PARAMETER STABILITY IN EVENT STUDIES*

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October 1986

Working Paper No. 423

*This paper is taken from my Ph.D dissertation at the University of Chicago. I am indebted to B. Peter Pashigian and Arnold Zellner for their suggestions and comments.

ABSTRACT

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This paper examines economic conditions which contribute to instability in the time-series estimates of the Capital Asset Pricing Model (CAPM). Recursive estimation is used to diagnose parameter changes in regression estimates of the CAPM. The methodology is applied to a study of the performance of new stock issues. Parameter stability is rejected in over 45% of the estimated CAPM equations. Shifts in beta and the CAPM intercept are linked to omitted economic variables. Estimation is improved when the CAPM is augmented to account for (1) industry-specific returns, (2) unanticipated changes in the variance of the return on the market portfolio, and (3) cyclical variation in beta induced by changes in firm leverage.

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. . . All is in flux, nothing is stationary.
Heracleitus, 513 B.C.

1. Introduction

This paper examines economic conditions which contribute to instability in the time-series estimates of parameters of the Capital Asset Pricing Model (CAPM). In addition to a large number of traditional asset pricing applications, the CAPM has become widely used in "event studies". These are studies in which the value of economic "news" is quantified by examining changes in a firm's market value during time periods surrounding the announcement of an "event". Under the rational expectations hypothesis, the forecast errors of the CAPM -- i.e., the excess, risk-adjusted returns -- can be interpreted as unanticipated economic rents accruing to a firm's shareholders. However, when the CAPM parameters vary over time, standard event study techniques will be unable to separate the event-related excess returns from the forecast errors induced by the failure to control for variations in the CAPM parameters.

Briefly, recursive estimation is used to diagnose parameter changes in regression estimates of the CAPM. The methodology is applied to a study of the performance of new issues of common stock before and after financial disclosure was mandated by the Securities Act of 1933. Note that the data cover 1926-1945, perhaps the most dramatic boom-to-bust financial cycle in history.[1] Parameter stability is rejected in over 45% of the CAPM estimates for the new issues samples. Shifts in beta and the CAPM intercept are linked to omitted economic variables. Estimation is improved when the CAPM is augmented to account for (1) industry-specific returns, (2) unanticipated changes in the variance of the return on the market portfolio, and (3) cyclical variation in beta induced by changes in firm leverage.

2.1 Event Studies and the CAPM

The CAPM (Sharpe 1964, Lintner 1965) states that the expected return to a firm's equity shareholders, $R_{i,t}$, can be written as a linear function of the expected return on a portfolio of all marketable assets, $R_{m,t}$, and the return on a riskless asset, $R_{f,t}$.

$$E[R_{i,t}] = R_{f,t} + \beta(E[R_{m,t}]-R_{f,t}) \tag{1}$$

The event study methodology uses the CAPM to quantify unanticipated returns to shareholders stemming from the realization of some exogenous, firm-specific event. Essentially, the abnormal return is a forecast error.

Estimate the Sharpe-Lintner (SL) CAPM as:

$$R_{i,t}-R_{f,t} = \alpha_i + \beta_i(R_{m,t}-R_{f,t}) \tag{2}$$

$$\epsilon_t = (R_{i,t}-R_{m,t}) - [\alpha_i+\beta_i(R_{m,t}-R_{f,t})] \tag{3}$$

In the absence of new information -- i.e., an "event" -- $E[e_t] = 0$.[2]

The random variables, $\epsilon_{i,t}$, are i.i.d. $N(0,\sigma^2)$. This implies that $COV(\epsilon_{i,t},R_{m,t}) = 0$ and $COV(\epsilon_{i,t},\epsilon_{j,t}) = 0$ for all $i \neq j$. The former follows from the assumption that $E[R_{i,t}|R_{m,t}]$ is a linear function of $R_{m,t}$. The latter is equivalent to assuming the absence of industry effects. By assumption the joint distribution of $R_{i,t}$ and $R_{m,t}$ is stationary over the sampling period. So, by assumption, are the CAPM parameters α and β. Neither the event, nor other time-varying economic forces are assumed to have any effect on the covariance structure of the firm's returns. This assumption is suspect, particularly in cases where the event under study is a change in the regulatory regime, a merger or acquisition, or anything else that affects the determinants of the firm's cash flows[3].

The event study methodology involves the estimation of residuals, or forecast errors, from the CAPM. Parameters are frequently estimated using a time-series which excludes the event window. The value of information received during the event is inferred by aggregating the forecast errors (excess returns) both cross-sectionally over affected firms and across event time. When parameters are estimated outside of the event window the excess returns are considered random variables, independent of the forecast model.

In many event study applications, however, parameters can not be estimated before or after the event since the event significantly affects the nature, or existence, of the firm. Furthermore, when the event date is not precisely known, or when the realization of the event occurs over a protracted time period, parameter estimates made outside the event window may not be relevant to the forecast period. Ceteris paribus assumptions are violated, intervening economic forces can generate spurious results. However, including the event period in the estimation period is troublesome. The regression residuals (abnormal returns) are no longer not independent. The occurrence of an event may bias model parameters.

A dummy variable approach is adopted in this paper as an alternative to residual analysis. The market model is estimated using time series inclusive of the event period. Dummy variables are created for the event period. Excess returns are captured in a piecewise linear fashion from the estimated coefficients on event-time specific dummy variables.[4] As discussed in Section 5, the dummy variable approach is frequently superior in terms of model specification, significance testing and the use of relevant data in the estimation of model parameters.

2.2 Parameter Stability in the CAPM

The literature is awash with empirical tests of the CAPM. Briefly the findings suggest that (1) stock returns are linearly related to the return on a market portfolio (Blume 1971; Fama 1965; Fama, Fisher, Jensen, Roll 1969; Fama and McBeth 1973; Roll 1977), (2) $COV(\epsilon_{i,t},\epsilon_{j,t}) \neq 0$, due, in part, to common industry effects (Binder 1985, Fabrozzi and Francis 1979, King 1966, Schipper and Thompson 1983), and (3) the parameters of the CAPM are not stable over frequently employed sampling periods (Black 1976, Blume 1971, Christie 1982, Levy 1971, Robichek and Cohn 1973, Simon 1985).

Parameter instability is the focus of this paper. We can identify several potential sources of variation in the CAPM parameters.

1. Changes in the composition of a firm's assets .

2. Changes in the riskiness of stocks vis a vis other marketable assets.

3. Leverage effects.

Over time, the composition of a firm's assets will evolve due to acquisitions, divestitures, innovation or changes in the market for its goods and services. The degree to which the firm's cash flows respond to exogenous economic (market) conditions is related to its line of business. Accordingly, beta, as a measure of the firm's covariability with the market, will change with changes in assets and market structure.

A change in the riskiness of common stock, vis a vis other marketable investments, will also affect CAPM parameters. Risk is typically measured in terms of the variance (expected and unexpected) of the return on a portfolio of assets. Given risk-averse investors, asset pricing theories suggest that the expected market risk premium (R_m-R_f) should be directly related to the risk (volatility) of the market return (Christie 1982, French, Schwert and Stambaugh 1985, Merton 1980, Pindyck 1984). The market risk premium reflects the equilibrium price of risk-bearing -- i.e., the rate of return that is required given the risk borne by investors. Ex post, there will be an inverse relationship between the unanticipated component of the market variance and stock prices. In short, following an increase in the market variance, investors revise their expectations of risk. Portfolios are rebalanced, substituting relatively less risky assets for common stock. Prices fall as expected returns rise commensurate with perceived risk.[5] The CAPM relationship shifts.

Beta is related to the degree of financial leverage. As shown by Modigliani and Miller (1958), Hamada (1973), and Black (1976) the riskiness of a firm's stock is directly related to the percentage of debt in its capital structure. As the amount of debt increases, equity holders, who hold subordinated claims, face more variable returns. Explicitly, $\beta_{equity} = (1/w)\beta_{asset}$, where $1/w =$(market value debt/equity) +1.[6] Apart from new issues of debt or equity, beta will fluctuate as the market value of the equity fluctuates -- i.e., with anticipated economic fortunes of the firm. In particular, leverage effects imply that beta will be inversely related to the magnitude of (unanticipated) cash flows.[7] As such, a firm's beta is a function of industry-specific variables as well as the general macroeconomic environment. Simon (1985) shows that over a business cycle a firm's beta moves counter-cyclically if the firm's debt/equity ratio is greater than the average debt/equity ratio in the market, and vise versa.[8] Many authors (Robichek and Cohn 1973, Levy 1974, and Fabrozzi and Francis 1977) have suggested calculating separate beta coefficients for bull and bear markets.

Inspite of the volume of evidence suggesting that beta may be unstable in simple time-series estimates of the CAPM, the problem is frequently ignored in empirical work. The implications of this omission are examined in the following sections.

3.1 Recursive Diagnostic Techniques

Recursive estimation falls under the broad category of exploratory methods for detecting parameter shifts.[9] Briefly, the regression equation is fit recursively, adding successive observations one at a time. Step-ahead forecasts of the dependent variable are computed for each iteration. In general, shifts in model parameters are indicated by tendencies of the model to over or under-predict. The standardized forecast errors, or recursive residuals, as defined originally by Brown, Dorbin and Evans (1975) are distributed with mean zero and constant variance under the standard assumptions of OLS, and, of particular interest, where the model parameters are constant. The recursive residuals may be analyzed graphically or by using more formal statistical tests to identify the timing, direction and magnitude of parameter changes.

