers appear necessary.

Combining the repeat-model with the Duplication of Purchase Law means that among all switchers, the percent switching to make j is virtually its market share p_j , i.e. in effect $D=1$.

Table D Average Observed Switching and Simplified Predictions D x share: BRITAIN

(Readings with Duplication Coefficients D other than .5 are in bold)

Britain Av.198a-d Av. switching from:	NEW PURCHASE															Average	r			
	Domestic			European				Japanese				Luxury								
	Ford	Rov	GM	VW	Peu	Ren	Fiat	Volv	Cit	Nis	Toy	Hon	Maz	BMW	Mer			Saa	Por	
Domestic	%	15	7	7	2	4	2	1	2	1	3	1	.6	.4	*.6	.2	.2	.0	2.8	
.5 Share	%	14	8	7	3	3	2	2	2	1	3	1	.6	.5	*.5	.3	.2	.0	2.8	.99
European	%	10	8	5	**3	4	3	3	2	2	4	1	.7	.4	1.0	.6	.5	.0	2.8	
.5 Share	%	14	8	7	**4	4	3	3	3	2	3	1	.6	.5	.9	.5	.3	.1	3.2	.97
Japanese	%	8	6	4	2	3	3	1	2	1	+5	3	1.4	1.2	.9	.4	.3	.1	1.7#	
.5 Share	%	14	8	7	3	3	2	2	2	1	+9	3	1.7	1.5	.9	.5	.3	.1	2.1#	.96
Luxury	%	*8	6	4	4	1	2	1	3	1	2	1	1.4	.2	***6.4	3.8	4.5	.5	2.9	
.5 Share	%	*8	5	4	3	3	2	2	2	1	3	1	.6	.5	***7.2	4.0	2.0	.4	2.9	.90
Market Share	%	27	16	14	5	5	4	3	4	2	6	2	1.1	1.0	1.8	1.0	.5	.1

* D=.3 ** D=.8 + D=1.5 *** D= 4.0 # Excluding Japanese to Domestic

Individual Propensities to Buy

The aggregate switching and repeat-buying models $p_{j/i} = Dp_j$, $p_{j/i} = 1 - D(1-p_j)$ can be accounted for by assuming that individual new-car buyers behave as if they had zero-order, stationary, but heterogeneous stochastic purchase propensities for the different makes. The apparent "loyalty" to the makes is then merely an aggregation effect. (The theory underlying the Dirichlet model is relevant here, e.g. Ehrenberg 1988, Chapter 13).

Conclusions

The broad conclusion is that there are in the main no strong makes and weak ones, but only are large makes and small ones. Exceptions are exceptional, rather than common.

Repeat-buying and switching levels tend generally to be closely linked instead of the various makes differing intrinsically in these respects from each other. And although switching between the Luxury makes (e.g. BMW to Mercedes) is exceptionally high relative to their market shares, about twice as many previous owners of Luxury makes switch to the "more popular" National or other European makes on their next purchase than switch to another Luxury make (see Tables A and D).

The observed sub-markets can probably be explained by segmentation by price (for Luxury makes), and by consumers' perceptions of the "less expensive" makes as being either (i) relatively exclusive (e.g. the locally small "European" makes) or (ii) "popular" but well-supported (the large, mostly locally-produced, "Domestic" makes). This explanation stands up in both France and Britain despite some of the market shares differing radically between the two countries (e.g. Renault and Peugeot versus Ford and GM).

The observed patterns and the underlying models of choice are the same as for brands of motor oil and petrol - also with exclusive retail franchises - and as those for some fifty different packaged grocery products where the leading brands are generally all available at a give outlet side-by-side (e.g. Ehrenberg 1972, 1991). This seems to support the classical "marketing mix" view that while dealerships and after-sales service are essential correlates of market share, they are not on their own its driving force.

We believe that the next stages of work should focus on (a) segmentation analyses to try to explain the sub-markets, (b) the analysis of switching patterns for car models (and allowing for price) rather than merely for makes, and (c) the inherent asymmetries of the data and trends over time. Although both of the latter are relatively small compared with the main structure of the market mapped out here, they can be managerially critical in terms of sales.

A fuller account of the analyses is given elsewhere (Ehrenberg and Pouilleau 1993).

Table E Repeat-Buying Levels and Market Shares

(Repeat-buying predictions from the Switching Model as $50\% + .5 \times$ market share.)

FRANCE (198a-8d)	Market Share*	Repeat Buying	Predicted	BRITAIN (198a-8d)	Market Share*	Repeat Buying	Predicted
	%	%	%		%	%	%
<u>Domestic</u>				<u>Domestic</u>			
Renault	29	60	65	Ford	25	68	63
Peugeot	19	54	60	Rover	17	(51)	58
Citroen	12	55	56	GM	14	60	57
<u>European</u>				<u>European</u>			
Ford	5	51	54	VW/Audi	5	55	53
VW/Audi	5	51	53	Peugeot	4	(38)	52
Fiat	4	44	52	Renault	3	45	52
GM	3	53	52	Fiat	3	48	51
Rover	1	37	51	Volvo	3	(60)	51
Seat	1	31	51	Citroen	1	50	51
Lada	1	39	50				
Alfa	1	32	50	<u>Japanese</u>			
				Nissan	4	54	52
				Toyota	1	52	51
				Honda	1	41	50
				Mazda	1	49	50
<u>Luxury</u>				<u>Luxury</u>			
BMW	1	50	51	BMW	2	55	51
Mercedes	1	(61)	51	Mercedes	1	(64)	51
Volvo	1	44	50	Saab	1	45	50
Saab	0	47	50	Porsche	0	45	50

* Share of previously-owned cars = % owning. () = substantial DJ exceptions.