MARKET MODEL STATIONARITY AND TIMING OF STRUCTURAL CHANGE

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Market Model Stationarity and Timing of Structural Changes

I. Introduction

In the Capital Asset Pricing Model (CAPM) developed and elaborated by Sharp (1964), Litner (1965) and Black (1972), the equilibrium expected rate of return of a security is related to its systematic risk. The model does not require that the parameters in the CAPM be stationary over time. In theory, market participants are presumed to have a sense about those parameters. An important issue in the application of the CAPM is the estimation of the market model to obtain an estimate of the ex ante beta (systematic risk). Since the market model usually is estimated on the basis of ex post data, a necessary condition for an unbiased and efficient estimate of beta is that the market model be stationary over the relevant period. Hence the knowledge about the stationarity of the market model is crucial to the proper application of the CAPM.

There are three major issues of stationarity. The first and most fundamental one is the existence and extent of nonstationarity. Blume (1971, 1975), Baesel (1974), and Alexander and Chervany (1980) devoted most of their attention to this issue. The second is related to the nature of nonstationarity. Brenner and Smidt (1977), Fabozzi and Francis (1977), Sunder (1980) and Beatty (1982) proposed various models to describe the nonstationarity of the market model. The third issue is related to the timing of nonstationarity. Gonedes (1973) and Alexander and Chervany (1980) explored the length of the period beyond which the issue of nonstationarity becomes significant to statistical estimation and inference. Fabozzi and Francis (1977) and Bey (1983) examine the point of time at which significant structural change in the market model takes place. This paper is concerned with two of the above three issues: (1) the existence and extent of nonstationarity and (2) timing of structural change.

The two statistical methods adopted in this study are identical to those used by Bey (1983).[1] While Bey's interest is limited to the comparative study of the utility industry and the selected non-utility industries over the period of January 1960 to December 1979, my work is concerned with the whole CRSP tape: all data on the tape over the whole period of January 1927 to December 1979. This paper provides future researchers over-all information about the stationarity of the market model. I take 36,772 Brown-Durbin-Evans Cusum of squares tests and calculate 1,679 minimum Quandt-Log-Likelihood-ratios. The results are summarized in five tables. The Brown-Durbin-Evans method tests the statistical significance of structural change and the Quandt method measures the timing of the most drastic structural change.

The rest of this paper is organized into three sections. Section II describes the hypotheses and the methodology. I shall briefly discuss the issue of market equation stationarity and the issue of equally weighted and value-weighted market indices. The empirical results will be presented and discussed in Section III. The final section concludes the paper with summary and remarks.

II. Hypotheses and Methodology

In this paper I shall apply two statistical methods to measure the significance and timing of structural change in the CAPM. Both methods allow data to show the extent and the timing of departure from stationarity rather than parametize these departure ex ante. They both involve the calculation of a standardized sum of squares of regression residuals over time. Tests are then performed to determine whether shifts in these sum of squares of residuals, which indicate shifts in the underlying structural relationship, are significant.

1. Hypotheses

The structural relationship to be tested is the CAPM given in eq. (1):

$$(1)\quad E(R_i) = \alpha_i + \beta_i\, E\,(R_m)$$

$$\beta_i = \frac{\mathrm{Cov}\ (R_i, R_m)}{\sigma^2(R_m)}$$

$$\alpha_i = (1-\beta_i)\ E\ (R_z)$$

where R_i and R_m are respectively the return of security i and the return of the market portfolio. If unlimited short-selling is allowed, then R_z is the return of the market-independent portfolio. On the other hand, if there exists a risk-free security, R_z is the risk free rate. On the estimation of eq. (1), R_m can be constructed as the equally weighted market index or value-weighted market index. When it is the former, then:

$$(2)\qquad \hat{\beta}_i = \frac{\sum_j^n \mathrm{SCOV}\ (R_i,\ R_j)}{\sum_i^n \sum_j^n \mathrm{SCOV}\ (R_i,\ R_j)}\ ;$$

where n is the sample size;

the cap "^" indicates equally weighted estimator;

SCOV is the sample covariance.

When it is the latter, then:

$$(3) \qquad \hat{\hat{\beta}}_i = \frac{\sum_{j}^{n} \Theta_i \Theta_j \text{ SCOV } (R_i, R_j)}{\sum_{i}^{n} \sum_{j}^{n} \Theta_i \Theta_j \text{ SCOV } (R_i, R_j)};$$

where Θ_i is the value share of security i in the market portfolio;

the double cap "$\hat{\hat{}}$" indicates the value-weighted estimator.

