ADJUSTING THE CAPM FOR THRESHOLD EFFECTS: AN APPLICATION TO FOOD AND AGRIBUSINESS STOCKS

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Abstract

The dynamics in stock returns and the market return for 21 food and agribusiness firms are estimated in a threshold switching-regression framework. Threshold adjustment levels and capital asset pricing model risk parameters are estimated and tested. Results indicate risk parameters differ for alternative regimes and are not constant over time. Accounting for periods of temporary disequilibrium leads to notably more stable risk measurement estimates.

Keywords: CAPM, Cointegration, Risk, Threshold
JEL codes: G1, G12

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The behavior of publicly traded stock returns provides much information on how risk is priced in addition to the measurement of risk. The Capital Asset Pricing Model (CAPM) of Sharpe (1964) and Lintner describes the relationship between an investment's risk premium and the market's risk premium, and is the basis for many empirical and theoretical financial market studies. In addition, key components of the CAPM, are regularly reported by market information services. The CAPM has been examined by numerous authors who have tested, refuted, and supported the model (Fama and MacBeth; Black, Jensen, and Scholes; Gibbons; Roll; Fama and French, 1992, 1996a; Black; Banz; Wallace; Breeden, Gibbons, and Litzenberger; Chan and Lakonishok; Jagannathan and Wang; Kothari, Shanken, and Sloan). Other work has modified the CAPM to account for additional assumptions and/or developed alternative pricing theories such as the arbitrage pricing theory (APT) (Breeden; Jensen; Merton; Ross; Wei; Shanken; McDonald; Connor and Korajczyk). Further work has examined asset pricing dynamics, beta components, and beta relationships (Fama and French 1996b; Campbell and Mei; Vijh; Harvey and Siddique; Hansen, Heaton, and Luttmer).

The fundamental idea behind the CAPM is that individual stocks have a long-run relationship to the overall market, and this relationship is captured by a risk parameter, generally referred to as the beta coefficient, or just beta. More specifically, the price of an asset is proportional to the price of the market portfolio. Beta is an individual risk measure for a given firm and is generally said to describe how responsive the stock's return is relative to movements in the entire stock market. However, the CAPM is a full-equilibrium model, and hence, assumes an immediate adjustment to equilibrium any time there is a shock to the system, but in actuality, complete and immediate market adjustment may not always occur. Return to the long-run equilibrium relationship may actually take place over a time period. Market dynamics of this nature have implications for meaningfully measuring equilibrium risk with beta from the CAPM. Little work has analyzed the consistency of beta across time. For example, asking the questions of: Is beta identical across all observations? Do markets have a point at which they are in disequilibrium, and thus fail to meet the assumptions of the CAPM? How does beta change if the periods when the market is in disequilibrium are removed prior to the estimation of beta, and at what level does an adjustment occur to trigger realignment with the long-run relationship?

These queries pose the issue of whether threshold levels or boundaries exist separating different regimes for the relationship of beta in the CAPM. Previous literature has primarily only examined threshold levels in crop markets and perishable commodity markets (Goodwin and Grennes; Goodwin, Grennes, and Craig), not in the financial markets, and much of the threshold model work discusses threshold levels being created by transactions costs (Obstfeld and Taylor; Goodwin and Grennes; Goodwin and Piggott; Hansen). However, risk and return relationships may also create threshold levels.

Risk can be broken into the categories of diversifiable and nondiversifiable risk. Diversifiable risk is risk specific to a company and is also referred to as unsystematic risk. Nondiversifiable risk is the risk inherent in the market and is also known as systematic risk. Systematic risk is the risk that is priced by investors. One basic idea of the CAPM is that, in order to capture greater returns, greater risk must be accepted, and investors generally require a premium for assuming greater risk. Inclusion of periods of disequilibrium into the risk estimation process will likely lead to over and under estimation of the unsystematic risk of a firm. Risk is an important component used in determining the cost of capital used by firms in capital budgeting, project evaluation decisions, and economic value added (EVA) analyses. Decision-makers also use risk and return measurements to compare the relative attractiveness of companies, and investor services make risk coefficient estimates available to interested parties. Information on the pricing of risk can help managers and decision-makers improve analyses and decisions since over- and under-estimated risk and the cost of capital can lead to erroneous assessments and decisions.

