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A REAPPRAISAL OF THE FORECASTING PERFORMANCE OF CORN AND SOYBEAN NEW CROP FUTURES

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This analysis evaluates the forecasting ability of the December corn futures contract and November soybean futures contracts during the previous spring. A regression equation is estimated which accounts for the well-known non-stationarity of commodity prices over the period 1952-1995. Results of this regression imply that the spring-time quotes of the corn and soybean harvest futures contracts are unbiased estimates of the prices at harvest. In addition, since 1974 the spring-time quotes are able to significantly predict the harvest-time quotes. This finding implies that farmers and others can use harvest futures at planting as a source of information concerning prices at harvest. Furthermore, in accordance with Stein, because the futures contracts are unbiased forecasts of realized prices, then the corn and soybean futures markets are functioning well in the sense that only unavoidable social loss exits. Magnitude of the unavoidable loss is measured by R^2. R^2 increased for corn but decreased for soybeans between 1952-72 and 1974-95. These findings suggest that unavoidable social loss has decreased in the corn market, but has increased in the soybean market. Last, since 1973, the spring quotes of the corn and soybean harvest futures are significantly less variable from year-to-year than the eventual harvest prices. This finding suggests that hedging expected corn and soybean production at planting can significantly reduce year-to-year variability in price received at harvest.

Introduction

In the U.S., substantial evidence exists that agricultural producers use futures prices in forming price expectations and production plans (e.g., Gardner, 1976; Hurt and Garcia, 1982; Chavas, Pope, and Kao, 1983; Eales, Engel, Hauser, and Thompson, 1990). Consequently, the accuracy of price discovery in agricultural futures markets has important social welfare consequences (Stein, 1981). Recent trade agreements, such as the *North American Free Trade Agreement* and the *General Agreement on Tariffs and Trade*, as well as the recently enacted revision of farm support programs, *Federal Agricultural Improvement and Reform Act of 1996*, imply that agricultural producers will operate in a more market-driven environment in the future. Thus, the pricing accuracy of futures markets will become an even more important consideration in the future.

The forecasting performance of the corn and soybean new crop futures contracts has been the subject of several studies over the last 35 years. In a classic article, Tomek and Gray (1970)

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regressed the December corn (November soybean) futures price at harvest on the price of the contract during the previous spring. Using data from the period 1952-1968, they concluded that the spring quote of the December corn and November soybean contract was an unbiased forecast of the subsequent price on the contract's expiration date. They also found a high R^2, indicating that the degree to which the spring-time quote could predict the subsequent harvest price was high. Heifner (1971), Kofi (1973), and others offered comments and extensions on this work.

More recently, Kenyon, Jones, and McGuirk (1993) updated Tomek and Gray's work through 1991. They confirmed Tomek and Gray's finding for the period 1952-68. However, for the period 1974-91, they found that neither the corn nor soybean regression equation was statistically significant at the five percent level. They concluded that the spring-time price of the December corn and November soybean futures contracts are no longer good forecasts of the harvest price.

Compared with the conclusion of Tomek and Gray, the conclusion of Kenyon, *et al.* has significantly different implications for social welfare, hedging effectiveness, and the need for producers to engage in information-search activities. Given the importance of these implications, this article reexamines the forecasting performance of the December corn and November soybeans futures contracts since 1952. In particular, we evaluate the impact of stationarity on the results. We find that correcting for this well-known time-series property of commodity prices yields empirical results which disagree with those generated by both Tomek and Gray, and Kenyon, *et al.* However, the implications of our findings more closely align with those of Tomek and Gray than Kenyon, *et al.*

Econometric Issues

Previous studies have investigated the forecasting performance of harvest futures prices during the previous spring by using the following specification:

$$(1) \qquad S_{t,h} = \alpha + \beta F_{t,s} + \epsilon_t$$

where $S_{t,h}$ is the price of the first futures after harvest during its expiration month in year t and $F_{t,s}$ is the price of this harvest futures contract some time before the expiration month, usually at planting. Use of the futures contract during the delivery month as the cash price allows the analysis to ignore basis risk.

