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Micro-Study on Stock Splits and Measuring Information Content Using Intervention Method

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ABSTRACT

In most of studies on market efficiency, the stability of risk measures and the normality of residuals unexplained by the pricing model are presumed. This paper re-examines stock splits, taking the possible violation of two assumptions into accounts. The results does not change the previous studies. But, the size of excess returns during the 2-week period before announcements decreases by 43%. The results also support that betas change around announcements and the serial autocorrelation of residuals is caused by events. Based on the results, the existing excess returns are most likely explained as a compensation to old shareholders for unwanted risk increases in their portfolio, or by uses of incorrect betas in testing models. In addition, the model suggested in the paper provides a measure for the speed of adjustment of the market to the new information arrival and the intensity of information contents.

1. Introduction

In this paper, an approach using intervention analysis will be presented to examine information contents of interventions such as mergers, splits, dividends, and the like. It is shown that intervention analysis is a useful tool for a test of the efficient market hypothesis. Especially, the approach provides us with a measure for intensity of an announcement effect and the speed of adjustment.

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There exists rich evidence to support the effeicient market hypothesis that means a market is efficient in processing information. In other words, the market fully and correctly reflects all available information at that time in the process of price formation.[1] Since we have to examine how well the market uses the information in setting the prices of securities, we need a model of market equilibrium to specify how equilibrium prices at time t-1 are determined from the characteristics of the market-accessed joint distribution of the prices at time t. Thus, any test of market efficiency is always testing a joint hypothesis of market efficiency and an equilibrium pricing model. There developed several versions of the equilibrium model, but the linear market model and two parameter capital asset pricing model were most widely used for this purpose. Sharpe(1963) was the first to suggest the market model in constructing efficient portfolios, and the two-parameter model was first derived by Sharpe(1964) and Lintner(1965). Recently, Stapleton and Subrahmanyam(1983) showed that the two-parameter model may be obtained if the market model is assumed. This means that two models are based on the same assumptions. Brenner(1979) investigates the impacts of the applications of the different market models on the test of capital market efficiency using the splits data. He reports that a choice of the equilibrium model may affect the results. Thus, he recommends to test the hypothesis by applying more than one models. Basically in this paper the market model which is discussed extensively in Fama(1976), however, is employed

Usually, empirical studies on the market efficiency examine the market response to the newly publicly available information such as earnings, mregers, stock splits, accounting policy changes, etc. To measure the market responses, a methodology to examine the behavior of security returns is required. Fama et al.(1969) have suggested the cumulative average residual method, and many other researchers have employed similar methods to test the efficient market hypothesis in the sense that they have used different models of market equilibrium.

Almost all studies presented so far were written on the basis of at least two assumptions : (a) stability of betas during the period examined ; (b) normality of residuals of the fitted market model including the assumption that they are not autocorrelated serially. Growing literature suggests the possibility of instability of betas and autocorrelation of residuals.[2] In practice, however, not only

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1. See Fama(1976)
2. Gonedes(1973) provides an evidence that the betas of individual securities are not constant through time. Bar-Yosef and Brown(1977) examines the stability of betas around the announcement of stock splits, and suggests moving betas methodology as a mean to treat the nonstability of betas.

would successive observations usually be dpendent but frequently the time series would be nonstationary. Rozeff(1984) and Keim and Stambaugh(1986) provide evidence of changes in expected returns with information. Ferson et al.(1987) allows the market risk factor(betas) to vary over time in testing mean-variance efficiency of market portfolios. The methodology to handle autocorrelation and homogeneous nonstationarity in a time series can be found in Box and Jenkins(1979), and Nelson(1973). Using this methodology and intervention analysis to examine the change of patterns in a time series by interventions, Larcker et al.(1980) reports the effectiveness of an intervention model using simulated data.[3] According to them, the classical cumulative average residual methodology may lead to show the existence of abnormal returns by change in betas even when the new information has no positive or negative effects. Intervention analysis may provide useful results by determining the value of betas and the level of changes in a series of returns simultaneously, adjusting the autocorrelation of residuals.

This paper examines the information contents of stock splits around the declaration date and the ex-date using intervention models. We first review the information contents of splits by the classical cumulative average residual method and the possible variability of betas in Section 2. The next section is to develop the intervention models and analyze the daily returns on splitting stocks using the intervention method in order to eliminate the usually presumed assumptions of stability of betas and normality of residuals.

2. Test of Stock Splits by the Classical Methodology

In this section, the abnormal returns from a market model during the period around the declaration date and ex-date on stock splits are examined using the classical cumulative average residual methodology. Before getting into the intervention analysis, we first need to know the results from the classical methodology. It may be used to see whether or not there exists any difference from the resurls of intervention analysis.