3.2 Estimation and Properties of Recursive Residuals

Consider the regression model

$$Y_t = X_t'B_t + u_t, \quad u_t \sim \text{i.i.d. } N(0,\sigma^2)$$

where the vector of coefficients B_t, may vary over time. The null hypothesis is

$$H_0: \; B_1 = B_2 = \ldots = B_T = B \quad \text{for all } t.$$

Following Brown, Durbin and Evans (BDE), we can construct the recursive parameter estimates

$$\hat{b}_r = (X_r'X_r)^{-1}X_r'Y_r \quad \text{for } r = k,\ldots,T$$

where X_r, Y_r denote observations from time periods 1 through r.

Recursive residuals are then computed for each period $t = k+1,\ldots,T$ as follows:

1. Forecast y_r using the coefficient estimates obtained from the first r-1 observations. Compute the forecast error,

$$e_r = Y_r - x_r\hat{b}_{r-1}$$

2. Under H_0, e_r is distributed with mean zero and variance $\sigma^2 d_r^2$, where

$$d_r = [1 + x_r'(X_{r-1}'X_{r-1})^{-1}x_r]^{1/2}$$

3. The recursive residual is defined as

$$w_r = e_r/d_r$$

which is shown by BDE to be $N[0,\sigma^2]$ with

$$E[w_r,w_s] = 0 \quad \text{for} \quad r \neq s.$$

3.3 <u>Diagnosing Parameter Instability</u>

The recursive residual procedure generates several time-series of statistics which may be graphed or listed for simple descriptive analyses of parameter changes over time. In particular, the research may wish to examine:

1. The recursive estimates of the regression coefficients.[10]
2. The one-step-ahead prediction errors.
3. The standardized step-ahead prediction errors.

Plots of the estimated coefficients over time provide straightforward evidence of the direction of parameter instability and the impact of individual observations on parameter estimates. Standardized raw prediction errors highlight the timing of potential parameter shifts. Systematic tendencies to over- or under-predict, jumps and break points in the series and runs of positive or negative forecast errors are symptomatic specification problems.

BDE propose the CUSUM square test to formally test for systematic (as opposed to haphazard) movements of B_t.

Define the CUSUM Square statistic:

$$CS_r = \left(\sum_{k+1}^{r} w_r^2\right) / \left(\sum_{k+1}^{T} w_r^2\right) = S_r/S_T$$

where, S_r = the total sum of squares of the residuals for the first r observations.

Under the null, CS_r can be shown to have a beta distribution with mean $(r-k)/(T-k)$. Again, one may derive a pair of confidence bounds

$$l_r = \pm c_o + (r-k)/(T-k)$$

such that the probability of crossing one, or both, bounds is α. Durbin (1969) derives the values for c_o for alternative confidence levels and degrees of freedom.[11]

4.1 An Application

The best way to illustrate the preceding concepts is by way of example. The following case suffers from (1) an event for which relevant information leaks out over time, (2) insufficient data before or after the event window and (3) considerable economic volatility during the estimation period. First, the standard event study methodology is employed. A constant parameter version of the SL CAPM is estimated. The residuals from the CAPM are interpreted as excess returns, permitting an assessment of the value of economic "news" to the firms shareholders. Next, the stability of the CAPM parameters is investigated using recursive techniques. Finally, parameter instability is linked to left-out economic variables. An augmented asset pricing model is evaluated. The section concludes with general suggestions for methodological improvements.

4.2 Do New Issues Earn Abnormal Returns?

Considerable research has addressed the after-issue performance of new stock issues. The focus of many of these studies (Benston 1973, Jarrell 1981, Simon 1985, Stigler 1964) was to examine the economic effects of financial disclosure regulations promulgated by the Securities and Exchange Commission (SEC). The data used here are taken from a study on the effects of the Securities Act of 1933. They include all issues of common stock valued at greater than $1.9 million, undertaken from 1926-1940. The '33 Act established standards for the disclosure of audited financial information prior to the sale of securities. It was the first, national regulation of its kind and its passage was fueled by the belief that inadequate financial disclosure had led to widespread misrepresentation and fraud in securities markets. To the extent that regulation improved investor information, the distribution of returns earned by investors should be different following the Act that was prior to 1933 -- returns should be higher and risk (variance) lower.[12] Our present purpose is to use these data to illustrate how parameter instability over the sampling period can lead to erroneous conclusions using standard event-study techniques. In doing so we focus on a subsample of securities issued between 1926 and 1933.[13]

4.3 Empirical Results Using the Standard Event-Study Approach

The cumulative abnormal return (CAR_T) measures the excess (risk-adjusted) returns earned by investors over the event period $t=1,\ldots,T$.[14]

Define for each firm, i, in the sample the abnormal return $\epsilon_{i,t}$.

$$\hat{\epsilon}_{i,t} = (R_{i,t}-R_{f,t}) - \hat{\alpha}_i + \hat{\beta}_i(R_{m,t}-R_{f,t}) \tag{4}$$

$$CAR_T = \sum_{i=1}^{N} \sum_{t=1}^{T} (\hat{\alpha}_i' + \hat{\epsilon}_{i,t}) \tag{5}$$

The event is typically assumed to occur in t=0, the effects of the information are reflected in subsequent returns. In the absence of economic news $E[CAR_T] = 0$ for all T.[15]

The timing and magnitude of the effects of the event are best displayed in a time-series plot of the CAR's.[16] The "event" -- i.e., market information about the true value of the security -- follows the issue date. Systematic overpricing (fraud, biased investor perceptions) implies a series of negative, risk-adjusted returns. Systematic underpricing implies series of estimated positive residuals. Since many of the firms are not publicly traded prior to the issue date the model must be estimated over the event period. The performance of a sample of stocks issued prior to the 1933 Act was tracked for 60 months following the date of issue. Returns data were collected from the Monthly CRSP Stock Tape and various issues of the Commercial and Financial Chronicle[17]. Issues are categorized according to whether they were initial public offerings or seasoned issues and by the exchange on which they were traded.[18] Categories attempt to control for differences in market information available to investors through trading histories and/or exchange disclosure requirements. The 1-60 month CARs are plotted in Figures 1 and 2.

Results strongly suggest that investors suffered large, risk-adjusted, losses over 24-48 months following the date of issue.[19] Losses are most pronounced for unseasoned issues and issues traded on the smaller, regional exchanges. Estimated 48-month CAR's range from -30% for unseasoned NYSE issues to -110% for seasoned regional issues and -160 for unseasoned, regional issues. Only investors in seasoned, NYSE issues earn normal risk-adjusted returns.[20] The results, however, may be artifacts of misspecification. In particular, note that the measured losses are most pronounced among the unseasoned issues. These tend to be smaller, newer firms which are more highly leveraged and subject to significant changes in the composition of assets.

An exploratory analysis of parameter stability was conducted:

1. Recursive residuals were computed. For each issue recursive estimates of the market model parameters were computed for $r = 6,\ldots,59$. Using these, the time-series of recursive residuals (step-ahead standardized prediction errors) were computed for $t = 7,\ldots,60$.

2. The recursive residuals and recursive estimates of β were plotted for samples of seasoned vs. unseasoned, national vs. regional exchange issues.

3. BDE CUSUM Squared statistics were computed, testing the null hypothesis of parameter stability over the 5-year post-issue period.

4.3 Descriptive Analysis

The time series of recursive residuals and recursive beta estimates were plotted for each issue. Space, time and the limits of reason preclude the inclusion of all 292 plots in this paper. The time-series plots of several "typical" issues are attached. Several general observations may be made as well.

1. The beta's of a large number of issues (over 70%) exhibit cyclical variation. Volatility is particularly notable around the market crashes of 1929 and 1931. Either changes in the expected variance of the market portfolio or in leverage could account for this.

2. Numerous issues (approximately 30%) exhibit trends in the recursive beta. Trends are most prevalent during periods when the market variance is rising or falling.

3. Estimated betas are particularly unstable prior to bankruptcy/severe financial distress. Twenty eight of the 43 issues by failing firms (65%) exhibit sharply rising betas prior to being delisted.

4. The estimated betas of unseasoned issues (initial public offerings) are less stable than those of seasoned issues.

The cyclical variation in beta can be observed in the pattern of recursive betas presented in Figures 3, 4 and 5. Betas are plotted for 13-60 month recursions -- earlier points being excluded due to the extremely low precision of the estimates. Figure 3 plots beta for a typical unseasoned issue traded on the NYSE. Substantial increases in beta are noted around October 1929 and in mid-1931, corresponding to downturns in the economy. Figure 4 presents beta estimates for an unseasoned issue traded on a regional exchange and Figure 5 illustrates recursions for a seasoned, regional issue. Cyclical movements are less pronounced for the seasoned issue, an observation which is typical of the sample.

