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**Product Differentiation and Film Programming Choice:
Do First-Run Movie Theatres Show the Same Films?**

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Abstract

We present an empirical analysis of product differentiation using a rich new dynamic panel data set on film programming choice in a major U.S. metropolitan motion-pictures exhibition market. These data allow us to investigate the determinants of strategic product differentiation in a multi-characteristics space. We find evidence of stability in the degree of product differentiation over time, but also find that the degree of product differentiation between theatre pairs reflects a balance between strategic concerns and contractual constraints. Similarity in one dimension is offset by differentiation in others. Finally, we find that theatres under common ownership make more similar programming choices than theatres with different owners.

JEL Classifications: L11, C33, L82

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The seminal analysis by Hotelling (1929) on “Stability in Competition” has sparked a large and growing theoretical literature concerned with the following deceptively simple questions. Should we expect to find, as Hotelling claimed, that firms offering horizontally differentiated products choose product designs with minimum differentiation? Or, should we expect to find, as d’Aspremont *et al.* (1979) claim in their critique of Hotelling, that these same firms seek maximal differentiation in their product designs in order to soften competition?

The simple but frustrating answer to these theoretical questions is that “it depends”. Specifically, it depends upon the particular modeling assumptions that we make. Borenstein and Netz (1999) aptly characterize the reason for the theoretical ambiguity.¹ Non-cooperative firms balance two forces when making their location, or more generally product-design choices: an “attraction” force that draws a firm closer to its rivals in order to steal business from them and a “repulsion” force that induces firms to separate in order to soften competition. There is no *a priori* reason to believe that one of these forces always dominates the other.

When theory is inconclusive, we must turn to empirical or experimental investigation to shed light on the interplay between these attraction and repulsion forces. Unfortunately, very few such investigations are available. Significant exceptions are Borenstein and Netz (1999) and Netz and Taylor (2002). In both cases, however, the area of application is essentially spatial rather than one of product design. Moreover, their areas of application are static, looking at location choices at a particular point in time.

Our paper examines a particularly rich and dynamic type of product differentiation: the weekly film programming choices made by first-run movie theatres within a well-defined geographic area. We can think of a first-run movie theatre as offering a product with multiple

characteristics: besides the location of the theatre there is also the number of different films being shown and the number of screenings of these films. On this basis, movie theatre i is less differentiated from movie theatre j in a particular period the more movies, or screenings, they have in common in that period.

Our analysis allows us to provide empirical evidence with respect to several important questions relating to product design and product re-design.

First, do first-run movie theatres that are in more direct competition with each other on one dimension, such as location, adopt product designs – film programming selections – that are more, or less, similar? Here we potentially have a theoretical prediction that is consistent with the “balancing” idea of Borenstein and Netz and that lends itself to empirical testing. Irmen and Thisse (1998) provide one of the few theoretical analyses of product design choices by firms that offer products with multiple characteristics. They develop a model with quadratic utility loss that might be expected to generate maximal differentiation, but show that if there is a “dominant” characteristic, then firms will maximally differentiate on this characteristic and minimally differentiate on the others.

Our empirical context is, of course, much more complex than that envisaged by Irmen and Thisse. Complicating factors include: heterogeneous consumers; product characteristics that are not easily classified as being dominant or dominated; and the ability to change product design (movie mix) over time at relatively low cost. Nevertheless, it seems reasonable to suggest that an empirical implication of the Irmen and Thisse analysis is that if movie theatres are

¹ In addition, they provide an extensive review of the current literature. See also Chisholm and Norman (2004).

“close” to each other in one set of characteristics, whether by choice or as a result of an exogenous factor,² they will seek to differentiate themselves on other characteristics.

Second, to what extent does ownership matter in product design? A familiar and not surprising result from theory is that multi-product firms typically make different location or product design choices from single-product non-cooperative oligopolists.³ In our specific context, therefore, we should expect that a multi-outlet firm, such as a theatre chain, makes different design decisions from those of a single-outlet firm. Full coordination of product-design choice by a particular multi-product firm is unlikely to be feasible, however, since this firm is in competition with other single- and multi-product firms.

A novel feature of our data is that we track weekly movie selection for each first-run theatre in our sample for a period of 52 weeks. This allows us to examine some of the dynamics of product differentiation. In particular, the specific contractual system within which the movie theatres operate has a significant impact on the exhibitors’ choice of which movies to show in particular weeks. The major studios typically release what they hope to be “blockbuster” movies close to important holidays and negotiate with the distributors and exhibitors to secure extensive coordinated release of these movies: the release of the final film in the “Lord of the Rings” trilogy is just one case in point. As a result, we would expect to find greater similarity in movie selection nearer to major holidays.

However, recall our hypothesis, derived from Irlen and Thisse, that when similarity is forced in one set of characteristics, we should expect to find differentiation in others. In our specific dynamic context, we conjecture that there are important strategic elements to movie

² We consider one such force, contractual relationships between movie producers and exhibitors, below.

³ See, for example, Chisholm and Norman (2004), Norman and Pepall (2000), Pal and Sarkar (2002).

selection, with theatres exhibiting a desire to differentiate their offerings to at least some extent. It follows that similarity in programming choices close to major holidays in response to contractual pressures should be expected to decline in response to strategic considerations when we consider weeks further from such holidays.

Our main findings can be summarized as follows. First, movie theatres that are located geographically more closely to each other make film programming choices that are less similar. Second, similarity is high close to major holidays but then declines with “distance” from such holidays. Third, “ownership matters” in the sense that theatre pairs under common ownership tend to be more similar in their film programming choices than do theatre pairs that have different owners. The first two results are consistent with our theoretical expectations. The third implies that the advantages of centralized contracting by theatres’ owners with movie distributors, and the importance of the center’s reading of the market, impact programming choice more than local strategic considerations.

In the next section we develop our measures of similarity in product design. Section III proposes a number of empirically testable determinants of similarity; Section IV describes the data, their sources and institutional background; Section V presents our empirical analysis; and Section VI provides concluding remarks.

II Measuring Product Differentiation in a Strategic Market Setting

The dependent variable throughout our analysis is the degree of product similarity, measured weekly, between pairs of first-run movie theatres. We consider two such measures. The first, SA_{ijt} , motivated by Jaffe (1986), measures the angle between two vectors whose elements reflect each theatre’s product attributes (movies being shown) between theatre i and

theatre j in a particular week t . This is an inverse measure of similarity in that the greater the angle, the lower is the similarity. The second, $SM_{ij,t}$, measures the percentage of movie matches between theatre i and theatre j , in a particular week t , relative to the total number of possible matches, with an appropriate normalization described below, and so provides a direct measure of similarity.

A complication in measuring similarity in our specific context is that popular films may be shown on multiple screens in a given week. As a result, our measure of similarity will differ depending upon whether we measure similarity in screenings or similarity in movies. Our econometric analysis considers both screening and movie measures of similarity.

