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DYNAMIC EFFECTS OF THE ORDER OF ENTRY ON MARKET SHARE, TRIAL PENETRATION, AND REPEAT PURCHASES FOR FREQUENTLY PURCHASED CONSUMER GOODS

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A time series cross-sectional analysis of 18 successful later entrants in 8 categories of consumer packaged goods over the period from October 1983 to January 1988 confirms previous empirical findings that, after correcting for differences in marketing effort, later entrants suffer a long-term market share disadvantage. New evidence of the penalties associated with later entry are found in statistical estimation of models of cumulative trial, first repeat, and subsequent repeat purchasing. Significantly lower asymptotic levels are found in both trial and repeat behavior. However based on this data, the rate of approach of later entrants to their lower asymptotic performance measures is either equal to or faster than early entrants and provides evidence of a compensating partial effect accrued by later entrants.
(New Products; Order of Entry; Share; Trial; Repeat; Pioneering)

Introduction

Considerable research has been published outlining theoretical economic (e.g., Schmalensee 1982) and behavioral bases for early market entry advantages (e.g., Carpenter and Nakamoto 1989), and examining the empirical evidence of the existence of a pioneering advantage (for a complete review of the literature see Lieberman and Montgomery 1988). This paper expands the empirical base of knowledge on the effects of order of entry.

Analyzing PIMS data from 371 mature consumer goods at the business-unit level, Robinson and Fornell (1985) found that there was a strong empirical association between order of entry and market share. Pioneers tended to have higher product quality and broader product lines even as they charged the same price as the later entrants. Robinson (1988a) replicated and extended his work to industrial goods. The results suggested that "many pioneers develop important and sustainable competitive advantages," and they are "quite robust across both consumer and industrial markets." Lilien and Yoon (1990) empirically examined new product success rates as a function of order of entry for a sample of French industrial products and found that success is lower for first and second entrants. This result combined with Robinson and Fornell's work suggests that early entrants have higher returns if they are successful, but they bear a higher risk of new product failure.

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Urban et al. (1986) analyzed a consumer packaged goods data base for the 1979–82 period. The data base included measures of market share, positioning and advertising expenditure and it was appropriate for cross-sectional investigation of the order of entry effects. The study found that "later entrants should plan on achieving less share than the pioneering brand if they enter with a parity product." However, if later entrants developed a differentiated product with either unique features and/or a lower price and backed the product with large advertising expenditures, they could achieve high shares and possibly even overtake the pioneer.

This paper examines the effects of order of entry in the frequently purchased consumer products industry and extends the previous study by Urban et al. (1986) in three important ways. First, a cross-sectional and time series data base is used to examine the dynamic effects of later entry rather than a cross-sectional data set as used by Urban et al. (1986). The new data allow one to address the question: do later entrants approach their asymptotic share at a slower or faster rate than pioneers? It is important for manufacturers to understand the dynamics because good strategy and profits will depend on the path to the asymptotic share as well as performance at the asymptotic level. Second, this study examines the effects of order of entry on trial penetration and repeat purchases as well as share. Separating trial and repeat behavior has long been a strategic thrust in new product development in packaged goods markets (see Urban and Hauser 1980, pp. 386–450 for a review). The trial purchases occur quickly and are generated by considerable advertising, promotion, and distribution expenditures while the repeat sales, given trial, build slowly due to product satisfaction and marketing actions to prevent customers from switching to other brands. The strategies to generate trial and repeat loyalty are often different and insight can be gained through an understanding of how the market share is built up from trial and loyal customer purchasing. Third, the use of UPC scanner data allows analysis of price, promotion, and distribution effects which were not included in the original cross-sectional analysis by Urban. This data source has the potential to improve the precision of the estimates of pioneering advantages and to provide a better understanding of market response.

In this paper we analyze 18 brand entrants across eight categories over 69 weeks. First we describe the structures for dynamic models for share, trial penetration, and repeat purchasing and then discuss their measurement and estimation. Next we present the empirical results and the implications of our study. We close with the identification of future research needs.

Model Development

Market Share

We model overall market share in each period by an underlying share growth pattern which is modified by order of entry, distribution, price, promotion, advertising, and product quality effects. We posit that the underlying share will grow at a decreasing marginal rate to an asymptote. The growth is described by an exponential function which depends on the order of entry of the brand. All variables except order of entry are expressed as ratios to the first brand to enter the category. The formal equation is:

$$S_{it} = E_i^{\alpha} D_{it}^{\beta} P_{it}^{\gamma} M_{it}^{\delta} A_{it}^{\theta} Q_i^{\epsilon} (1 - e^{-\phi t-(\Psi/E_i)t}), \tag{1}$$

S_{it} = Ratio of share of ith brand to share of first brand to enter the category as of period t,

E_i = Order of entry of ith brand, $i = 2, 3, \ldots, N$,

D_{it} = Ratio of distribution of ith brand to distribution of first brand in period t,

P_{it} = Ratio of price of ith brand to price of first brand in period t,

M_{it} = Ratio of promotion of ith brand to promotion of first brand in period t,

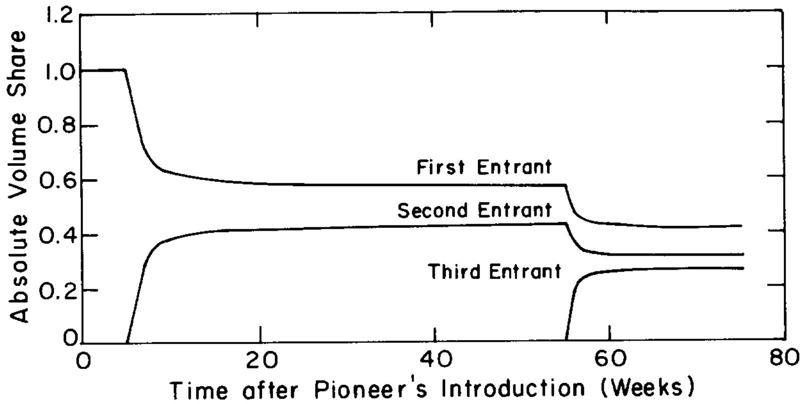

FIGURE 1. Share by Order of Entry.

