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**When to Exit a Product:
Evidence from the U.S. Motion-Pictures Exhibition Market**

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When is it optimal for a multi-product firm to exit a product? We analyze strategic product exit using data on motion-pictures exhibition choices in a major metropolitan first-run market to estimate the survivor function for films at a given theatre. This analysis indicates that a film's survival at a particular theatre is affected by intra-firm relative performance and inter-firm competitive pressures. We find that theatres within chains avoid business stealing. Preliminary analysis further suggests that theatres compete for market share with neighboring theatres by increasing the time to exit when the competing theatre is owned by a different chain.

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I. Strategic Aspects of Product Re-Design

The characteristics of a particular theatre consist of its physical characteristics that are relatively inflexible, and the selection of movies that it shows in a particular week, that is relatively flexible. What, then, determines the menu of films that will be offered by a particular theatre in a particular week and how does this choice change from week to week?

To address this question, we estimate the survivor function for films at a given theatre. Arthur De Vany and W. David Walls (1997) estimated survivor functions for films at the aggregate, national level. Our approach is fundamentally different, analyzing the week-by-week decision-making of a theatre's owner to identify theatre-specific weekly trade-offs. We use measures studied by De Vany and Walls, such as rank and revenue performance, but also consider the time path of such variables to identify how the presence or absence of a film at a competitor's theatre in a given week affects the survival probability of that film at the focal theatre. De Vany and Walls's study allows for the possibility of films experiencing extended runs, making the survivor function difficult to estimate when a film becomes a "break-away" hit. By contrast, since we limit our focus to the weekly decisions of first-run theatres in a well-defined market, exit occurs with certainty, even with the "break-away" hits, rendering probability distributions with well-defined means and variances.

Our duration analysis relates to studies of exit in industries other than the motion-pictures market. Mary E. Deily (1991) studied steel-plant closings, using an ordered-logit framework, finding that individual plant characteristics and firm size influenced plant-closing decisions. Shane M. Greenstein and James B. Wade (1998) examined product life cycles in the computer-mainframe markets, using duration estimation methods for the product exit decision. We adopt

Greenstein and Wade's estimation approach to incorporate both time-invariant and time-varying covariates in our analysis of product (film) survival.

II. Data on Motion-Pictures Exit by Exhibitors.

Our dataset includes 13 first-run theatres in the Boston metropolitan market from June 30, 2000 through June 28, 2001. The data were collected by Synergy Retail, with support from a research grant from the DeSantis Center for Motion-Pictures Industry at Florida Atlantic University. We limit the scope of our study to first-run theatres, reflecting the industry view that these theatres compete in a market that is distinct from second-run and art-house theatres.

Contracts regarding the date on which a new film can be introduced are relatively inflexible but exhibitors have significant discretion over the termination of a film's run. Thus, we take the decision-making unit to be the theatre and focus on the decision to exit products (films) taking as fixed the contractual agreements with distributors. Our present analysis considers the weekly film-programming choices of three of the theatres in the full data set: Assembly Square (Somerville); Fresh Pond 10 (Cambridge); and Fenway 13 (Boston). These theatres are of interest since Assembly is owned by the Loew's movie chain, Fresh Pond is Assembly's nearest first-run neighbor owned by Loew's, and Fenway is Assembly's nearest first-run neighbor not owned by Loew's. Thus, we can explore the empirical significance of within-chain cannibalization and across-chain competition.

III. Measuring Strategic Determinants of Product Exit

Each theatre offered between 106 and 121 "products" (films) over the sample period, the typical duration of a film's inclusion in a first-run theatre's offerings being relatively short (mean and variance are 3.5 and 2.6, respectively). So we have the opportunity to study a rich, dynamic set of product-exit decisions.

An exhibitor's strategic choices will be influenced by intra-theatre factors such as the film's rank, *RANKATTHEATRE*, based on relative revenues, percentage of theatre revenue generated by the film, *%THEATREREV*, and first week's revenues, *REVFIRSTWEEK*.