This paper investigates the dynamics in food and agribusiness stock returns to determine if threshold risk effects exist, at what levels short-run dynamics trigger adjustments to long-run equilibrium relationships, and to determine the impacts on CAPM risk measurements. The long-run, steady-state relationships among stock returns of food and agribusiness firms and the overall market are analyzed in a switching-regression framework. Specifically, threshold regression models are used to estimate and examine the threshold levels that induce equilibriating adjustments when deviations exceeding the threshold level occur. In addition, with the information gathered from the threshold models, CAPM models are estimated to examine the effect of disequilibrium on CAPM risk measurement estimates.

Theoretical Thresholds

Market integration suggests that price or return series have an existing equilibrium relationship. A general expectation of firms within an industry is that the firms face the same market factors and risks. Companies within specific sectors of the food and agribusiness industry are likely to face many of the same market forces, factors, and situations. These market relationships often create the existence of a stochastic relationship between food and agribusiness stock returns and the market return.

Markets are generally considered efficient, and thus, they reflect available information. However, market activities may at times occur that create reactions that cause the series to move out of equilibrium, creating a temporary disequilibrium in the market. These times of disequilibrium may arise due to idiosyncratic risk. Since firms within a specific sector of an industry generally face the same market risks, it is the changes in risks or activities distinct to the individual companies that may lead to temporary deviations from a long-run relationship.

These periods of disequilibrium will not exist at all times, and when they do exist, short-run market dynamics trigger adjustments to return the series to the long-run equilibrium relationship. The hypothesis is that these triggers are specific levels of the series' differential. Once the series' differential reaches or exceeds a specific level, i.e., a band or threshold, the market recognizes the deviation from the long-run relationship, and market forces react to create an adjustment that reestablishes the stochastic relationship and returns the series' differential back within the threshold range. In the case of corporate stocks, appreciation or depreciation of a specific stock occurs, arbitragers recognize the market opportunity and act, and the long-run relationship is reestablished.

The relationship within the threshold bounds might be characterized as the normal market relationship between two data series, in this study an individual stock and the market (proxied by a market index). Sharpe (1964) and Lintner characterized the long-run relationship between stock prices and the market as the relationship estimated by the CAPM. In the context of this study, the "normal" CAPM relationship would be the relationship estimated within the threshold levels. Time periods when the relationship is outside the threshold bands would indicate deviations from the long-run CAPM relationship. At a level exceeding the threshold, the risk premium associated with the stock is large enough to entice arbitragers to act in the market.

The market recognizes that one or both of the stocks is over or under priced, investors react, and the market activity creates an adjustment that brings the differential back inside the threshold bands and back to the long-run equilibrium relationship. Since firms within specific industry sectors face the same market factors, then it is activities, risks, or situations specific to the firm that gives rise to the deviations from the equilibrium relationship.

Empirical Threshold Cointegration

Dynamic long-run relationships have been found to exist in exchange rates, interest rates of different maturities, dividends and prices, equity markets in different countries, size-ranked portfolios, and stock prices within a given industry (Baillie and Bollerslev; Engle and Granger; Campbell and Shiller; Taylor and Tonks; Cerchi and Havenner; Bossaerts). Engle and Granger provide the foundation for cointegration work, and since their work, considerable literature has examined the cointegration of markets. Contemporary work has expanded cointegration to include threshold cointegration for examining price relationships, implied transactions costs, and structural changes.

Obstfeld and Taylor, Tong, Tsay, Hansen, and Goodwin, Grennes, and Craig have developed threshold methods, tested threshold models, and/or applied cointegration threshold methods to investigate autoregressive processes. A threshold autoregressive model (TAR) is a standard autoregressive (AR) model that has been modified to allow thresholds corresponding to price or return limits (bands or boundaries, τ) within which arbitrage does not occur. The simple

$$x_t = \rho\, x_{t-1} + e_t \quad ,$$

autoregressive model applied to stock returns is of the form:

where $x_t = r_{1t} - r_{2t}$, e_t is the white noise residual, ρ is a parameter estimate, and r_{1t} and r_{2t} are compound monthly stock rates of return for the two data series being examined, for example, the individual stock and the market, respectively. When a cointegrating relationship exists between the two series, any shock to the series differential will eventually fade. The series' differential is stationary, and $|\rho| < 1$ when a long run equilibrium relationship exists. The adjustment process in the series' differential returning to the stable equilibrium relationship is generally modeled as an

$$\Delta x_t = \lambda x_{t-1} + e_t \quad ,$$

autoregressive error-correction model of the form:

where $\lambda = \rho - 1$ and Δ is a differential operator such that $\Delta x_t = (x_t - x_{t-1}) = (r_{1t} - r_{2t}) - (r_{1t-1} - r_{2t-1})$.