A_{it} = Ratio of advertising expenditure of ith brand to advertising expenditure of first brand in period t,

Q_i = Ratio of quality of ith brand to quality of first brand,

t = Time period since the introduction of brand i to the market,

$\alpha, \beta, \gamma, \delta, \theta, \phi, \Psi, \epsilon$ = Parameters.

We have suppressed a category subscript for notational simplicity.

Underlying share growth. The underlying market share for later entrants to enter a category relative to the pioneer is described by $(1 - e^{-\phi t})$. Figure 1 shows the typical underlying share pattern in a market as entry occurs. Initially the pioneer has 100% of the market but loses share as the second brand enters. We assume that the second brand's share grows at a decreasing rate over time and approaches an asymptote. When the second brand enters, a discrete change takes place in the curve describing the pioneer because shares in the market must add to 100%. Similarly when the third brand enters, the share curves for the first and second entrants undergo a discrete change as the third entrant's share grows asymptotically. These curves are not smooth exponential functions, but if we assume that the third entrant takes share from brands one and two in a manner proportional to their shares, we obtain the desired smoothness in the share ratios of equation (1). This is the constant ratio model assumption of competitive interaction and it has the attractive property in our case that, when we ratio the share of the ith brand to enter the market to the first entrant in the category, the curves of relative share versus time become smooth and are consistent with our model of underlying share growth.[1] The constant ratio model formulation employed here is similar to the logit choice model that assumes that successive entrants draw shares from all earlier entrants proportional to their respective shares. The logit model has been widely employed and empirically found to be very useful in package goods analysis (e.g., Guadagni and Little 1983).

One reason why we ratio the ith brand share to the first brand to enter the category is now evident, but another reason results from our desire to estimate equation (1) with time series and cross-sectional data. Ratios allow reasonable comparisons across categories with different numbers of brands. In a three-brand as well as in a two-brand category we posit that the share ratio will be the same between the second and first entrants even though the absolute share may be very different (e.g., 40% vs. 60% in a two-brand market

[1] If the share of ith entrant (i greater than 2) is S_i' and S_1' and S_2' are the shares of the first and second entrants before entry of the ith brand, the ratio of the second to first entrant after entry is $S_2/S_1 = (S_2'/(1 + S_i))/(S_1'/(1 + S_i)) = S_2'/S_1'$.

and 33.3% vs. 50% in a three-brand market). A third reason is that the ratios are an appropriate way of eliminating cross-category differences in marketing instruments, e.g., some categories have higher prices or promotion or advertising expenditures and others have lower levels.

Share growth and asymptotic effects for later entrants. The submodel of underlying growth in share ratios described above ($1 - e^{-\phi t}$) is extended in equation (1) to allow the asymptotic level and the growth rate to the asymptote to be different for later entrants. The asymptotic effect is modeled by a multiplicative factor (E^{α}). This allows the asymptote to be lower for later entrants if $\alpha < 0$ or higher if $\alpha > 0$.

The effect of order of entry on the rate of growth in share is modeled through the multiplicative factor *and* by adding an additional exponential term. The multiplicative effect E^{α} changes the growth rate because it affects each period's share estimate. When α is less than zero this component of the growth rate as well as the asymptote are lowered and vice versa. This functional form for asymptotic effects assumes that the order variable is linearly scaled.

The additional exponential term is $-(\Psi/E_i)t$ and it increases the growth rate in share if Ψ is greater than zero and decreases it if Ψ is less than zero. When we divide the growth parameter Ψ by the order of entry we are assuming that this component of the growth effect is smaller for later entrants whether the effect is to increase or decrease the growth rate. When examining the effect of later entrants versus earlier entrants in this exponential term we must consider the effect of Ψ/E_i for $E = i$ and $i + 1$ where i is greater than or equal to two. If Ψ is greater than zero the entry effect is a *higher* growth rate for all later entrants but not as much higher for entrant $i + 1$ as for i, so the later entrant $i + 1$ is growing at a *slower* rate relative to entrant i. If Ψ is less than zero the entry effect is *lower* growth for all later entrants but not as much lower for entrant $i + 1$ as for i, so the later entrant $i + 1$ has a *faster* growth than entrant i. The total growth rate must be assessed by the combination of the components for the specific values of the parameter estimates (α, ϕ, and Ψ). Finally, we note that the underlying share pattern we describe is only correctly represented by $1 - e^{-\phi t-(\Psi/E_i)t}$ or equivalently $1 - e^{-(\phi+\Psi/E_i)t}$ when we assume the term $(\phi + \Psi/E_i)$ to be greater than zero.

Effects of marketing variables. The effects of changes in distribution, price, promotion, advertising, and quality are modeled as multiplicative effects where each variable of the ith entry is defined as a ratio to the pioneer's level for the variable and raised to an exponent. This multiplicative form allows for nonlinear response and interaction effects between the variables. Major introductory campaigns that induce large trial sales are captured by the promotion and advertising terms which are multiplied times the basic growth term. After the introductory campaign is finished the sales will be dominated by the underlying growth effects. The model can produce the sales pattern of high sales growth due to promotion induced trial and a decline in sales until the repeat sales build to equal to or greater than trial sales. It can represent as well a pattern of smooth share growth if trial growth is slow and/or repeat sales build rapidly (see Urban and Star 1991, Chapter 6 for a discussion of possible life cycles in consumer package goods).