Previous studies have used slightly different assumptions regarding the dates of the spring-time and harvest prices. For example, Tomek and Gray used the settlement price on April 30th as the spring quote of the November soybean futures contract and the settlement price of the November soybean contract on its last trading day as the harvest quote. In contrast, Kenyon, *et al.* used the settlement price of the November soybean contract on April 15th as the spring quote and the settlement price on the 15th of the contract delivery month as the harvest quote. Comparative results suggest that findings are not sensitive to these alternative dating assumptions.

Hypothesis tests are derived from equation 1 in a straightforward manner. If $\alpha=0$ and $\beta=1$, then $E(S_{t,h}) = F_{t,s}$. This leads to hypothesis tests for bias in the spring forecast of the subsequent harvest price. Explanatory power of the spring forecast can be evaluated by testing the equation's R^2 for significance.

Previous studies have not considered the potential importance of non-stationarity. There is a large body of work that indicates that commodity futures prices are non-stationary in levels, but stationary after appropriate differencing (e.g., Ardeni, 1989). Non-stationarity has two important implications. First, variance-covariance estimates will be biased, which implies that hypothesis tests will be misleading. Second, sample R^2 estimates will be inconsistent. McGuirk and Driscoll (1995) provide evidence of the degree to which R^2 can be misleading when the dependent variable is non-stationary.

Beck (1994) notes that several approaches are available for addressing non-stationarity in forecasting tests. One approach is to take first-differences of the variables and re-estimate the forecasting regressions (e.g. Ma, 1989). A second approach is to estimate an error correction model that takes into account the co-integrating relationship between the dependent and independent variable. A third approach is to regress cash price changes on the futures-cash basis (e.g. Fama and French, 1987). Beck finds that the first approach yields unreliable results, while the latter two approaches generally yield similar results.

Cointegration is the theoretically preferred approach to address stationarity problems; however, cointegration is valid only asymptotically. Not only is our sample size small to begin with (1952-95), but, similar to Kenyon, *et al.*, we find that the variance of the regression forecast error is statistically different between the first half of the analysis period (1952-72) and the last half of the analysis period (1974-95). This finding invalidates the OLS assumption of constant variance, and implies that the analysis period needs to be divided into these two subperiods. These two periods essentially reflect the importance of events in the early 1970s, including relatively high general inflation, a sharp reduction in government stocks of farm commodities, and changes in farm policy which increased the importance of direct income payments in lieu of minimum price supports.

Given the limitation imposed by our sample size and the findings of Beck, we choose to estimate the regression using the specification suggested by Fama and French:

$$(2) \quad \ln S_{t,h} - \ln S_{t,s} = \alpha + \beta[\ln F_{t,s} - \ln S_{t,s}] + \epsilon_t$$

where $S_{t,h}$ is the cash price at harvest in year t [closing December corn (November soybean) futures price on December 1 (November 1)], $S_{t,s}$ is the cash price in the spring [closing May futures price on May 1], and $F_{t,s}$ is the spring quote for the harvest futures price [closing December corn (November soybean) futures price on May 1], and ln is the natural logrithim. The use of natural logrithims allows the price changes to be interpreted as continuously compounded percentage price changes.

The dependent variable in this regression is the change in cash prices between spring and harvest. The independent variable is the predicted change in cash price between spring and harvest. Thus, the regression evaluates how much of the observed change in cash price between spring and harvest is explained by the spring-time basis of the harvest futures contract. To evaluate this performance, the regression R^2 is tested for significance. In addition, the usual joint hypothesis of $\alpha=0$ and $\beta=1$ is used to test for unbiased forecasting ability. As Barnhart and Szakmary (1991) point out, this joint test really tests for both unbiasedness of the forecast and whether a zero risk premium exists.

Descriptive Analysis

The December corn futures prices for May 1 and December 1 are presented in Figure 1. Figure 2 contains the difference between the natural log of the cash corn price on May 1 and the natural log of the cash corn price on December 1, as well as the difference between the natural log of the December futures price and natural log of the cash price on May 1. Consistent with previous analysis, a comparison of these two figures suggests that first differencing creates a stationary price series. The same conclusion emerges for soybean prices (see Figures 3 and 4).

The figures also suggest that prices have become more variable during the 1974-95 period than during the 1952-72 period. This expected result is confirmed by comparing the standard deviation of the price levels of corn and soybeans between the two periods (see Table 1). Furthermore, standard deviation of the difference between the natural log of the cash prices increased between the first and second period. In contrast, the standard deviation of the May 1 basis expressed in natural logs was essentially constant over both periods.

