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GRAPHICAL ANALYSIS FOR EVENT STUDY DESIGN

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Abstract

This paper describes a graphical procedure that was used to select the length and placement of the announcement period, the number of securities in the comparison portfolio, and the length of the comparison period for an event study involving over 16,000 earnings announcements. The literature does not suggest a single "best" methodological approach for an event study. Plotting information content as the dependent variable and placement of the announcement period as the independent variable, the procedure produced families of nested curves, one set for each combination of parameters being tested. Interpretation of the plots is based on the general notion that the optimal combination of parameters will produce a plot with high amplitude and sharp increases and decreases as the announcement period placement approaches, passes through, and moves away from the optimal placement. The analysis led to the selection of an announcement period of ten days (announcement date plus seven days prior and two days following), a comparison period of 30 days, and a comparison portfolio of ten securities

INTRODUCTION

The literature does not suggest a single "best" methodological approach for an event study. Alternatives exist at each step, and each has advantages and disadvantages. Beaver (1982, 329) furnished an indication of the variety of the alternatives. His "Partial List of Selected Research Design Issues" for market-based research listed 40 issues and sub-issues in five major categories. This paper describes a graphical procedure that was used to select the size of the period, the number of securities in the comparison portfolio, and the length and placement of the comparison period for an event study involving over 16,000 earnings announcements.

Basic Event-Study Approach

The basic approach of the study that incorporated the graphical analysis which is the focus of this paper was fairly typical of event studies involving earnings announcements. The following brief description is furnished to set the stage for the graphical analysis that is the principal focus of this paper.

The *analysis period* is the time span of the daily series of returns on which the measurement of information content for an earnings announcement is based. The analysis period is made up of the announcement period and the comparison period, which are defined in relation to the event date. The periods and their relationships to each other and to the event date are illustrated in Figure 1.

The *event date* is the date on which the effect of an event is presumed to take place, or the date around which a diffused effect is presumed to be distributed. The event date is assigned event time t=0. Researchers generally use the date on which the first public announcement of an event took place. However, it is not always possible to know with certainty the exact date on which a piece of information first reached the market. The information may become known to a wide segment of the market prior to the first public announcement through a news leak or it may be released in a form which effectively communicates the information but which is not considered to be a public announcement of the event itself. For example, Foster (1973) reported that announcement of an "earnings estimate" by a company official effectively usurped the information content of the subsequent earnings announcement.

Empirical studies suggest that event-date uncertainty affects the power of the tests which are designed to detect the presence of abnormal performance associated with an event, and that events, both treatment events and

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confounding events, can be hard to find and even harder to date. See, for example, Brown and Warner (1980, 1985), Dyckman, Philbrick, and Stephan (1984), and Wright and Groff (1986).

The *announcement period* is the total period of time over which all statistically significant effects of the event on the stock price are presumed to take place. The announcement period may contain only the event date, or it may contain additional days. The additional days may be arranged either symmetrically or asymmetrically around the event date. The length of the announcement period is an important methodological issue, closely related to event-date uncertainty.

Dyckman, Philbrick, and Stephan (1984) investigated announcement periods of 1 through 5 days in length. They reported that a longer event period should be used when the bounds of the uncertain period are known ex ante. Brown and Warner (1985, 14-15) reported that the power of statistical tests decreased with longer event periods, but that event study test statistics continued to be well specified when the event period was longer than one day. Lev (1979) suggested that shorter analysis periods reduced the likelihood of including confounding events. Brown, Lockwood, and Lummer (1985) suggested that the event period should be selected on a case-by-case basis, which suggests the use of some analytical method on which to base the selection.

Announcement periods of various lengths are found in the literature. Kiger (1972) used a seven-day period beginning one day prior to the announcement date. Zeghal (1983, 1984) and Bamber (1986) used a three-day period beginning with the day prior to the announcement date.

The *comparison period* is the period which is used as the basis for estimating what the values of the observed time series during the announcement period would have been if the announcement had not occurred. The comparison period excludes the announcement period, and can be symmetrical or asymmetrical around the announcement period. Kiger (1972) used a five-day period beginning eight days prior to the earnings announcement. Eades, Hess, and Kim (1984) used 30 days on each side of the announcement period. Zeghal (1983, 1984) used all of those days of the calendar year which did not fall within an announcement period.