In order to test for threshold levels, two series are often thought to be cointegrated. A

$$r_{1t} - \beta r_{2t} = x_t \quad ,$$

general cointegrating relationship between the rates of return for two stocks can be written as:

where $x_t = \rho x_{t-1} + e_t$. The nature of the autoregressive process of x_t determines the cointegration of the r_{it} variables. The r_{it} variables are not cointegrated when ρ approaches 1. In this situation, deviations from the equilibrium return are nonstationary. Thresholds can be incorporated into the autoregressive process by extending the model such that x_t follows a threshold autoregressive process. This can be accomplished in the following framework used by Balke and Fomby and Goodwin, Grennes, and Craig:

$$\rho = \begin{matrix} \rho^{(1)} \; if \; |x_{t-1}| \leq \tau \;\; and \\ \rho^{(2)} \; if \; |x_{t-1}| > \tau \end{matrix}$$

where τ denotes the threshold that defines the separate regions or regimes.

The simple autoregressive model in equation 1 can be modified slightly to yield a threshold autoregressive model with symmetric threshold bounds:

$$x_t = \delta(\rho^{(1)} x_{t-1}) + (1-\delta)(\rho^{(2)} x_{t-1}) + e_t \quad ,$$

where δ=1 if $|x_{t-1}| > \tau$ and 0 otherwise. The parameter τ is the threshold generally representing transactions costs in cointegration work.[1] In the case of stock market rates of return, τ represents the differential that must be reached for arbitrage to occur. Within the threshold bands, $\rho^{(2)}$ is constrained to equal 1, and the series difference is not cointegrated, indicating a random walk or a stable market equilibrium. Equation 5 can be simplified and written in error-correction form

$$\Delta x_t = \delta(\rho \, x_{t-1}) + (1-\delta)(x_{t-1}) + e_t \quad .$$

as:

An error-correction occurs outside but not within the transactions costs bands. Outside the bands, the differentials in the series are large enough to stimulate error-correcting

[1] Following Goodwin, Grennes, and Craig, it is assumed that $e_t^{(1)}$and $e_t^{(2)}$ have constant means and variances which is only relevant to standard error estimates of the ρ parameters. As Goodwin, Grennes, and Craig note, this is a minor issue since standard inferences are complicated by the identification of δ.

equilibriating adjustments. Outside the threshold bands or levels, the difference in returns is large enough to cause market participants to react, and their reaction creates readjustments in stock prices that reestablish the long-run equilibrium relationship as stocks move forward. Goodwin, Grennes, and Craig suggest that threshold effects occur when larger shocks, those outside the threshold levels, create different responses than smaller shocks. Within the threshold bands, there is no error to correct for, the small series differentials do not elicit adjustments, hence, there is no error-correction.

Threshold models are a form of regime switching models. When a relevant variable, or relationship, moves across a threshold, this stimulates the regime switch. Goodwin, Grennes, and Craig point out that combinations of regimes may exist at times, leading to nonlinearity in model structure.

The general cointegrating relationship in equation 3 can be re-written in threshold error-

$$\Delta r_t = \begin{cases} \sum_{i=1}^{p} \gamma_i^{(1)} \Delta r_{t-i} + \theta^{(1)} x_{t-1} + \varepsilon_i^{(1)} & if \quad |x_{t-1}| \leq \tau \quad and \\ \sum_{i=1}^{q} \gamma_i^{(2)} \Delta r_{t-i} + \theta^{(2)} x_{t-1} + \varepsilon_i^{(2)} & if \quad |x_{t-1}| > \tau \end{cases} ,$$

correction form as:

where $\gamma_i^{(1)}$, $\gamma_i^{(2)}$, $\theta_i^{(1)}$, and $\theta_i^{(2)}$ are parameters, and ε_t is a residual of mean zero. This general model can be extended to models with multiple thresholds and symmetric or asymmetric adjustments (Balke and Fomby).

