Systematic Skewness in Futures Contracts

Joan C. Junkus

Under the Capital Asset Pricing Model (CAPM), the excess rate of return on a risky asset depends on its contribution to the variance of the market portfolio, that is, its systematic risk. The CAPM has been applied to futures contracts in an effort to discover, and measure the size of, a risk premium for these assets. However, the existence of a risk premium in futures contracts and its size remains a subject of controversy.

The mean-variance asset pricing model has been extended to three moments in common stocks to include a positive investor preference for systematic skewness of asset return. This article tests a three-moment version of the CAPM for futures contracts.

Several issues relating to a risk premia in futures are addressed. First, applying a three-moment pricing model to futures contracts can shed light on the nature of the risk premium in futures. Since commodity futures appear to have little systematic risk, it may be that the risk of these contracts takes a form other than the usual covariance with the market. A three-moment asset pricing model that incorporates more information on futures returns distributions may be more appropriate for futures contracts than the traditional CAPM.

Second, systematic co-skewness is consistent with a two-factor Arbitrage Pricing Model of asset returns: if investors exhibit a positive preference for skewness, a second, quadratic market factor may have significance in explaining returns on futures contracts. Therefore, this article also tests a two-factor, quadratic asset pricing model for futures contracts.

Third, the significance of co-skewness is tested using three different proxies for the market portfolio: the S&P500, the traditional measure of the market portfolio; a combined commodity cash price/S&P500 portfolio, reflecting the relative weighting of commodities in the U.S. wealth portfolio; and a 100% commodity portfolio representing a well-diversified portfolio of agricultural wealth. It may be that co-skewness, like systematic risk in futures, depends on the composition of the market portfolio used to test for its significance. Use of an agricultural portfolio makes the strongest possible case for the explanatory power of systematic risk or systematic co-skewness in futures returns because the correlation between futures returns and an agricultural wealth portfolio (thereby the measure of risk for the futures) should be high. Finally, the tests for risk premia in futures are conducted here on a much larger number of contracts than have been used in previous studies.

The results of this article show that futures are not risky assets, despite their apparent volatility, within either a 2- or 3-moment asset pricing model. Further, fu-

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tures prices are shown to have no significant risk premium even when measured against an explicitly agricultural portfolio. Thus, the risk of futures contracts appears to be exclusively nonsystematic risk, and no significant risk premium is reflected in futures prices. This seems to indicate that the risk transferred to the speculator from the hedger in futures markets is eliminated through diversification in the capital market.

I. LITERATURE REVIEW

Tests on the nature of a risk premium in futures contracts are inconclusive. Early tests of Keynes' normal backwardation hypothesis tend to support the idea that hedgers pay a risk premium to speculators to assume the risk of price uncertainty in the futures market, especially in markets with low liquidity (see, for instance, Houthakker (1957); Cootner (1960); Telser (1960); Gray (1961); and Rockwell (1967)). These studies, in general, test for significant trends in futures prices. In other words, if speculators are net long, prices should tend to rise, on average, to pay speculators for their risk.

Tests under the CAPM or the Arbitrage Pricing Theory (APT), on the other hand, find no significant risk premium in futures prices (see Dusak (1973); Baxter, Conine, and Tamarkin (1984); Ehrhardt, Jordan, and Walkling (1987); and So (1987)). Only departures from the traditional framework of the CAPM show a risk premium in futures prices (see Raynauld and Tessier (1984) and Chang (1985)).

There is disagreement concerning the choice of the proper index to use for futures in the single factor CAPM. Different percentages of commodities versus stock in the index construction can lead to different conclusions regarding risk and return in futures contracts. While Carter, Rausser, and Schmitz (1983) find a significant risk premium using a combination of S&P500 and a commodity futures proxy for the market return, Baxter Conine, and Tamarkin (1985) find no significant risk premium with a larger weight applied to the S&P500.