The model in equation (1) includes the critical asymptotic and dynamic share effects for order of entry and it can represent many of the complex share patterns that may occur in the market.

Trial Penetration Model

We model trial penetration analogously to share. Underlying trial penetration is the fraction of the market who has ever tried a brand and typically this measure of trial displays asymptotic growth and is concave. We model order effects on the rate of growth and asymptotic level. Controllable variables of distribution, promotion, price, advertising, and quality modify this underlying growth in penetration. But in this model we use the geometrically weighted values over two past periods instead of the current period values because cumulative trial is influenced by cumulative marketing variables and not just the current period values. We assume the same geometric delay parameter (λ) applies to each variable and we cumulate the weights over the past three periods.[2]

$$T_{it} = E_i^{\alpha'} \bar{D}_{it}^{\beta'} \bar{P}_{it}^{\gamma'} \bar{M}_{it}^{\delta'} \bar{A}_{it}^{\theta'} Q_i^{\epsilon'} (1 - e^{-\phi' t - (\Psi'/E_i)t}), \tag{2}$$

T_{it} = Ratio of cumulative penetration of ith brand to first brand in category in period t where:

$$\bar{D}_{it} = D_{it} + \lambda D_{i,t-1} + \lambda^2 D_{i,t-2},$$
$$\bar{P}_{it} = P_{it} + \lambda P_{i,t-1} + \lambda^2 D_{i,t-2},$$
$$\bar{M}_{it} = M_{it} + \lambda M_{i,t-1} + \lambda^2 M_{it-2},$$
$$\bar{A}_{it} = A_{it} + \lambda A_{i,t-1} + \lambda^2 A_{i,t-2},$$
$$\lambda = \text{parameter.}$$

Repeat Purchasing Model

The cumulative percent of those who tried who ever repeat is modeled similarly to the trial penetration with order effects on underlying repeat purchasing and marketing variables as modifiers of the underlying pattern of asymptotic growth.

$$R_{it} = E_i^{\alpha''} \bar{D}_{it}^{\beta''} \bar{P}_{it}^{\gamma''} \bar{M}_{it}^{\delta''} \bar{A}_{it}^{\theta''} Q_i^{\epsilon''} (1 - e^{-\phi''(t - (\Psi''/E_i)t}), \tag{3}$$

R_{it} = Ratio of cumulative percent of triers who repeat by period t for ith brand to first brand in category.

We also use the same form to model additional purchases after trial and first repeat. The cumulative number of additional repeat purchases per person who had repeated once after a trial purchase is used as the dependent variable in the same model form as described in equation (3).

Measurement and Estimation

Data

The data used in this study are based on UPC measures in eight markets for share, trial penetration, repeat purchases, distribution, price, and promotion supplied by Information Resources Inc.[3] Advertising expenditure data were obtained from *Leading National Advertisers*. We found 28 new brand entrants across 8 frequently purchased categories over a time span of 220 weeks. We selected categories where new brand entrants were present. Our definition of a new category was based largely on our reading of trade journals, IRI definitions, interviews with managers in packaged goods, and our judgment of the boundaries of competition. The categories studied are tartar control toothpaste, hi-fiber cereals, frozen orange drink, frozen pineapple juice, wine coolers, microwave popcorn, gel toothpaste, and ibuprofen pain relievers. Two brands achieved measurable share and then fell to approximately zero sales levels (the second entrant in wine coolers and the fourth in microwave popcorn). We omitted these brands from the statistical

[2] In period one of a product's history we use only that period's value for the variable. In period two we use the period two value and λ times the period one value. After period two we apply equation (2).

[3] We would like to acknowledge and thank Information Resources Inc. for providing this data to us. The 8 cities represent IRI BEHAVIORSCAN® cities. The data include store scanner records from over 75 supermarkets and 25 drug stores as well as panel records from over 2,500 respondents in each market. Data from October 31, 1983 to January 15, 1988 were available.

analysis, but kept them in the order of entry count for the category. If we had included them, their low sales levels would have overstated the penalties for late entry that successful brands would experience. Eight of the remaining 26 successful entrants were first entrants. Across the 18 successful later entrants there were 1,241 weekly observations or on average 69 weeks per entry.

Measures

The raw UPC store and panel measures were used directly or manipulated to correspond to the definitions in equation (1). Market share is obtained directly from the IRI weekly data reports and is ratioed to the first entrant to provide the dependent measure S in equation (1). Order of entry (E) is not completely defined in the UPC data. For brands that entered in our 220-week span of UPC data, the order of entry of each brand was obtained by observing the week in which the brand first appeared in the UPC store data. In cases where existing brands entered the market before the beginning of our data (October 31, 1983), we interviewed brand managers in the respective category and reviewed trade publications (*Advertising Age* and *Marketing News*) to determine order of earlier entrants. The order of entry effect variable is an ordinal measure and, technically, this is not appropriate for regression (we test this linearity assumption later in this paper).

Distribution in the IRI data is measured by the occurrence of some sales movement in a store over a week. The percent distribution is the proportion of the stores recording sales of the brand weighted by the volume of that store relative to the total market volume. This "all commodity weighted volume" measure is used as the distribution variable in the ratio D.