Measuring Information Content

The *expected daily return* was defined for this study as the daily return on a variance-matched *comparison portfolio*. Comparison portfolios were formed in three steps. First, the variance of the daily returns was calculated for each firm in the CRSP file of daily returns for the year preceding the announcement year. Next, the firms were ranked in order of the variance of their daily returns. The use of variance ranking to form comparison portfolios is due to Black and Scholes (1973). Finally, each firm was assigned a comparison portfolio composed of the p firms ranked immediately above it and the p firms ranked immediately below it in the variance-ordered listing, where p is one half the desired portfolio size. Announcements for the firms with the p highest and the p lowest variance of daily returns were discarded, since complete comparison portfolios could not be formed for those firms.

The *daily return* for each comparison portfolio was calculated as the simple mean of the daily returns of the individual securities in the portfolio, taken directly from the CRSP file of daily returns. The *daily excess return* for each security was calculated by subtracting its daily return from the daily return of its comparison portfolio.

The *information content* of an earnings announcement was defined as the ratio of two variances: the variance of the excess returns during the announcement period divided by the variance of the excess returns during the comparison period.

Portfolio Size

Evans and Archer (1968), in one of the earliest empirical studies of the benefits of diversification, suggested that a “relatively stable and predictable relationship” (Evans and Archer 1968, 767) exists between portfolio size and the level of portfolio dispersion. They described this relationship as “a rapidly decreasing asymptotic function, with the asymptote approximating the level of systematic variation in the market” (Evans and Archer 1968, 767). They reported that incremental benefits of diversification were very small once the size of the portfolio reaches about ten securities.

Dyckman, Philbrick and Stephan (1984) investigated the performance of portfolios containing 10, 20, 30, 40, 50, 75, and 100 securities. They found,

> For a given level of event-date uncertainty, larger portfolios more accurately detect the presence of abnormal performance. The importance of the interaction of the two factors is striking. For instance, with a portfolio size of ten, the probability of detecting abnormal performance drops from 0.99, almost certainty, to only 0.22 when event-date

> uncertainty increases from one to five days. . . . Similarly, with five days uncertainty about the event date, increasing portfolio size from 10 to 100 triples (0.26 to 0.86) the probability of detecting abnormal performance. Increasing portfolio size mitigates the problem of event-date uncertainty. (Dyckman, Philbrick and Stephan 1984, 11-12)

Brown and Warner (1985) reported findings which supported larger portfolio sizes where the portfolio is the basis of estimating excess returns for an event study. According to Brown and Warner, cross-sectional mean excess returns were less likely to be abnormally distributed than were the excess returns of individual securities, ". . . as would be expected under the Central Limit Theorem. For samples of size 50, the mean excess return seems close to normal" (Brown and Warner 1985, 10).

GRAPHICAL SENSITIVITY ANALYSIS

The information-content measure described above is the cornerstone of the study. It seemed only prudent, therefore, to examine the sensitivity of that measure to the length and placement of the announcement period, length of the comparison period, and size of the comparison portfolio. It seemed, *a priori*, that plotting information content as the dependent variable and placement as the independent variable should produce a family of curves, with one curve for each level of the parameter being period tested.

Figure 2 illustrates the process graphically for an announcement period of three days. It is assumed, for purposes of this illustration, that the optimal placement of the three-day announcement period is centered on the announcement date. The announcement period (shaded) is placed initially so that its center falls on the seventh day before the announcement date (Figure 2, placement number one). The announcement period is subsequently placed at progressively later positions. The value of the information-content measure should rise as the announcement period is moved toward the optimal (placements two through seven), peak as the announcement period is placed at the optimal location (placement eight), and then decline as the announcement period is moved past the optimal (placements nine through 15). If the portfolio size and the other design factors truly make a difference in the information-content measure, then performing this procedure for several different levels of the various design factors should produce families of nested curves that illustrate the differences.

METHODOLOGY

A random sample of 300 earnings announcements was selected as the basis for the sensitivity analysis. Then, for various combinations of portfolio size, length of comparison period, length of announcement period, and placement of announcement period, the analysis proceeded in the following steps:

1. Calculate the log of the information-content measure which was produced by a particular combination of parameters
2. Combine the 300 observed measures of information content for that combination of parameters
3. Plot the combined observations
4. Examine the plots for trends and relationships

Log Transformation. The log transformation, using the SAS LOG10 function, was necessitated by the occasional appearance of large values for information content. Those values created a data range for which it was not possible to produce a meaningful plot. Trial runs also showed that the data contained a few (13 of 216,000) occurrences where information content equaled zero. Those were set to .000001 so that the log transformation would function.

Combining of Observations. Observations were combined by taking the simple mean of all of the values of information content being plotted.

Plotting. The data were plotted using the SAS procedure PROC GPLOT. Points were joined using a spline technique described in the SAS documentation as being particularly suited to smoothing noisy data. The technique is the SAS GPLOT interpolation option *I=SMnn*, where values of *nn* can range from 01 to 99 and represent the relative importance of the factors. This analysis used *I=SM50*.