An extension of the Capital Asset Pricing Model of asset selection incorporating three moments is developed and tested in common stocks by Arditti and Levy (1975); Conine and Tamarkin (1981); Jean (1971, 1973); and Kraus and Litzenberger (1976). In these models, the investor has a positive preference for skewness of return. If the returns on an asset are positively skewed, that asset has a higher probability of large, positive returns and it is then reasonable to assume that an investor would prefer the asset with positive skewness. Since positive skewness is a preferred characteristics of an asset, the rate of return on an asset should *decrease* with positive skewness. Unlike a security's systematic risk, which is considered an economic "bad" for which an investor must be compensated through a higher return, positive skewness is an economic good for which the investor should be willing to receive a lower return.

Specifically, in the K-L model, the return to an investor holding a security depends on the security's contribution to the market portfolio's variance and skewness:

$$E(R_i) - R_f = a_0\beta_i + a_I\gamma_i$$

where $\beta_i = \mathrm{cov}(R_i,R_m)/\sigma^2\,(R_m)$, the market beta; and

$$\gamma_i = \frac{E[(R_i - E(R_i))\,(R_m - E(R_m))^2]}{E[R_m - E(R_m))^3]},$$

the market gamma, a measure of the systematic skewness of the *i*th asset; and R_i, R_m, and R_f are the returns on the security, the market portfolio, and the risk-free asset, respectively; a_0 and a_1 are the market premiums for bearing risk. As stated above, the market price of gamma, a_1, is expected to have the opposite sign to the skewness of market return. While K-L find co-skewness to be a significant factor explaining common stock returns, Friend and Westerfield (1980) reject the K-L version of the CAPM. More recently, Lim (1989) uses a generalized method of moments approach and finds some evidence that systematic co-skewness is priced. In addition, Barone-Adesi (1985) finds some support for skewness preference within an APT model.

In both Barone-Adesi and K-L, the three-moment capital asset pricing model is consistent with a quadratic characteristic line:

$$E(R_i) = R_f + C_{1i}[(E(R_m) - R_f] + C_{2i}[(E(R_m) - R_m)^2]$$

Under the Arbitrage Pricing Theory, the expected security return is a linear combination of the risk-free rate, R_f, and expected excess returns on (a) the market portfolio and (b) a portfolio correlated with the squared market return. Thus, the K-L three-moment pricing model applied here to futures can be considered also as a form of asymptotic arbitrage equilibrium.

The distributions of futures prices or returns have not been extensively examined, but the studies performed thus far find evidence of nonnormality in both commodity and financial futures. Stevenson and Bear (1970) find the distribution of daily prices of corn and soybean futures to be leptokurtic. Dusak (1973) find the distribution of semi-monthly prices of wheat, corn, and soybeans to deviate substantially from the normal distribution. Helms and Martell (1985) measure skewness in the log of price changes for transaction data for both commodity (wheat, corn) and financial (GNMA and T Bond) futures and reject the normality of returns on these contracts.

More recently, Hudson, Leuthold, and Sarassora (1987) find evidence of leptokurtosis in returns in wheat, soybean, and live cattle futures. Since the distribution of returns in futures is found, like stock returns, to be nonnormal, it is logical to extend the equilibrium model of futures returns to include a measure of nonnormality. This article examines whether a risk premium in futures contracts can be detected and explained through the existence of nonnormal returns to a holder of a futures contract.

II. METHODOLOGY

Data

Monthly deflated excess rates of return, r_{it}, are calculated for twenty futures contracts and for the market portfolio for the 10-year period, January, 1978 to December, 1987:

$$r_{it} = (R_{it} - R_{ft})/R_{ft}$$

where R_{it}, R_{ft} = 1 + the monthly return for the futures and the 90-day Treasury Bill, respectively. Deflated excess returns are used to ensure that, with a changing risk-free rate, the r_i are observations on an identically distributed random variable.[1] Returns for the futures are calculated as ln (Futures price$_t$/Futures price$_{t-1}$). Fu-

[1]The assumptions required for this to be so are (a) proportional stochastic growth of return with either constant relative risk aversion or stationarity of end-of-period wealth distribution of (b) a state-independent investment opportunity set (see K-L).