Empirical Methods

The dynamics of food and agribusiness stock return relationships with the market, threshold effects, and the impacts on the CAPM relationship were investigated through a series of empirical econometric models. First, the standard CAPM relationship was estimated for 21 agribusiness firms. Ordinary least squares (OLS) estimates of the beta coefficient were obtained using 5 years of rolling compound monthly returns for all possible 5-year periods for each firm. The 5-year period using monthly data was chosen because this is the standard used in the

$$r_s = \alpha + \beta r_m + e \quad ,$$

industry. The relationship estimated is represented by:

where r_s is the stock return, r_m is the market return, and e_t is a white-noise residual.

Second, autoregressive (AR) and threshold autoregressive (TAR) models of the return differentials were estimated, as were symmetric threshold bands, and the statistical significance of the estimated threshold bands was tested. The autoregressive error-correction model form

$$\Delta x_t = \lambda x_{t-1} + e_t \quad ,$$

used was:

where x_t is the return differential and e_t is a white-noise residual.[2] Models were estimated using compound monthly rates of return in levels. Data were demeaned and detrended prior to estimating the thresholds and the AR and TAR models by estimating the following model and then using the residuals from this estimation in the subsequent models estimated:

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[2]This is the same model as in equation 2.

$$x_t = \alpha + \beta t + e_t \quad ,$$

where x_t is the return differential, t is a time trend variable, and e_t is the white-noise residual.

Symmetric threshold bands, denoted by τ, were estimated for the TAR models, parameter estimates for the differentials were estimated outside the threshold bands, that is when $|x_{t-1}| > \tau$. A random walk was assumed within the threshold bands, when $|x_{t-1}| \leq \tau$. The random walk assumption means that $\lambda = 0$ is imposed within the threshold bands.

Following Balke and Fomby and Goodwin, Grennes, and Craig, a two-dimensional grid search that minimizes the sum of squared error criteria was employed to determine the thresholds and to define the alternative regimes. The statistical significance of the thresholds, which is the significance of the differences in estimated parameters over the alternate regimes, was then tested.

Hansen's test approach was used to examine the statistical significance of the threshold effects. Hansen's approach consists of identifying the thresholds and performing a Chow-type test that determines the significance of the threshold effects. The test statistics of a conventional Chow test have nonstandard distributions so Hansen uses simulation models to approximate the asymptotic null distribution and determine the critical test values. A grid search was used to determine the optimal thresholds and the standard Chow test was used to test the threshold effects. The asymptotic p-value was approximated from the sample of test statistics as the percentage of test statistics from the estimation sample that exceeds the observed test statistics.[3]

[3] Goodwin, Grennes, and Craig use this approach in examining threshold effects in butter markets.

Finally, the results of Hansen's test were used to determine which firm and market stock relationships had significant threshold effects and which did not. For those cases in which threshold effects were determined, the CAPM was re-estimated inside and outside the thresholds using only that data which lie inside and outside the threshold levels, respectively. Once again, OLS estimates of the beta relationship were obtained using 5 years of rolling compound monthly returns for all possible 5-year periods for each firm. However, data not lying in the regime was eliminated from these estimations. The model estimated is again represented by equation 8.

Data

Data in this study consist of compound monthly rates of return to common stock for 21 food and agribusiness firms trading on the New York and American Exchanges and the NASDAQ from 1963-1998. Data also include rates of return for the Center for Research and Security Prices Database (CRSP) Value Weighted Index which is a broad market index. All return data were obtained from the *Center for Research and Security Prices Database,* (CRSP). Throughout this paper, rates of return are simply referred to as returns.

The daily stock rate of return for the CRSP market index and for each agribusiness firm was calculated as the change in stock price between consecutive time periods plus dividends.

$$k_{i,t} = \frac{(P_{i,t+1} - P_{i,t} + D_{i,t})}{P_{i,t}} \quad ,$$

This is:

where $k_{i,t}$ is the percentage return to an investor in firm *i*, $P_{i,t}$ is the price per share of firm *i* stock in time period *t*, and $D_{i,t}$ is the dividend per share of firm *i* stock in time period *t*. Daily rates of return were compounded to monthly rates of return by:

$$r_{i,t} = \prod_{j=1}^{n} (1 + k_{i,t}) - 1 \quad ,$$

where $r_{i,t}$ is the compound monthly return to an investor in firm i in month t, $k_{i,t}$ is the daily rate of return, and n represents the number of trading days during month t.