For both the angular and the matching measures of similarity, we consider a well-defined geographic market, in our case the Boston metropolitan area. For each week t we begin by counting the total number of films, N_b , playing in the first-run movie theatres across the entire market on a particular day: given our data sources, we chose the Friday of each week. We define the angular measure, SA_{ijt} , based on screenings, as follows. The attributes vector A_{it} for theatre i in week t has length N_b , where the n th element a_{nit} corresponds to the n th film, with the films ordered alphabetically. Suppose theatre i has five screens, each of which can show four films on a typical Friday and thus possesses a total “showings capacity” of 20 time slots. Suppose further that in week t theatre i is showing four films, one of which is presented on two screens, out of a total of ten films that are being shown across the entire market that week. The elements of the attributes vector corresponding to the four films playing at theatre i are the percentages of screen capacity devoted to each film. In the present example, three of the a_{nit} elements equal 0.20; the fourth element, corresponding to the film showing on two screens, equals 0.40. The remaining

six cells of the attributes vector equal zero to reflect the absence of a current film from theatre i 's offerings in that week. The attributes vector A_{jt} for theatre j is constructed analogously.

The angular measure of the similarity between the two theatres' film offerings based on screenings is the angle between vector A_{it} and vector A_{jt} :

$$SA_{ijt} = \arccos\left(\frac{A_{it} \cdot A_{jt}}{\|A_{it}\| \|A_{jt}\|}\right) \quad (1)$$

converted to degrees. Thus if the two theatres have an identical set of films, with an identical distribution across screens, the angle between the vectors will be zero. The angle between the vectors increases, and approaches 90 degrees, the more dissimilar or differentiated the theatres are relative to one another.

An alternative angular measure we consider focuses on a simple comparison of films showing at theatres i and j . Again, in week t we begin with a vector of length N_t as defined above. If a film is playing at theatre i , the element in the vector corresponding to that film equals one; it equals zero otherwise. If both theatre i and theatre j are showing the same set of films, even if the capacity distribution differs, the movie-count attributes vectors will be identical. The angle between the vectors will be zero, implying "identical" products in a qualitative, but not proportionate, sense. As the two theatres' offerings diverge, this angular measure again approaches 90 degrees.

A particular advantage of the angular measure of similarity, whether based on screenings or films, is that the "measure of proximity is purely directional i.e. it is not directly affected by the length of the (A) vectors." (Jaffe, 1986, p. 986, fn 5) In our specific context, the angular measure of similarity is unaffected by variation in the number of films shown in different weeks.

A limitation of the angular measure, however, is that it is sensitive to differences in the number of screens between theatres i and j : the greater is this difference the greater A_{ijt} is likely to be. In contrast to the matching measure (see below) no simple normalization for the impact of differences in numbers of screens suggests itself. As a result, in the empirical implementation we include an independent variable that is designed to capture this effect.

The second similarity measure we consider is derived from the percentage of matches between two theatres and thus quite naturally ranges between zero and one as two theatres move from perfectly dissimilar, or highly differentiated, to perfectly identical, or homogeneous. Once again, we must take into account two complicating factors. First, the number of screens at a particular theatre affects the characteristic (movie) mix that the theatre can offer. Second, there is the possibility that a particular film might be shown on multiple screens in one theatre but not in another.

This suggests the following approach for any pair of theatres i and j in each week t . For each film playing at theatre i , determine if that film is also playing at theatre j in that week. If so, and if the film is playing three times at theatre i and four times at theatre j , the number-of-screenings matches for this film is three. Add this to the other number-of-screenings matches for all other common films across both theatres to derive the total number of screenings in common, S_{ct} . This information is used to generate a similarity metric:

$$S_{ijt} = \left(\frac{S_{ct}^2}{\bar{S}_i \cdot \bar{S}_j} \right)^\beta \quad (2)$$

where \bar{S}_h is the number of screenings that is possible at movie theatre $h = i, j$ and β is a parameter greater than zero.

An obvious limitation of S_{ijt} is that, while it is distributed on the interval $[0, 1]$, it is concatenated in this interval if $\bar{S}_i \neq \bar{S}_j$. In other words, as with the angular measure the matching measure in (2) is affected by differences in the number of screens between theatre pairs. In this case, however, a simple correction for this potential bias is available. We normalize S_{ijt} by the maximum degree of similarity $\bar{S}_{ij} = \left(\left(\min(\bar{S}_i, \bar{S}_j) \right)^2 / \bar{S}_i \cdot \bar{S}_j \right)^\beta$ to give the normalized matching similarity measure:

$$SM_{ijt} = \left(\frac{S_{ct}}{\min(\bar{S}_i, \bar{S}_j)} \right)^{2\beta} \quad (3)$$

The normalized matching similarity index (3) can be thought of as a count measure, reflecting the number of “successes” (or matches) the two products mutually possess, relative to the maximum potential for success (or matches). This formulation of the similarity index suggests an underlying binomial process, which motivates our choice to confine our attention to $\beta = 1/2$. Note also that, as with the angular measure, N_t does not directly affect this measure of similarity.

III Determinants of Product Similarity

We now turn to the specific strategic and institutional factors that might be expected to influence the degree of similarity in film programming choice between two theatres. In doing so, we distinguish between time-invariant effects that are likely to affect similarity in programming across weeks and time-variant effects that are likely to affect the dynamics of film programming choice.

Given the nature of our data and the available theory discussed in the introduction, there are three obvious time-invariant effects that we expect will influence the degree of similarity in movie selection for each theatre pair. First, theatres that are located more closely to each other are likely to be in competition much more directly than those that are geographically separated. In order to test for this effect we construct $DISTANCE_{ij}$, the distance in miles between theatre i and theatre j , derived from GPS data for each theatre. The Irmen and Thisse analysis discussed above leads us to expect that theatres more closely located to each other in one characteristic, in this case geographic location, will seek to differentiate themselves in other characteristics (movie offerings) in order to soften competition for customers. Thus we expect the angular similarity index to decrease, and the proportionate similarity index to increase, with $DISTANCE_{ij}$.⁴

Second, we expect to find that “ownership matters” in film programming choice, but in this case precisely how is not clear *a priori*. To capture the different incentives that might arise when two theatres are owned by the same company, we create the dummy variable $SAMEOWNER_{ij}$, which equals one if theatre i and theatre j are owned by the same company, and zero otherwise. If companies negotiate better contracting terms with distributors when movies are acquired in bulk, or if programming decisions are centralized and affected by the “center’s” reading of the market, we would expect $SAMEOWNER_{ij}$ to increase programming similarity. By contrast, if programming decisions are centralized and dominated by the desire to avoid direct competition between theatres under common ownership we would expect $SAMEOWNER_{ij}$ to decrease similarity. Finally, if individual theatres behave autonomously, with inter-theatre

⁴ A movie distributor might decide that only one theatre, within close proximity to another, is allowed to show a particular film based on a clearance zone. While data are not available on the specific clearance terms of the films in our data set, the existence of such contracts only serve to enhance to predicted impact of $DISTANCE_{ij}$ on similarity.

competitive forces dominating programming choice, and with few economies from large-scale distribution contracts, then $SAMEOWNER_{ij}$ should have little or no effect.