tures prices for the nearby contract are from the Commodity Research Bureau. Twenty futures contracts (traded continuously during the 10 years) are used. The contracts include: interest rate (T Bond, T Bill), currency (pound, Canadian dollar, mark), metals (gold, silver), and commodity (corn, wheat, soybean) futures. The nearby futures contract is the contract closest to maturity, and generally has between one and three months to maturity. The newly auctioned 13-week cash T Bill rate is used for an estimate of the risk-free lending rate, and the market portfolio return is based on the monthly index level of the S&P500 and the Wholesale Price Index for all Farm Products.

Estimation

This article assumes that the traditional form of the CAPM:

$$r_i = b_0 + b_1\beta_i, \tag{1}$$

the null hypothesis, H_0, is misspecified and that the alternative form:

$$r_i = c_0 + c_1\beta_i + c_2\gamma_i \tag{2}$$

incorporating both systematic risk, beta, and systematic co-skewness, gamma, the alternative hypothesis H_1, is the correct form for pricing returns on futures contracts.

The method used to test the hypotheses (Eq. (1) and (2)) is similar to the procedure used by Fama and Macbeth (1973):

First, an estimate of beta and gamma for the ith futures contract is calculated by, respectively:

$$\hat{\beta}_i = \left[\sum_t (r_{mt} - \bar{r}_{mt})(r_{it} - \bar{r}_{it})\right] / \sum_t [(r_{mt} - \bar{r}_{mt})^2]$$

$$\hat{\gamma}_i = \left[\sum_t (r_{mt} - \bar{r}_{mt})^2(r_{it} - \bar{r}_{it})\right] / \sum_t [(r_{mt} - \bar{r}_{mt})^3]$$

for $i = 1$, 20 futures contracts, for the 5-year period, 1/78 through 12/82 ($t = 60$ months).

Next, cross sectional regressions of deflated excess rate of return of the twenty futures contracts against their beta and gamma values are estimated for each month of 1983:

$$r_i = c_0 + c_1\beta_i + c_2\gamma_i + u_i \tag{2}$$

for 1983.1, 1983.2, etc. Equation (2) relates the size of excess return against the size of systematic risk (beta) and systematic co-skewness (gamma) in each of the twelve months of 1983 (12 regressions).

Finally, the procedure in (a) and (b) is repeated one year at a time for the years 1984 through 1987. That is, the next 5-year period, 1/79 to 12/83, is used to estimate the beta and gamma of each futures contract, and then twelve monthly cross sectional regressions (Eq. (2)) are estimated for 1984, etc. Note that under this procedure, 60 estimates of c_0, c_1, and c_2 are obtained, 12 per year for the 5 years 1983 through 1987. Under the three-moment model, $c_0 = 0$; $c_1 > 0$; c_2 has the opposite sign to market skewness, m^3; and $c_1 + c_2 = E(r_m)$.

A univariate regression of return on gamma is estimated also for the 60 month time period:

$$r_i = d_0 + d_2\gamma_i + u_i \tag{3}$$

Comparisons can be made then between the results found in previous studies and the results obtained here.

Because the independent variables used in the cross sectional regression (Eq. (2)) are themselves estimates of random variables, there can be a problem with errors in variables. The estimated coefficients may be biased and inconsistent. The usual procedure used to address this problem in stocks is to rank the securities (usually 1000) by size of beta, and group the stocks into portfolios (usually 20) before the cross sectional regression in step (b) is carried out. This serves to reduce the variance of the estimates' error terms. Note, however, that this grouping procedure is not possible with futures since the total number of futures contracts available for the test is far fewer than the number of U.S. stocks. Thus, the interpretation of the results must be made with caution.

An additional problem with the estimation is the possible multicollinearity of beta and gamma. Correlation between the independent variables generally results in high standard errors for the regression parameters. Thus, even if the estimates of the regression coefficients are unbiased, the power of the test for significance is weak.