A sample of 21 agriculturally-related firms was used in this study. They include Hormel, IBP, Smithfield Foods, ConAgra, Seaboard, General Mills, Kellogg, Quaker Oats, Archer Daniels Midland, Kroger, Albertson's, Fleming, Safeway, Winn Dixie, Deere, Case, AGCO, Monsanto, Pioneer, McDonald's, and Wendy's.

Empirical Results

The empirical results section will first discuss the threshold model (TAR) results. Then, the CAPM models will be discussed for the entire sub-sample and then for the sub-sample with the observations outside the threshold bounds eliminated.

Table 1 contains the threshold test results, model estimates, and years for which data were available. Seven of the 21 firms have periods of time where there are distinct threshold effects between the market and the individual firm. These firms are Archer Daniels Midland (ADM), ConAgra Foods (CAG), John Deere (DE), Hormel (HRL), Kroger (KR), Pioneer (PHB), and Smithfield Foods (SFD). The threshold value represents the return difference between the individual stock and the market that will cause an adjustment back to equilibrium to occur. These range from 1.5% for Kroger to 2.6% for ADM. The units on the adjustment are a per month difference.

The results from the threshold regression models were then used to examine the effect of removing the observations that were in disequilibrium from the data set on the estimate of beta. These results are found in Table 2. The second column in Table 2 (ADM_A) represents the estimate of beta using all observations from the sixty month time period for Archer Daniels Midland. The next column represents the estimate of beta only when the observations are in "equilibrium". The last column represents the estimates for beta using only those observations that are out of equilibrium. The rows represent a sixty month rolling time-period beginning with January 1963 and ending with December 1967. The next row deletes 1963 and adds 1968. The results of Table 2 are summarized in Figures 1 through 7. The bold line illustrates the CAPM estimates using the entire time period (CAPM). The dashed line represents the CAPM estimates only when the market is in equilibrium (TAR CAPM). Beta estimates change over time, however, accounting for temporary periods where the individual stock is in disequilibrium results in a far more stable estimate of beta. In each case, the estimates of beta are notably more stable with the elimination of the outliers (disequilibrium).

Table 3 reports the average beta and the standard deviation for the time period under the CAPM and under the TAR CAPM. The average beta for the entire sample is often fairly equivalent to the TAR beta estimate. In 6 out of the 7 firms, the average beta was .01 higher in the TAR sample than the full sample. However, the standard deviation is quite different. In all cases, the standard deviation across periods under the TAR model results in beta estimates that are substantially more stable. In all cases, the standard deviation is reduced by more than 50%.

Conclusions

This manuscript examined the effect of accounting for periods of disequilibrium in the estimates of the risk parameter beta in the CAPM. A threshold autoregressive model was estimated to test whether periods of disequilibrium could be detected in the relationship between individual stock returns and the market return. Several questions were examined related to food and agribusiness stocks. The research found that beta is not constant over time. Substantial shifts in beta occur using a rolling five year window of monthly returns to estimate beta as is often done by market information services. Seven of 21 food and agribusiness stocks had periods where the individual stock and the market were out of equilibrium and thus fail to meet the full-equilibrium assumption of the CAPM. After eliminating the observations where the markets were in disequilibrium, the estimates of beta were far more stable.

The implications of the threshold estimates may have important significance for the pricing of risk and the measurement of systematic and unsystematic risk. Since the CAPM is a full-equilibrium model, shocks to the system resulting in periods of disequilibrium have the opportunity to create problems with equilibrium parameter estimates. If the market does not experience an immediate full adjustment to a shock, then appropriate equilibrium risk measurements will not be obtained. Periods when the individual stock return is not in equilibrium with the market lead to far more variability in the estimates of beta from period to period. Therefore, choosing a five year time period without consideration of periods of disequilibrium will lead to inaccurate estimates of beta. Inclusion of these periods of disequilibrium in the risk parameter estimation process leads to an over-estimation of firm unsystematic risk on average 40% of the time and an under-estimation 60% of the time.