Each two-dimensional plot depicts the log of the information-content measure (XINFO) on the vertical axis and the announcement period placements on the horizontal axis. The plotted data represent the log of the combined values for information-content. Each point represents, therefore, the combined measure of a number of observations equal to the product of the levels of the variables not included in the labels for the axes or the plots. Figure 3, for example, shows the log of the information-content measure by portfolio size. Each data point on each of the plots represents a combined measure over three levels of length of comparison period and six levels of length of announcement period, a total of 18 observations.

RESULTS

Interpretation of the plots is based on the general notion that the optimal combination of parameters will produce a plot with high amplitude and sharp increases and decreases as the announcement period placement approaches, passes through, and moves away from the placement which produces the highest amplitude for that plot. Figures 3, 4, and 5 are based on all possible combinations of:

1. three levels for portfolio size, as previously described;
2. three levels for length of comparison period, as previously described;
3. six levels for length of announcement period, comprising periods of two through seven days in length;
4. twenty placements of each announcement period, with the initial placement such that the first day of the announcement period falls on the fifth day following the announcement date.

Figure 3 suggests that portfolio size makes no significant difference in the measurement of information content. The larger portfolios appear to confer no advantage and they have the disadvantage of requiring the rejection of more observations for which it is not possible to construct a complete comparison portfolio at the top and bottom of the variance-ranked file. Therefore, a portfolio size of ten securities was selected for the study.

Figure 4 suggests that a comparison period of 30 days produces higher values of information content than comparison periods of 60 or 120 days, so the 30-day comparison period was selected for the study.

Figure 5 shows a monotonic increase, at a decreasing rate, in information content as the length of the announcement period is sequentially incremented from two to seven days, accompanied by a flattening of the curve. This suggests that the selection of a length and placement for the announcement period warrants further investigation.

The above procedures were repeated for a second randomly-drawn sample of 300 earnings announcements and produced plots (not shown) similar to Figures 3, 4, and 5.

Before proceeding with a further investigation of length and placement of the announcement period, a plot similar to Figure 5 was generated for only a portfolio size of ten securities and only a comparison period of 30 days, so that each data point represents a single observation. The results, shown in Figure 6, are very similar to Figure 5 and invite the same interpretation.

A new plot, shown in Figure 7, was generated for a portfolio size of ten securities, a comparison period of 30 days, announcement periods of two through 30 days in two-day increments, and 40 placements of the announcement period. An announcement period of ten days was selected as representing a reasonable trade-off between amplitude and sharpness-of-slope. The plot for the ten-day announcement period reaches its maximum at or near placement 12. Since placement zero puts the first day of the announcement period five days past the announcement date, placement 12 puts the first day of the announcement period seven days prior to the announcement date. Therefore, the ten-day announcement period includes the announcement date, the seven days prior to the announcement date, and the two days following the announcement date.

CONCLUSION

Design of a market-based event study usually requires the researcher to specify the length and placement of the announcement period, the number of securities in the comparison portfolio, and the length of the comparison period. The graphical techniques illustrated in this paper are useful for evaluating the sensitivity of the event measurement metric to changes in those parameters and identifying the best combination for that study.

FIGURE 1
Defining the Analysis Period

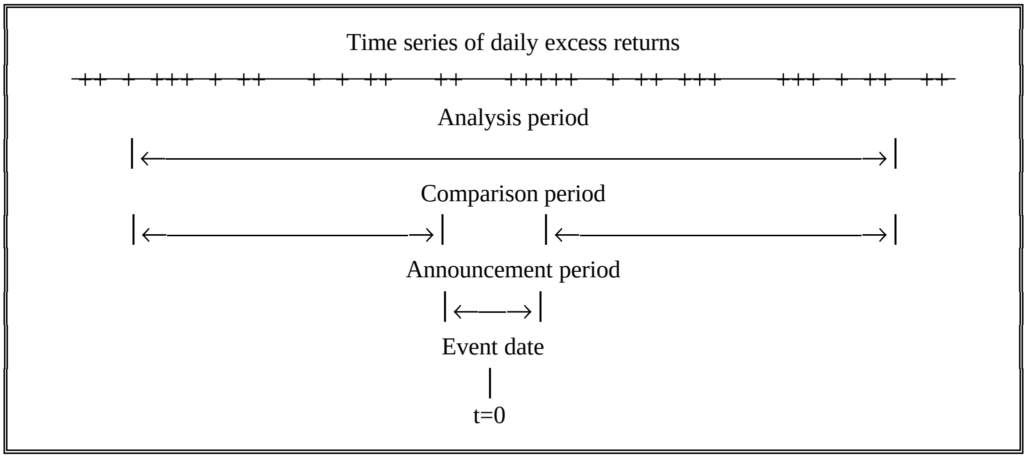


FIGURE 2
Illustrative Placements of Announcement Period and Expected Plot of Information Content