Third, we expect that programming choice will be affected at least in part by demographics, to the extent that movie-going choices differ by the precise characteristics of the movie-going population “close to,” and thus within, the natural catchment area of a particular movie theatre. As a result, we test for the importance of differences in a number of demographic variables, including age, income, population, and households, each measured within three-, five-, and ten-mile radii of each of the theatres in a given ij pair.

We noted in the introduction that the contractual context in which movie theatres operate is likely to affect film programming choice. In particular, since our focus is on first-run theatres in a major metropolitan area, we would expect similarity in programming choice to be greatest in the vicinity of major holidays when many of the theatre owners are contractually committed to allocate multiple screens to “holiday” films, whose release dates are announced several months in advance.

One approach to measuring this effect would be to introduce a dummy variable, dependent upon whether or not a particular week is “close to” a holiday. We conjecture, however, that similarity forced by contractual considerations is counteracted by the desire to differentiate deriving from strategic considerations. If this is the case, then we should expect to find that similarity decreases more smoothly with “distance” from major holidays. We test for this effect by $HOLIDAYDISTANCE_t$, defined as the number of weeks the current week is away from the nearest holiday. If the current week is a holiday week, $HOLIDAYDISTANCE_t$ equals zero. If the current week is between two holidays, the total number of weeks between the two

holidays is divided in half. As a result, $HOLIDAYDISTANCE_t$ increases with the number of weeks away from the first holiday until it reaches the half-way point between the two holidays, then declines incrementally until it reaches zero again at the next holiday. We use Memorial Day, the Fourth of July, Thanksgiving, and Christmas as the holidays in our sample, reflecting the historical importance of these major holidays for revenue generation for motion-pictures exhibitors. Our general expectation is that theatres will offer more similar programming choices closer to holidays.

We noted in the previous section that the angular measure SA_{ijt} is likely to be positively biased if theatres i and j have different numbers of screens. Differences in screens between theatre pairs reflect differences in capacity and so should result in differences in revenues. As a result, we introduce the variable $\%REVDIFF_{ijt-1}$, the magnitude of the difference in total weekly revenue between the two theatres during the previous week, divided by the average weekly revenue generated by the two theatres during the previous week.⁵ We anticipate that there will be a positive relationship between differences in market share and revenue generation and our angular measure of similarity SA_{ijt} . By contrast, since the angular measure is normalized for screens, $\%REVDIFF_{ijt-1}$ should have no significant impact on SM_{ijt} .

Finally, we expect to observe some degree of inertia in programming choice: if two theatres offer similar film programming choices this week they are likely to have been similar last week; if they were similar last week they will have been similar the week before, and so on. As with our holiday measure, however, this inertia will be offset by strategic considerations that lead theatres to try to differentiate themselves. The stronger are the strategic considerations the

⁵ An alternative approach is to introduce a time-invariant measure such as the absolute difference in the number of screens between theatre pairs. We tested both in the empirical implementation.

shorter will be the period over which inertia in programming is likely to be important. This leads us to include lagged values of the dependent variable in the analysis.

IV Film-Programming Data and Institutional Background

The implementation of our econometric analysis is based upon data drawn from the first-run motion-pictures exhibition market in the Boston metropolitan area. The market contains 13 theatres in and around Boston: see Figure 1 for their locations. For each theatre, for each week from June 30, 2000 through the week of June 22, 2001, we have information from Nielsen EDI on which films were playing, and on the revenues generated at each theatre by each film for that week. We supplemented these data by recording screening times on the Friday of each week, for each film, for each theatre in our data set. Screening-time information was determined by reviewing *Boston Globe* movie advertisements on microfilm.⁶ This screening information is the basis for constructing the screenings-count similarity indexes.

(Figure 1 near here)

Descriptive statistics are presented in Table 1. The total number of observations for each of the similarity indexes is 4,056, generated for 78 ij pairs over the 52 weeks we study. As we noted above, the angular similarity index is restricted to the interval $[0, 90]$ while the matching index is restricted to the interval $[0, 1]$. The mean of the angular index is 39.74 and of the matching index is 0.80. This indicates that there is some underlying degree of similarity in film programming choice across the theatre pairs in our sample. However, there is also considerable

⁶ One first-run theatre in Quincy advertised in the *Boston Globe* from June 30, 2000 through September 28, 2000, but did not advertise for the remainder of the time period. We have excluded the Quincy theatre from our main empirical analysis under the assumption that it belongs to a market south of Boston and thus it is not reasonable to treat it as being in competition with the theatres that were closer to Boston and that advertised in the same medium. However, when we include Quincy in our analysis and limit our period of study to June 30th through September 28th, we obtain results similar to our main findings. These findings are documented in detail in Section V along with our main results.

variability in film programming choice, as indicated by the ranges of the angular and matching indexes. Figure 2, which illustrates the weekly pattern in the angular similarity measure for one theatre relative to the others in the sample,⁷ further suggests that while there are significant differences in the degree of similarity across theatre pairs, there is some consistency in the variation in the similarity measure over time, perhaps as a result of the seasonal contractual issues noted above.

(Table 1 near here)

(Figure 2 near here)

DISTANCE between two *ij* pairs varies from a minimum of little over a mile, the distance between Copley Place and Fenway 13, both in Boston, and a maximum of roughly 54 miles, the distance between Liberty Tree Mall, Danvers and Showcase Cinemas, Randolph. The mean distance between theatre pairs is roughly 19 miles. Figure 1 suggests, and Table 1 confirms, that there is no significant difference in the average distance between theatres in our sample that are under the same ownership and those that are owned by different chains.

SAMEOWNER has a mean of 0.28 indicating that roughly twenty-eight percent of the *ij* pairs are theatre pairs owned by the same parent company. Three companies owned the theatres comprising the first-run Boston market during our period of study: National Amusements Corporation; General Cinema (G.C.) Corporation; and Loews Cineplex Entertainment Corporation.⁸ Of these three companies, National Amusements held the dominant market

⁷ The theatre we chose is Assembly.