Market Model

As a process of price formation of the securities, Fama(1973) showed that conditional expected

3. The basic idea of intervention analysis comes from the multiple input transfer functiovn in Box and Jenkins(1976). This model was first tried by Glass(1972). Box and Tiao(1975) has presented a full description.

return on security can be stated as follows, under the assumption of the bivariate normality of R_{jt}, a random variable representing a daily return on stock j at time t, and R_{mt}, a random variable representing a daily return of the value weighted market index ;

$$E(\tilde{R}_{jt} \mid \phi_{t-1}, R_{mt}) = \alpha_j + \beta_j R_{mt} \tag{1}$$

where $\beta_j = Cov(\tilde{R}_{jt}, \tilde{R}_{mt}) / Var(\tilde{R}_{mt})$

$\alpha_j = E(\tilde{R}_{jt} \mid \phi_{t-1}) - \beta_j E(\tilde{R}_{mt} \mid \phi_{t-1})$

and ϕ_{t-1} is an information set available at time t-1. As a proxy for the market, the value weighted portfolio of all common stocks in the NYSE and the AMEX is used. Therefore, the return of security j at time t may be written in terms of the market portfolio return.

$$\tilde{R}_{jt} = \alpha_j + \beta_j \tilde{R}_{mt} + \tilde{e}_{jt} \tag{2}$$

This valuation model is the one suggested by Sharpe(1963). The market estimates the parameters in (2) using the historical data of prices which are a subset of all available information at that time. The market will use the equation

$$\tilde{R}_{jt} = \tilde{a}_j + \tilde{b}_j \tilde{R}_{mt} + \tilde{e}_{jt} \tag{3}$$

to set the prices of the stocks at time t. The equation (3) provides a mean to test the market efficiency. Since the efficient market fully and correctly uses all the information available at the time, if (1) is the pricing model the market uses and the market is efficient, we must have

$$E_m(\tilde{e}_{jt}^{m} \mid \phi_{t-1}^{m}, R_{mt}) = 0,$$

where ϕ^{m}_{t-1} is the information set the market actually used. Fama et al.(1969) is the first study which uses this model for a test of market efficiency.

The remaining of this section will be devoted to an application of this model for an analysis of stock splits, and the stability of betas will be discussed using moving betas which has been suggested by Bar-Yosef and Brown(1977).

Data

The data used in this paper comes from the daily stock return file maintained by the Center for Research of Stock Prices of the University of Chicago. Stock splits are a frequent phenomenon. Among the listed firms on the CRSP file, about five to ten percent of the firms split their stocks. Our test sample consisted of stock splits announced during the period from 1973 to 1982. The sampling criteria include 100% of the split factor, 30-day time period between the declaration and ex-data, no missing transaction for 90 day before the declaration date and 120 days after the ex-date, and no split for 3 years around the declaration date.[4] The second is required to examine stock prices between the events. We add the third criterion for convenience of estimating the beta. If the sample data include missing values, the Scholes and Williams(1977) method may be applied.

In selection of the period to estimate the model parameters, we have three alternatives : (a) use the period preceding the testing period ; (b) use the period following the testing period ; (c) use the period around the testing period.[5] This paper uses the last method which may adjust the possible variation of betas to some extent.

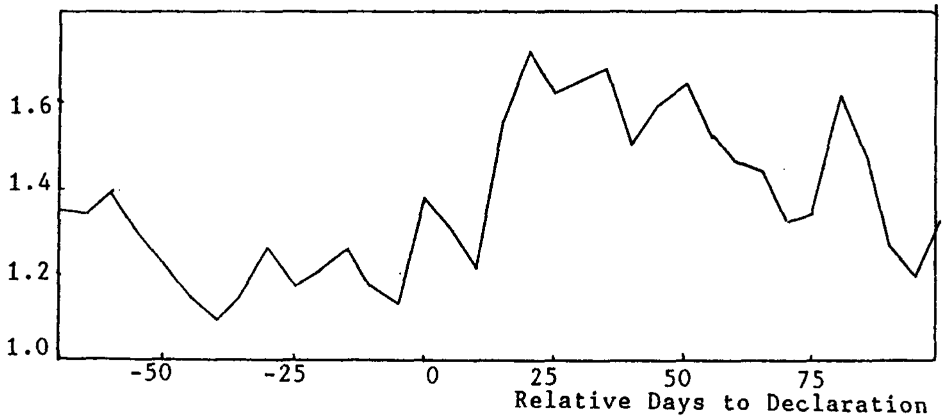


Figure 1. Average Excess Returns for Stock Splits

4. These criteria applied for sampling are quite arbitrary.
5. Among others, Mandelker(1974) is an example of (a), and (b) was used by Brenner(1979). Fama et al.(1969) and Ball(1972) adopted (c).