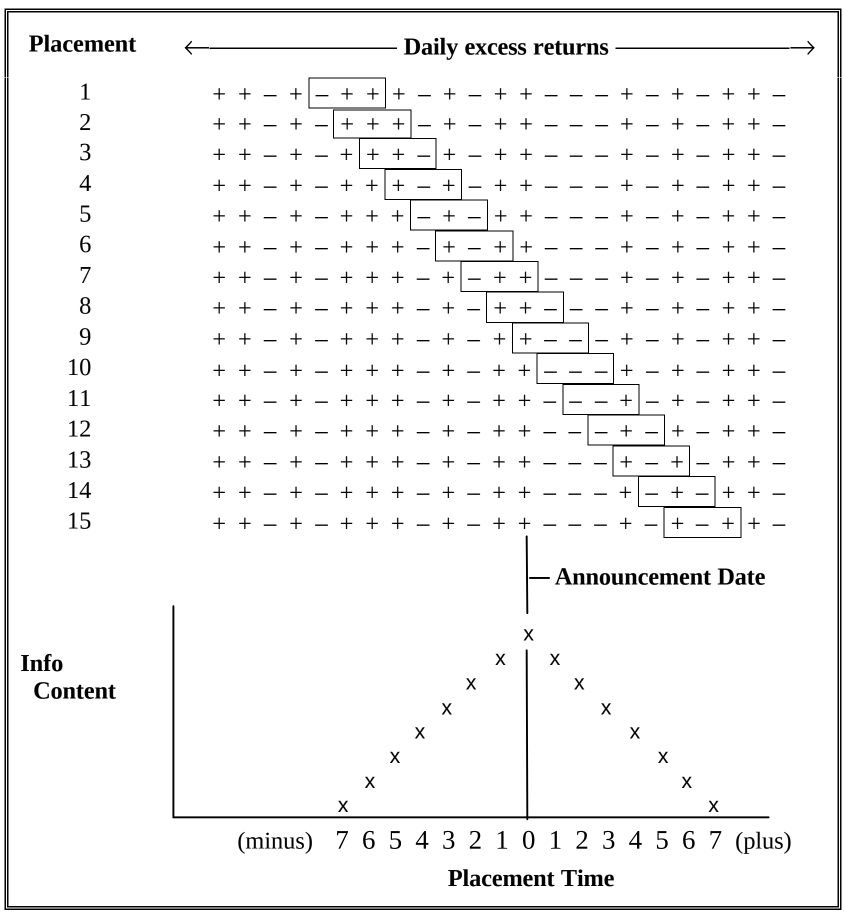


FIGURE 3
Portfolio Size (ISIZEIP)