The beta and gamma estimates are indeed highly correlated in the first two five-year periods. However, the correlation decreases over the sample period; and, for the last two years of estimates, the correlation of beta and gamma becomes small and negative.[2] Two procedures are used to address multicollinearity. First, an ordinary ridge regression (ORR) estimator is used to reduce the variance.[3] Secondly, the results of the multiple regression are reported for both the full 60 regressions and separately for the last two years of ($n = 24$) regressions.

Finally, eqs. (1) through (3) are estimated using three measures of the market portfolio: the S&P500, the traditional proxy for the market portfolio; a weighted average of the S&P500 (93.7%) and the BLS Wholesale Price Index for all farm products produced in the US (6.3%); and the WPI-farm products (100%). The weighted average reflects the relative value of commodities to common stock in the U.S. wealth portfolio (Ibbotson and Fall, (1979)). The WPI index averages the prices of a broad array of commodities, including grains, livestock, fruits, vegetables, fibers, and other farm products such as coffee and tobacco. The weight of any commodity in the index is equal to the value (price times volume) of that commodity in total U.S. farm production. Like the S&P500, the WPI is a value-weighted index of transactions prices for a large, well diversified sample of US agricultural products and includes a much larger sample than, for instance, the Dow-Jones Commodity Index. Use of these three proxies for the market portfolio determines whether co-skewness, like systematic risk, is sensitive to the market proxy used.

[2]With the S&P500 used as the market portfolio, the correlation between the beta and gamma estimates is 0.89770 in the first 5-year period (1978–82) and decreases to −0.05749 in the last 5-year period (1982–86). Similar results are found for the other two proxies of the market portfolio.

[3]The ordinary ridge regression estimate of $c' = [(X'X + kI)^{-1}X'Y]$, or the OLS estimator c multiplied by $[I + k(X'X)^{-1}]^{-1}$. The practical difficulty in applying the ORR method is that the value of k determines the trade-off between bias and variance: the larger k, the larger bias but smaller variance. Further, the value of k is not given and is usually assigned a small value such as 0.01 to reduce bias. In calculating the corrected estimates of c', various values of k from 0.0 (unadjusted) to 0.99 were tried in each of the first 36 cross sectional regressions (1983.1 through 1985.12). The estimates of c' did not change significantly with changes in k. Further, when the adjusted c' estimates were averaged over all 60 regressions, the results were almost identical to the unadjusted.

III. RESULTS AND DISCUSSION

The estimates of systematic risk, beta, and systematic co-skewness, gamma, are listed for the S&P500 in Table I(a), the combined S&P500/WPI in Table I(b) and the WPI in Table I(c) for the first 5-year period, 1978–1982, and the last 5-year period, 1983–1987.

As shown in Table I(a), the traditional beta measure (using the S&P500 as the market proxy) varies between commodity groupings and over time. For instance, in the 1978–82 period, the metals have higher betas than the grains and the soybean complex, which in turn have higher betas than the currencies. In addition, the soybean complex, the metals, and two of the four currencies (British pound and Canadian dollar) have significant betas, and thus these futures exhibit significant systematic risk in the 1978–82 period. Also, the metals' relative high betas are contrary to the usual estimates of low or negative betas for gold, silver, and for mining stocks. During this early period, the metals futures show a relatively higher correlation with stock market movement than do other commodities, currencies, or interest rate futures.

During the later 5-year period, 1983–1987, the beta estimates for most of the commodity and metals futures are much lower and none of the betas is statistically significant. While the estimates appear to vary considerably, only cotton futures show a statistically significant instability when the Chow predictive test of beta stability is applied.

Table I(a) also contains the R^2, standard errors, and F statistics for the market model for the later estimation period (1983–87). The market portfolio has relatively little explanatory power for the size of return in futures.