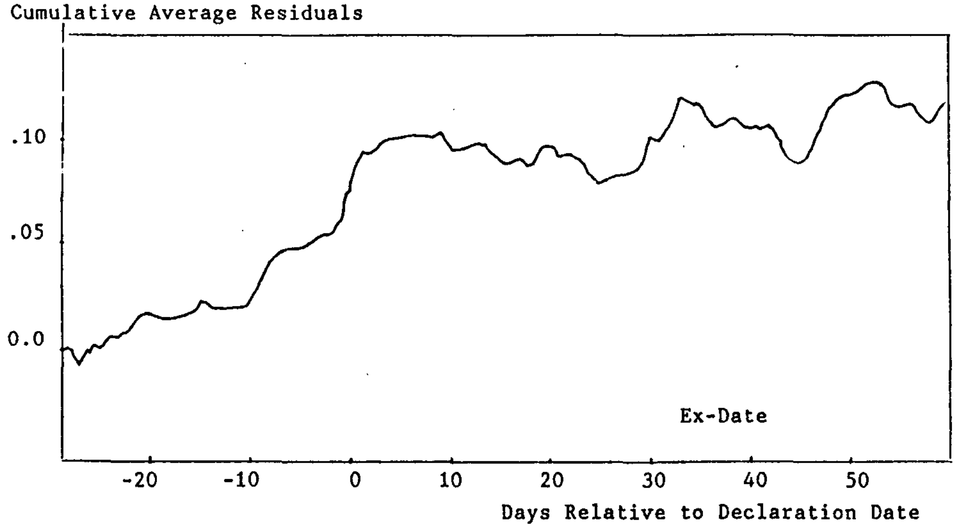


Figure 2. Cumulative Average Residuals for Stock Splits

Figure 1 and 2 display the results. We observe increasing cumulative average residuals until the declaration date. This may indicate the information leak before announcement. After declaration of stock splits, the increasing pattern stops and the plot moves around a 10% level. We do not see any noticeable change in the plot around the ex-date. We conclude that the ex-date does not have any information contents, but the announcement of splits has positive information contents and all the gains by split announcement are revealed before the announcement. We cannot make use of the public announcement to beat the market. The result confirms the former studies. Even though the general pattern is similar to the previous ones, it is not as smooth as the previous results. This is expected because our sample size is small and we are using daily stock return data. Is this result really from the positive information contents of split announcements. If the stability of betas and serial independence of residnals are proved, then the answer would be affirmative.

Change in Betas

The risk measure, beta, depends on the expected future earning stream from business activities. Therefore, it is most likely that the beta changes by an investment descision. But, it is possible for splits to accompany changes in beta. Splits are usually announced by the firms with significantly high earning growth rates. Lakonishok and Lev(1987) reports that the growth rate differences between the splitting and the control group widen as the date of split announcement approaches. This implies that the beta may be changing around split announcecements. Another reasoning of changes in beta by splits is based on the optimal price argument of split motives. Investors with small means are penalized by high stock prices, because it denies them the economies of buying stocks in round lots. On the other hand, wealthy investors save the brokerage costs if stocks are priced high. Thus, splitting will result in an increase of the number of small investors. The resulting change in the shareholder composition eventually leads to a change in the company's risk level.

In the above analysis, it was implicitly assumed that the betas did not change through the split event. And we applied the same estimates to measure excess returns before and after the announcement. If stock splits change the level of systematic risks, the results might be biased by the use of inappropriate betas.

To investigate the stability of betas, the moving betas method is applied. Since what we want to see is the evidence for instability of betas, it is not necessary to calculate the betas everyday. We calculate the moving betas every one week period (5 trading days). Two sets of moving betas, 40-day moving average betas and 60-day moving average betas, were calculated by the equation (4) and (5).

$$\bar{b}_T = \frac{1}{n} \Sigma_{j=1}^{n} b_{jT} \quad (4)$$

$$b_{jT} = \Sigma_{t=T-w}^{T+w} (R_{mt} - \bar{R}) R_{jt} / \Sigma_{t=T-w}^{T+w} (R_{mt} - \bar{R})^2, \quad (5)$$

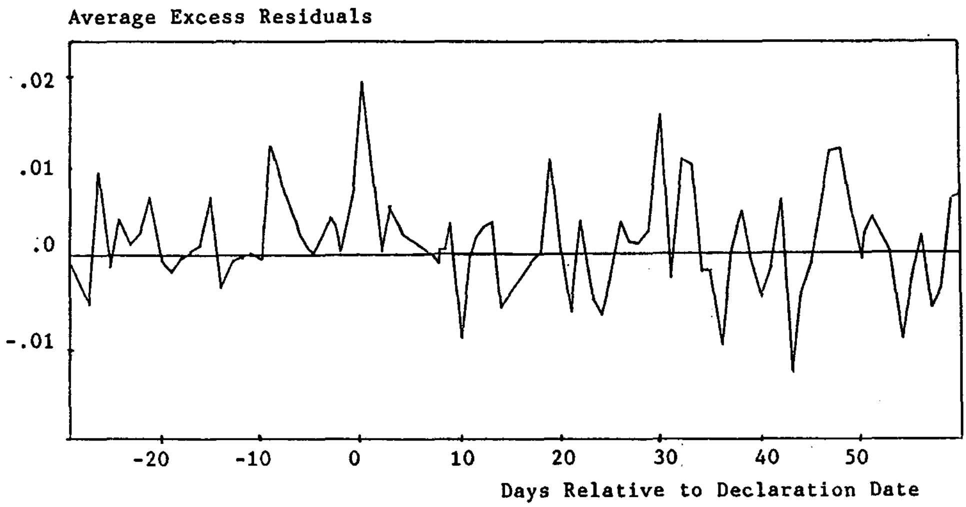


Figure 3. Average Moving Betas for Stocks around Split Announcement (40−day Moving Average Betas)