⁸ Theatres owned by National Amusements include: Cleveland Circle Cinemas (Brookline); Quincy Cinemas; Showcase Cinemas of Dedham; Showcase Cinemas of Randolph; Showcase Cinemas of Revere; and Showcase Cinemas of Woburn. Theatres owned by General Cinema include: Braintree 10; Burlington 10; Chestnut Hill Cinema 5; and Fenway 13 (Boston). Theatres owned by Loews Cineplex Entertainment include: Assembly Square (Somerville); Copley Place (Boston); Fresh Pond 10 (Cambridge); and Liberty Tree Mall (Danvers). Note that this description includes the Quincy theatre; see discussion in note 4.

position, owning six theatres, spread across the radial market around Boston, with significant coverage on or near the I-95 loop enclosing the Boston metropolitan area. General Cinema Corporation owned four theatres, distributed in a similar pattern to National Amusements' capacity, but on a smaller scale, and with proportionately greater market concentration closer to Boston.⁹ Loews owned four theatres, whose locations were concentrated in the Boston/Cambridge area, with one theatre located further north on the I-95 loop.¹⁰

HOLIDAYDISTANCE has a mean of 4 and a maximum of 10, attained in week 11 and in weeks 36 and 37 in our sample. These are the weeks that lie midway between the Fourth of July and Thanksgiving, and between Christmas and Memorial Day, respectively.

Figure 3 compares *HOLIDAYDISTANCE* to the mean similarity indexes for each week for the total sample, for theatre pairs under the same ownership, and for theatre pairs under different ownership. A number of implications follow from this figure, each of which is tested formally in our econometric analysis. It does, indeed seem to be the case that there is an inverse relationship between similarity in film programming choice and “distance” from major holidays (recall that the angular index is an inverse measure of similarity). Further, the dynamics of film programming choice seem quite similar whether the theatres pairs are under the same or different ownership. However, ownership does indeed appear to be important, with theatre pairs under common ownership typically offering more similar film programming choices than those under different ownership.

⁹ General Cinema Corporation filed for Chapter 11 reorganization on October 11, 2000; AMC Entertainment won approval to acquire General Cinema's assets in March 2002. The GCC theatres in the Boston market operated continuously throughout our period of study, and the quality and features of the theatres were similar to competing first-run theatres in the Boston market. See “Court Approves GC Cos. Sale to AMC,” *Boston Business Journal*, March 19, 2002.

The variable *%REVENUE DIFF* has a mean of .65 and ranges between a minimum of nearly zero to 1.70 for the total sample. Thus the percentage difference in the previous week's revenue can range from virtually no difference to almost 170 percent difference. The average percentage difference is similar for theatre pairs under the same ownership (.69) as for theatre pairs under different ownership (.63).

The demographic variables, which measure percentage differences in demographic values within five-mile radii of theatre *i* compared the values within a five-mile radius of theatre *j*, cover age, income, population, and number of households. The *%AGE DIFF* and *%INCOME DIFF* measure percentage differences in average age and average income, respectively. The means of *%AGE DIFF*, *%INCOME DIFF*, *%POPULATION DIFF*, and *%HOUSEHOLD DIFF* are 0.04, 0.17, 0.73, and 0.76, respectively. We focus on differences in age distribution and income in the econometric analysis.

During the time period of our study, no first-run theatres in this market opened or closed. Thus we can treat the spatial structure of the market as essentially constant throughout the period of study. Further, when we examine the theatre *i* and theatre *j* pairs using panel-data techniques, we work with a balanced data set.

V Econometric Model and Results

Because a number of our important explanatory variables are time-invariant (*DISTANCE*, *SAMEOWNER*, and the demographic characteristics), we adopt pooled ordinary least-squares as

¹⁰Loews Cineplex Entertainment Corporation resulted from the merger of Sony/Loews Theatres and Cineplex Odeon Corporation in May 1998. We treat theatres operating under either the name of Sony or Loews as being owned by the same company.

our main estimation method.¹¹ We estimate equations of the following general form, where SI_{ijt} represents the similarity index of interest, either angular (SA_{ijt}) or matching (SM_{ijt}):

$$SI_{ijt} = \alpha + x_{ijt}\beta_1 + v_{ij}\beta_2 + \varepsilon_{ijt} \quad (4)$$

Note that in this formulation, each theatre pair is treated as the ij th cross-sectional group.

Equation 4 states that the similarity index for a given theatre pair, in a given week, will be a function of strategic factors, some of which vary with time, x_{ijt} , and some of which are time-invariant, v_{ij} , within this theatre-pair relationship. ε_{ijt} is the usual disturbance term. One complication arises due to the fact that our dependent variable is truncated either on the interval $[0, 90]$ or $[0, 1]$. This means that we may obtain predicted values outside the range of actual possible values. One way of addressing this limitation is to transform the dependent variable using, for example, a log-odds ratio. One drawback of such a transformation is that the interpretation of the estimated coefficients then becomes more complicated. Thus our preferred strategy is to report coefficients estimated using the truncated variables.¹²

To summarize, we estimate the following reduced-form equation using pooled ordinary least squares:

$$SI_{ijt} = \alpha + \beta_1 SAMEOWNER_{ij} + \beta_2 DISTANCE_{ij} + \beta_3 HOLIDAYDIST_t + \beta_4 \%REVDIFF_{ij,t-1} + \beta_5 \%AGEDIFF_{ij} + \beta_6 SI_{ij,t-1} + \beta_7 SI_{ij,t-2} + \varepsilon_{ijt} \quad (5)$$

¹¹ Within (ij pair) estimates reported in the appendix show that the estimated coefficients on the time-varying variables correspond closely to the estimates obtained using pooled OLS.

¹² The matching index, SM_{ijt} , is the more appropriate candidate for a log-odds transformation, since it ranges from zero to 1; with appropriate adjustments for values of zero and one, the problem of out-of-range predictions is addressed. The qualitative results for the SM_{ijt} estimations are unaffected when the estimation is repeated using a log-odds transform ($\log SM_{ijt}/(1-SM_{ijt})$).

where the dependent variable represents either the angular measure of similarity or the normalized matching measure.¹³ We extend this regression by systematically replacing *%AGEDIFF* with the three other demographic variables discussed previously.

The estimation results for the angular showtimes similarity index are presented in Table 2, Regression I.¹⁴ Using a modified Breusch-Godfrey test (Greene p. 270), we test for autocorrelation of order one (AR1) and do not find evidence of AR1. We include the demographic variable *%AGEDIFF* in Regression I; we replace this demographic with *%INCOMEDIFF* in Regression II.

(Table 2 near here)

The results in Table 2 indicate that as the distance between two theatres decreases, the angle between the attributes vectors increases: theatres' offerings become more differentiated the more geographically proximate they are. This is consistent with our hypothesis that similarity in one characteristic, in this case location, will lead theatres to differentiate themselves in other characteristics, film programming, in order to soften competition between them.

It is also clear that ownership does, indeed, matter, although we noted above that the expected sign of *SAMEOWN* is ambiguous. Our results show that when the same company owns two theatres, the angle between their attributes vectors declines. Thus, all else equal, two theatres owned by the same company are more similar in their film offerings than are two

¹³ Given our interest in the impact of both time-varying and time-invariant explanatory variables, we considered adopting a random-effects estimation approach. One drawback to this approach is that including lagged values of the dependent variable would introduce correlation with the other regressors. We repeated our empirical analysis, removing lagged-dependent values, using a random-effects specification, verifying its appropriateness with a Hausman specification test. The qualitative results under this specification are consistent with those presented in Table 2.