Mathematical properties of an expectation variable suggest that expectations will be less variable than the variable's realized values. However, it is an empirical question whether the differences will be significant. For the period 1974-95, the spring quotes of the corn and soybean harvest futures were significantly less variable from year-to-year than the eventual harvest prices. This holds for prices measured in levels as well as differences (see Table 1). The evidence for the earlier 1952-72 period is mixed in regards to statistical significance; however in all situations the standard deviation is larger at harvest than during the spring. Our findings for the 1974-95 period are consistent with Heifner's arguments that the planting-time quote for inventory as well as noninventory (e.g., potatoes) crops are more stable than harvest prices. Our findings are not consistent with Tomek and Gray's argument that for inventory commodities, such as corn and soybeans, variability of the spring-time quote of harvest prices and variability of harvest prices will be nearly equal because of the ability to adjust inventories to market events which occur between planting and harvest.

Regression Analysis

Results of the regression analysis are reported in Table 2. The level regressions serve as a check between our analysis and those of Tomek and Gray, and Kenyon, *et al.* We use two post-1974 periods (1974-91 and 1974-95) to test the sensitivity of adding four more years to Kenyon, *et al.*'s data period. The sensitivity test is desirable given the limited number of observations. Results are similar for the 1974-91 and 1974-95 periods.

Similar to Kenyon, *et al.,* we find that R^2 is substantially lower in the post-1973 period using price levels, and that R^2 is insignificant for corn and soybeans at the five percent level of significance. Neither Tomek and Gray nor Kenyon, *et al.* conduct a joint test of the regression parameters. Using a 10 percent significance level, our joint test implies that the spring quote of the November soybean contract is a biased estimator of the harvest price of the contract for all three sample periods. In contrast, the spring quote of the December corn futures contract is an unbiased estimator of the harvest price of the contract for all three sample periods.

Given space constraints, we do not present the results for 1952-68. For both corn and soybeans, the joint parameter test is insignificant at the 10 percent level. This finding implies that the spring-time quote of the harvest futures is an unbiased estimate of the harvest quote of the futures contract. This conclusion agrees with Tomek and Gray.

For the difference regressions, the joint test of the regression parameters indicate that the spring-time quotes of the corn and soybeans harvest futures are unbiased estimators of the eventual harvest price. This holds for all three sample periods. In addition, R^2 of the regression equation is significantly different from zero for five of the six periods analyzed. The only exception is for corn over the 1952-72 period. In addition, R^2 of the corn equation is higher during the post 1973 periods while the R^2 of the soybean equation is lower during the post 1973 periods.

Conclusions and Implications

This analysis evaluates the forecasting ability of the December corn futures contract and November soybean futures contracts during the previous spring. A regression equation is estimated which accounts for the well-known non-stationarity of commodity prices over the period 1952-1995. Results of this regression are consistent with a conclusion that the spring-time quotes of the harvest futures are unbiased estimates of prices at harvest. In addition, since 1974 the spring-time price quotes are able to significantly predict the harvest-time prices. This finding implies that farmers and others can use the December corn futures contract and November soybean futures contract at planting as a source of information concerning harvest cash prices.

Stein divides forecast error into avoidable and unavoidable social loss. If forward prices are unbiased forecasts of realized prices, then only unavoidable social loss exits. Our finding of unbiased forecasts of harvest prices during the previous spring suggests that the corn and soybean futures markets are functioning well in the sense that only unavoidable social loss exists.

The magnitude of unavoidable social loss is measured by R^2. R^2 increased for corn but decreased for soybeans between 1952-72 and 1974-95. These findings suggest that unavoidable social loss decreased in the corn market, but increased in the soybean market. This differential change in R^2 is interesting and worthy of further investigation.

Since 1973, the spring quotes of the corn and soybean harvest futures were significantly less variable from year-to-year than the eventual harvest prices. This holds for prices measured in levels as well as differences. It suggests that hedging corn and soybean production at planting can significantly reduce year-to-year variability in the price received at harvest.