4.4 <u>BDE CUSUM Test</u>

The BDE Cusum Square statistic was computed from the series of recursive residuals. Disaggregating according to whether the new issue is seasoned or unseasoned, and whether the issuing firm is listed on the NYSE, Table 1 gives the percentage of issues for which the null hypothesis can be rejected at significance levels $\alpha = .01$, .05, and .10.

As shown in the table, at $\alpha = .05$, parameter stability is rejected in over 1/3 of the seasoned issues. The null is rejected 50% of the time for unseasoned NYSE firms, and in 63% of the cases for non-NYSE initial public offerings.

5.1 A Better Mousetrap

The previous sections have identified several potential problems with the standard event study methodology.

1. Parameter instability over the sampling period,

2. Potential left-out economic variables.

3. Limitations of the cumulative abnormal returns approach in measuring excess returns.

An augmented asset pricing model is developed to address these issues. Let the return-generating process be given by

$$R_{i,t} - R_{f,t} = \alpha_i - \beta_i (R_{m,t} - R_{f,t}) + \sum_{j=1}^{4} \gamma_{j,i} D_{j,t} \tag{6}$$

$$+ \delta_i [RIND_{i,t} - R_{m,t} - R_{f,t}] + \theta_i UVAR_t$$

$$+ \phi_i [CYCLE_t * (R_{m,t} - R_{f,t})] + \epsilon_{i,t}$$

where

$R_{i,t}$ = Return on the i^{th} firm in time t, where t refers to the number of months since the date of issue.

$R_{f,t}$ = Risk free rate

$R_{m,t}$ = Return on a value weighted market portfolio.

$D_{j,t}$ = Time-specific dummy variables designed to pick up average abnormal performance over designated periods of time.

$D_{1,t}$ = 1 for t = 1,...,12 months following the date of issue, = 0, otherwise

$D_{2,t}$ = 1 for t = 13,...,18 months following the date of issue, = 0 otherwise

$D_{3,t}$ = 1 for t = 19,...,24 months following the date of issue, = 0 otherwise

$D_{4,t}$ = 1 for t = 25,...,36 months following the date of issue, = 0 otherwise

α_i = the constant, measures average abnormal performance over the estimation period. Under the efficient markets hypothesis the expected value of α_i is zero.

$RIND_{s,t}$ = the return on an equally-weighted portfolio of firms in the same 2-digit SIC as the firm issuing stock, is included to capture industry-specific returns. In this manner the firm-specific component of the abnormal returns -- i.e., that portion related to the new issue itself -- is clearly separated from any unanticipated changes in the fortunes of the industry.

$UVAR_t$ = unanticipated component of the market variance in time period t. $UVAR_t$ is estimated as the residual from an ARIMA (1,0,1) model on the market variance (VAR_t). I.e.,

$$UVAR_t = VAR_t - .979VAR_{t-1} + .084e_{t-1}$$

and

$$VAR_t = \sum_{i=-11}^{0} [R_{m,t+i} - \bar{R}_{m,t}]^2/12$$

where $\bar{R}_{m,t}$ = average return on the market over $t = -11,\ldots,0$. Unanticipated changes in the variance of the market induce changes in the returns earned by equity investors. Because the CAPM assumes constant variance, and anticipated changes are presumably already factored into a security's price, the unanticipated component of market variance is included to control for subperiod changes in the market variance that shift the equilibrium return on common equity assets.

$CYCLE_t$ = cyclical component of general economic activity. Cycle is computed as the detrended value of the Index of Industrial Production over the period 1925-1945. $CYCLE_t$ is interacted with $(R_{m,t}-R_{f,t})$ to capture cyclical variations in beta due to changes over the business cycle in the market value Debt/Equity Ratio.

The pattern of abnormal returns is captured, in a stepwise fashion, by the estimated values of the $\gamma_{1,i},\ldots,\gamma_{4,i}$, and α_i coefficients. Figure 6 illustrates the pattern for a hypothetical firm that suffers abnormal losses in the early months following the date of issue, with the magnitude of the losses declining over time.

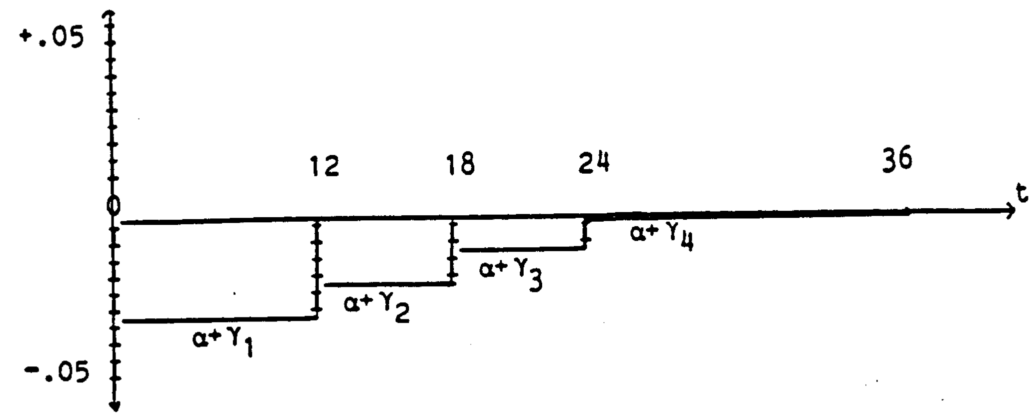

Fig. 6 -- Dummy Variable Representation of Excess Returns

5.2 <u>The Dummy Variable Approach to Measuring Excess Returns</u>

Under the efficient markets hypothesis the coefficients on the event-time dummy variables (γ_i) and the intercept term (α) should all equal zero if investors earn normal, risk-adjusted returns. Alternatively, if abnormal returns are realized, the dummy variable coefficients can be used to construct a piece-wise linear time-path of the abnormal returns. Note that the dummy variables are constructed to cover a range of months, as opposed to designating a single month in post-issue time. This implicitly assumes that information relevant to the "true" value of the security will emerge slowly over time as trading histories are developed and data on firm performance reaches the market.

Two sets of average abnormal returns hypotheses are tested:

1. For each event-time period, j, dummy variable $\gamma_{i,j}$,

$$H_o: \sum_{i=1}^{n} \gamma_{i,j} = 0 \quad N = \# \text{ firms.}$$

That is, on average no abnormal returns are earned in a specific event-time period, j, over all issues, i.

2. $$H_o: \sum_{i=1}^{N} \alpha_i + \sum_{i}^{N} \sum_{j}^{4} \gamma_{i,j} = 0.$$

I.e., on average no abnormal returns are generated over the 60 months following the date of issue.

We can test the linear restrictions implied by the hull hypotheses as follows:

Represent the constraint (null hypothesis) as:

$$R\beta = r$$

where r = a q-element vector, q = number of constraints, and, R = matrix of order $q \times (K_1+K_2+,\ldots,K_J)$, K_1 = number of estimated coefficients in equation (1).

The quadratic form

$$(r-R\hat{\beta})' \{R(X'X)^{-1}X'(\hat{\Sigma} \otimes I)X(X'X)^{-1}R'\}^{-1} (r-R\hat{\beta})$$

is asymptotically distributed as $\chi^2(q)$, where q = number of constraints, and $\hat{\Sigma}$ is the estimated matrix of contemporaneous covariance terms.[21]

The dummy variable approach has several advantages over the use of cumulative residuals. First, it permits the use of data during the event period in estimating the model. Otherwise "spurious" economic events occurring during the event period can be directly controlled. By dummying over the event period model parameters will not be biased by outliers in the event of significant excess returns. Second, the dummy variable coefficients can be readily aggregated over firms and/or over time. Hypothesis tests are constructed as joint tests on the sums of coefficients.[22] Third, seemingly unrelated regression (SURM) techniques can be used to control for contemporaneous correlation in the errors of the single firms regressions.

Finally, a dummy variable configuration is easily adapted to situations in which the exact timing of the event is unknown or where multiple announcements and news "leaks" are assumed to occur over time.

6. <u>Comparison of the Results</u>

Equation 6 was estimated separately for each new issues in the sample. Average coefficient estimates are presented in Tables 2 and 3. Results are disaggregated according to prior seasoning of the issue (seasoned vs. unseasoned) and the exchange on which it was traded (NYSE vs. Regional). Table 4 compares the excess returns estimated using the dummy variable model (eqn. 6) with those obtained earlier using the simple event study methodology and equation (2).

The results are striking. The CAR approach implied that, on average, unseasoned issues as well as seasoned new issues trading off the NYSE suffered significant, risk-adjusted losses prior to disclosure regulation. New issues were, by large, overpriced. The dummy variable model, however, suggests that overpricing behavior is far less prevalent. Only unseasoned, non-NYSE issues suffer losses. All seasoned issues and all issues subject to NYSE disclosure requirement earn normal risk-adjusted returns. The comparative magnitude of the measured losses is also notable. The CAR approach suggests massive net-of-market losses. The 36-month CARs for the regional issue sample measure -95% and -124% for seasoned and unseasoned issues respectively.[23]

Figures 7-9 present the information in Table 4 in graphic form. The CARs from the Sharpe-Lintner Model are plotted alongside the time series of excess returns implied by the dummy variable coefficients in eqn 6. Again, note that the simple event study leads to large measured losses and the implication of persistent over-pricing where the augmented CAPM (eqn. 6) suggests, on average, new issue prices reflected the unbiased expectations of future risk-adjusted returns.