where T goes from 70 to 100 relative date increasing by 5 trading days, and w represents the window size, i.e., 20 or 30 in this study. Two sets did not show any difference. The 40-day moving average betas are displayed on the Figure 3. A change in the level of betas before and after the announcement of splits is visible.

The Kolmogorov-Smirnov normality test shows that each sample has been drawn from a normal distribution. However, we canont apply the two-sample t-test since the samples before and after the announcement have different variances. We reject $H_0 : \sigma^2_a=\sigma^2_b$ at 5% significnace level where σ^2_a and σ^2_b are the variances of betas after and before the announcement, respectively. In order to test that the betas after stock split announcement is stochastically larger than those before the announcement, we applied the Kolmogorv-Smirnov test. The result was to reject H_0 at 1% level that the systematic risk measures before and after splits are the same.[6] We cannot reject that the systematic risks increase through stock splits. This result confirms the findings of Bar-Yosef and Brown(1977) and Charest(1978).

It is a strong evidence for the variation of betas through the examined period. But, the figure also shows that the betas revert to the original level after 90 days. We are left with a problem. Which betas must be used to measure excess returns? Our choice is to apply different betas before and after the announcement. We will use the same sample data in the next section to examine stock splits more closely using intervention analysis.

3. Intervention Models

The existence of abnormal excess returns around stock split announcements has been observed. And an evidence of nonstationarity of betas has also been presented. We are now interested in the net effect of split announcements after adjusting the variability of betas and possible autocorrelation of residuals. Box and Tiao(1975) developed a methodology to handle this type of the problems. They discuss the effect of interventions on a given response variable in the presence of dependent noise structure. To represent the possible dynamic characteristics of both interventions and noise, difference equation models are employed. Their pure intervention model can be regarded as a special case of the multiple input transfer function(MITF) model introduced by Box and Jenkins(1976) [7] The most general form of the MITF may be written as

6. $D_{1321}=0.637$. The p-value was less than 0.001.

$$D(B)\tilde{Y}_t = \Sigma_{j=1}^{n} \frac{\omega j(B)}{\delta j(B)} D_j(B)B^{bj}\tilde{X}_{jt} + \frac{\alpha(B)\triangle(B)}{\phi(B)\tau(B)} \tilde{u}_t + c, \tag{6}$$

where $D_j(B) = (1 - B^{sj})^{dj}(1 - B)^{dj}$

$\omega_j(B) = \omega_0 - \omega_1 B - \omega_2 B^2 - \cdots\cdots - \omega_{sj}B^{sj}$

$\delta_j(B) = 1 - \delta_1 3 - \delta_2 B^2 - \cdots\cdots - \delta_{\tau j}B^{\tau j}$

$\theta(B) = 1 - \theta_1 B - \theta_2 B^2 - \cdots\cdots - \theta_q B^q$

$\phi(B) = 1 - \phi_1 B - \phi_2 B^2 - \cdots\cdots - \phi_p B^p$

$\triangle(B) = 1 - \triangle_1 B^s - \triangle_2 B^{2s} - \cdots\cdots - \triangle_Q B^{sQ}$

$\tau(B) = 1 - \tau_1 B^s - \tau_2 B^{2s} - \cdots\cdots - \tau_p B^{sp}$

where c is the constant term, u_t prewhitened noise series, and B the backward shift operator. The more detail descriptions of the notations are found in Box and Jenkins(1970) and Nelson(1973).

From the above MIFT model, it is possible to derive the mixed intervention model describing simultaneous effects of the market equilibrium model and the interventions on stock returns. Thus, the stock returns at any point in time, R_{it}, can be stated as

$$\tilde{R}_{it} = f_o(\tilde{R}_{mt}) + \Sigma_j f_{ij}(\tilde{I}_{ijt}) + \tilde{N}_{it} \tag{7}$$

The first term of the left hand side of (7), $f_0(R_{mt})$ is a model of market equilibrium which represents the portion of R_{it} explained by the market factors. This may be substituted by any equilibrium models. We replace it with the market model.

$$f_o(R_{mt}) = \alpha_i + \beta_i R_{mt} \tag{8}$$

If we want to test market efficiency under the assumption of the nonstationarity of betas, we need to break down the equation (8) as below