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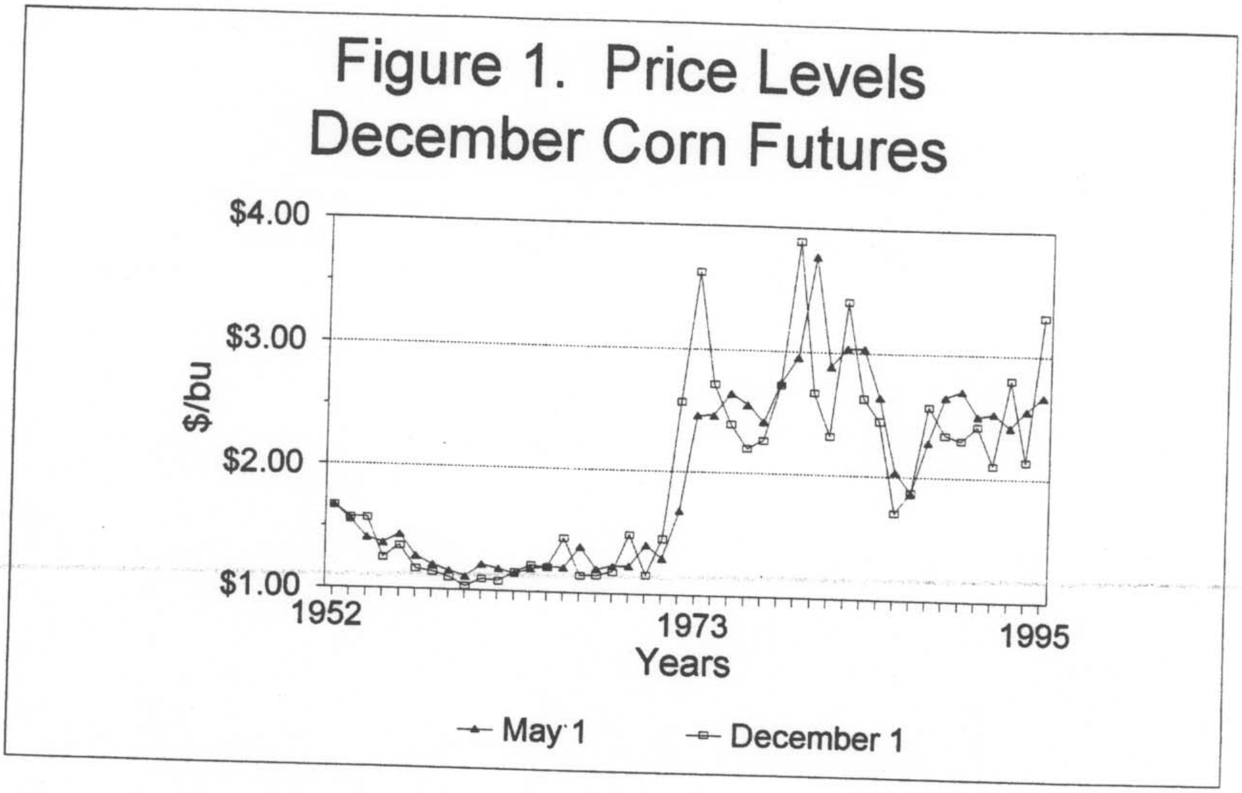

Figure 1. Price Levels
December Corn Futures
$4.00
$3.00
$2.00
$1.00
$/bu
1952
1973
1995
Years
May 1
December 1