¹⁴ When the estimation is repeated including the Quincy theatre, and limited to the period June 30,2000-September 28, 2000, over which the Quincy theatre advertised showtimes in the *Boston Globe*, all coefficients retain the signs

theatres owned by separate companies. This result suggests that the economies from studio-exhibitor contracts, and centralized control of movie program choice, are more important than coordination of programming choices to mitigate business stealing from a chain's own theatres. It should further be noted, however, that this result is specific to our particular context. Sweeting (2003) in a study of music variety in the radio industry finds the opposite effect: radio stations under common ownership tend to be more differentiated in their music programming choices.

It might be suggested that there is some relationship between *DISTANCE* and *SAMEOWN*. There are, however, two reasons for rejecting this. First, as we noted in the previous section, there is no significant difference in the average distance between theatres in our sample that are under the same ownership and those that are owned by different chains. Second, including the interaction term *DISTANCE*SAMEOWN* leaves the estimates largely unchanged, while the coefficient on the interaction term is insignificant.¹⁵

As expected, program selection is more similar across theatres the nearer we are to major holidays, consistent with our hypothesized interaction between contractual and strategic determinants of program choices. Contractual considerations are driven by binding commitments on the part of exhibitors to exhibit "holiday" films on high-profile, longstanding release dates. There is an industry pattern of wide release of holiday films, expected to appeal to a broad audience, followed by more limited releases of a larger number of films expected to succeed in niche markets. The former effect "forces" similarity close to holidays while the latter provides theatres more flexibility to capitalize strategically on theatre-specific strengths.

found in Table 2, Regression I. *SAMEOWN* becomes insignificant and *%REVDIFF* becomes significant, with p-values of 0.161 and 0.021, respectively.

¹⁵ Note also that including interaction terms for *DISTANCE* and *SAMEOWNER* with *HOLIDAYDISTANCE* leads to insignificant coefficients on these interaction terms.

Larger percentage differences in last period's revenue are, as expected, associated with an increase in the angle between the attributes vectors of two theatres, reflecting the positive bias in SA_{ijt} when the theatres have different screen capacities.¹⁶

Differences in demographic characteristics of neighboring populations also have a significant influence on the degree of differentiation in programming choice. The greater the difference in the mean income of residents within a five mile radius of each theatre in a theatre pair the more similar is that pair's programming choice.¹⁷ This result would appear at first to be counter-intuitive. If differences in income are associated with differences in tastes, then we might expect that differences in income would be associated with more product differentiation: theatres located close to higher-income individuals would show a different set of films from theatres located close to low-income individuals. On the other hand, suppose that differences in income are associated not with differences in tastes but with a separation in the natural markets for a pair of theatres: high-income individuals do not go to theatres in low-income markets and vice versa. Then theatres located in markets differentiated by income will not have strong strategic reasons to differentiate their program choices.

This latter interpretation is consistent with our finding that when we use percentage differences in average age at a five-mile radius, we find a significant, positive coefficient.¹⁸ In other words, larger differences in the age of the surrounding population lead to more differentiated programming. The industry has long believed that the choice of which movie to

¹⁶ There was no change to our qualitative results when we repeated this analysis using the time-invariant variable $DIFFSCR_{ig}$ - the absolute value of the difference in screens between theatre i and j .

¹⁷ The income effect is insignificant at the three-mile radial measure but significant at a ten-mile radius.

¹⁸ The age effect is insignificant at the three-mile and ten-mile radial measures. When $\%POPDIFF$ or $\%HOUSEHOLDDIFF$ replaces the age demographic, neither is significant for either three- or five-mile radii. Both are marginally significant (p-values of 0.107 and 0.088, respectively) for ten-mile radii.

see is significantly affected by the age of the movie-goer. If this is the case, then markets with very different age groups are likely to be serving consumers with different tastes, weakening the strategic interaction between these markets and leaving film programming choice to be determined more by taste than strategic considerations.¹⁹

Finally, we find that there is, indeed, a degree of inertia in the relative film programming choices between two theatres. If the theatres were similar in their programming choices last week, they will be similar this week.

When we replace the angular showtimes similarity index with the angular movie-count index, we obtain results that are substantively similar to the signs, magnitudes of the coefficients, and significance levels of the results in Table 2. Table 3 presents these results. The modified Breusch-Godfrey test indicates the presence of AR1, thus we estimate (5) using feasible generalized least squares (FGLS) and present the AR1-corrected results.²⁰

(Table 3 near here)

The estimation results of Equation 5 using the normalized matching similarity index, with the appropriate AR1 corrections, are presented in Table 4. Note that the interpretation of the coefficients in Table 4 is the opposite of the interpretation for the angular measure: the angular measure increases with differentiation; the matching measure increases with similarity.

(Table 4 near here)

¹⁹ See Davis (2001) for a formal model of consumer taste parameters in the motion picture exhibition market.

²⁰ The demographic patterns mirror those found in Table 2; neither the population nor the household measure is significant at three- or five-mile radii; both measures are marginally significant at the 10-mile radius (p-values 0.123 and 0.104, respectively). For the partial-year subsample including the Quincy theatre, all coefficients retain the signs in Table 3 and all variables remain significant, with the exception of *%AGEDIFF*, now marginally significant (p-value 0.109) and *%INCDIF* now positive but insignificant.

The results for this alternative similarity measure are qualitatively consistent with those for the angular similarity index. Similarity between theatre pairs decreases when theatres are geographically proximate, increases when theatres are under common ownership and decreases the further we are from major holidays. As anticipated, $\%REVENUE\ DIFFERENCE_{ij,t-1}$ is no longer significant, reflecting our normalization of the matching measure to correct for any bias associated by differences in screen capacities across theatre pairs..

VI Conclusion

Hotelling's claim that non-cooperative oligopolists will offer consumers product variants characterized by an "excessive sameness" has given rise to considerable debate. The outcome has been a large and growing theoretical literature with little consistency in its predictions and so with few clear empirically testable propositions. This is, in fact, not at all surprising. As Borenstein and Netz (1999) point out, firms competing in a simple, one-dimensional characteristics space seek to balance competing forces: an attraction force as they try to steal each others markets and a repulsion force as they seek to soften competition. There is no reason to believe *a priori* that either of these forces will dominate the other.

Extending the analysis to a multi-characteristics space, as in Irmen and Thisse (1998), while presenting formidable technical challenges, does generate a cleaner testable proposition. Simply put, we should expect to find that when firms either choose or are constrained to be more similar in some characteristics they will seek to differentiate themselves on others.