Changing the market portfolio proxy affects the relative size of the beta estimates between contracts (see Table I(a) through I(c)). With the WPI, beta estimates for the commodities for both 5-year periods are, in general, larger than those of the currencies, metals, or interest rate futures. This is a reversal of the results reported in Table I(a). It appears that the beta estimates are also less homogonous within groups of commodity futures, especially for the first 5-year period. For instance, the beta estimate for corn is four times that of wheat, as is cattle versus pork bellies. In addition, there appears to be a negative relation between dollar weakness in the currency futures (futures price increases) and agricultural prices. This result appears unusual in light of the usual relation between exports, dollar strength, and farm prices.

Evidence of statistical significance and stability of the beta estimates are, however, quite similar between the two market proxies (compare Table I(a) with I(c)). As with the S&P500 betas, the soybean complex and metals estimates show significant risk in the first subperiod (1978–82) but not in the latter (1983–87). Again, only the beta estimate for cotton futures shows a significant instability. Table I(c) contains the *changes* in R^2, standard error and F statistic between the S&P500 estimation equation (Table I(a)) and the estimates using the WPI (Table I(c)) as the market proxy. As the last columns in Table I(c) show, the R^2 and the F statistics for the beta estimations do not change greatly between market portfolio proxies. Whether using the S&P500 or the WPI as the market portfolio, the R^2 and the F are relatively small.

The systematic co-skewness estimates show similar behavior. (Unlike the betas, the gamma estimates are not the result of a regression estimation procedure, and the statistical information for the gamma estimates is consequently smaller.) As with systematic risk, systematic co-skewness measured with the S&P500 is highest in the metals in the first 5-year period and diminishes across the grains/soybean complex and currencies. Like the betas, the gamma rankings are reversed when using the WPI as the market proxy. Also, the estimates of systematic co-skewness, in general, decrease in size in the second 5-year period. While there is no prior assumption on the size of the gamma estimates, the size of the gamma estimates found here for futures are similar to that found for common stocks by KL.

Table II contains the results for the cross-sectional regressions of futures return against beta and gamma for both the full 5-year period and the most recent 2-year subperiod. Again, the coefficients presented in Table II are the averages of the 60 monthly cross sectional regression estimates for Eqs. (1) through (3) for the months 1983.1 through 1987.12. The t ratio is estimated as: coefficient/sd(coefficient). The average R^2 is the mean of the 60 monthly R^2s.

The results on futures return and systematic risk alone (Eq. (1)) are consistent with the lack of statistical significance found for the grains by Dusak (1973) and Baxter, et al (1987). This is true regardless of the market proxy. Thus, even measured against a strictly agricultural market portfolio, systematic risk, or beta, is not significant in explaining the size of futures returns.

Systematic co-skewness with the S&P500, on the other hand, is statistically significant and negative in sign, as expected if systematic co-skewness is an attractive feature of futures returns. However, this is the only evidence of significant explanatory power. When measured using the WPI, systematic co-skewness loses statistical significance. In addition, the average R^2 for the two factor model (Eq. (2)) is quite low under all three market proxies.

The results of the multiple regressions show no significant relationship between co-skewness and asset returns using either the S&P500 or the WPI as the market proxy. The F test between the traditional CAPM (Eq. (1)) and the additional co-skewness factor model (Eq. (2)) shows that the alternative hypothesis of a systematic co-skewness effect must be rejected. Thus, co-skewness of futures returns is not significant in explaining the size of futures returns. A test of $c_1 + c_2 = E(R_m)$ finds that in most cases the relation is statistically significant.

Summary

Systematic co-skewness is tested with both agricultural and financial futures using both a pure stock market index (S&P500) and a measure of farm product prices (WPI-all farm products) as the "market" portfolio. Both the estimates of systematic co-skewness and systematic risk (beta) are shown to change, though not significantly, through the 10-year estimation period and the correlation between these two measures of risk decreases through the period as well.

Systematic risk has little significance in explaining futures returns, confirming the results found previously with a few agricultural and interest rate futures. There is some evidence that systematic co-skewness may be a significant factor in explaining futures returns in a single regression test. However, when combined with systematic risk in a multivariate test, the measure of co-skewness is not significant.