Suggested retail price is not reported directly in the UPC reports but can be derived from the weekly reported check out prices per unit volume (these include promotion effects) by considering the IRI measures of "deal volume percentage" (average percent of volume purchased on any deal) and "promotional price cut" (the average percentage of suggested price cut per unit volume of purchase). The check out price is suggested price weighted by the deal volume percentage and promotional price cut:

$$P_{it}^c = (P_{it})(1 - L_{it}) + (L_{it})(P_{it})(1 - C_{it}), \qquad \text{where} \tag{4}$$

P_{it}^c = Check out price per unit volume,
P_{it} = Suggested price per unit volume,
L_{it} = Deal volume percentage,
C_{it} = Promotional price cut,
and the suggested price is therefore:

$$P_{it} = (P_{it}^c)/(1 - L_{it}C_{it}). \tag{5}$$

The dollar promotional expenditure is constructed from the deal volume percentage and promotional price cut variables:

$$M_{it} = P_{it}C_{it}V_{it}L_{it}, \qquad \text{where} \tag{6}$$

M_{it} = Promotional expenditure for a brand at period t,
V_{it} = Unit volume sales at time period t.

Advertising expenditure from *Leading National Advertisers* (LNA) is based on audits of seven media (magazines, newspapers, newspaper supplements, network television, spot television, network radio, outdoor, and cable TV). The ratio of the ith entrant to the first entrant (A) is calculated from the reported magnitudes. The absolute magnitude of this measure is not required in this model so we need only assume that the audit data are correctly representing the relative expenditures. Advertising is the last measure required in the share model equation (1). The LNA data are quarterly so we assume equal spending over each week in the quarter in the share equation.

Dependent measures of trial and repeat for equations (2) and (3) were obtained directly from IRI panel reports. In contrast to the store reported share data which were available weekly, the panel based trial and repeat data were available only on a five-week basis. The price and promotion variables were aggregated to the five-week interval for the trial and repeat calculations, but in other respects the independent variables for equations (2) and (3) were defined as above. The total number of five-week observations for later entrants was about 300 or 17 five-week periods per entry on average.

Two repeat measures were available. Equation (3) represents one of them—cumulative number of triers who repeat by period t. The second measure is the cumulative number of "repeat purchases per repeater" or the number of purchases in the panel that reflect the second or higher repeat purchases divided by the number of people who have repeated at least once at time t. In the results section we report the use of both measures as dependent measures of repeat purchasing.

One variable is missing from our measures—product quality (Q). In the Urban et al. (1986) a constant sum preference measure was available based on survey measures from pretest market research, but in our case such measures were not available. To compensate in part for this limitation, a dummy variable that represents quality and other brand specific effects is estimated statistically.

Despite this limitation, the data base is attractive because it measures not only share but also trial and repeat behavior, includes price, promotion, and distribution variables, and reports store level marketing activity on a weekly basis.

Estimation

The share, trial, and repeat models developed above are nonlinear time series cross-sectional models from the estimation point of view. We linearize the basic terms of equations (1), (2), and (3) by taking logs of both sides of them. As stated above, because we do not have a quality measure in our data base we use a brand-specific constant (Q) to account for quality and other variations unique to the brand. The brand-specific constants do not measure only quality but rather the effect of all the missing brand variables. While the constants provide limited insight into quality effects, they reduce possible misspecification errors. In the log-log versions of the equations the term $1 - e{-}\phi t{-}(\Psi/E_t)t$ represents the dynamics.

We employ nonlinear least squares estimation methods (SYSNLIN OLS in SAS) to estimate the coefficients. These procedures are based on nonlinear search algorithms and often required very large computer run times in our data (e.g., 45 minutes of CPU on an IBM 4341). The search is sometimes very sensitive to the equation, data structure, and starting points due to flat or lumpy portions of the squared error space searched by the algorithms. To minimize this sensitivity we try to keep the equation structure as simple as possible and repeat runs with alternative starting points to be sure the algorithm converges to the same solutions.

Empirical Results

The statistical results of estimating the share, trial penetration, and repeat equations are shown in Table 1. The fits are good with R-squared values in the range of 0.815 to 0.934 across the four models.

In the share, trial, cumulative repeat, and repeat per repeater models the alpha parameter is negative and significant at the one percent level in all cases. This indicates that later entrants achieved lower asymptotic performance. Order of entry penalties are found in not only trial, but also in repeat behavior. The asymptotic results for the share model confirm previous work (Urban et al. 1986) but the parameter value is a little smaller in magnitude (−0.40 in this study versus −0.48 in the Urban et al. study). The trial and