Our analysis has tested and provides strong support for this proposition using a particularly rich and dynamic data set from the motion-pictures exhibition market. As might be expected, we observe inertia in product differentiation between theatre pairs over time.

However, we also find strong evidence that there are important strategic determinants of product differentiation. In particular, our empirical results are consistent with the hypothesis that the degree of product differentiation between theatre pairs reflects a complex balance between strategic concerns and contractual constraints. Theatre pairs located more closely in geographic space make less similar programming choices. Although contractual constraints may force similarity in programming near major holidays, strategic considerations lead to a reduction in similarity as we move away from such holidays. Both of these results suggest that when firms' product design choices are similar in one dimension, strengthening the business stealing effect that underlies the attraction force, the repulsion force leads them to seek to differentiate in other dimensions.

Theory is less clear regarding the impact of ownership on product differentiation. Our analysis has found evidence that theatre pairs under common ownership tend to make more similar programming choices. This may well reflect the organizational architecture in this industry, where local managers' autonomy to make programming choices is constrained by the movie-studio/theatre-chain relationship. It suggests more generally that the impact of ownership on strategic product differentiation is institution specific.

Several extensions of this work suggest themselves. Both the angular and matching indexes provide robust, dimensionless measures of the degree of differentiation between pairs of products that can be easily modified to measure product-attribute differences in a wide range of industries. This offers the potential for broader empirical investigation of the determinants of product differentiation and product similarity. Looking specifically at the movie exhibition market, the basic unit of analysis in this paper has been the degree of similarity between theatre

pairs. Similarity in turn is determined by specific decisions at the individual theatre level regarding which films should be retained and which dropped from week to week. In our future work we hope to apply hazard function and duration model techniques to analyze these more micro-level decisions.

Table 1. Descriptive Statistics for First-Run Theatres in Boston Metropolitan Market
June 30, 2000-Jun 22, 2001

Variable	All Theatre Pairs				Theatre Pairs with Same Owners Only				Theatre Pairs with Different Owners Only			
	Mean	St. Dev.	Min.	Max.	Mean	St. Dev.	Min.	Max.	Mean	St. Dev.	Min.	Max.
Angular Similarity Index, SA_t	39.74	16.33	4.40	90.00	36.28	15.30	4.40	90.00	41.09	16.53	7.63	90.00
Normalized Matching Similarity Index, SM_t	80.41	18.99	0.00	100.00	85.29	16.07	0.00	100.00	78.49	19.70	0.00	100.00
SAME OWNER	0.28	0.45	0.00	1.00	1.00	0.00	1.00	1.00	0.00	0.00	0.00	0.00
DISTANCE	18.74	11.63	1.24	54.04	19.99	11.04	2.58	44.93	18.25	11.82	1.24	54.04
HOLIDAY DIST _t	4.33	3.09	0.00	10.00	4.33	3.09	0.00	10.00	4.33	3.09	0.00	10.00
%REVENUE DIFF _{t-1}	0.65	0.40	0.0004	1.6963	0.69	0.38	0.0004	1.6672	0.63	0.41	0.0013	1.6963
%AGE DIFF	0.04	0.03	0.0008	0.0934	0.04	0.02	0.0008	0.0839	0.04	0.03	0.0020	0.0934
%INCOME DIFF	0.17	0.13	0.0003	0.5432	0.17	0.14	0.0014	0.4193	0.17	0.13	0.0003	0.5432
%POPULATION DIFF	0.73	0.46	0.0054	1.4574	0.77	0.44	0.0054	1.4180	0.72	0.47	0.0229	1.4574
%HOUSEHOLD DIFF	0.76	0.48	0.0104	1.5002	0.80	0.46	0.0407	1.4486	0.74	0.49	0.0104	1.5002

Similarity indices are based on showtime counts; SM_t is scaled by 100 for interpretation as percentage match.

Demographic difference variables are based on comparisons of values within a five-mile radius of each theatre, for each ij pair, from 2001 Census estimates.

Total number of observations is 4,056; for lagged variables total number of observations is 3, 978.

Table 2. Estimation of Angular Show-Count Similarity Index

Variable	(I)	(II)
CONSTANT	3.053 (0.439)***	3.713 (0.479)***
SAMEOWN	-0.548 (0.251)**	-0.451 (0.249)*
DISTANCE	-0.045 (0.009)***	-0.041 (0.009)***
HOLIDAY DISTANCE _t	0.218 (0.040)***	0.215 (0.040)***
%REVENUE DIFFERENCE _(t-1)	1.250 (0.295)***	1.143 (0.294)***
%AGE DIFFERENCE	13.493 (4.605)***	
%INCOME DIFFERENCE		-1.747 (0.831)**
SA _{t-1}	0.856 (0.017)***	0.857 (0.017)***
SA _{t-2}	0.032 (0.016)**	0.034 (0.016)**
Sample Size	3900	3900
Overall R ²	0.8227	0.8225
p-Value for AR1 Test	0.207	0.133

Estimation by pooled OLS with robust standard errors.

Dependent variable is SA_t, the angle between theatre-pair attributes vectors, using showtime counts.

Percentage age and income differences are based on comparisons of average age and average income within a five-mile radius of each theatre, for each *ij* theatre pair, from 2001 Census estimates.

Data ranges over 50 of the 52 weeks due to twice-lagged dependent variable.

Significance levels *.10, **.05, ***.01; standard errors reported in parentheses.

Table 3. Estimation of Angular Movie-Count Similarity Index

Variable	(I)	(II)
CONSTANT	3.800 (0.471)***	4.315 (0.517)***
SAMEOWN	-0.642 (0.246)***	-0.514 (0.244)**
DISTANCE	-0.049 (0.010)***	-0.045 (0.010)***
HOLIDAY DISTANCE _t	0.251 (0.036)***	0.243 (0.036)***
%REVENUE DIFFERENCE _(t-1)	1.567 (0.280)***	1.431 (0.279)***
%AGE DIFFERENCE	15.232 (4.446)***	
%INCOME DIFFERENCE		-1.744 (0.839)**
SA _{t-1}	0.702 (0.016)***	0.705 (0.016)***
SA _{t-2}	0.168 (0.016)***	0.175 (0.016)***
Sample Size	3900	3900
Wald Test	14067.47	14973.82

Estimation by FGLS for panel data with AR1 and panel-heteroskedasticity corrections.

Dependent variable is SA_t, the angle between theatre-pair attributes vectors, using movie counts.

Percentage age and income differences are based on comparisons of average age and average income within a five-mile radius of each theatre, for each *ij* theatre pair, from 2001 Census estimates.

Data ranges over 50 of the 52 weeks due to twice-lagged dependent variable.

Significance levels *.10, **.05, ***.01; standard errors reported in parentheses.