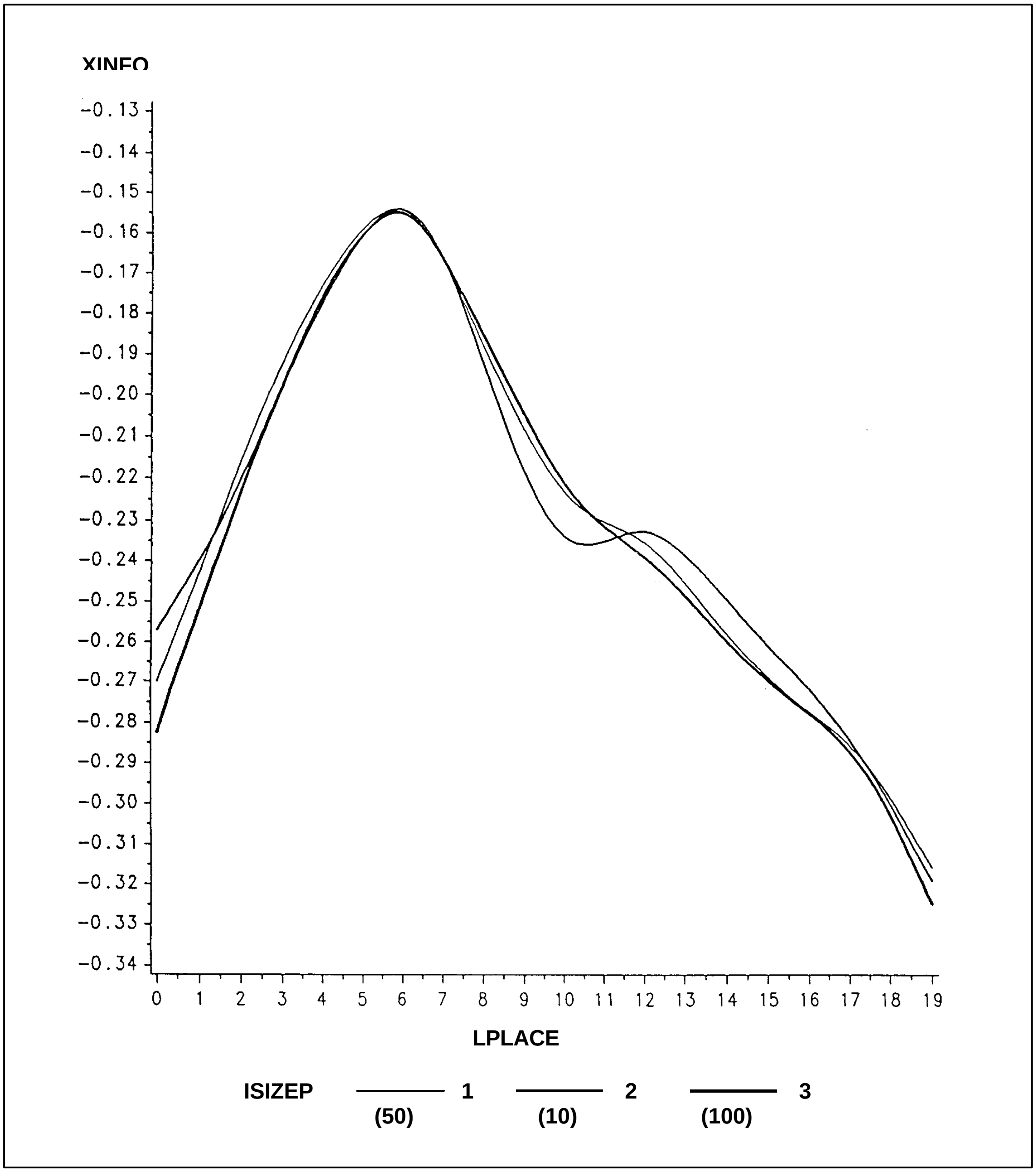


FIGURE 4
Length of Comparison Period (JLPRDC)