TABLE 1

Share Trial and Repeat Model Estimation Results

	Estimates			
Parameters (t)	Share	Trial	Frist Repeat	Additional Repeats
Asymptotic Entry (α)	−0.396	−0.478	−0.259	−0.147
	(−14.02)***	(−6.91)***	(−3.04)***	(−3.08)***
Distribution (β)	0.698	0.763	0.136	0.162
	(13.74)***	(6.29)***	(1.04)	(2.34)**
Suggested Price (γ)	−0.310	−0.170	0.259	−0.140
	(−8.18)***	(−1.22)	(1.36)	(−1.34)
Promotion Dollars (δ)	0.330	0.190	−0.046	−0.015
	(30.97)***	(7.45)***	(−1.95)*	(−1.16)
Advertising Expenditure (θ)	0.037	0.040	0.007	−0.007
	(6.71)***	(3.33)***	(0.51)	(−1.05)
Constant (ϕ)	2.925	0.662	0.625	0.258
	(1.94)*	(2.60)**	(3.37)***	(3.88)***
Rate of Growth (Ψ)	−5.638	−0.666	−1.026	−0.026
	(−1.87)*	(−1.04)	(−2.64)***	(−0.14)
Geometric Weight (λ)	—	0.10	0.25	0.30
		(NA)	(NA)	(NA)
Brand Specific Constants:				
Brand 1	−0.421	−0.800	−0.111	−1.030
	(−7.45)***	(−5.15)***	(−0.53)	(−11.43)***
Brand 2	−1.111	−1.71	−0.644	−1.769
	(−13.38)***	(−8.33)***	(−2.68)***	(−14.09)***
Brand 3	−0.851	−1.44	−0.884	−3.029
	(−8.57)***	(−6.05)***	(−3.27)***	(−11.52)***
Brand 4	−0.337	−1.09	−0.267	−1.320
	(−4.67)***	(−4.90)***	(−1.07)	(−9.89)***
Brand 5	0.027	1.23	−0.457	0.243
	(0.40)	(10.14)***	(−3.15)***	(3.64)***
Brand 6	0.491	0.008	−0.157	−0.782
	(5.58)***	(0.04)	(−0.84)	(−8.02)***
Brand 7	0.828	−1.10	−0.480	−1.555
	(8.71)***	(−4.08)***	(−1.56)	(−9.45)***
Brand 8	−0.456	0.970	−0.775	−0.478
	(−7.25)***	(7.53)***	(−5.67)***	(−6.88)***
Brand 9	−0.672	−1.03	−0.977	−1.435
	(−7.61)***	(−5.40)***	(−4.44)***	(−11.69)***
Brand 10	0.395	1.56	0.559	0.811
	(4.49)***	(9.28)***	(3.31)***	(9.88)***
Brand 11	0.309	1.48	0.320	0.609
	(3.59)***	(8.68)***	(1.72)*	(6.36)***
Brand 12	0.358	1.30	0.395	0.440
	(4.14)***	(6.98)***	(1.97)**	(4.19)***
Brand 13	−0.286	1.05	0.447	0.057
	(−2.66)***	(5.36)***	(2.08)**	(0.52)
Brand 14	0.535	1.14	0.952	0.497
	(6.08)***	(5.26)***	(3.83)***	(4.04)***
Brand 15	−0.788	−0.67	−0.142	−0.138
	(−13.77)***	(−4.84)***	(−0.93)	(−1.75)*
Brand 16	−0.619	−1.00	−4.014	−0.965
	(−10.31)***	(−6.88)***	(−23.38)***	(−11.01)***
Brand 17	−0.321	0.095	0.187	0.083
	(−8.32)***	(1.05)	(1.48)	(1.47)
Number of observations:	1241	300	320	307
R-Square:	0.905	0.934	0.815	0.912

The "t" values are shown in the parentheses. First Repeat and Additional Repeats refer to repeat models with cumulative repeaters as a percent of triers and average additional repeats per repeater as the respective dependent measures.

* Significant at the 10% level.

** Significant at the 5% level.

*** Significant at the 1% level.

TABLE 2

Share Growth for Later Entrants with Price, Promotion, Advertising and Distribution Equal to Pioneer

(a) Estimated Fraction of Asymptotic Share Ratio Level Achieved at Time t (Weeks)

Time	Entry 2	Entry 3	Entry 4	Entry 5
1	0.100	0.648	0.780	0.834
2	0.550	0.824	0.890	0.917
3	0.700	0.882	0.926	0.944
4	0.775	0.912	0.945	0.958
5	0.820	0.929	0.956	0.966
6	0.850	0.941	0.963	0.972
7	0.871	0.949	0.968	0.976
8	0.887	0.956	0.972	0.979
9	0.900	0.960	0.975	0.981
10	0.910	0.964	0.978	0.983
11	0.918	0.968	0.980	0.984
12	0.925	0.970	0.981	0.986
13	0.930	0.972	0.983	0.987
14	0.935	0.974	0.984	0.988
15	0.940	0.976	0.985	0.988
16	0.943	0.978	0.986	0.989

(b) Estimated Share Ratio Values Achieved at Time t (Weeks)

Time	Entry 2	Entry 3	Entry 4	Entry 5
1	0.076	0.419	0.450	0.441
2	0.418	0.533	0.514	0.484
3	0.532	0.571	0.535	0.499
4	0.589	0.590	0.545	0.506
5	0.623	0.601	0.552	0.511
6	0.646	0.609	0.556	0.514
7	0.662	0.614	0.559	0.516
8	0.674	0.618	0.561	0.517
9	0.684	0.621	0.563	0.518
10	0.691	0.624	0.564	0.519
11	0.697	0.626	0.566	0.520
12	0.703	0.628	0.566	0.521
13	0.707	0.629	0.567	0.521
14	0.711	0.630	0.568	0.522
15	0.714	0.632	0.569	0.522
16	0.717	0.633	0.569	0.523

repeat estimates provide new evidence to suggest that order of entry penalties will occur in trial and repeat behavior when all other variables are equal. The order effect is observed on both first repeat and subsequent repeat purchases by those who have repeat purchased once. The market reward evident in share is the result of early entrant advantages in all phases of the purchase sequence.