Table 4. Estimation of Normalized Matching Show-Count Similarity Index

Variable	(I)	(II)
CONSTANT	11.959 (0.778)***	11.150 (0.720)***
SAMEOWN	0.882 (0.231)***	0.796 (0.229)***
DISTANCE	0.030 (0.009)***	0.034 (0.009)***
HOLIDAY DISTANCE _t	-0.207 (0.035)***	-0.206 (0.035)***
%REVENUE DIFFERENCE _(t-1)	0.349 (0.284)	0.382 (0.284)
%AGE DIFFERENCE	-8.24 (4.363)*	
%INCOME DIFFERENCE		2.420 (0.753)***
SA _{t-1}	0.799 (0.016)***	0.799 (0.016)***
SA _{t-2}	0.064 (0.016)***	0.063 (0.016)***
Sample Size	3900	3900
Wald Test	13541.22	14029.32

Estimation by FGLS for panel data with AR1 and panel-heteroskedasticity corrections.

Dependent variable is SM_t, the normalized matching index, using showtime counts, scaled by 100 for interpretation as percentage match .

Percentage age and income differences are based on comparisons of average age and average income within a five-mile radius of each theatre, for each *ij* theatre pair, from 2001 Census estimates.

Data ranges over 50 of the 52 weeks due to twice-lagged dependent variable.

Significance levels *.10, **.05, ***.01; standard errors reported in parentheses.

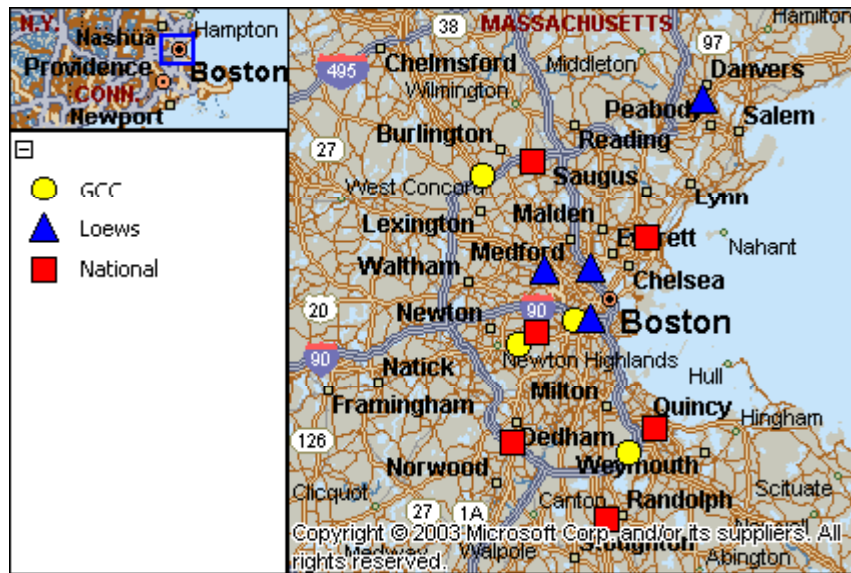


Figure 1—Theatre Locations by Owner Boston MSA 2000.