7. We are using the term of the pure intervention model in a sense that the model does not include exogeneous variables except dummy variables which represent the interventions. On the other hand, the term of the mixed intervention model is used for the models including both types of variables.

$$f_o(R_{mt}) = \Sigma_k(\alpha_{ik} + \beta_{ik}R_{mt})D_{kt}. \quad (9)$$

where D_{kt} is a zero-one variable defined by

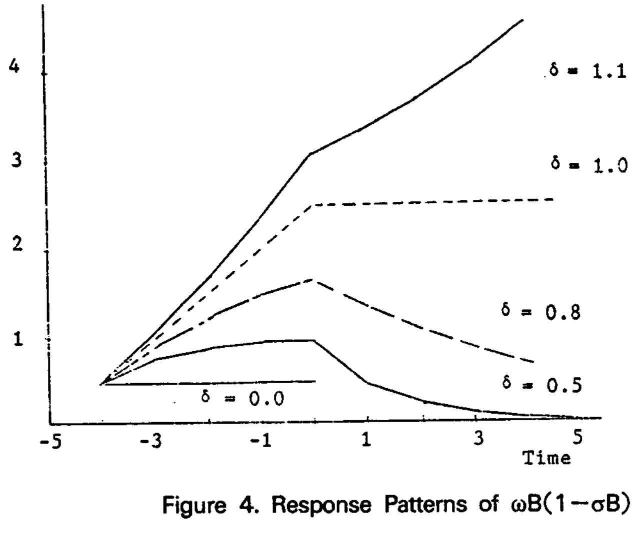
$$D_{kt} = \begin{cases} 1 \text{ if t belongs to a period relevant to } \beta_{ik} \\ 0 \text{ otherwise.} \end{cases}$$

If the beta is nonstationary, it is very likely that the constant term is also nonstationary. In the relationship of the market model with the capital asset pricing model, we know the intercept term is a function of the beta. However, if we replace the R_{mt} with the excess returns on the market portfolio over the returns on the riskless asset, we may assume the intercept is stationary. The equation (9) allows us to regress R_{it} on the returns of a market portfolio piece-wise linearly.

The second term of (7) stands for a dynamic resopnse model for interventions. It describes the response of the market to inputs I_j, s, if any. It is assumed to be given as

$$f_{ij}(I_{ijt}) = (\omega_{ij}(B)/\delta_{ij}(B))I_{ijt}. \quad (10)$$

where $\omega_j(B)$ and $\delta_j(B)$ are as defined in (6), and I_{ijt} is intervention j occured to stock i at time t. The equation (10) omits the difference equation D(B) and delay function B^b, but they may be added if necessary.[8] The dynamic transfer function, $\omega(B)/\delta(B)$, in (10) specifies the response type of the market to inputs.



Note : ω=0.5.
I_t=1 if $-5 \leq t \leq -1$, I_t=0 otherwise.

Figure 4. Response Patterns of $\omega B(1-\sigma B)^{-1}I_t$

8. These two functions, difference and delay function, are used to obtaine a stationary time series. If these are adopted in our model, it is not a normal market model any more.

The negative value of ω means that the input has a negative effect, and vice versa. Figure 4 displays responses for a step input by different values of δ. This may be used for interpretation of information contents of an intervention.

The last term of (7) is a stochastic function for the noise. It could be modeled by a autoregressive moving average process,

$$\tilde{N}_{it} = \frac{\theta_i(B)}{\phi_i(B)} \tilde{u}_{it}. \qquad (11)$$

where u_{it} is a sequence of independently distributed normal variables having zero means. For certain kinds of homogeneous nonstationary series, the denominator can be replaced by $(1-B)^d\phi(B)$. The term (11) is appended to (7) to remove the possible autocorrelation of residuals.

With (9) (10), and (11), we write a full model of the mixed intervention model.

$$R_{it} = \Sigma_k(\alpha_{ik} + \beta_{ik}R_{mt})D_{kt} + \Sigma_j \frac{\omega_{ij}(B)}{\delta_{ij}(B)} I_{ijt} + \frac{\theta_i(B)}{\phi_i(B)} u_{it} \qquad (12)$$

The model (12) is applied to the stock split data to see the true market responses to the new information by adjusting the variablitity of betas and serial autocorrelation of residuals.

4. Empirical Results

We have already seen that the ex-data has no information content. We are only concerned with market responses around the declaration data to the split interventions. Return series of stocks in the sample are examined for 120 trading days around the event. Two types of the intervention model are designed and used in this paper. One is the mixed intervention model, and the other will be called the pure intervention model.