These results indicate that the risk of futures contracts, whether measured by covariance or co-skewness with the market return, is fully diversifiable in capital markets. This risk can be considered diversifiable even when measured within a subset of portfolio assets, agricultural commodities. It also appears that a two-

Table I(a)
S&P 500

	1978–1982		1983–1987		1983–1987			
Commodity	**Beta**	**Gamma**	**Beta**	**Gamma**	**se**	**R^2**	**F**	**F (Chow)[1]**
Corn	.26492 (1.379)	0.6726	−.12823 (−0.465)	0.3995	0.071	0.004	0.22	0.447
Wheat	.24103 (1.118)	0.6759	−.11234 (−0.431)	−0.7092	0.067	0.003	0.19	0.025
Soybeans	.42136 (2.070)**	0.9071	−.14120 (−0.539)	0.7124	0.068	0.005	0.29	0.166
Soy Oil	.43758 (2.056)**	−0.0286	−.19581 (−0.527)	0.8246	0.096	0.005	0.28	1.146
Soy Meal	.41658 (1.879)*	1.0474	−.33412 (−1.256)	0.0641	0.069	0.027	1.58	0.013
Gold	.84590 (2.942)**	4.3122	−.16095 (−0.735)	−0.2536	0.057	0.011	0.54	−0.621
Silver	.18315 (3.384)**	10.3500	.00506 (0.013)	2.4101	0.102	0.001	0.01	−0.623
Copper	.88525 (3.375)**	5.3612	.13849 (0.732)	0.1154	0.051	0.011	0.54	−0.634
Pork Bellies	.65496 (1.264)	0.2456	.06981 (0.183)	0.3304	0.099	0.001	0.03	−0.617
Cattle	.24341 (1.128)	1.4068	.23197 (1.052)	−0.8477	0.057	0.019	1.11	−0.265
Coffee	−.15479 (−0.429)	−5.0042	−.08840 (−0.232)	2.8681	0.098	0.001	0.05	−0.216
Cotton	.18130 (1.047)	0.3315	.48065 (1.038)	−0.0118	0.121	0.021	1.08	4.029**

Orange Juice	−.18914 (−0.549)	−0.6927	−.17880 (−0.733)	0.7097	0.063	0.009	0.54	−0.647
Sugar	.37351 (0.783)	0.0645	.59904 (0.737)	−0.4277	0.211	0.011	0.54	1.042
T-Bills	.05115 (1.001)	0.0970	−.01289 (−0.574)	−0.2823	0.006	0.006	0.33	−0.864
T-Bonds	.21695 (1.475)	−0.7830	.17013 (1.046)	0.7209	0.042	0.019	1.09	−0.139
Deutsche Marks	.14557 (1.149)	1.1110	−.07228 (−0.487)	−0.4153	0.038	0.004	0.24	0.034
Swiss Francs	.16463 (1.007)	1.1259	−.01931 (−0.125)	−0.6796	0.042	0.001	0.02	−0.373
British Pounds	.22281 (2.149)**	1.3415	.01241 (0.084)	−0.0385	0.038	0.001	0.01	0.442
Canadian Dollars	.16467 (3.470)**	0.6479	.07827 (1.627)	−0.2504	0.012	0.045	2.65	−0.374

[1]The Chow test tests the stability of regression parameters:

$$\frac{(SSE)_{78-87} - (SSE)_{83-87}/obs_{83-87}}{(SSE)_{83-87}/(obs_{78-87}) - 3}$$

*Indicates significance at the 0.05 level.