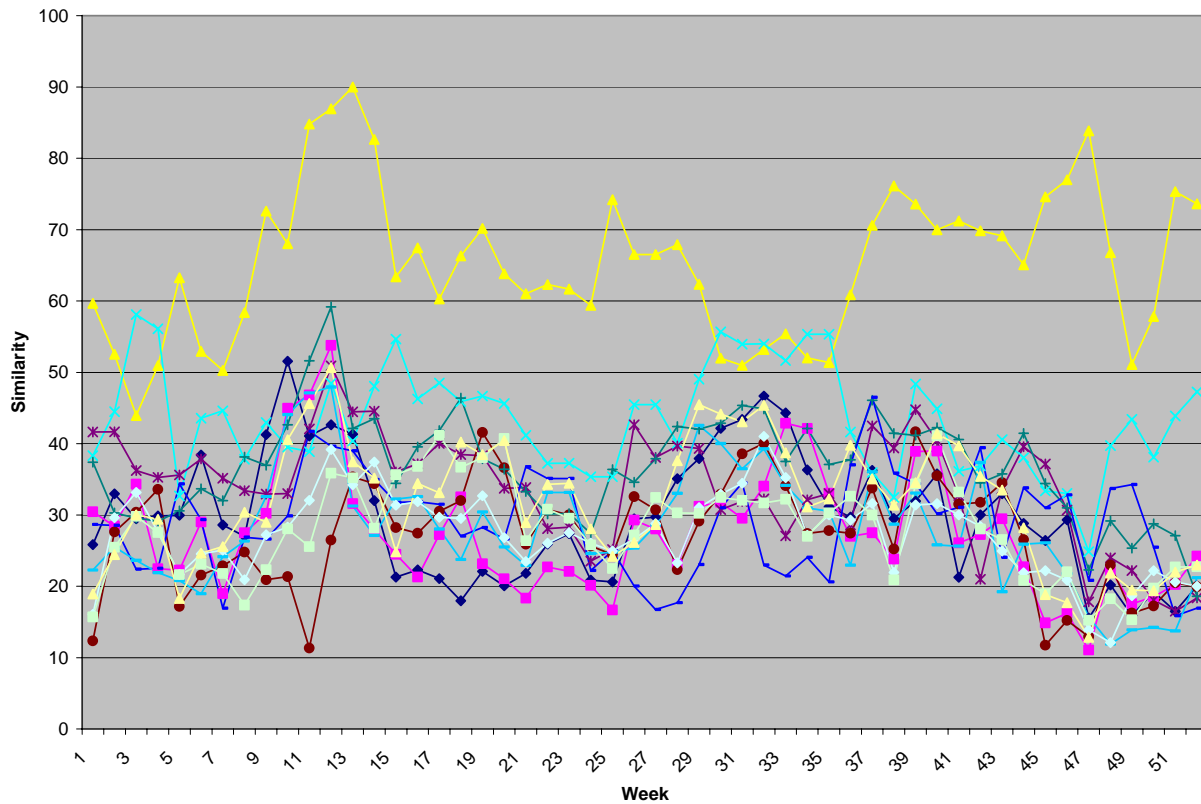


Figure 2: Angular Similarity Measure for Assembly Theatre

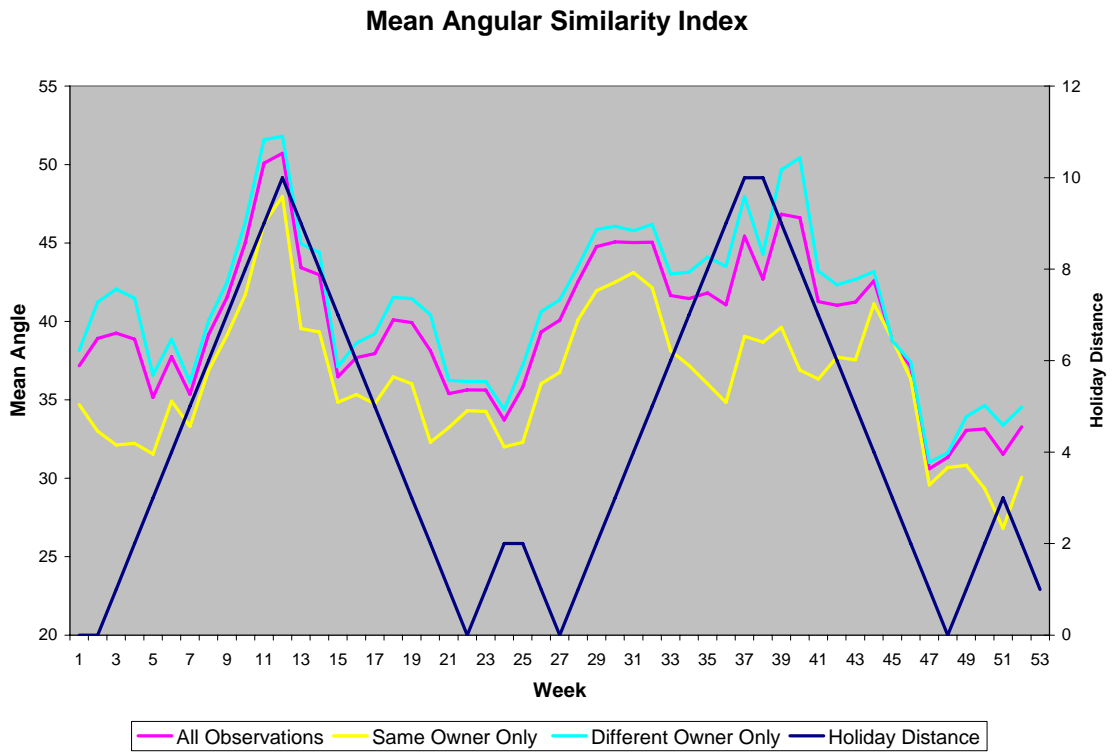
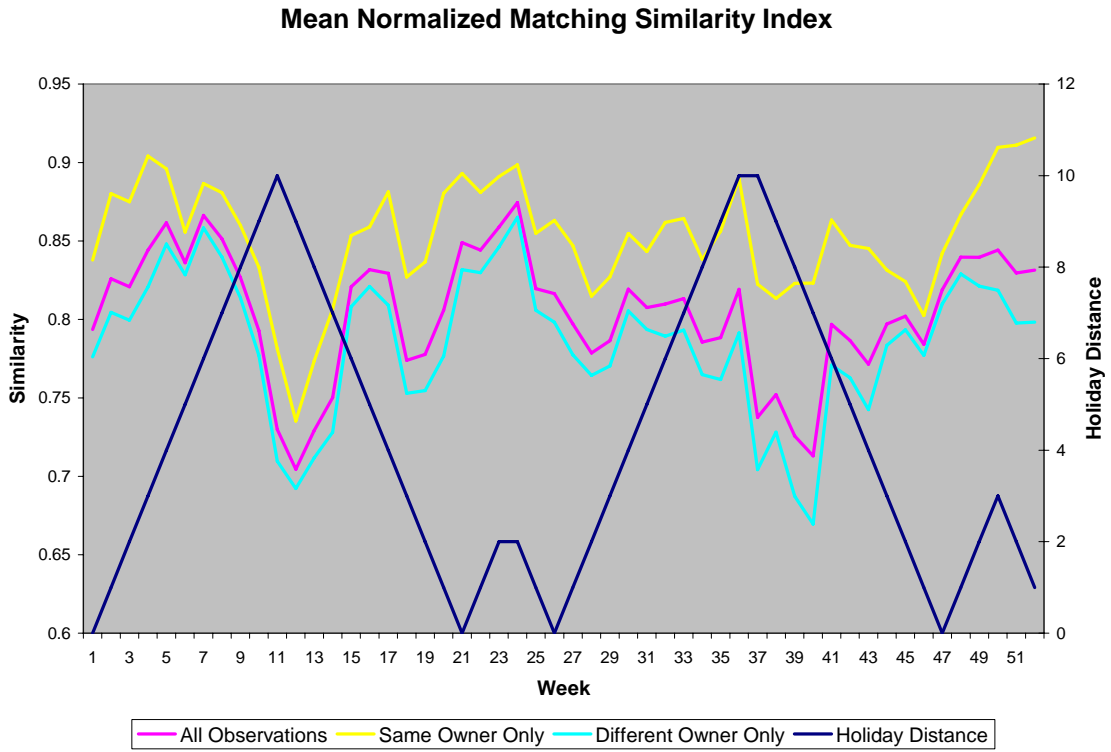


Figure 3: Holiday Distance and Mean Similarity Indexes by Week

Appendix

In the event that our time-invariant variables do not capture all of the time-invariant heterogeneity, the pooled OLS estimates will be inconsistent. Therefore, we report below results of the within estimator that controls for all possible time-invariant effects. Because our model includes lagged dependent variables, we sweep away the fixed effects using a forward-mean differencing transformation, which removes only the forward mean, i.e. the mean of all future observations available for each ij pair. This transformation is otherwise known as “orthogonal deviations” or the Helmert transformation and is described in Arellano and Bover (1995) and Bond and Meghir (1994). Unlike first-differencing, the forward-mean differencing preserves the error structure and therefore does not require any correction for serial correlation in the error terms. We then estimate the model using instrumental variables. Our instruments are lags ($t-1$) of the right hand side variables. To test the validity of our instruments, we report both a Sargan test of over-identifying restrictions, and direct tests of serial correlation in the residuals. Our tests of serial correlation are based on a Gauss-Newton regression and described in Davidson and McKinnon pp. 357-373 (1993).

Appendix Table 1: Within Estimates

	Angular Show-Count Similarity Index	Angular Movie-Count Similarity Index	Normalized Matching Count Similarity Index
Holiday Distance _{t}	0.525 (4.40)**	0.249 (1.95)*	-0.300 (3.75)**
%REVENUE DIFFERENCE _($t-1$)	18.513 (2.27)*	27.934 (1.97)*	-7.916 (0.87)
SA _($t-1$)	0.505 (1.99)*	0.929 (2.74)**	0.842 (4.94)**
SA _($t-2$)	-0.113 (0.65)	-0.305 (1.35)	-0.129 (0.96)
Constant	1.152 (4.02)**	0.815 (2.15)*	-0.036 (0.16)
Observations	3588	3588	3588
	Diagnostic Tests (p-values)		
Sargan Test	0.175	0.494	0.314
First-Order Serial Correlation	0.122	0.749	0.559
Second-Order Serial Correlation	0.612	0.450	0.701

Notes: Robust standard errors in parentheses. z statistics in parentheses. * significant at 5%; ** significant at 1%. Estimates obtained using a Helmert transformation and the generalized method of moments. Instruments used are the appropriate lags of the explanatory variables.

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