Mixed Intervention Model

Based on the results presented in the previous section, we take two levels of betas, prior and posterior to the declaration data, into consideration in the model. Two dummy variables, D_1 and D_2, indicate the pre and the post announcement period, respectively. In addition, we adopt two intervention variables since we have seen a different pattern of market responses around the stock split event. I_1 stands for information leakage for 10 days preceding the announcement, and I_2 represents information flow for 10 days following the announcement. Therefore, the two intervention variables are step inputs. The empirical model is

$$R_{it} = c + a_i D_{1t} + b_{1i} D_{1i} R_{mt} + b_{2t} D_{2t} R_{mt} + \omega_{1i} I_{1it} + \omega_{2i} I_{2it} + (1 - \phi_i B)^{-1} u_{it}$$

where

$$D_{1t} = \begin{cases} 1 & \text{if } -60 \leq t < 0 \\ 0 & \text{otherwise} \end{cases}$$

$$D_{2t} = \begin{cases} 1 & \text{if } 0 \leq t \leq 60 \\ 0 & \text{otherwise} \end{cases}$$

$$I_{1it} = \begin{cases} 1 & \text{if } -10 \leq t \leq 0 \\ 0 & \text{otherwise} \end{cases}$$

$$I_{2it} = \begin{cases} 1 & \text{if } 0 < t \leq 10 \\ 0 & \text{otherwise} \end{cases}$$

The last term in the above empirical model is for the noise. The preliminary tests showed that the first order autoregressive function described the characteristics of residuals adequately.

The coefficients b_1 and b_2 represent the systematic risks of the stock before and after the announcement. The ω_1 and ω_2 indicate the amounts of drift from the regression line. Therefore, if we cannot find any evidence that the coefficients are not significantly different from zero, we cannot reject the hypothesis that there exist abnormal returns during the relevant period. It is also possible to examine the stability of betas by checking the statistics of b_1 and b_2.

We ran the model stock by stock. The Box-Pierce χ^2 statistics showed that the mode was acceptable at the 10% significance level for the most of stocks.[9] For some stocks, it was found that

9. We expect that the residuals, u, are not serially correlated. If the sample autocorrelations of residuals are not small, it indicates that the model should be modified. Box and Pierce(1970) suggested the Q statistic which offers a test on the smallness of a whole set of sample autocorrelations for lags 1 through k as follows,

$$Q(k) = T\Sigma_{i=1}^{k} r_i^2$$

where T is number of observation in the sample, r_i is the autocorrelation of residuals for lag i. The statistic follows approximately a chi-square distribution with (k-d) degrees of freedom, where d represents the sum of orders in the noise function.

ARMA(1, 1) explained better. The first order sample autocorrelation was large. We present the statistics of mean values of the parameters at Table 1.

We cannot reject the existence of abnormal excess returns during 10 trading days preceding the announcement date. But the existence of excess returns during the post-announcement period is questionable. The market responds to the newly available information quickly so that excess returns do not persist after the public announcement. We observe that the more sophisticated model does not change the previous conclusion. However, the magnitude of average excess returns during 10 days of the pre-announcement period is smaller than the previous result by the residual analysis.(4 % vs.7%) The model also provides us with a mean to investigate stability of betas. Table 1 shows a big difference of the average value of b_1 from that of b_2. To test significance of the difference, Wilcoxon one sample rank test was employed under the hypothesis that two distributions have the same mean. The statistic 0.0186 of p-value. provides an evidence that we may reject the null hypothesis at 5% of significance level. The result by the sign test leads to the same decision. Although the p-value is higher than that of the moving betas test, the tests again confirm the previous result.

Table 1. Estimated values of parameters of mixed intervention model

	b_1	b_1	ω_1	ω_2	ϕ
sample mean	1.26	1.52	0.0039	0.0027	0.08
t-statistics	6.60	8.54	2.38	1.19	2.98

Pure Intervention Model

To use the pure intervention model, we need to purify the endogeneous variable by removing the effect of the market factor. We substract the market-wide effect from daily stock returns by the market model. In fact, the endogeneous variable examined here is a series of average residuals from the one factor market model which is presented in Figure 1. The purpose of this subsection is to rexamine the series of residuals by the intervention model to see the market response pattern more precisely. The residuals are examined by two models from the pure intervention model.

Model 1 :
$$e_t = \frac{\omega_1 B}{1-\delta_1 B} I_{1t} + \frac{\omega_2 B}{1-\delta_2 B} I_{2t} + \frac{1}{1-\phi B} u_t + c$$

$$I_{1t} = \begin{cases} 1 & \text{if } -5 \leq t \leq -1 \\ 0 & \text{otherwise} \end{cases}$$

$$I_{2t} = \begin{cases} 1 & \text{if } t = 0 \\ 0 & \text{otherwise} \end{cases}$$

Model 2 :

$$e_t = \frac{\omega_1 B}{1-\delta_1 B} I_t + \frac{1}{1-\phi B} u_t + c$$

$$I_t = \begin{cases} 1 & \text{if } -5 \leq t \leq 0 \\ 0 & \text{otherwise} \end{cases}$$

In both models, t goes from -30 to 30. Model 1 adopts two intervention variables : one is a step input which represents the dissemination of information by insiders ; and the other is a pulse input which represents the public announcement. Model 2 employs only one step input. In these models, it is presumed that there is no more information after the public announcement. The constant term c may be interpreted as a mean value of residuals after the intervention effects were removed.