Inaccurate estimates of beta have implications in risk pricing that lead to implications for cost of capital estimates and firm and investor decisions. Beta is used in determining the cost of equity capital for a firm, which is then used in capital budgeting, new capital investment decisions, project evaluation decisions, and EVA analysis. Beta estimates are generally available from investor services and are often used in the comparison of firms. Over and under estimation of beta and unsystematic risk can potentially lead to erroneous comparisons, analyses, and decisions. Perhaps, beta would be a more useful economic concept when estimated only during periods of equilibrium.

Table 1. Threshold Test Results and Model Estimates

Firm	AR Lambda	TAR Lambda	Threshold	Hansen's Test[1]	Time Period
ADM	-1.0195	-1.0344	0.0262	7.6486***	63.01-98.12
ConAgra	-1.1810	-1.1894	0.0238	3.5030*	72.12-98.12
Deere	-1.0023	-1.0133	0.0212	5.8778**	63.01-98.12
Hormel	-1.0424	-1.0534	0.0192	7.3942***	63.01-98.12
Kroger	-0.9514	-0.9557	0.0148	2.7932*	63.01-98.12
Pioneer	-1.1311	-1.1364	0.0167	2.6380*	73.09-98.12
Smithfield	-1.0146	-1.0214	0.0256	3.6021*	72.12-98.12
Albertson's	-1.1150	-1.1160	0.0046	0.7725	70.02-98.12
AGCO	-1.0786	-1.0824	0.0435	0.0720	92.04-98.12
Case	-0.8116	-0.8419	0.0369	1.9750	94.06-

					98.12
Fleming	-1.1039	-1.1069	0.0124	1.8484	68.12-98.12
General Mills	-1.0944	-1.0948	0.0046	0.3167	63.01-98.12
IBP	-1.0888	-1.0904	0.0136	0.2772	87.10-98.12
Kellogg	-1.0713	-1.0715	0.0032	0.1917	63.01-98.12
McDonald's	-0.8989	-0.9037	0.0139	2.4724	63.01-98.12
Monsanto	-0.9855	-0.9892	0.0130	2.0535	63.01-98.12
Quaker Oats	-1.0576	-1.0614	0.0133	2.2147	63.01-98.12
Seaboard	-1.1618	-1.1627	0.0083	0.8434	63.01-98.12
Safeway	-1.1979	-1.2012	0.0108	0.7088	90.04-98.12
Wendy's	-0.8862	-0.8873	0.0095	0.5011	76.06-98.12

Winn Dixie	-1.0715	-1.0760	0.0145	2.4547	63.01-98.12

[1]A single asterisk indicates statistically significant at α=0.10, a double asterisk indicates statistically significant at α=0.05, a triple asterisk indicates statistically significant at α=0.01.

Table 2. Capital Asset Pricing Model Beta Estimates Using Full and Modified Data Sets[1]