The null hypothesis for market model stationarity is a joint test of α_i and β_i which is formulated as:

$$H_o: \; B_1 = B_2 = \ldots = B_T$$

where B is the vector (α, β). The alternative hypothesis is that not all of the B's are equal.

The test is based on the regression residuals e_{it} defined in equation (4)

$$\hat{e}_{it} = R_{it} - \hat{\alpha}_{it} - \hat{\beta}_{it} \hat{R}_{mt}$$

$$(4) \qquad \hat{\hat{e}}_{it} = R_{it} - \hat{\hat{\alpha}}_{it} - \hat{\hat{\beta}}_{it} \hat{\hat{R}}_{mt};$$

where $\hat{e}_{it}$ is the equally weighted regression residuals and $\hat{\hat{e}}_{it}$ is the value-weighted regression residuals. As implied by eqs. (2) and (3), the stationarity of $\hat{e}_{it}$ is independent of relative price adjustment in the security market but the stationarity of $\hat{\hat{e}}_{it}$ depends on the relative price adjustment. If the relative price adjusts drastically, then the equally weighted estimator would be more stationary than the value-weighted estimator; hence it is more useful in practice. In this paper, I shall test the stationarity of both the equally weighted estimator and the value-weighted estimator. Hence we can gain some insight on the relative advantage of adopting the two market indices in practice.

2. Brown-Durbin-Evans (BDE) Cusum of Square Test

Consider the standard regression model:

$$(5) \qquad y_t = X_t B_t + u_t, \qquad t = 1 \ldots, T.$$

where y_t is the dependent variable in period t; X_t is a column vector of k explanatory variables in period t. The first element, X_t, is unity, representing the constant term.

In this paper, y_t is R_{it} and X_t is the vector $(1, R_{mt})$ ...

regression coefficients and $u_1, \ldots, u_T$ are normal independent variables with zero means and variances $\sigma_1^2, \ldots, \sigma_T^2$. The null hypothesis to be tested is that the B_t are constant :

$$B_1 = \ldots = B_T = B,$$

against the alternative hypothesis that the B_t are different.

Let $\bar{B}$ be the least-squares estimate of B:

$$(6) \qquad \bar{B} = \left[\sum_1^T X_t X_t'\right]^{-1} \sum_1^T X_t y_t,$$

so that B_r is the estimate of B from the first r observations. Brown-Durbin-Evans (1975) define a variable W_r as:

$$(7) \qquad W_r = \frac{y_r - X_r' \bar{B}_{r-1}}{\sqrt{1 + X_r' (X_{r-1}' X_{r-1})^{-1} X_r}}, \quad r = k + 1, \ldots, T .$$

This variable is essentially a one-period prediction error standardized by a factor so that under the null hypothesis the variance of W_r is σ^2. It can be shown that these variables, W_r, are normal, independent with mean zero and variance σ^2. The proof is contained in BDE (1975).

If B_t is a constant up to time t = r and different from then on, the Wr will also have a zero mean up to r and nonzero mean thereafter. The BDE measures the following variable against time:

$$(8) \qquad S_r = \frac{\sum_{k+1}^{r} W_t^2}{\sum_{k+1}^{T} W_t^2}, \quad r = k + 1, \ldots, T.$$

This statistic S_r is the cumulated sum of squared W_t up to time r, divided by the cumulated sum of squared W_t over the whole period. Because of this normalization the value of S_r will lie between zero and one:

$$S_r = 0, \text{ for } r = k,$$

$$S_r = 1, \text{ for } r = T.$$

The expectation of S_r is E $(S_r) = (r - k)/(T - k)$. On the null hypothesis that the

the S_r from the mean-value $(r - k)/(T - k)$ can therefore be interpreted as shifts in the parameters of the regression relationship and significance tests can be performed by calculating the significance interval $[(r - k)/(T - k)] \pm C_0$. If the sample S_r lies outside the significance interval, the null hypothesis of parametric stationarity can be rejected. The approximate values for the C_0's can be obtained from Durbin (1969).