The number of screens on which a film is released during the first week of its national run, *OPENINGSCREENSUS*, may influence a film's survival. A wide release can signal the studio's expectation that a given film be marketed as a blockbuster film. We further control for film attributes by using two measures of the "star power" of the cast of each film using *Hollywood Reporter's* 1999 Star Power Survey (www.hollywoodreporter.com/thr/index.jsp). *RISINGSTAR* is an indicator variable equal to 1 if any leading cast member in a given film was identified as possessing significant boxoffice potential in 1999. *STARPOWERMAX*, which has range [0, 100], represents the maximum index score assigned to cast members for a given film. Finally, we include fixed effects for the genre classification of each film.

Theatre chains differ in the contracts they negotiate with distributors. Thus, among the three theatres we study, whether or not the theatre is owned by Loew's should influence survival rates; *LOEWS* is an indicator variable equal to 1 for such cases and zero otherwise.

It is also to be expected that theatres owned by the same chain are less likely to engage in direct competition than two theatres owned by different chains. We construct a weekly history for each film showing at Assembly. If in the first week of a film's run, the film is also showing at Fresh Pond during that week, *SHOWATNEIGHBOR*, an indicator variable, equals one, otherwise it equals zero, for $t = 1$. We construct a history of this indicator variable until the final run-week of the film at Assembly. We then examine a second subsample, using Assembly as the focal theatre and comparing its offerings to Fenway in an analogous fashion.

If a chain wishes to avoid cannibalization the time-ratio for *SHOWATNEIGHBOR* will be less than one: the presence of the film at the nearest same-owned theatre decreases the likelihood of survival at the focal theatre. When the two theatres are owned by different chains, we expect them to compete for market share, giving a time-ratio greater than one: the presence of the film at a nearby competing chain's theatre increases the probability of the film surviving at the focal theatre. This measure builds on Greenstein and Wade's (1998) analysis of the competitive influence of close and distant substitutes on the product life-cycle of mainframe computers.

IV. Duration Analysis

To identify the general shape of the survivor function for, we use the Kaplan-Meier non-parametric product-limit estimator. We conduct three tests for equality of survivor functions across ownership (by chain) and across individual theatres: the exponential scores log-rank test; the Wilcoxon-Breslow-Gehan test; and the Peto-Peto-Prentice test. In all cases, we reject the null hypothesis that the survivor functions are the same across chains or across theatres, each with significance beyond the .01 level. We further consider maximum-likelihood estimations of the hazard function, $\lambda(t) = f(t) / S(t)$, where $f(t)$ is the probability distribution of T , the length of a film's run in a first-run theatre, and $S(t)$ is the corresponding survivor function. Graphs of these estimates suggest log-normal or log-logistic probability distributions for T .

The unit of analysis is a film-theatre pair. The values of the time-varying covariates are measured during each week of the film's run. Using the covariates and controls described above, we estimate the Cox proportional hazards model. Based on the Schoenfeld test, we reject the assumption of proportional hazards beyond the .05 level. We thus use an accelerated failure-time (AFT) model to estimate the following equation:

$$\ln t_j = x_j \beta + z_j \tag{1}$$

where x_j is the vector of relevant attributes, β is the vector of coefficients, and z_j is the error term. Note that “accelerated failure-time” refers to an increase in the expected waiting time until product exit. Based on the general shape of the estimated hazards functions, we assume that the error term follows a normal distribution. This leads to the lognormal survival function of the following form: $S(t) = 1 - \Phi\{(\ln(t) - \mu)/\sigma\}$. The results of our estimations are presented in Table 1. To test the robustness of these results, we also estimate (1) with the log-logistic and the Weibull specifications. The qualitative results of Table 1 hold under both specifications.

The estimates are time-ratios derived by exponentiating the regression coefficients. An estimate greater than one indicates the percentage by which the expected survival time of the film increases. Similarly, a time-ratio less than one implies a decrease in the expected survival time of the film by a percentage equal to the deviation from one.

Regression I, covering the combined sample, shows that internal opportunity costs affect exit. The coefficient on *RANKATTHEATRE* suggests that films with better relative performance run longer. When the rank variable is replaced by *%THEATREREV*, the percentage of a theatre’s revenue generated by a given film has a positive and significant impact on expected time until exit, consistent with the rank result. The statistically significant impact of ownership on run length suggests that inter-firm considerations also affect exit decisions. Ownership by Loew’s tends to shorten expected time to exit by just over 20%. The presence of a rising star has, if anything, a negative impact on a film’s survival. When *RISINGSTAR* is replaced with *STARPOWERMAX*, the impact of star status on survival is insignificant. While *OPENINGSCREENSUS* and *REVFIRSTWEEKEND* are statistically significant, the magnitude of their impact on survival is low. This is consistent with DeVany and Walls’ (1996) finding that

when a film's entire run length is considered, and we allow for movement of the film to theatres beyond those at which they open initially, a film's success can take a highly unpredictable path.