In interpreting the dynamic parameters we observe that the term $(\phi + \Psi/E_t)$ is empirically always greater than zero for the share, trial and repeat models as assumed in our model of later entrants. The effects of the multiplicative and exponential growth parameters (α, ϕ, Ψ) on share can be most easily interpreted by the values in Table 2 which show the overall growth progression of the share ratio for second, third, and fourth entrants based on the estimated parameters and the assumption that the price, promotion, distribution, and advertising are equal to the first brand entry's levels. The table shows

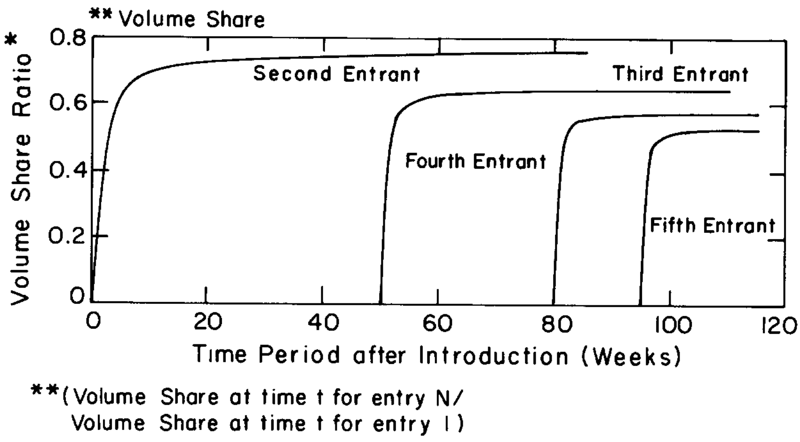

FIGURE 2. Share by Order of Entry.

the fraction of the asymptotic share ratio achieved in each period as well as the magnitude of the share ratio itself. The data in part (a) of Table 2 indicate that the rate of convergence to the asymptotic value is faster for entrant 3 than 2, 4 than 3, and 5 than 4. Later entrants approach their eventual share levels faster than early entrants all else being equal; however, the asymptotic values for later entrants are lower (see part (b) of Table 2). Figure 2 represents graphically the data in part (b) of Table 2 where the time between entrants is the average we observed in our data.[4]

In the trial penetration model the exponential growth parameter Ψ is not significant so the null hypothesis of equal rates of growth to the asymptote for later entrants cannot be rejected at the 10 percent level. The later entrants would not achieve trial penetration faster or slower than the earlier entrants, but they would achieve lower levels of asymptotic trial penetration if all else were equal. The trial penetration ratios are shown in Table 3. In the first repeat measure, the asymptotic and exponential growth parameters are significant at the 10 percent level. This indicates that later entrants achieve lower asymptotic results but at a faster rate than early entrants. The Ψ parameter is not significant for additional repeat purchases.

The patterns of growth for trial and repeat are analogous to the share patterns and are shown in Table 3 for 12 five-week periods. In all cases the later entrants achieve the same proportion of their eventual values faster than earlier entrants. When the asymptotic value for the order of entry effect (E_i^{α}) is combined with the proportion of asymptote achieved in each period, the ratios of trial or repeat purchasing versus the pioneer are generally less for earlier entrants in the initial early periods and greater in later periods.

The elasticities of price, promotion, distribution, and advertising are all significant in the share equation with distribution and promotion being most responsive. The trial behavior is similar with promotion and advertising significant. The repeat models show few significant variable coefficients. Only promotion is significant at the 10% level in the first repeat model; its coefficient is small and negative (a counterintuitive result). In the additional repeat model distribution is significant at the 5% level and positive in sign as expected.

The geometric weights for past variables (λ) were estimated by successive runs of the models with alternative levels of λ rather than directly in the nonlinear estimation algorithm because with λ as a parameter the procedure would not converge in a feasible

[4] Note that the slope of the share ratios for later entrants is not higher for all periods relative to the earlier entrants, but they do grow at a faster rate in terms of proportion of their asymptote as shown in Table 2(a).

TABLE 3

Trial and Repeat Ratios for Later Entrants with Price, Promotion, Advertising and Distribution Equal to Pioneer

(a) Estimated Trial Ratio (5-Week Time Periods)

Time	Entry 2	Entry 3	Entry 4	Entry 5
1	0.201	0.211	0.201	0.190
2	0.460	0.401	0.358	0.327
3	0.546	0.464	0.411	0.372
4	0.589	0.496	0.437	0.395
5	0.615	0.515	0.453	0.409
6	0.632	0.528	0.463	0.418
7	0.644	0.537	0.471	0.424
8	0.653	0.544	0.476	0.429
9	0.661	0.549	0.481	0.433
10	0.666	0.553	0.484	0.436
11	0.671	0.557	0.487	0.439
12	0.675	0.560	0.489	0.441

(a) Estimated Cumulative Percent of Triers Who Repeat (5-Week Time Periods)

Time	Entry 2	Entry 3	Entry 4	Entry 5
1	0.089	0.185	0.215	0.226
2	0.462	0.469	0.457	0.443
3	0.587	0.563	0.537	0.515
4	0.649	0.611	0.578	0.551
5	0.686	0.639	0.602	0.572
6	0.711	0.658	0.618	0.587
7	0.729	0.671	0.629	0.597
8	0.742	0.681	0.638	0.605
9	0.753	0.689	0.645	0.611
10	0.761	0.696	0.650	0.616
11	0.768	0.701	0.654	0.620
12	0.773	0.705	0.658	0.623

(c) Estimated Repeats Per Repeater (5-Week Time Periods)

Time	Entry 2	Entry 3	Entry 4	Entry 5
1	0.196	0.188	0.181	0.176
2	0.550	0.519	0.499	0.483
3	0.667	0.630	0.604	0.585
4	0.726	0.685	0.657	0.636
5	0.762	0.718	0.689	0.667
6	0.785	0.740	0.710	0.687
7	0.802	0.756	0.725	0.702
8	0.815	0.768	0.736	0.713
9	0.825	0.777	0.745	0.721
10	0.832	0.785	0.752	0.728
11	0.839	0.791	0.758	0.734
12	0.844	0.796	0.763	0.738

time (less than one hour of CPU time on an IBM 4341). Runs were made over the range of 0 to 1.0 in 0.05 intervals to minimize the squared errors. For trial a value 0.10 was found, for first repeat 0.25, and for additional repeats 0.30. Past marketing efforts did have an effect but the R^2 values increased only from 0.932 to 0.934 for trial, 0.814 to 0.815 in first repeat, and 0.881 to 0.912 in additional repeat, so the inclusion of the geometric weighting does not improve the fits very much except in the additional repeat model.