**Indicates significance at the 0.10 level.

Table I(b)
COMBINATION

	1978–1982		1983–1987		
Commodity	**Beta**	**Gamma**	**Beta**	**Gamma**	***F* (Chow)[1]**
Corn	.98991 (3.429)**	0.5002	.38828 (0.889)	0.5734	0.669
Wheat	.23245 (0.660)	0.5781	−.30151 (−0.729)	−0.8101	0.005
Soybeans	.85358 (2.642)**	0.7967	.18827 (0.451)	0.7409	0.218
Soy Oil	.71552 (2.074)**	0.0186	.65424 (1.114)	0.8509	1.113
Soy Meal	.76469 (2.146)**	0.9262	−.07081 (−0.165)	0.0160	0.059
Gold	.00400 (0.008)	3.9665	−.53648 (−1.565)	−0.2514	−0.677
Silver	.84496 (0.996)	9.5308	−.03249 (−0.051)	2.7887	−0.681
Copper	.31778 (0.686)	4.8894	−.11806 (−0.390)	−0.1500	−0.689
Pork Bellies	.19877 (0.233)	0.4038	.49897 (0.824)	0.2825	−0.631
Cattle	.81246 (2.410)**	1.2756	−.13314 (−0.376)	−1.0026	−0.196
Coffee	−.89641 (−1.562)	−4.3057	−.05539 (−0.091)	3.3301	−0.185
Cotton	.34546 (1.235)	0.2984	−.46067 (−0.621)	0.1762	4.127**

Orange Juice	.33191	−0.6147	.80340	0.7487	−0.671
	(0.595)		(2.139)**		
Sugar	−.61021	0.1970	−.73954	−0.5205	1.049
	(−0.789)		(−0.571)		
T-Bills	−.13528	0.0875	−.02213	−0.3336	−0.961
	(−1.657)*		(−0.619)		
T-Bonds	−.59344	−0.6132	−.34333	0.8099	−0.087
	(−2.580)**		(−1.333)		
Deutsche Marks	.04850	0.9983	−.33070	−0.4510	−0.094
	(0.234)		(−1.421)		
Swiss Francs	−.14527	1.0221	−.37056	−0.7833	−0.405
	(−0.545)		(−1.538)		
British Pounds	.02314	1.2243	−.22336	0.0090	0.314
	(0.132)		(−0.952)		
Canadian Dollars	−.01668	0.5961	−.06217	−0.3151	−0.463
	(−0.197)		(−0.857)		

[1]The Chow test tests the stability of regression parameters:

$$\frac{(SSE)_{78-87} - (SSE)_{83-87}/obs_{83-87}}{(SSE)_{83-87}/(obs_{78-87}) - 3}$$

*Indicates significance at the 0.05 level.

**Indicates significance at the 0.10 level.

Table I(c)
AGRICULTURAL

	1978–1982		1983—1987			S&P500 - Agric Market Proxy Change in Regression		
Commodity	**Beta**	**Gamma**	**Beta**	**Gamma**	**se**	R^2	F	F Chow[1]
Corn	.30715 (1.509)	1.9454	−.12530 (−0.426)	−0.1104	0	−0.001	−0.02	0.457
Wheat	.26138 (1.141)	2.1205	−.12748 (−0.459)	−4.1768	0	0.001	0.02	0.026
Soybeans	.46909 (2.177)**	3.1367	−.14436 (−0.517)	1.0098	0	0	−0.02	0.175
Soy Oil	.48242 (2.139)**	3.5509	−.18904 (−0.477)	−0.0149	0	−0.001	−0.05	1.16
Soy Meal	.46186 (1.966)**	3.0989	−.35730 (−1.260)	1.7129	0	0.001	0.01	0.018
Gold	.89436 (2.825)**	−0.5643	−.18640 (−0.800)	−0.1844	0	0.001	0.1	−0.621
Silver	1.9591 (3.410)**	−1.8535	.00420 (0.010)	1.4833	0	0	0	−0.622
Copper	.94520 (3.394)**	1.6373	.14369 (0.712)	1.1338	−0.01	−0.001	−0.03	−0.633
Pork Bellies	.69815 (1.268)	3.5200	.08830 (0.217)	7.8524	0	0	0.02	−0.617
Cattle	.27930 (1.221)	1.6483	.24307 (1.034)	1.1175	0	0	−0.04	−0.262
Coffee	−.19777 (−0.490)	−0.9352	−.9519 (−0.235)	−0.5808	0	0	0.01	−0.216