Period	ADM_A	ADM_I	ADM_O	CAG_A	CAG_I	CAG_O	DE_A	DE_I	DE_O
1963-67	0.6489	1.1067	0.5609				0.7049	0.9761	0.6113
1964-68	1.0733	1.1394	1.0520				0.4652	0.9875	0.2718
1965-69	0.9937	0.9149	1.0044				0.6007	0.9644	0.4543
1966-70	0.9288	0.7961	0.9619				0.8828	0.9840	0.8560
1967-71	0.7402	0.7888	0.7078				0.9566	0.9366	0.9690
1968-72	0.7270	0.7885	0.6967				1.2567	1.0151	1.3088
1969-73	0.7203	0.7919	0.6687				1.3368	1.0142	1.3974
1970-74	0.8239	0.9227	0.7377				1.5674	0.9951	1.6422
1971-75	0.8555	0.9625	0.8503				1.1435	0.8705	1.2054
1972-76	0.7682	0.9626	0.6809				1.0842	0.8518	1.2099
1973-77	0.8013	0.9684	0.7232	1.1359	1.1151	1.1388	0.9526	0.8809	0.9870
1974-78	0.8616	1.0055	0.7919	1.1941	1.2603	1.1856	0.9746	0.9093	1.0120
1975-79	1.1097	0.8879	1.1886	1.4972	1.2317	1.4976	0.6010	0.9408	0.1223
1976-80	1.2100	0.9367	1.2624	1.1464	1.1712	1.0303	0.9159	0.9832	0.8560
1977-81	1.4358	1.0258	1.5432	1.0328	1.0910	0.9346	0.9041	1.0060	0.8607
1978-82	1.4304	1.1044	1.5137	0.7649	1.1025	0.6345	1.0147	0.9954	1.0352
1979-83	1.3873	1.0533	1.4906	0.6798	1.0843	0.4722	0.9982	1.0118	0.9911
1980-84	1.3346	1.2244	1.3489	0.5464	1.0835	0.3787	1.0365	1.0707	0.9942
1981-85	1.3300	1.1389	1.3920	0.4676	1.2092	0.3153	1.1695	1.0354	1.2197
1982-86	1.3986	1.0801	1.4675	0.5803	1.1816	0.4581	1.3547	1.0126	1.7647
1983-87	1.1940	0.9493	1.2038	1.0543	1.1398	1.0469	1.1482	1.0168	1.1993
1984-88	1.1814	1.0065	1.1950	1.0271	1.0414	1.0268	1.1493	1.0135	1.1965
1985-89	1.1590	1.0530	1.1780	1.0907	1.0719	1.0981	1.1115	0.8719	1.1801
1986-90	1.1030	1.1530	1.1009	1.0458	0.9928	1.0582	1.0975	0.8949	1.1411
1987-91	0.9639	1.1409	0.9480	1.0719	1.0156	1.0759	0.9360	0.9362	0.9367
1988-92	1.0643	1.1947	1.0374	0.9740	0.9836	0.9244	0.8966	0.9866	0.8843
1989-93	1.1159	1.2156	1.0971	1.0413	0.9944	0.9925	0.8864	1.0416	0.8641
1990-94	1.0324	1.1502	0.9875	0.9402	0.9230	0.8740	0.8792	1.3171	0.8283
1991-95	0.8792	1.1217	0.7440	0.9541	0.8653	0.9666	0.6807	1.2557	0.5654
1992-96	1.0252	1.1967	0.9434	0.8853	0.8891	0.9680	1.1649	1.1191	1.2518
1993-97	0.6750	1.1565	0.1672	0.9381	0.9961	0.8742	0.9113	0.9747	0.9018
1994-98	0.6782	1.1039	0.5305	0.7415	1.0184	0.6167	1.0656	0.9099	1.0762

[1] The subscript A represents the entire sample, the subscript I represents equilibrium, the subscript O represents disequilibrium.

Table 2. Capital Asset Pricing Model Beta Estimates Using Full and Modified Data Sets[1] (Continued)