Eighty-nine percent of the dummy variables are significant at the 10 percent level. The variables appear to capture meaningful brand-specific effects, but the variation evident by inspection suggests that more than quality effects may be represented in the coefficients.[5]

Discussion and Future Research

Asymptotic Order of Entry Penalties

The reported analysis indicates substantial order of entry penalties for market share. Table 4 gives the asymptotic estimates for share in 2-, 3-, 4-, 5-, 6-, and 7-brand markets based on the order of entry penalty parameter of −0.4. Substantial share rewards are granted by the market for early entry. Late entrants should expect lower shares unless they market their products more aggressively or have better quality. If a firm is contemplating entry in a category, equation (1) can be used to calculate the effects of alternate advertising, price, distribution, and promotion. For example, it is doubtful that the 3rd brand to enter can justify the same advertising as the first brand. The share reduction due to lower advertising can be estimated by equation (1) with the Table 1 values. If the advertising and promotion of the third entrant is 0.65 of the first brand, price is equal to the pioneer, and distribution is 0.9 of the first entrant, the long-run share potential is 22% rather than 26% and the weekly market share is reduced proportionally in each period.

As we indicated earlier, the estimation results assume that the order variable ($E = 2, 3, 4, \cdots$) is linearly scaled in the asymptotic term E^{α}. The standard way to avoid this assumption would be to use dummy variables for each entry and estimate their values in the scaling problem. In our model this standard procedure cannot be used because the order dummy variables would be linearly related to the brand-specific dummies; the equation system would be singular and could not be estimated (recall we need the dummy variables on each brand to capture quality and other missing variables). However we can do a test of the scale assumption by dropping the brand-specific dummy variables and comparing a statistical fit of this reduced model with the exponential order effects (equation (1) with no brand specific dummies) to one with the order effect based on dummies for each order integer. In the first restricted model case the order parameter α is estimated to have a value of −0.66 and the calculated values for E^{α} for order 2, 3, 4, and 5 are, respectively, 0.63, 0.48, 0.40, and 0.35 (all values were significant at the one percent level and the R^2 was 0.853). These can be compared to the results of the second restricted model estimation in which the order dummy values for $E = 2$ to 5 are, respectively, 0.59, 0.43, 0.44, 0.34 (all values were significant at the one percent level and the R^2 was 0.856). The values are similar (mean difference −0.016 and RMS 0.042) and adding the additional parameters for the order dummies increases the fits very little (0.003). The linear scaling assumption seems acceptable and it allows us to include the brand-specific parameters in the estimation of the order effects reported in Table 4.

The statistical analysis of trial and repeat models indicates that overall asymptotic order of entry penalty is manifest in trial, first repeat, and subsequent repeat purchase behavior. Schmalensee (1982) modeled the source of order advantage based on the notion that once buyers use the first entrant's product, they will be unwilling to buy a second entrant without a price concession because they are not certain the second product will work. This would suggest the order effect will be seen only on trial. A number of authors (Hauser and Shugan 1983, Lane 1980, Prescott and Visscher 1977, and Rao and Bass 1985) suggest that if the early entrant takes the premier positioning in a space of heter-

[5] Only 17 brand dummies are reported because if all 18 dummies were included, the order of entry vector (E) would be a linear combination of the brand dummy vectors and the matrix would be singular.

TABLE 4
Order of Entry versus Market Share

	Asymptotic Market Shares for Each Order of Entry						
	1st	2nd	3rd	4th	5th	6th	7th
Number of brands in market							
1	100						
2	57	43					
3	42	32	26				
4	34	26	22	18			
5	29	22	18	16	15		
6	25	19	16	15	13	12	
7	23	17	15	13	12	11	9

ogeneous preferences, the later entrants will have to settle for lower shares. This again suggests a trial penalty. It would not posit a repeat order effect because those consumers who try the product do it because the product matches their preferences and we therefore would expect to have normal repeat rates. Our statistical results indicate order effects on *both* trial and repeat and therefore although our results support the above theories with respect to trial, our results indicate that the theories are not complete because they do not explain the observed repeat purchasing response to order of entry.

Carpenter and Nakamoto's experimental work (1989) suggests that early entrants enjoy an advantage by influencing the preference structure so that it favors the pioneer in situations in which preferences are ambiguous (not well-formed attribute importances). If this is true, the preference structure (brand attribute weights and ideal points) could favor early entrants in both trial and repeat behavior. They also identify the prototypicality of the pioneer as another source of advantage. If the pioneering brand becomes the prototype of the new category, customers may use it as a cognitive referent and the brand can gain accessibility advantages in memory. Such superiority in a schema in memory is an advantage (Sujan 1985) that could affect trial and repeat behavior. Our results support such theories and others that suggest a persistent advantage due to early entry (Kardes and Kalyanaram 1990, Samuelson and Zeckhauser 1988, Hauser and Wernerfelt 1990).