Part of the reason behind the discrepancy can be seen by examining the estimated coefficients of the augmented CAPM. The objective of the event study is to isolate <u>event-specific and firm-specific</u> returns accruing from changes in the investor's information set. The significance of the economic variables added to the standard CAPM suggest that the losses estimated under the simple event-study approach may be attributed to changing CAPM parameters and left-out economic variables which are unrelated to the event in question. First, the industry returns variable is significant in all subsamples of new issues. The 1920's were marked by the rapid expansion of several industries -- radio, communications, transportation -- and the relative decline of others -- e.g. agricultural products, alcoholic beverages (Prohibition). The industry variable separates the unanticipated returns due to sectoral growth/decline from those attributed to the event itself.[24]

The CYCLE interaction term permits the value of beta to fluctuate over economic cycles. Fluctuation is caused by changes in firm leverage. Ideally, beta should be constructed as a function of the market value of the firm's debt/equity ratio. Data on the value of debt in a firm's capital structure were not generally available for the period covered in this study. It is well documented, however, that newer and smaller firms typically have higher debt/equity ratios. Firms traded on regional exchanges are, in general, smaller and younger than their NYSE counterparts. Likewise, firms making initial public offerings (IPO's) would be expected to have a greater proportion of debt in their capital structures, and as such, exhibit greater cyclical variation in beta.[25] As shown in Tables 2 and 3, the CYCLE coefficient is negative and significant for the regional issue subsamples. Unseasoned issues exhibit relatively greater counter-cyclical fluctuation than seasoned issues. The CYCLE coefficient is, on average, negative for the NYSE subsamples as well, however, the estimate is not significantly different from zero.

With respect to UVAR, an unanticipated increase in the variance of stock market returns should lead to a decline is share prices and returns. Theory is supported by the evidence. The coefficient on UVAR is negative in all subsamples and significant at the .10 level or greater.

8. Summary and Conclusions

This paper has explored several hazards in the application of standard event study techniques. Economic conditions which can lead to instability of the time-series parameters of the CAPM were examined using recursive diagnostic techniques. Parameter variation has been found to pose a significant problem over frequently employed sampling periods. Omitted economic variables were linked to shifts in beta and the CAPM intercept. Estimation was improved when the CAPM is augmented to account for (1) industry-specific returns, (2) unanticipated changes in the variance of the return on the market portfolio, and (3) cyclical variation in beta induced by changes in firm leverage. Finally, dummy variables were used to capture excess returns over the event window, in lieu of cumulative abnormal returns. The dummy variable approach is found to make better use of relevant data and permits the researcher to control for "spurious" economic conditions during the event window.

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Footnotes

[1]From January 1926 to August 1929 the stock market rose by over 190%, only to lose over 40% of its market value over each of the 2 years subsequent to the Great Crash of '29. In recent years the market return has ranged from a loss of 25% in 1974 to a gain of over 30% in 1985. The historic (1926-1985) standard deviation of the annual return on common stock is 21%.

[2]According to SL $E[\alpha]=0$. Roll (1977), however, provides evidence that the intercept of the security market line is greater than the riskless rate and its slope is less than the market risk premium. Relaxing the SL assumption which permits borrowing and lending at R_f, Black (1972) derives an alternative form of the CAPM that is consistent with Roll's findings. According to Black, $E[R_{i,t}] = E[R_{z,t}] + \beta_i(E[R_{m,t}] - E[R_{z,t}])$, where $E[R_{z,t}]$ equals the return on a minimum variance portfolio, uncorrelated with $R_{m,t}$. If the alternative model holds and the CAPM is (incorrectly) estimated as (2), $E[\alpha] = (1-\beta_i)(E[R_{z,t}] - R_{f,t})$. The literature, while extensive, does not consistently support one version of the model over the other. The SL version is used throughout this paper.

[3]The event study methodology has been used extensively in addressing the gains and losses accruing from regulatory actions and mergers/acquisitions. For example see Schwert (1981), Binder (1985) regarding measuring the effects of regulations using capital market data. With respect to mergers and acquisitions Jensen and Ruback (1979) provide a review of the empirical literature.

[4]This technique was first used by H. Izan (1978) in her study of the effects of bank audit regulations. See Izan (1978) and Schipper and Thompson (1984) for a complete discussion of the dummy variable formulation vis-a-vis conventional event study techniques.

[5]Pindyck argues that the variance of the real return on a firm's invested capital has risen significantly, and unexpectedly, since the mid-1960's. This has increased the relative riskiness of holding stocks, and in turn can explain a portion of the market's decline during the 1970's. Disintermediation leads to a decline in share prices. Empirically, restraining the CAPM parameters to constant values during the 1970's has lead to conclusions that the CAPM systematically overpredicted returns during this era -- i.e., measured intercepts were negative. This relation is tested in French, Schwert and Stambaugh (1985).

[6]Note, $\beta_{asset} = s\beta_{equity} + (1-s)\beta_{debt}$, where s = (the value of equity)/(the value of assets). Abstracting from default risk, $\beta_{debt}=0$, giving us the equation above.

[7]For example, as a firm approaches bankruptcy beta rises.

[8]Highly leveraged firms have betas that rise during economic downturns and fall during periods of prosperity. Empirically, these more highly leveraged firms tend to be smaller, newer establishments. The higher proportion of debt in the capital structure reflects earlier dependence upon bank financing and forms of venture capital.

[9]Instability in regression relationships has been investigated by numerous econometricians, notably Chow (1960), Tukey (1977), Brown, Durbin and Evans (1975), and DuFour (1980, 1982). One approach to the problem has been to assume that the econometric model suffers from omitted variables, or that the functional form has been incorrectly specified. An alternative track such as recursive estimation focuses on exploratory techniques, designed to detect instability where, a priori, the pattern and timing of the changes in unknown.

[10]Durbin (1969) and Dufour (1982) suggest the use of moving window estimates of the parameters -- i.e., the estimation period is fixed at some subperiod j, $k < j < n$. Successive estimates of the parameters are computed by moving the window of observations used in the estimate forward in time -- adding one observation in the future, dropping the first observation.

[11]The joint distribution of the $((T-k)/2) - 1$ statistics $\{CS_{k+2}, CS_{k+4}, \ldots\}$ is the same as that of an ordered sample of $((T-k)/2) - 1$ independent observations from the uniform $(0,1)$ distribution. Specifically, let the statistics c^+ and c^- be the maximum positive and negative deviations of the set of statistics $\{CS_{k+2}, \ldots\}$ from the mean value line. The theory of non-parametric statistics relies upon the distribution of an ordered sample of observations from the uniform $(0,1)$ distribution. Thus, the statistics c^+ and c^- can be shown to be equivalent to the modified Kolomogorov-Smirnoff statistic C_n^+ for $n = ((T-k)/2) - 1$. For the derivation and additional information see Durbin (1969). The BDE test is designed to be exploratory. It avoids the need to a priori, specify parameter movements, and then employ formal tests

designed to have high power against particular alternatives. However, when parameter movements is suggested by the BDE tests, the point of time at which the significance boundaries are crossed does not necessarily coincide with the timing of parameter shifts. Hence the BDE statistic is most useful when coupled with descriptive graphic analyses.

[12]This paper looks at the average, risk-adjusted return earned by investors following the date of issue. Simon (1985) shows that changes in information costs may lead to changes in the variance of returns as well.

[13]Parameter instability is a greater problem during this era. The methodology applies to the 1934-1940 sample of data, as well (Simon 1985).

[14] The intercept, α, reflects the average abnormal return over the estimation period. The abnormal return in period t is defined as $(\alpha + \epsilon_t)$. When the same time series are used for estimating the model and calculating the CAR's, the estimated abnormal returns are not independent across time. In the final period, T, CAR_T is constrained to equal $T\alpha$.

[15]"Leaks" in information prior to the announcement date can be captured by simply moving the event window forward in time.

[16]Standard significance tests can be conducted using standardized CAR's.

[17]The price series from the Commercial and Financial Chronicle were adjusted for stock splits and stock distributions. Dividends are not included in the issue returns or in the market return measure.

[18]The sample includes all publicly traded new issues of stock with market value exceeding $1.9 million issued between 1926 and 1932. There are 228 seasoned issues, 64 unseasoned, 214 NYSE-traded, 78 traded on regional exchanges (non-NYSE). Of the regional issues, 43 are seasoned and 35 unseasoned (IPO's).

[19]The losses are statistically significant, standardizing the residuals for differences in the error variances across securities.

[20]There is an obvious problem in the interpretation of measured gains or losses. A CAR of -110%, of course does not imply that the investor was paying the firm. It is the result of summing streams of negative returns -- i.e., if a firm loses 50% in 2 successive periods the two period CAR will equal -100%, when actually the firm has lost only 75% of its value.

[21]The test statistic is derived in Simon (1985). The statistic controls for cross-sectional covariance in the residuals of the individual firm CAPM regressions -- I.E $cov(e_{i,t}, e_{j,t}) \neq 0$.

[22] Binder (1985) has investigated the small sample properties of significance tests typically used in event study applications of the multivariate regression model.