Period	HRL_A	HRL_I	HRL_O	KR_A	KR_I	KR_O	SFD_A	SFD_I	SFD_O
1963-67	1.3415	0.9647	1.4499	0.6458	1.0571	0.6357			
1964-68	1.3346	0.9551	1.5148	0.4512	1.4306	0.4307			
1965-69	1.1315	0.9462	1.2048	0.5561	1.2253	0.5416			
1966-70	0.9549	0.9336	0.9343	0.7355	0.9495	0.7015			
1967-71	0.8312	0.9381	0.7363	0.9640	0.9675	0.9538			
1968-72	0.5801	0.9472	0.4253	1.0361	1.0201	1.0596			
1969-73	0.4216	0.9083	0.2974	1.1877	0.9547	1.3136			
1970-74	0.3958	0.9479	0.2752	1.2592	0.9553	1.3429			
1971-75	0.3283	1.0110	0.2456	1.3700	1.0017	1.4710			
1972-76	0.3207	0.9771	0.2601	1.1516	0.9675	1.2037			
1973-77	0.3747	1.0117	0.3007	1.1272	0.9793	1.1546	1.6679	1.2184	1.8027
1974-78	0.3773	1.0298	0.3109	1.0039	1.0436	0.9956	1.3720	1.1766	1.3970
1975-79	0.6514	0.9927	0.5645	0.9113	1.0186	0.8913	1.4408	1.1086	1.5240
1976-80	0.6436	0.9923	0.5810	0.7321	0.9888	0.7038	1.1373	1.0569	1.1471
1977-81	0.6950	0.9772	0.6437	0.9654	1.0662	0.9494	0.4166	1.0233	0.2986
1978-82	0.8149	0.9216	0.7816	0.7233	1.0571	0.6774	0.4670	1.0382	0.3629
1979-83	0.8056	0.9099	0.7644	0.6645	1.0778	0.6338	0.4915	0.9656	0.4195
1980-84	0.5724	0.8183	0.5426	0.5948	1.1181	0.5561	0.2827	0.8274	0.2610
1981-85	0.7168	0.8676	0.6815	0.4832	1.1580	0.4184	0.1703	0.7052	0.8495
1982-86	0.6950	0.8959	0.6470	0.2687	1.1332	0.2176	0.9082	1.0318	0.8963
1983-87	0.6625	0.9663	0.4276	0.6619	0.9584	0.4539	1.0525	1.0253	1.0441
1984-88	0.7356	0.9689	0.5211	0.7811	0.9589	0.5897	1.0819	1.0331	1.1122
1985-89	0.8242	0.9601	0.6403	0.8527	0.9656	0.6763	1.0989	1.0351	1.1310
1986-90	0.9873	0.9743	0.9704	1.1163	0.9578	1.1938	1.1612	1.0367	1.2674
1987-91	0.8830	0.9998	0.7983	1.2849	0.9594	1.4994	0.9470	1.0304	0.8710
1988-92	0.8975	0.9533	0.8876	1.8657	1.1122	1.9222	0.9778	1.0412	0.9741
1989-93	0.9192	0.9342	0.9163	1.8687	1.1429	1.9092	1.0085	1.0154	1.0040
1990-94	0.7813	1.0211	0.7414	1.6576	0.9774	1.6851	1.0607	1.0108	1.0487
1991-95	0.4143	1.1174	0.2104	1.5289	1.1023	1.5709	0.9244	1.0861	0.8862
1992-96	0.8987	0.9286	0.8884	1.3118	0.9453	1.4404	0.5484	1.0188	0.3897
1993-97	0.6486	1.0612	0.5430	0.5430	0.9524	0.3544	0.0979	1.0565	-0.2145
1994-98	0.8226	0.9760	0.7423	0.4771	0.9716	0.3522	0.9645	1.1130	0.937

[1] The subscript A represents the entire sample, the subscript I represents equilibrium, the subscript O represents disequilibrium.

Table 2. Capital Asset Pricing Model Beta Estimates Using Full and Modified Data Sets[1] (Continued)

Period	PHB_A	PHB_I	PHB_O
1963-67			
1964-68			
1965-69			
1966-70			
1967-71			
1968-72			
1969-73			
1970-74			
1971-75			
1972-76			
1973-77			
1974-78	1.0407	1.0084	1.0432
1975-79	1.2063	0.9827	1.2310
1976-80	1.2166	0.9671	1.2369
1977-81	0.9359	0.9967	0.9331
1978-82	0.7385	0.9314	0.7254
1979-83	0.4342	0.8952	0.3934
1980-84	0.4322	0.9116	0.3886
1981-85	0.3312	0.8809	0.2970
1982-86	0.5822	0.9092	0.5287
1983-87	0.8758	0.8996	0.8504
1984-88	0.9832	0.8826	0.9752
1985-89	1.0111	0.8899	1.0112
1986-90	1.0787	0.9128	1.0963
1987-91	1.1289	0.9203	1.1857
1988-92	1.1591	0.9393	1.2261
1989-93	1.1796	0.9549	1.2597
1990-94	1.1627	0.9639	1.2222
1991-95	1.0274	1.0550	1.0255
1992-96	0.7387	0.5902	0.7483
1993-97	0.4837	0.8114	0.4629

1994-98	0.0779	0.9371	0.0207

[1] The subscript A represents the entire sample, the subscript I represents equilibrium, the subscript O represents disequilibrium.

Table 3. Average Beta Estimate for the Entire Period and Under the TAR Adjustment

	Average		Standard Deviation		
Firm	**CAPM**	**TAR CAPM**	**CAPM**	**TAR CAPM**	**Time Period**
ADM	1.020	1.032	0.238	0.130	63.01-98.12
ConAgra	0.946	1.066	0.233	0.105	72.12-98.12
Deere	0.995	0.993	0.228	0.097	63.01-98.12
Hormel	0.733	0.963	0.258	0.055	63.01-98.12
Kroger	0.962	1.037	0.405	0.103	63.01-98.12
Pioneer	0.876	1.030	0.328	0.089	73.09-98.12
Smithfield	0.849	0.916	0.406	0.101	72.12-98.12

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