The Box-Pierce chi-square statistics show the models describe the process adequately at the 10% significance level. Table 2 summarizes the results.

Table 2. Estimated values of parameters of pure intervention model

	ω_1	ω_2	δ_1	δ_2	ϕ	c
			Model 1			
sample mean	0.0044	0.0033	0.63	-0.87	0.151	0.0009
t-statistics	2.12	1.16	2.94	-6.03	0.99	1.17
			Model 2			
sample mean	0.0046		0.51		0.116	0.009
t-statistics	1.97		2.43		0.796	1.17

The first order auto-regressive parameters(ϕ) for both models are not different from zero at the 5% significance level. We reject the hypothesis that there exists autocorrelation in the series of residuals obtained from the market model if we substract the intervention effect. We have seen a positive evidence of autocorrelation of residuals from the mixed intervention model. Based on the result on Table 2, we know that the autocorrelation was caused by the intervention. Once we eliminate the intervention effect during one week period, the autocorrelation of residuals disappears.

Figure 5 shows the estimated market response patterns to the split intervention which was calculated by the pure intervention models.

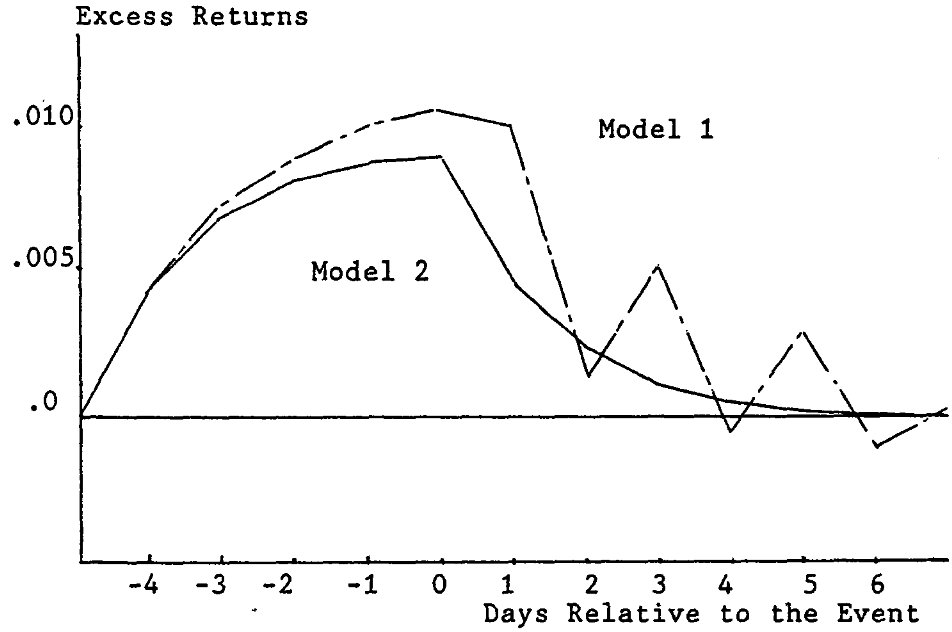


Figure 5. Estimated Market Responses by the Intervention Models

Note : The fitted models are

Model 1 : $e_t = \frac{0.0044B}{1-0.63B} I_{1t} + \frac{0.0033B}{1+0.87B} I_{2t}$

Model 2 : $e_t = \frac{0.0046B}{1-0.51B} I_{1t}$

In the expressions, the noise and constant terms were deleted. The terms were not significant.

The figure shows that there exist abnormal excess returns during the period prior to the declaration date. The abnormal returns increase until the declaration date. But, they vanish repidly after the declaration. The market adjusts the stock prices fast to reflect the newly available information. It is doubtful that we could use the publicly available information to beat the market.

5. Discussion

Using the cumulative average residual methology, we confirmed the evidence of existence of abnormal excess returns during the period preceding the announcement. It is noticeable that the residuals from the market model are serially autocorrelated, and the phenomenon is caused by the announcement. The beta prior to and posterior to the event are significantly different from each other in the sense that they are selected from the distributions with different means. But, the beta tends to decrease after 4 months from the announcement of stock splits. Therefore, the classical method based on the presumed assumptions of randomness of residuals and stability of betas, might be biased. However, the result by the intervention method does not significantly change the observations from previous studies.

The adjustment of betas and the elimination of autocorrelation in the residuals reduce the magnitude of excess returns by the split announcement. Even after the corrections are made, there still exists a significant pattern of excess returns.