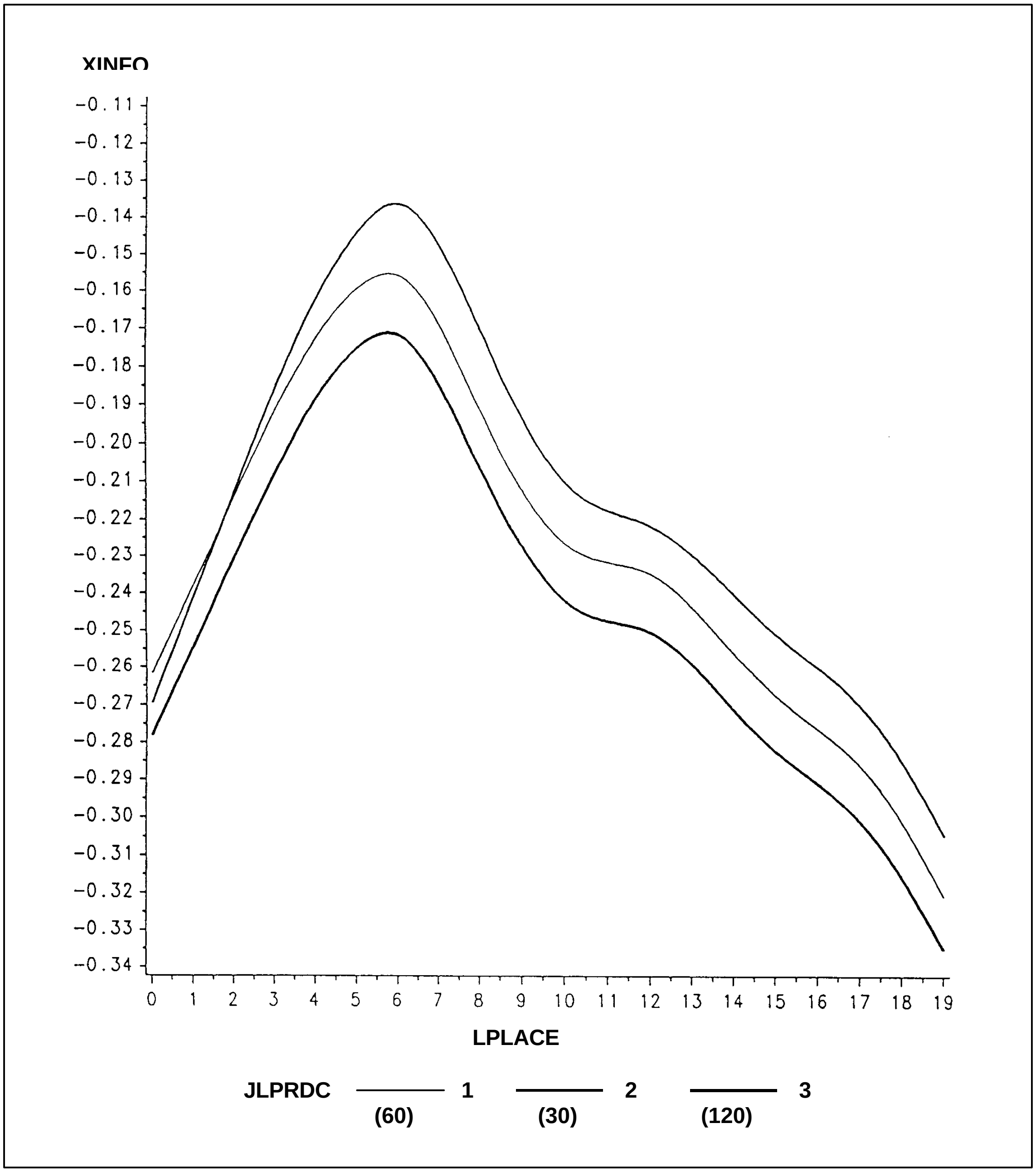


FIGURE 5
Length of Announcement Period (KLPRDA)
for Periods of Two Through Seven Days