3. Quandt's Log-Likelihood Ratio (QLR)

If the BDE test indicates that the regression relationship may have changed in a certain time period, it is possible to identify the timing of structural change more precisely by using the technique developed by Quandt (1960). The Quandt method involves calculating for each r from $r = k + 1$ to $r = T - (k + 1)$ the ratio:

$$L_r = \log \frac{[\text{Maximum likelihood of the observations given } H_0]}{[\text{Maximum likelihood of the observations given } H_1]} \tag{9}$$

where H_0 is the null hypothesis of parametric stationarity and H_1 is the alternative hypothesis that there is a structural change at time point r. The statistic L_r is a standard likelihood ratio for deciding between two hypotheses H_0 and H_1, and it can be shown that:

$$L_r = 1/2\ r \log \hat{\sigma}_1^2 + 1/2\ (T - r)\ \hat{\sigma}_2^2 - 1/2\ T \log \hat{\sigma}^2, \tag{10}$$

where $\hat{\sigma}_1^2$, $\hat{\sigma}_2^2$, and $\hat{\sigma}^2$ are the ratios of the residual sums of squares to the number of observations when the regression is fitted to the first r observations, the remaining $T - r$ observations, and the T observations. When L_r attains its minimum value, the market equation experiences the peak structural change. Unfortunately, no test of significane has yet been devised for the minimum L_r since its distribution on H_0 is unknown. However, if a structural change is indicated by the BDE test, the minimum L_r should provide useful information about the timing of peak structural change.

III. Empirical Results

On the estimation of systematic risk, one would like to extend the time period as far as possible in order to increase the sample size and improve the precision of estimation. However the longer the time period the longer the chance that the market equation has gone through a significant structural change. The nonstationarity will give rise to biased estimates. To provide some guidance on sample size in estimation of systematic risk, I study the stationarity in two period-lengths: a seven-year period and a four-year period. They are respectively reported in Tables 1 and 2. I calculate The BDE statistics for all monthly security returns on the CRSP tape. Because I need three monthly data to calculate the initial value of S_r, my tests begin at January 1927.[2]

In this paper, market equations are estimated with two market returns indices. When the equally weighted market index is used, the test results describe the nonstationarity in the joint stochastic processes of security returns. When the value-weighted market index is used, the test results describe the nonstationarity of relative prices as well. The value-weighted market index does not necessarily give rise to higher statistical rejections of stationarity because the nonstationarity in joint stochastic processes of security returns and that in relative prices are not independent.

TABLE 1

Brown-Durbin-Evans Cusum of Squares Test:

Nonstationarity in Seven-Years Period

Periods	Number of Securities	Null hypothesis of stationarity rejected at 1% level		Null hypothesis of stationarity rejected at 10% level	
		Value-Weighed	Equally Weighted	Value-Weighed	Equally Weighed
1/27-12/33	335	295 (88.1%)	309 (92.2%)	325 (97.0%)	330 (98.5%)
1/34-12/40	578	411 (71.1%)	421 (72.8%)	512 (90.3%)	539 (93.3%)
1/41-12/47	717	498 (69.5%)	506 (70.6%)	659 (91.9%)	677 (94.4%)
1/48-12/54	850	558 (65.6%)	565 (66.5%)	759 (89.3%)	783 (92.1%)
1/55-12/61	870	517 (59.4%)	530 (60.9%)	751 (86.3%)	753 (86.6%)
1/62-12/68	793	507 (63.9%)	505 (63.7%)	696 (87.8%)	694 (87.5%)
1/69-12/75	959	638 (66.5%)	620 (64.7%)	851 (88.7%)	840 (87.6%)
1/73-12/79	999	808 (80.9%)	763 (76.3%)	944 (94.4%)	948 (94.9%)
Total	6101	4232 (69.4%)	4219 (69.2%)	5497 (90.1%)	5564 (91.2%)
Wilcoxon |Z|	(Prob-value)	0.420	(0.674)	1.750	(0.080)

TABLE 2

Brown-Durbin-Evans Cusum of Squares Test:

Nonstationarity in Four-Years Period

Periods	Number of Securities	Null hypothesis of stationarity rejected at 1% level		Null hypothesis of stationarity rejected at 10% level	
		Value-Weighted	Equally Weighted	Value-Weighted	Equally Weighted
1/27-12/30	383	232 (60.6%)	238 (62.1%)	338 (88.3%)	336 (87.7%)
1/31-12/34	560	413 (73.7%)	413 (73.7%)	541 (96.6%)	543 (97.0%)
1/35-12/38	618	354 (52.9%)	368 (55.4%)	523 (83.0%)	517 (82.0%)
1/39-12/42	711	441 (62.0%)	446 (62.7%)	619 (87.1%)	621 (87.3%)
1/43-12/46	759	411 (54.2%)	428 (56.4%)	651 (85.8%)	661 (87.1%)
1/47-12/50	825	373 (45.2%)	383 (46.4%)	653 (79.2%)	656 (79.5%)
1/51-12/54	944	476 (50.4%)	493 (52.2%)	768 (81.4%)	778 (82.4%)
1/55-12/58	941	445 (47.3%)	458 (48.7%)	741 (78.7%)	738 (78.4%)
1/59-12/62	939	343 (36.5%)	349 (37.2%)	693 (73.8%)	711 (75.7%)
1/63-12/66	962	473 (49.2%)	480 (49.9%)	787 (81.8%)	778 (80.9%)
1/67-12/70	975	386 (39.6%)	409 (41.9%)	720 (73.8%)	746 (76.5%)
1/71-12/74	1147	661 (57.6%)	654 (57.0%)	971 (84.7%)	949 (82.7%)
1/75-12/78	1267	968 (76.4%)	846 (66.8%)	1111 (92.0%)	1129 (89.1%)
1/76-12/79	1255	540 (43.0%)	562 (44.8%)	988 (78.7%)	986 (78.6%)
Total	12286	6516 (53.0%)	6527 (53.1%)	10159 (82.7%)	10149 (82.6%)
lcoxon |Z| (Prob-value)		2.201	(0.028)	0.031	(0.975)

Table 1 indicates that about 70% of market equations go through significant (at the 1% level) structural change over a period of seven years. Table 2 shows that about 53% of market equations go through significant (at the 1% level) structural change over a period of four years. If we measure significance at the 10% level, then respectively 90% and 83% of market equations are nonstationary over periods of seven years and four years. The assumption of stationarity in the application of the CAPM is a precarious one indeed.

Measuring financial market instability in terms of the cross-sectional dispersion of significant structural changes among firms, the most unstable seven-year period is 1927-1933. The next most unstable seven-year period is 1973-1979. The former can be associated with the Great Depression during which many firms failed while other went through difficult adjustment. The latter can be associated with the energy crisis; the oil embargo set off a global realignment of financial structure and a worldwide economic adjustment. Table 2 is consistent with Table 1: the most unstable four-year period is 1931-1934 and the next most unstable four-year period is 1975-1978.

Overall, the value-weighted and equally weighted market indices generated consistent results on the stationarity of market equations. The only exceptional period is 1975-1978 in Table 2, where 76.4% of the stationarity tests that adopt value-weight market indices reject the null hypothesis, but only 66.8% of the tests that adopt equally weighted market indices do so. Hence in 1975-1978, the relative price adjustment in the stock market greatly increases the nonstationarity of market equations.

To further examine the effect of different measurement of market indices on the stationarity tests, I take four Wilcoxon Matched-Pairs Rank-Signs tests on the results of the stationarity tests reported in Tables 1 and 2. The first step, involves normalizing the results since the number of stationarity tests differ from period to period. To do this I calculate the proportions of rejections of the stationarity tests. In the second step, I study the four matched pairs in Tables 1 and 2. The differences in the matched proportions of rejections are ranked, ignoring signs, and the sums of the ranks for positive and negative differences are calculated. From the positive and negative rank sums, a test statistic Z is calculated. For a large sample, the Wilcoxon Z is approximately Gaussian with mean zero and variance one.

The results of Wilcoxon tests are reported in the last rows of Tables 1 and 2. None is significant at the 1% level. Hence we can infer that the relative price adjustment does not significantly affect the stationarity of the empirical market equation. Since the value-weighted market index is more compatible with the theory of the CAPM, it is the more preferred choice in practice than the equally weighted market index.

Tables 1 and 2 illustrate the cross-sectional dispersion of market instability. When the time period is very short, all market equations can be assumed stationary. When the time period is very long, all market equations go through at least one significant structural change. It would be interesting to know when each market equation goes through the most drastic structural change. While Tables 1 and 2 illustrate the market instability in terms of cross-sectional dispersion of structural change, Tables 3 to 5 illustrate the market instability in terms of the largest structural change of each market equation.