[23]Recall that the CAR is the simple sum of estimated monthly abnormal returns. This translated, on a compounded basis, to a 58% loss for seasoned issues and a 72% loss for unseasoned issues.

[24]Inclusion of a industry variable also reduces contemporary correlation of residuals, as documented by King (1966).

[25] The book value of debt was obtained for a non-random sample of 25 firms. Debt/equity ratios were computed using the market value of equity. Firms were ordered according to the D/E values. The CYCLE variable coefficient of the highest D/E quartile of firms was significantly lower (more negative) than the CYLE coefficient of the lowest D/E firms. All firms in the highest D/E quartile had significant counter-cyclical fluctuations in beta.

TABLE 1

Summary of BDE CUSUM Square Tests,

Testing Parameter Stability in the CAPM

$$R_{i,t} - R_{f,t} = \alpha_i + \beta_i(R_{m,t} - R_{f,t})$$

	Percent of Issues in Which H_o Rejected at Various Significance Levels		
	α = .01	.05	.10
Seasoned Issues -- NYSE	25%	35%	38%
non-NYSE	18%	34%	34%
Unseasoned Issues -- NYSE	35%	50%	56%
non-NYSE	40%	63%	69%

Note: H_o: Parameters are stable over the 60 months following the date of issue.

TABLE 2

Average Coefficient Values: Eqn. (6)

Seasoned New Issues, Pre-SEC [1926-1933],

Disaggregated by Exchange

	NYSE		REGIONAL EXCHANGES	
Variable	Avg. Est. Coefficient	χ^2	Avg. Est. Coefficient	χ^2
Constant	.00219	.75	-.00058	.02
D_1 (1-12 months)	-.00292	.49	-.00275*	3.63
D_2 (13-18 mos.)	-.00555	1.12	-.00210	1.51
D_3 (19-24 mos.)	-.00052	.09	-.00536	.08
D_4 (25-36 mos.)	.00066	2.37	-.00261	2.17
R_m-R_f (Beta)	1.1166***	3936.35	.9285***	208.56
RIND-R_m-R_f (Industry)	.7735***	816.84	.6491***	68.36
(R_m-R_f)*Cycle Cyclical Beta	-.0082	3.55	-.03331**	4.78
UVAR (Unanticipated Mkt. Variance)	-7.2049***	54.71	-1.50110*	3.14
cum. 1-60 mo. (abnormal rtn.)	+.0551	0.48	-.1214	2.41
# of issues	196		43	

* Significant at the .10 level.

** Significant at the .05 level.

***Significant at the .01 level.

TABLE 3

Average Coefficient Values: Eqn. (6)

Unseasoned New Issues, Pre-SEC [1926-1933],

Disaggregated by Exchange

	NYSE		REGIONAL EXCHANGES	
Variable	Avg. Est. Coefficient	χ^2	Avg. Est. Coefficient	χ^2
Constant	-.00142	.04	-.00511**	4.06
D_1 (1-12 months)	.0069	.43	-.0082*	3.08
D_2 (13-18 mos.)	-.00092	.01	-.02544**	3.99
D_3 (19-24 mos.)	.00531	.69	-.00835*	2.78
D_4 (25-36 mos.)	-.00257	3.21	.00124	.23
R_m-R_f (Beta)	.8772***	175.90	.9275***	185.9
RIND-R_m-R_f (Industry)	.8824***	65.30	.6142***	34.41
(R_m-R_f)*Cycle Cyclical Beta	-.0173	1.80	-.05101**	4.18
UVAR (Unanticipated Mkt. Variance)	-4.46***	19.97	-1.44706***	12.92
cum. 1-60 mo. (abnormal rtn.)	-.0116	0.68	-.5261**	4.11
# of issues	18		35	

* Significant at the .10 level.

** Significant at the .05 level.

***Significant at the .01 level.

TABLE 4

Comparison of Estimated Abnormal Returns

Sharpe-Lintner CAPM, CARs (CAR vs.

Augmented CAPM Using Dummy Variables (DV))

	Abnormal Returns, by Model and Months Following Issue Date							
	1-12 mo.		13-24		25-36		1-60	
	CAR	DV	CAR	DV	CAR	DV	CAR	DV
NYSE-								
seasoned	-.070	-.009	-.021	-.002	.034	.028	-.045	.055
unseasoned	-.038	.053	-.052	.009	-.261*	-.043	-.032*	.012
Non-NYSE-								
seasoned	-.341*	-.034	-.262*	-.045	-.331*	-.030	-1.18*	-.320*
unseasoned	-.376*	-.149*	-.416*	-.247*	-.385	-.041	-1.62*	-.526*

Note: All returns are expressed as decimal quantities -- e.g., 10% = .10.

*Significantly different from zero at $\alpha = .05$.

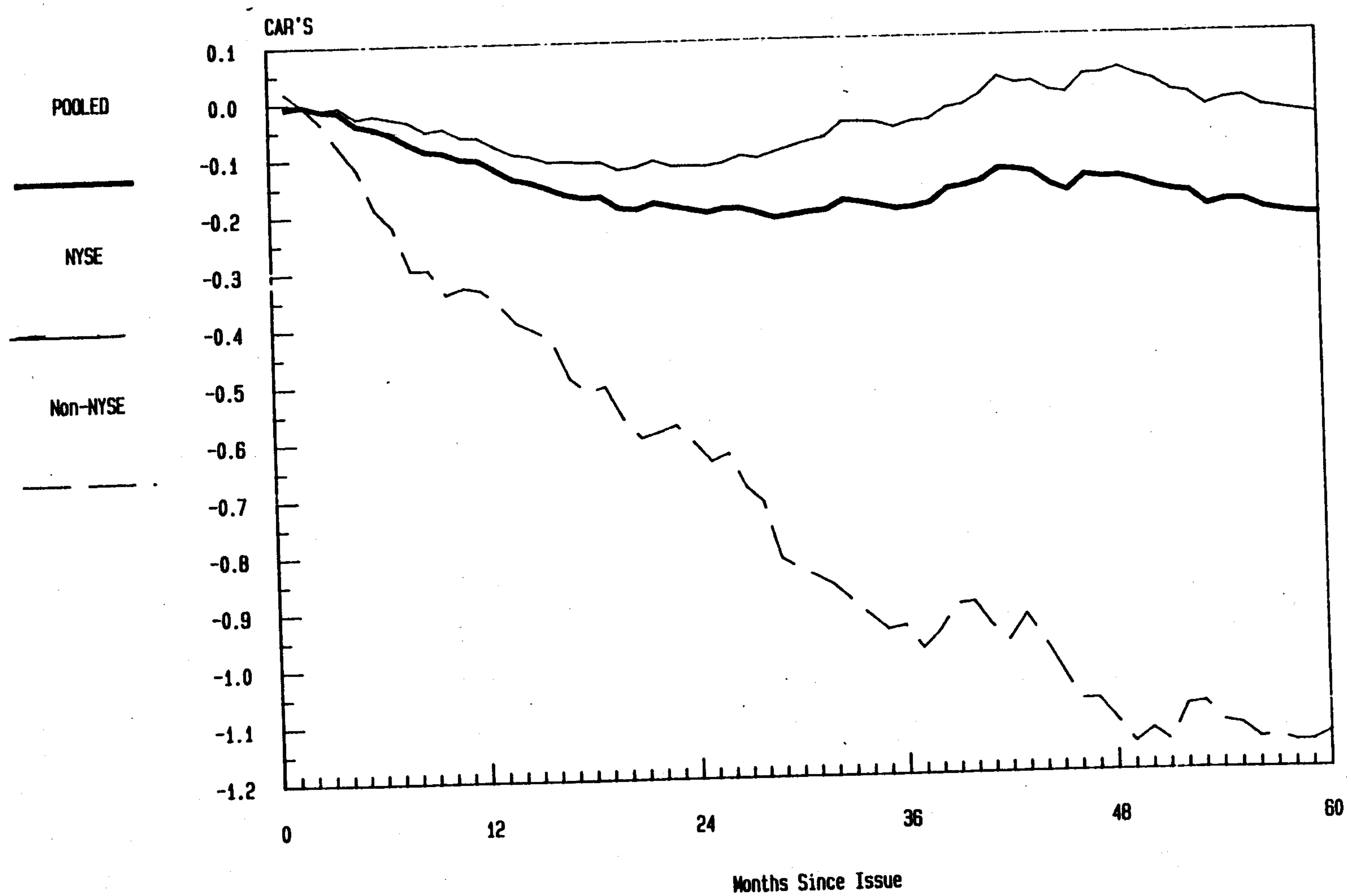

Fig. 1 Cumulative abnormal returns, seasoned issues, pre-SEC, by exchange, computed using constant beta CAPM.