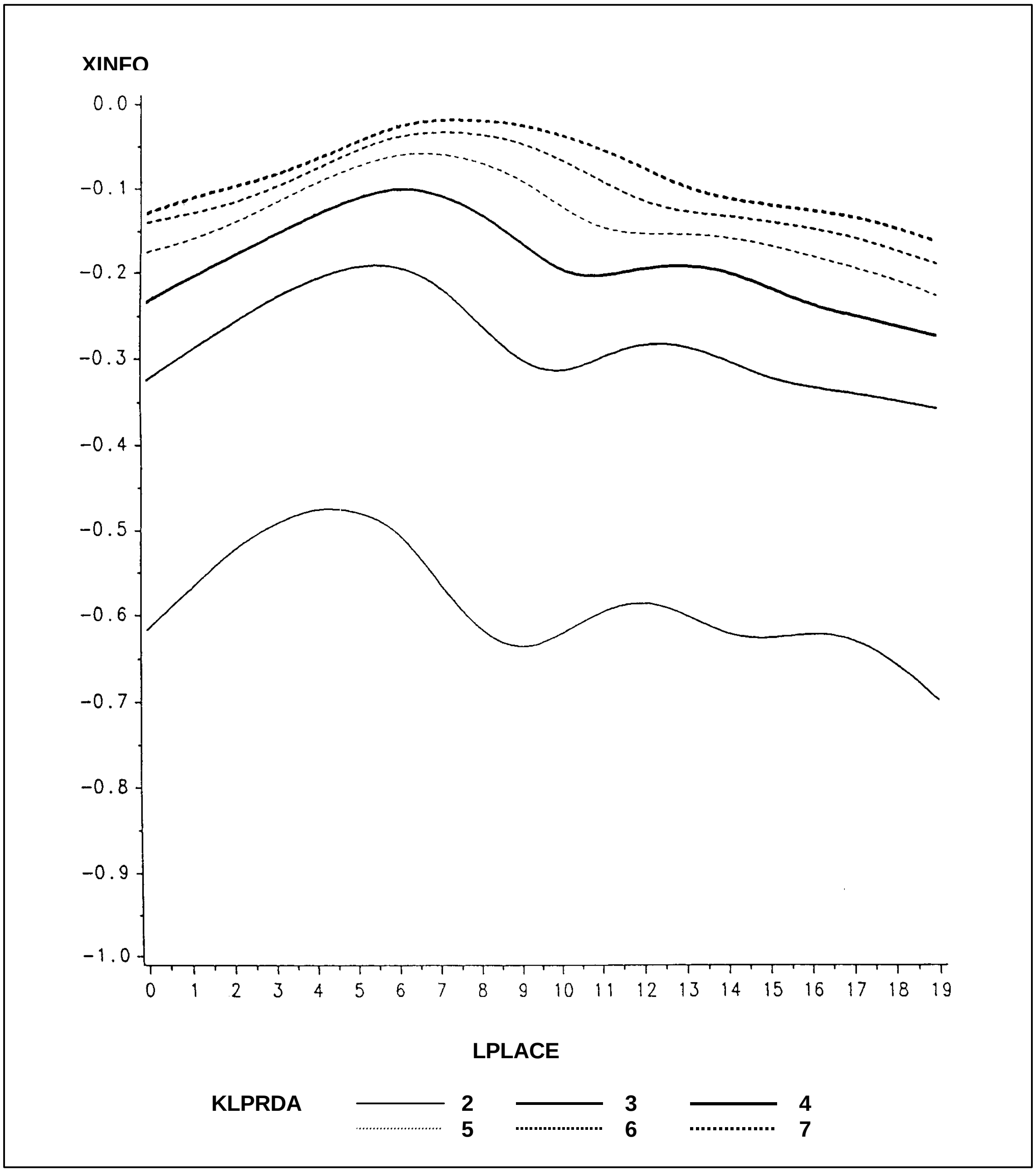


FIGURE 6
Length of Announcement Period (KLPRDA) for Periods of Two Through Seven Days, Portfolio Size of Ten Securities and Comparison Period of 30 Days