Regressions II and III treat Assembly as the focal theatre and include the variable *SHOWATNEIGHBOR*. When the same chain owns the comparison theatre, the presence of a given film among both theatres' offerings decreases the expected time to exit for the focal theatre by 27%; this result is significant beyond the .01 level and provides evidence that theatres within chains avoid business stealing. By contrast, when a different chain owns the comparison theatre, the presence of a given film among both theatres' offerings *increases* the expected time to exit by 12%; theatres compete for market share with neighboring theatres owned by competing chains. While the p-value for this result is only (0.253), the result is promising, suggesting that extension to a larger sample will produce more robust findings.

V. Conclusions

All multi-product firms have to make strategic decisions with respect to their product offerings. In particular, as new products come available, the firms have to determine whether, and which of their current products should be dropped. This paper presents an empirical analysis of the product-retention/product-exit decision in a particularly rich and dynamic setting: the weekly film programming choices that are made by first-run movie theatres.

As might be expected, we have shown that the decision to drop a film is affected by intra-theatre considerations; particularly the film's ranking relative to other films showing at the theatre. By contrast, external more global factors, such as the number of screens on which a film opens nationwide or the "star-power" of the main actors, either do not affect the film's survival at the theatre level or are insignificant as determinants of survival.

We have also shown that inter-theatre strategic factors influence product (film) exit. Our analysis provides strong evidence that ownership matters to the product exit decision. Theatres under different ownership compete for market share by retaining particular films. By contrast, theatres under common ownership attempt to avoid business stealing.

Several extensions to this analysis can be suggested. First, we can extend the analysis to the entire first-run Boston metropolitan market. We anticipate that when we include all 13 first-run theatres in the analysis, with adjustments for distance to all theatres in the market, and controls for chain ownership across the sample, the significance level on *SHOWATNEIGHBOR* will increase. We further expect that the influence of inter-theatre strategic factors on expected time to exit will diminish as the distance between competing theatres increases.

Secondly, extending the analysis to the first-run market in South Florida will allow us to investigate how the intra- and inter-firm competitive factors identified here affect radial markets, such as the Boston market, as compared to linear markets, such as South Florida.

Third, we aim to introduce further strategic and control variables. For example, survival of a current film is likely to be affected by the number of new films being released nationally in a particular week. We expect to find a more strategic effect on film survival in the week(s) before a holiday. Among the control variables, we propose to include more detailed controls for release dates and for the precise characteristics of the individual films.

Table 1. Accelerated Failure-Time Estimation with Censored Durations

Parameter	(I)	(II)	(III)
RANKATTHEATRE	0.865 (-9.85)***	0.886 (-7.27)***	0.876 (-7.05)***
RISINGSTAR	0.865 (-1.69)*	0.989 (-0.11)	1.023 (0.20)
OPENING SCREENS US	1.000 (1.78)*	1.000 (1.45)	1.000 (0.65)
REVFIRSTWEEKEND	1.000 (3.94)***	1.000 (3.66)***	1.000 (3.57)***
LOEWS	0.783 (-3.30)***		
SHOWATNEIGHBOR		0.730 (-2.62)***	1.121 (1.14)
σ	0.494 (0.024)	0.413 (0.028)	0.431 (0.032)
Number of Subjects	378	130	130
Number of Exits	346	121	121
Total Observations	1717	602	602
Log Pseudo-Likelihood	-130.06	-25.24	-27.66
Wald $\chi^2(11)$	235.42	125.73	110.81

Estimation of survivor functions under log-normality assumption with robust standard errors clustered on film-theatre subjects; time interval is one week. Fixed effects for film genre.

Time ratios reported from exponentiated coefficients.

Estimations based on: combined data from Assembly, Fresh Pond, and Fenway (I); Assembly-Fresh Pond subsample (II); and Assembly-Fenway subsample (III).

z-values reported in parentheses; standard error reported in parentheses for σ estimates.

Significance levels *.10, **.05, ***.01.

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