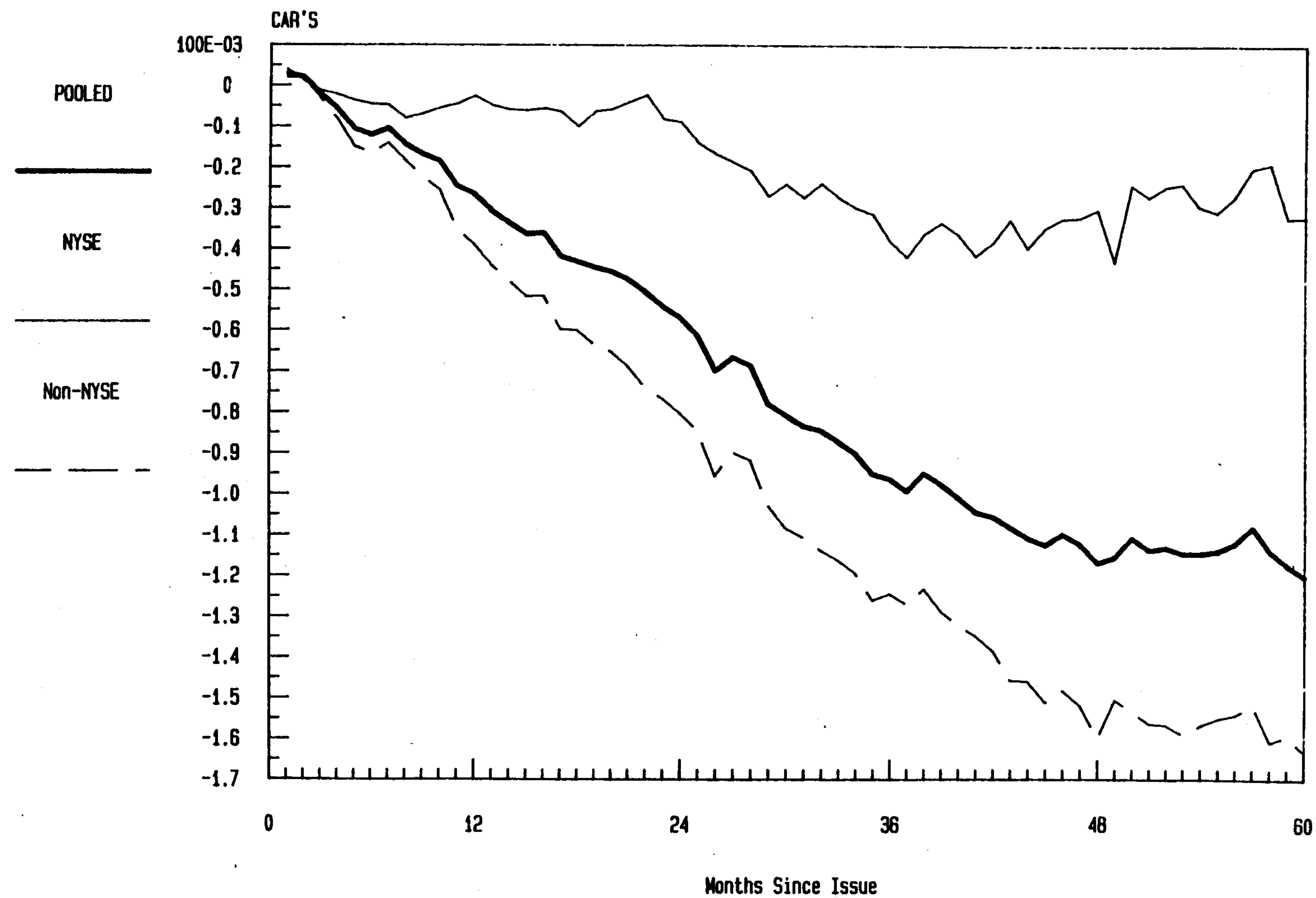

Fig. 2. Cumulative abnormal returns, unseasoned issues, pre-SEC, by exchange, computed using constant beta CAPM.