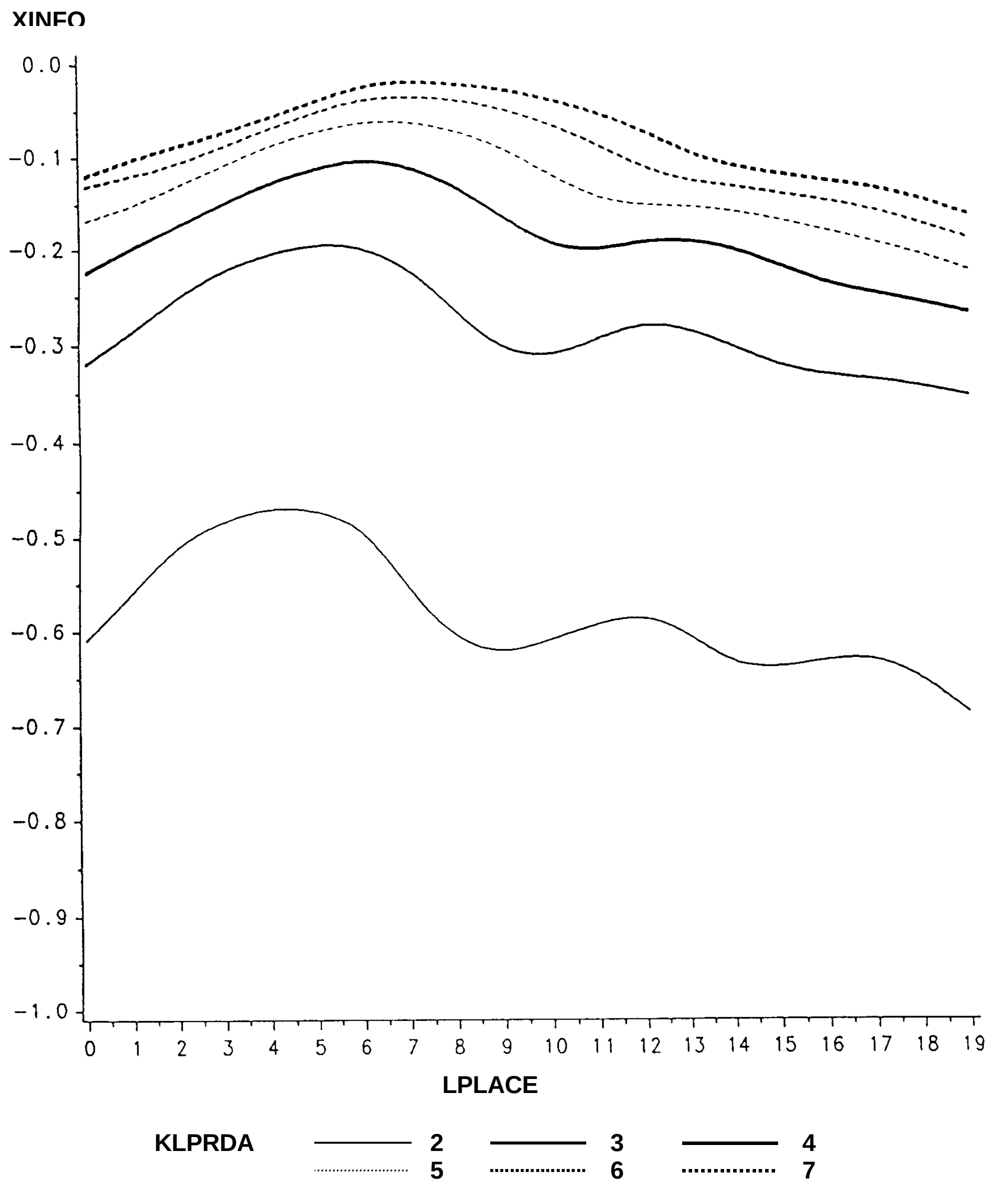
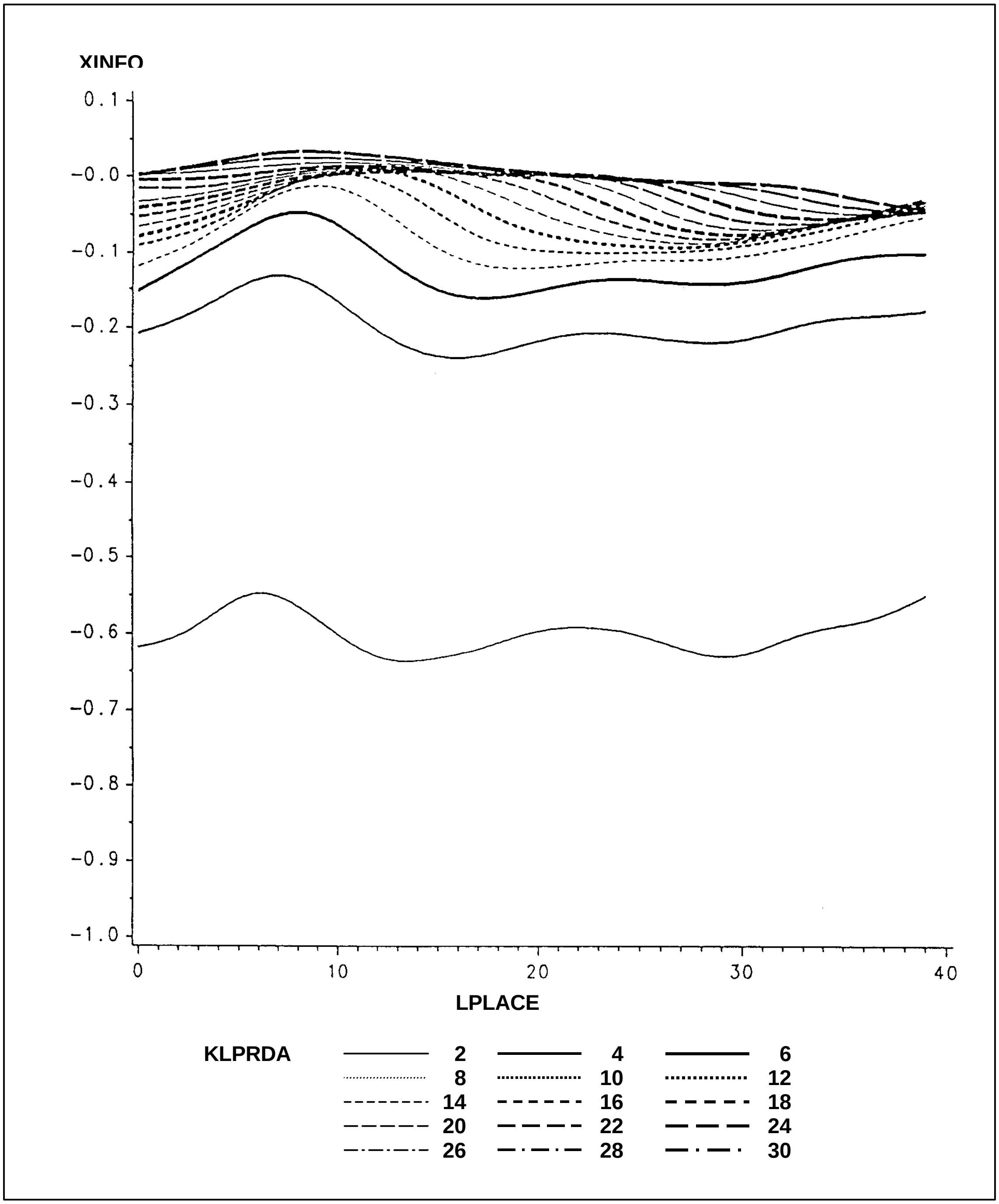


FIGURE 7
Length of Announcement Period (KLPRDA) for Periods of Two Through 30 Days in Increments of Two Days, Portfolio Size of Ten Securities and Comparison Period of 30 Days



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