Cotton	.20129	1.3758	.49872	−5.1335	0	−0.002	−0.06	4.042**
	(1.095)		(1.010)					
Orange Juice	−.19079	0.9532	−.16700	1.7415	0	−0.002	−0.13	−0.646
	(−0.521)		(−0.641)					
Sugar	.37780	1.0276	.61674	2.7747	0	−0.001	−0.03	1.041
	(0.745)		(0.712)					
T-Bills	.05051	0.1456	−.01430	0.3248	0	0	0.03	−0.864
	(0.929)		(−0.597)					
T-Bonds	.21364	−0.2043	.17159	1.7343	0	−0.002	−0.11	−0.143
	(1.363)		(0.989)					
Deutsche Marks	.15540	0.3686	−.08589	−0.4191	0	0.001	0.05	−0.035
	(1.155)		(−0.543)					
Swiss Francs	.17029	0.4964	−.03062	−0.5653	0	0.001	0.01	−0.376
	(0.979)		(−0.186)					
British Pounds	.23649	0.4545	.00717	0.4401	0	0	−0.01	0.441
	(2.146)**		(0.045)					
Canadian Dollars	.17380	0.0671	.07589	0.1575	0	−0.002	−0.13	−0.374
	(3.442)**		(1.588)					

[1]The Chow test tests the stability of regression parameters:

$$\frac{(SSE)_{78-87} - (SSE)_{83-87}/obs_{83-87}}{(SSE)_{83-87}/(obs_{78-87}) - 3}$$

*Indicates significance at the 0.05 level.

**Indicates significance at the 0.10 level.

Table II
REGRESSION RESULTS FOR BETA AND GAMMA[1]

b_0	b_1	b_2	Avg R^2	
S&P500 as Market Portfolio				
0.017859		−0.003750	.095	
(4.045)**		(2.212)**		
0.018306	−0.00644		.070	Eq.(1)
(3.769)**	(−0.585)			
0.028456	−0.02290	0.001708	.024	Eq.(2)
(5.185)**	(−1.325)	(0.529)		
(Avg. F (1) vs. (2): 0.9042; 6 out of 60 regressions significant)				
0.023737	0.022109	−0.005530	.120	Last 2 years
(2.757)**	(0.897)	(−1.536)		
		S&P500/WPI		
0.021790		0.000822	.043	
(4.756)**		(0.365)		
0.020407	0.005022		.070	Eq.(1)
(3.786)**	(0.429)			
0.024484	0.00743	0.009622	.098	Eq.(2)
(4.476)**	(−0.415)	(1.123)		
(Avg..F (1) vs. (2): 0.7771; 4 out of 60 regressions significant)				
0.016392	0.01585	−0.003480	.136	Last 2 years
(3.173)**	(0.625)	(−0.948)		
		WPI		
−0.00974		0.004544	.038	
(−0.132)		(0.132)		
−0.00393	0.002767		.029	Eq.(1)
(−0.131)	(0.019)			
0.002897	0.007389	−0.00379	.050	Eq.(2)
(0.562)	(0.906)	(−1.035)		
(Avg. F (1) vs. (2); 0.5615; 1 out of 60 regressions significant)				
−0.01483	−0.00667	0.006593	.069	Last 2 years
(−1.846)*	(0.593)	(1.449)		

**Indicates significance at the 0.05 level.
*Indicates significance at the 0.10 level.
[1]Regression equation: $r_i = b_0 + b_1\beta_i + b_2\gamma_i + u_i$
β = systematic risk
γ = systematic co-skewness for the ith futures contract.
b_0, b_1, and b_2 are averages of 60 regression coefficients.

Test of $b_1 + b_2 = E(r_m)$:	Number of t statistics significant at the 5% level:
S&P500	49 out of 60
S&P500/WPI	51 out of 60
WPI	49 out of 60

moment asset pricing model does not explain the returns generating process of futures contracts in a significant fashion. No systematic risk premium in futures returns is found.

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