FIGURE 3

RECURSIVE BETA ESTIMATES

Unseasoned,NYSE Issue

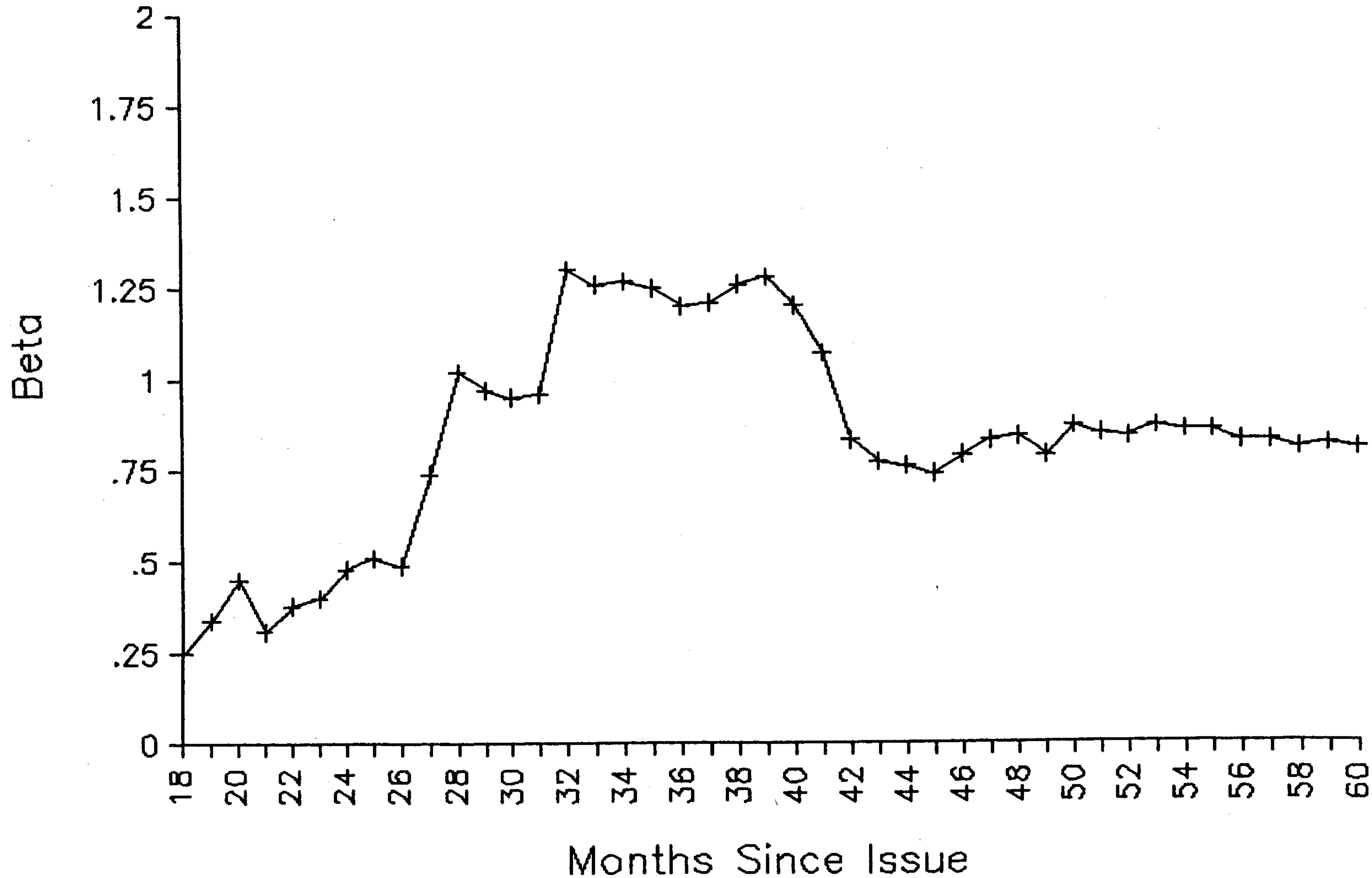

FIGURE 4

RECURSIVE BETA ESTIMATES

Unseasoned, Non-NYSE Issue

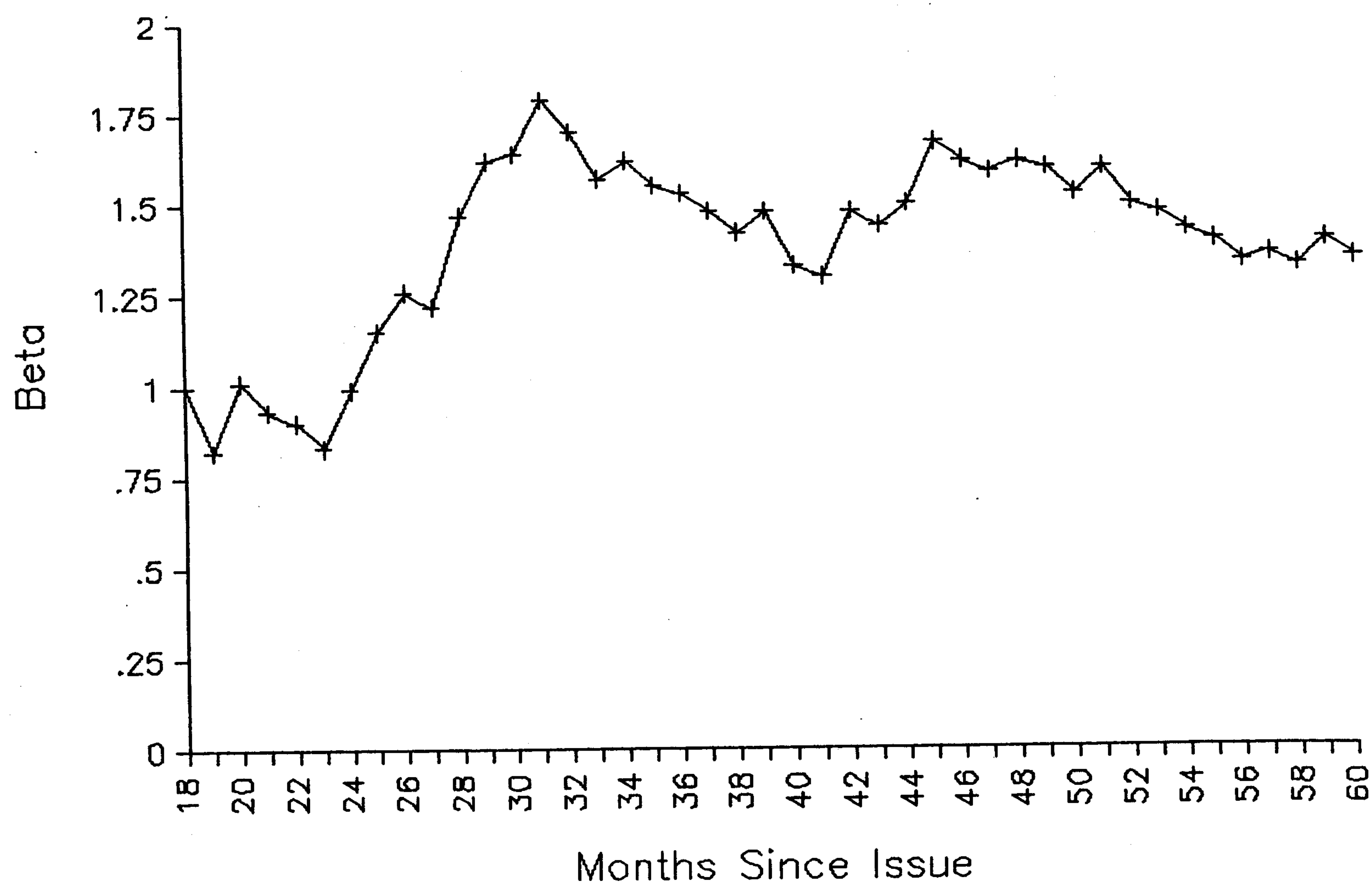

FIGURE 5

RECURSIVE BETA ESTIMATES

Seasoned, Non-Nyse Issue

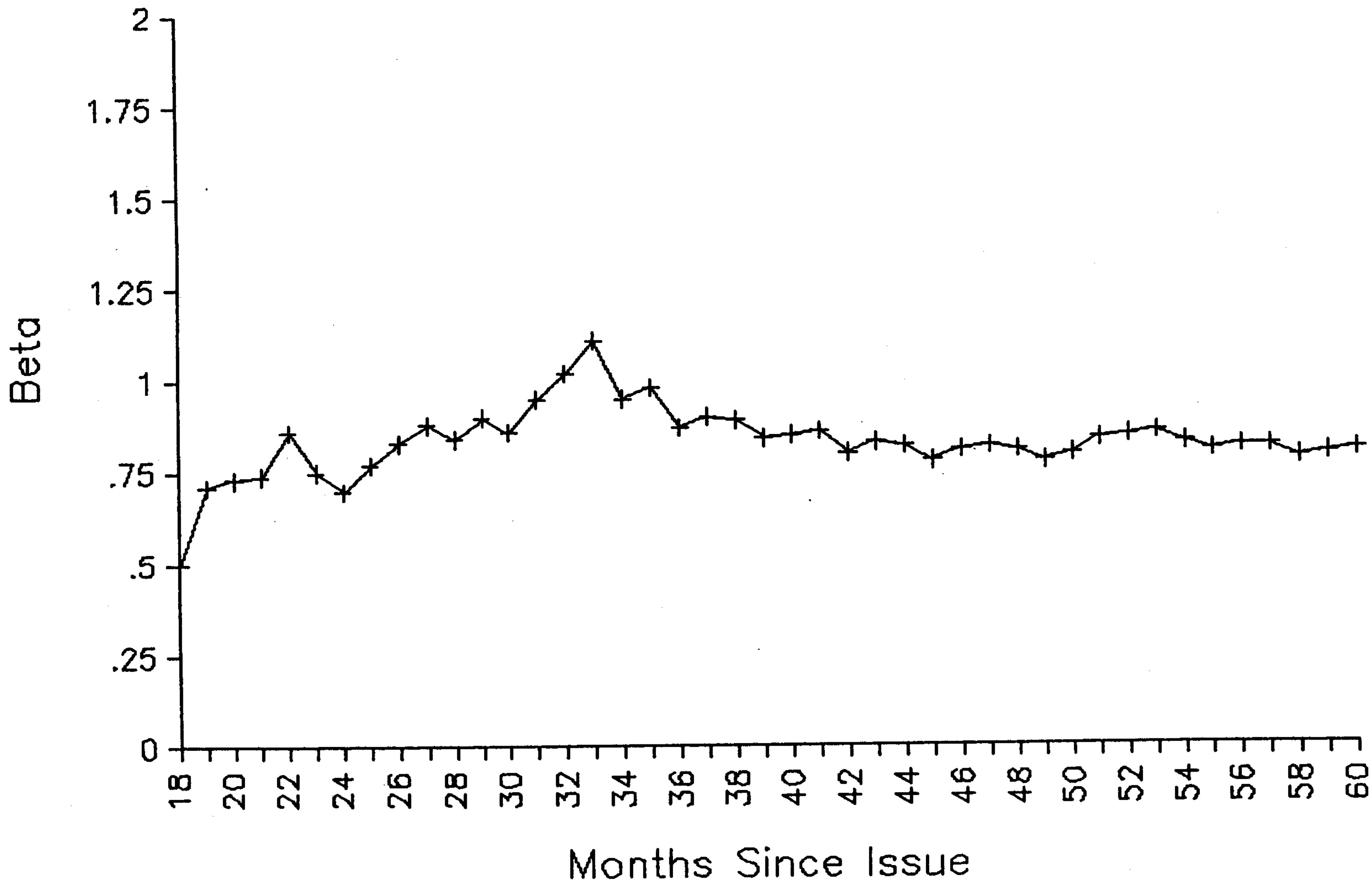

FIGURE 7

CAR vs Dummy Variable Models

Excess Returns:Seasoned NYSE Issues

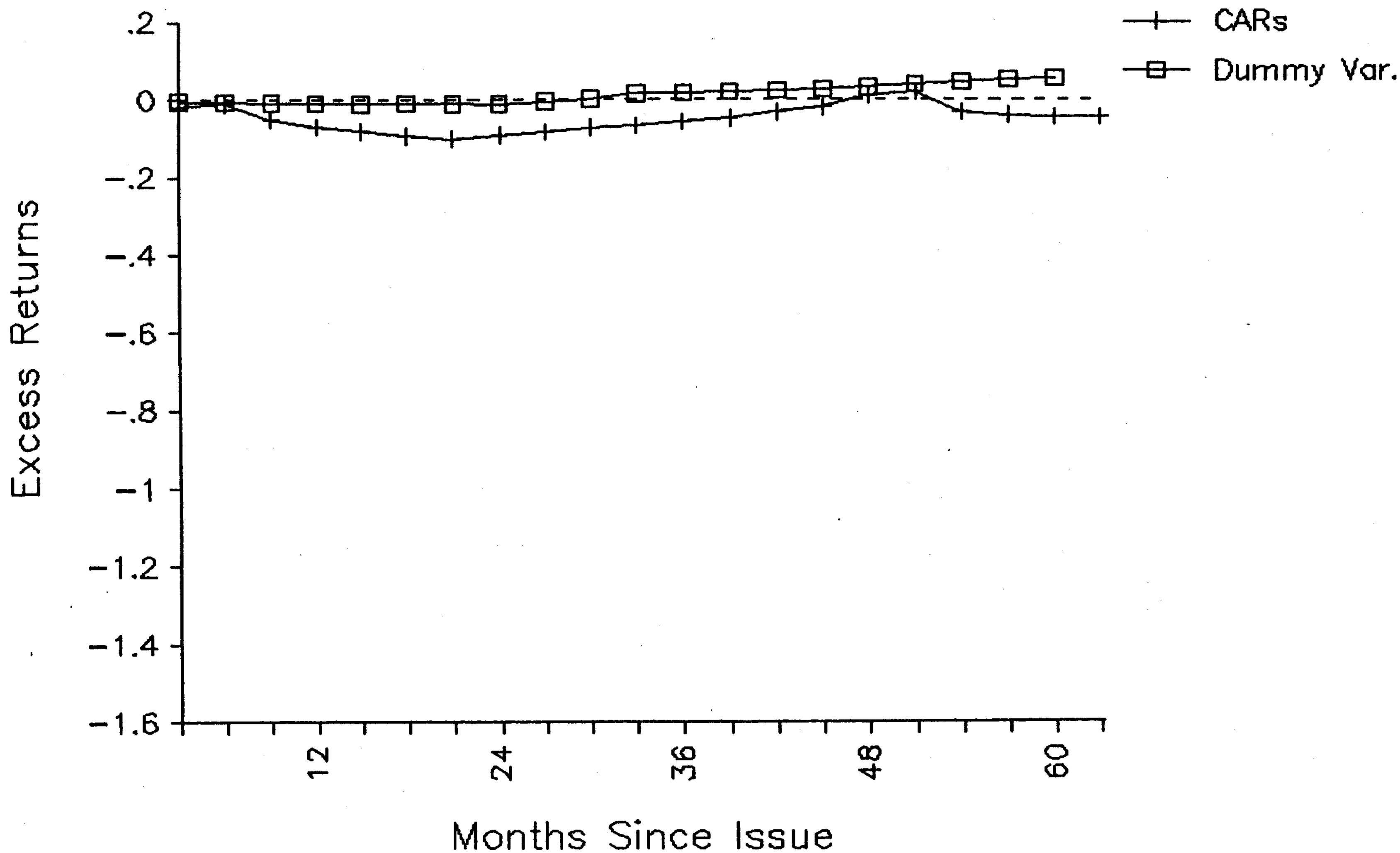