Then, the remaining question is what is able to explain the excess returns previous the announcement. The oft-mentioned motives of stock splits are classified into two groups, signalling and optimal price. Lakonishok and Lev(1987) reports that the signalling motive of stock splits is supported some, but the price correction motive seems more strongly supported than the signalling motive. The price correction motive itself does not seem to explain the significant excess returns. In this paper, we have seen an evidence of increase in beta around the announcement period. It is logical to think of the risk level change as an explanation of the existence of excess returns. The excess returns might be a compensation to the old shareholders for the unwanted increase in their portfolio risk. Those who want to maintain the risk level should pay to change their portfolio. This is another hypothesis which must be tested.

The most interesting result we can get from intervention analysis is to know how fast and strongly the market responds to the newly publicly available information. The parameter of δ provides us with information on the speed of adjustment of the market to the new information. As we can see on the Eigure 4 the smaller the absolute value of δ means that the more rapidly the market responds to the intervention. Thus, the higher value of δ implies that the market is less efficient in processing information. Meanwhile, the estimated values of ω represents the strength of information contents the market perceives. The larger absolute values imply that the given intervention is stronger and more significant. The negative value of ω means that the information has negative contents, and vice versa. The area under the estimated curve represents the sum of excess returns by the intervention. The larger the area is, the information on an intervention is the more valuable.

We may apply intervention analysis to investigate relative efficiency of the markets or relative strength of the interventions. Another use of the intervention model is to examine what kinds of interventions changes the level of betas by how much. It is not clear what characteristics of stocks determine the level of betas. Investigations of intervention by intervention might give us a clue to understand the question.

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〈요 약〉

주식분할 미시분석과 정보효과 측정

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시장 효율성 가설의 검증방법으로 가장 많이 이용되는 방법은, 시장이 새로 들어온 정보를 가격형성에 얼마나 빨리 또 어떻게 반영하는가를 검사하는 것이다. 이경우 시장이 개별 주식의 가격을 결정하는 가격모형이 사전에 가정되어야 하며, 이 때문에 효율성가설의 검증에서는 결국 시장모형과 효율성가설이 동시에 검증될 수 밖에 없다. 기존의 대부분 연구에서는 개별 주식의 수익율이 정규분포를 따른다는 가정으로 부터 유도된 시장모형(market model)이나 자산가격모형(capital asset pricing model)이 가격결정모형으로 사용되었으며, 위험성 척도베타의 안정성과 가격모형이 설명하지 못한 잔차항의 정규성, 상호독립성의 자정하에 시장의 새로운 정보에 대한 반응을 살펴봄으로써 시장의 효율성을 평가하려고 하였다.

그러나 최근의 많은 연구는 베타가 안정적이지 못하며(nonstationary), 잔차항 또한 시계열적으로 자동상간(autocorrelation)되어 있다고 보고하고 있다. 이러한 점을 감안한 상태로 효율성 가설을 검증하기 위한 시도로, 본 연구에서는 시장모형을 기본으로 한 간섭모형(intervention model)을 사용하여 주식분할정보에 대한 시장의 반응을 일간수익율(daily returns)자료를 바탕으로 조사하였다.

본 연구에서도 베타의 불안정성, 잔차의 자동상관이 관찰되었으며, 특히 주식분할을 발표하는 싯점에서 베타는 눈에 띄게 증가하였다. 주식분할정보를 시장이 충분히 빨리 반영하지 못한다는 기존의 연구결과는 본 연구에서 사용된 방법으로도 바뀌지 않으나, 발표후 2주간의 초과수익은 전통적 방법으로 조사한 결과보다 43퍼센트 정도 감소하였다. Lakonishok과 Lev(1987)는 초과수익의 존재를 가격수정동기(price correction motive)로 설명하나, 가격수정동기 자체가 초과수익의 존재를 설명한다기 보다는 주식분할에 다른 위험수준(베타)의 변동이 초과수익의 원인이라 보는 것이 타당하다. 분할이 발표된 주식을 소유하고 있던 기존의 주주들의 입장에서 볼때 자신의 포트폴리오 위험이 자신의 의사와 달리 증가되었으므로 이에 상응한 보상을 원할 것이며, 이 보상이 우리가 관측한 초과수익이라는 설명이 가능하고, 이러한 설명은 주식분할이 발표된 후의 베타가 전에 비하여 증가한다는 점으로 뒷받침된다.

본 연구에서 사용된 모형은 기존의 연구에서 반영하지 못한 베타의 불안정성, 잔차의 자동상관성 문제를 해소시켜줄 뿐 아니라, 시장이 접하는 각 종의 정보에 대하여 시장의 차별적 효율성을 조사하는 데에도 적용될 수 있다는 점에서 재미있다. 즉 본문의 모형에서 매개변수 델타(s)는 시장이 새로운 정보를 가격결정에 반영하는 속도를 측정하는 척도이고, 오메가(v)는 시장에 들어온 정보의 강도(strength)의 척도로 볼 수 있다.