Fershtman, Mahajan, and Muller (1990) recently have argued based on a game theoretic economic model that mere order of entry has no relevance to market share in the long run and its effect is only through the effect of order of entry in production costs, advertising, price, quality, distribution and breadth of the product line. Our empirical results do not support this theory and we find the existence of an innate order of entry penalty after corrections for the effects of marketing variables.

Our work provides evidence of order effects on share and both trial and repeat purchasing and supports several of the behavioral theories indicated above that could explain these results. Behavioral experimentation and economic modeling is needed to isolate the determinants of these effects, the relative importance of each of the determinants, and the product situations where they operate.

Rate of Approach to Asymptote

The results on the dynamics of the order effects are mixed. The share equation identifies significant parameters that suggest later entrants approach lower levels of share but at a faster speed (see Table 2(a) and Figure 1 for the share dynamics and asymptotes based on the share parameter estimates and the price, promotion, distribution, and advertising equal to the pioneer). In the trial and additional repeat models, however, we do not find significant dynamic effects, while the cumulative first repeat model shows significantly faster approaches to lower levels of repeat for later entrants. We would have expected the trial dynamics to be significant because it is a large part of the overall share behavior of a new product. More empirical analysis is needed to clarify this question. It may be that the mixed results in the trial and repeat equations are due to the five-week basis of the data for these estimations (recall share measures are weekly). Larger sample sizes and improved nonlinear estimation algorithms may be needed. Given the available evidence in this paper, either there is no difference in the approach to the lower asymptotic share, trial, and repeat values or later entrants approach a lower asymptote at a faster rate.

Future Research

In addition to the need for the statistical, economic, and behavioral experimentation and analysis indicated above, it would be desirable to extend our model to include the effects of entry on price, promotion, advertising and distribution. If later entry is significantly correlated to the level of these variables, it may indicate the order of entry penalty is not innate, but rather due to later entrants charging higher prices and having lower promotion, advertising, and distribution levels. Entry penalties may also be affected by the defensive reactions of pioneers rather than the basic market granted advantage. Although Robinson (1988b) finds only limited competitive reactions in his analysis of 199 entrants in PIMS new startup businesses, it would be worth examining the phenomena in our consumer packaged goods data. A simultaneous equation extension of our model to include competitive reactions and entry on marketing mix variables is needed. Such a model would allow a comparison of the results to Robinson and Fornell's (1985) simultaneous modeling of consumer durable and nondurable goods data obtained from the PIMS business level data base.

In our analysis we did not include the time between entrants as a variable because we did not have a reliable measure of when the previous brand had entered if it entered before the beginning date of our UPC data (October 31, 1983). We have only 18 brands in the data base and in eight cases the previous brand entered before October 1983. Based on the UPC measures and rough estimates we got for the ten brands, we found no significant effect for the time between entries. Brown and Lattin (1990) have used the time from the pioneer's entry into the market to the ith brand entry as a variable to capture the longevity effect or what they call a "headstart" effect. They found significant effects in regional rollout and cross-sectional data for packaged goods. If a larger longitudinal data base were available we could include this headstart effect in our model. The presence of national UPC data bases should make this kind of estimation possible in the future.

Our model of the effects of marketing variables is symmetric and although it fits the data adequately it could be enriched. Research on market response modeling has indicated that asymmetries exist and can be important phenomena in modeling marketing variable effects (Carpenter, Cooper, Hanssens, and Midgley 1988; and Blattberg and Wisniewski 1989). It would be an interesting extension of the work here to include asymmetric response in the marketing variables. This would allow, for example, the effects of promotion changes by brand one to be different on brand two versus brand three in a category. We could not use an asymmetric form here because our data did not include all the brands in a category,[6] but the modeling of asymmetries may be particularly important if the asymmetries are systematically related to order of entry.

[6] Some of the intermediary entrants are not completely represented in our data window of October 1983 to January 1988. The largest number of complete brand histories we have in any one category is three brands of tartar control toothpaste, and this includes 3 of 4 brands. The smallest category contains 1 out of 5 entrants in gel toothpaste. We have 18 brands across 8 categories, so although we have many degrees of freedom due to the multiple periods, we have very few degrees of freedom across brands and we have captured much of this information in the dummy variables.

Cross-category differences in the order of entry effect should be examined and an appropriate behavioral mechanism to explain these cross-category differences must be studied if they are found. In this paper we have pooled data from eight categories. We are not able to undertake individual category level analyses in our data base because we do not have enough data within any one category to obtain convergence of the nonlinear share, trial, or repeat models. Ideally, we should perform the analyses in individual categories to prevent the biases that pooling could produce. Again, expanded data bases will soon make these analyses possible.

A final direction of future research is to model early entry as an endogenous phenomenon. If the "best" firms choose to enter early, perhaps the order effects are the result of the firm's unique strength and not entry per se? In this situation, entry is the result of the firm's attributes and strategy (endogenous) and not an independent (exogenous) variable. Early work by Vanhonacker and Day (1987) and Keck and Rao (1987) and recent work by Moore, Boulding and Goodstein (1991) suggest treating pioneering as exogenous may bias the statistical findings. Robinson, Fornell and Sullivan (1990) empirically do not find evidence of an endogenous marketing competence that might lead to pioneering, but what is needed is an explicit model that includes pioneering in its structure as a function of the firm's competence along with the effects of order of entry on the promotion, distribution and advertising levels of brands.

Our study only examines consumer packaged goods; it would be interesting to test the share model on consumer durables, industrial products, and services to see if order of entry penalties are evident. Data may be difficult to collect, but ethical pharmaceuticals could provide a fertile empirical data base.

Much research remains to be done in calibrating the size of the advantages of early entry, the behavioral determinants of such effects, when they can be expected to occur, and their managerial implications.[7]

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