FIGURE 8

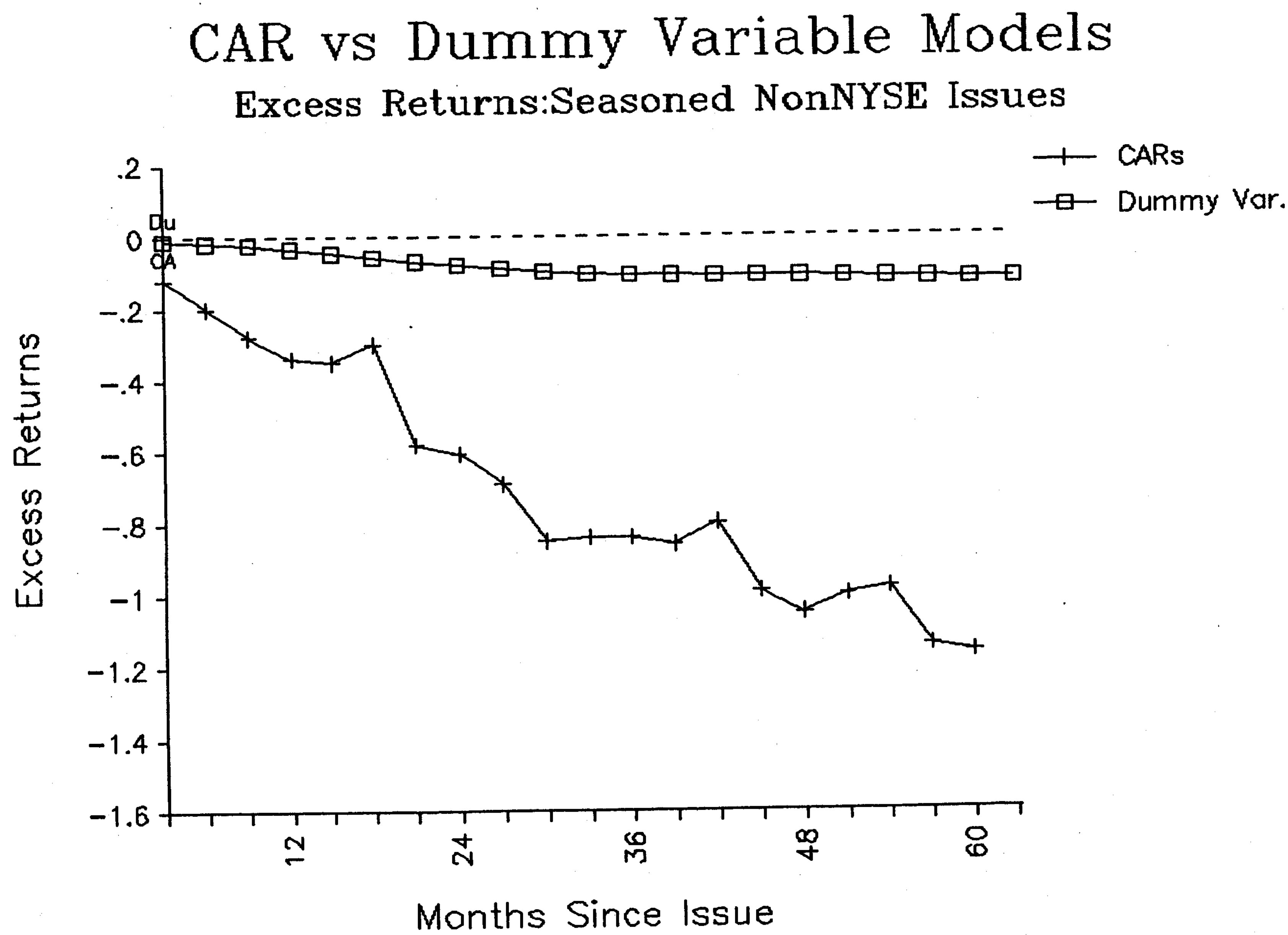
CAR vs Dummy Variable Models
Excess Returns:Seasoned NonNYSE Issues
CARs
Dummy Var.
Du
CA
.2
0
-.2
-.4
-.6
-.8
-1
-1.2
-1.4
-1.6
Excess Returns
12
24
36
48
60
Months Since Issue

FIGURE 9

CAR vs Dummy Variable Models

Excess Returns:Unseasoned NYSE Issues

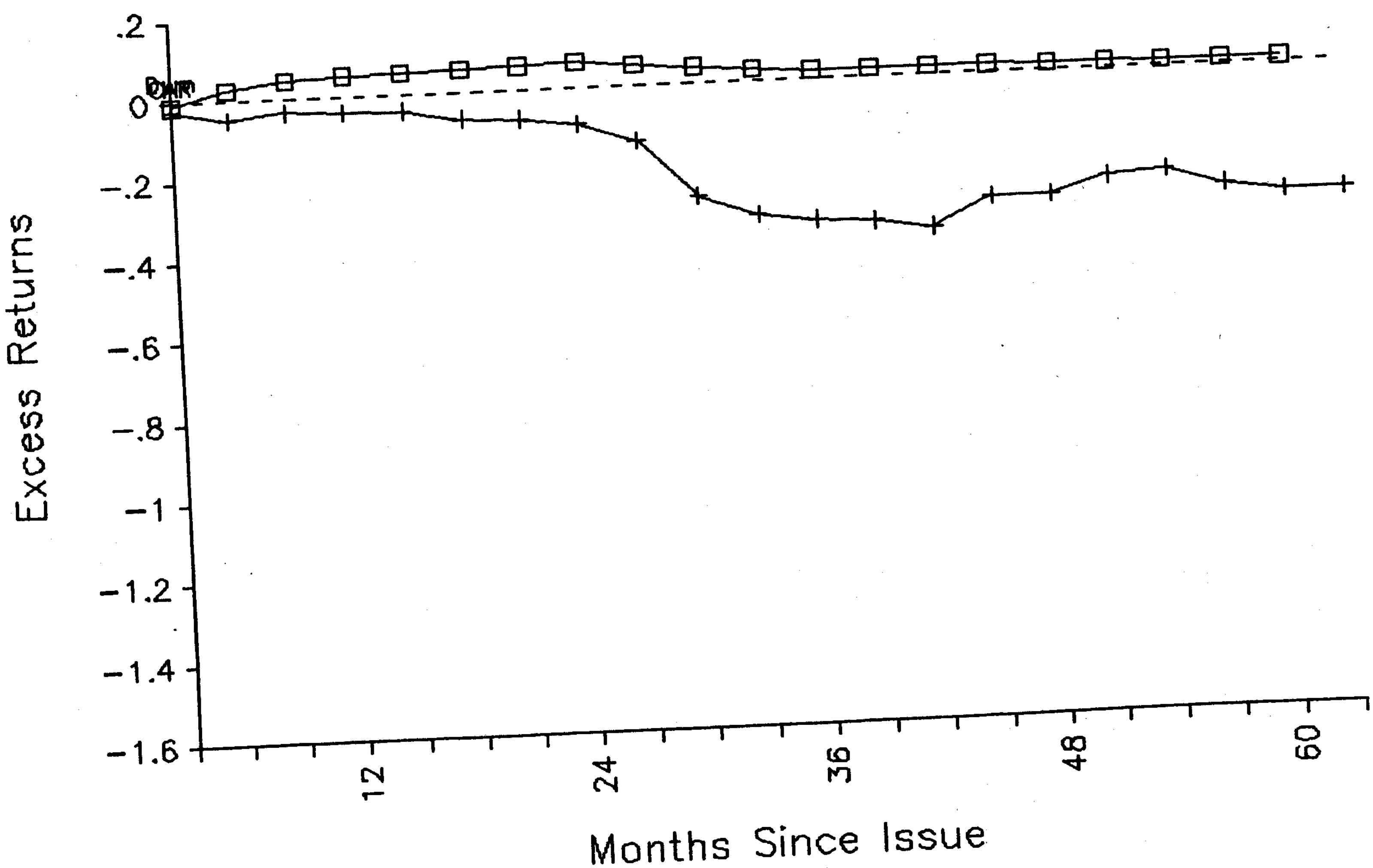

FIGURE 10

CAR vs Dummy Variable Models

Excess Returns:Unseas. NonNYSE Issues