TABLE 3

Quandt Log Likelihood Ratio:

Frequency Distribution of Peak Structural Change, 1927-1979

Year	Value-Weighted	Equally Weighted	Year	Value-Weighted	Equally Weighted
1927	0	0	1955	0	0
1928	0	0	1956	1 (0.83%)	1 (0.83%)
1929	2 (1.67%)	0	1957	0	0
1930	1 (0.83%)	1 (0.83%)	1958	2 (1.67%)	2 (1.67%)
1931	1 (0.83%)	0	1959	0	0
1932	2 (1.67%)	3 (2.5%)	1960	1 (0.83%)	1 (0.83%)
1933	10 (8.33%)	9 (7.5%)	1961	0	2 (1.67%)
1934	14 (11.67%)	16 (13.33%)	1962	0	0
1935	6 (5 %)	7 (5.83%)	1963	1 (0.83%)	1 (0.83%)
1936	8 (6.67%)	14 (11.67%)	1964	1 (0.83%)	1 (0.83%)
1937	0	1 (0.83%)	1965	0	0
1938	4 (3.33%)	9 (7.5%)	1966	3 (2.5 %)	2 (1.67%)
1939	11 (9.17%)	6 (5.0%)	1967	3 (2.5 %)	1 (0.83%)
1940	13 (10.83%)	9 (7.5%)	1968	0	0
1941	4 (3.33%)	5 (4.17%)	1969	1 (0.83%)	0
1942	5 (4.17%)	7 (5.83%)	1970	2 (1.67%)	2 (1.67%)
1943	7 (5.83%)	6 (5.0 %)	1971	0	0
1944	3 (2.5 %)	1 (0.83%)	1972	0	0
1945	1 (0.83%)	2 (1.67%)	1973	2 (1.67%)	1 (0.83%)
1946	5 (4.17%)	5 (4.17%)	1974	3 (2.5 %)	3 (2.5 %)
1947	1 (0.83%)	1 (0.83%)	1975	0	0
1948	0	0	1976	0	0
1949	0	0	1977	0	0
1950	1 (0.83%)	1 (0.83%)	1978	0	0
1951	1 (0.83%)	0	1979	0	0
1952	0	0	Total	120 (100%)	120 (100%)
[illegible]	[illegible]	[illegible]			

TABLE 4

Quandt Log Likelihood Ratio:

Frequency Distribution of Peak Structural Change, 1927-1951

Year	Value-Weighted		Equally Weighted		Year	Value-Weighted		Equally Weighted	
1927	1	(0.4%)	1	(0.4%)	1940	32	(12.1%)	27	(10.2%)
1928	1	(0.4%)	0	(0.0%)	1941	8	(3.0%)	13	(4.9%)
1929	4	(1.5%)	2	(0.8%)	1942	12	(4.5%)	13	(4.9%)
1930	9	(3.4%)	8	(3.0%)	1943	21	(8.0%)	14	(5.3%)
1931	11	(4.2%)	3	(1.1%)	1944	5	(1.9%)	7	(2.7%)
1932	8	(3.0%)	4	(1.5%)	1945	4	(1.5%)	4	(1.5%)
1933	20	(7.6%)	26	(9.8%)	1946	6	(2.3%)	9	(3.4%)
1934	23	(8.7%)	24	(9.1%)	1947	3	(1.1%)	2	(0.8%)
1935	17	(6.4%)	9	(3.4%)	1948	2	(0.8%)	2	(0.8%)
1936	24	(9.1%)	29	(11.0%)	1949	0	(0.0%)	0	(0.0%)
1937	8	(3.0%)	10	(3.8%)	1950	2	(0.8%)	1	(0.4%)
1938	18	(6.8%)	26	(9.8%)	1951	1	(0.4%)	0	(0.0%)
1939	24	(0.1%)	30	(11.4%)					
					Total	264		264	

TABLE 5

QUANDT LOG LIKELIHOOD RATIO:

FREQUENCY DISTRIBUTION OF PEAK STRUCTURAL CHANGE, 1952-1976

Year	Value-Weighted	Equally Weighted	Year	Value-Weighted	Equally Weighted
1952	6 (1.3%)	7 (1.5%)	1968	18 (4.0%)	24 (5.3%)
1953	19 (4.2%)	17 (3.7%)	1966	41 (9.0%)	39 (8.6%)
1954	32 (7.0%)	17 (3.7%)	1967	22 (4.8%)	19 (4.2%)
1955	13 (2.0%)	9 (2.0%)	1968	24 (5.3%)	23 (5.1%)
1956	13 (2.9%)	16 (3.5%)	1969	12 (2.6%)	15 (3.3%)
1957	28 (6.2%)	29 (6.4%)	1970	21 (4.6%)	28 (6.2%)
1958	24 (5.3%)	30 (6.6%)	1971	13 (2.9%)	6 (1.3%)
1959	9 (2.0%)	15 (3.3%)	1972	18 (4.0%)	16 (3.5%)
1960	23 (5.1%)	25 (5.5%)	1973	44 (9.7%)	40 (8.8%)
1961	9 (2.0%)	10 (2.2%)	1974	26 (5.7%)	31 (6.8%)
1962	11 (2.4%)	9 (2.0%)	1975	7 (1.5%)	6 (1.3%)
1963	10 (2.2%)	8 (1.8%)	1976	4 (0.9%)	6 (1.3%)
1964	8 (1.8%)	10 (2.2%)	Total	455 (100%)	455 (100%)

There are 120 securities that survive the 53 year history of the CRSP tape. The BDE tests over the 53-year period indicate that they all went through at least one significant structural change. The minimum QLR would indicate the timing of the peak (i.e., the most drastic) structural change. Table 3 demonstrates the frequency distribution of the peak structural changes of the 120 market equations over 53 years. For these 120 long lasting firms, the peak structural changes are clustered in the earlier period. When these firms matured, their market equations became more stationary. There are two clusters of peak structural change: one is 1933-1936 and the other is 1939-1940. This result is consistent with Tables 1 and 2.

The result in Table 3 is subject to a survivalship bias. When a firm becomes more mature, bigger and more established, its systematic risks will be smaller and more stationary. Hence, Table 3 does not necessarily represent the clustering of peak structural change of the financial market as a whole. To reduce the survivalship bias, we examine the QLR in two shorter subperiods: 1927-1951 and 1952-1976.

Table 4 indicates that the survivalship bias may not be a serious problem in Table 3. By shortening the period to 1927-1951, I include 144 non-surviving firms. But I get essentially the same result. The peak structural changes of the market equations are clustered in 1933-1936 and 1939-1940.

The clusterings of peak structural changes in Table 5 are less concentrated than in Table 4. Nevertheless, we can find four clusters of peak structural change: in 1953-1954, 1957-1958, 1966-1967, and in 1973-1974. The largest cluster is in 1973-1974 which is associated with the energy crisis. Since Tables 4 and 5 are related to different set of firms, the comparison between Tables 4 and 5 is not very meaningful.

IV Concluding Remarks

This paper employs the BDE and QLR to examine the extent and timing of structural change in market equations. It provides useful information about the validity of the application of the CAPM.

As far as the stationarity of the market equation is concerned, I find that there is little difference between the equally weighted market index and the value-weighted market index. The relative price adjustment is not the major source of market equation nonstationarity.

Over a period of four years, about 53% of market equations went through at least one significant (at the 1% level) structural change. Over a period of seven years, about 70% of market equations went through at least one significant (at the 1% level) structural change. These findings cast an uncomfortable shadow on the current application of the CAPM. Generally, the systematic risks are estimated from the data of 50 months or longer. The nonstationarity could generate a significant bias in the estimation of beta.

For those securities that survive the 53 year history of the CRSP tape, the most drastic structural changes are concentrated in 1933-1934, the period in which new laws and new regulations were imposed on the financial market and in which the whole financial market went through the largest overhaul in history.

According to the BDE tests, a relatively large number of market equations went through significant structural change in 1931-1934 and 1975-1978. The estimation of systematic risk in these two periods is especially precarious. For example, Biddle and Lindahl (1982) found that when firms change their inventory accounting method from FIFO to LIFO, the beta's are not stationary. Since their samples are concentrated in 1974-1975, the nonstationarity could be an economy-wide phenomenon and could be independent of the change of inventory accounting method.

According to the QLR, in the earlier period, 1927-1951, the most drastic structural changes are concentrated in 1933-1936 and 1938-1943. The former is attributable to the overhaul of the financial market and the latter is attributable to the War. In the second period, 1952-1976, the peak structural changes of market equations are more evenly spread out. The largest concentration is in 1973-1974, the years of oil embargo, energy crisis, world-wide inflation, and world-wide recessions.

FOOTNOTES

1. I started this project in January 1981 and completed a rough draft in March 1981. I was not aware of Bey's work until its publication in June 1983.

2. The CRSP tape starts from January, 1926.

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