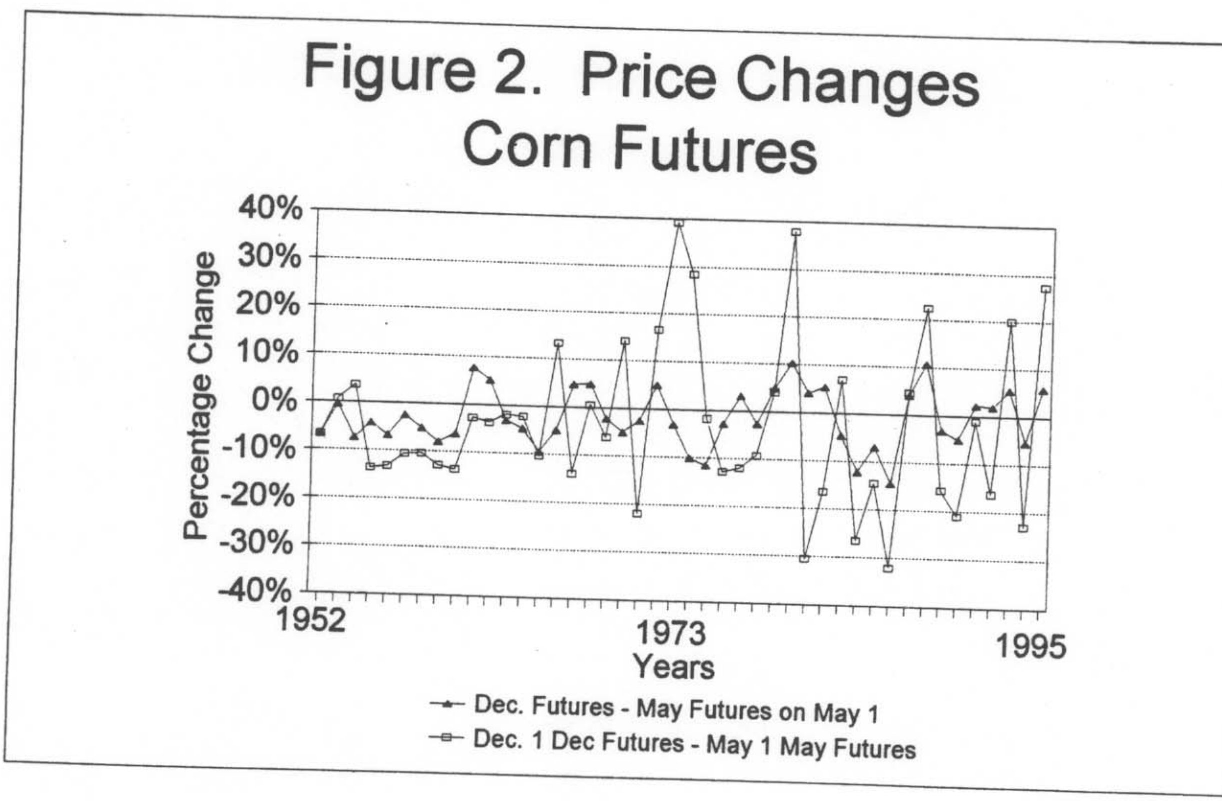

Figure 2. Price Changes
Corn Futures
40%
30%
20%
10%
0%
-10%
-20%
-30%
-40%
Percentage Change
1952
1973
1995
Years
Dec. Futures - May Futures on May 1
Dec. 1 Dec Futures - May 1 May Futures

Figure 3. Price Levels November Soybean Futures

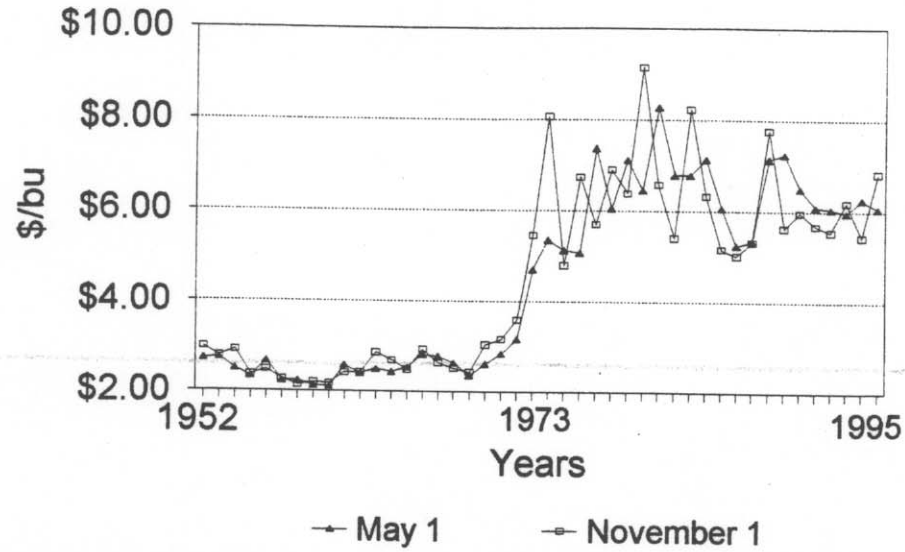

Figure 4. Price Changes Soybean Futures

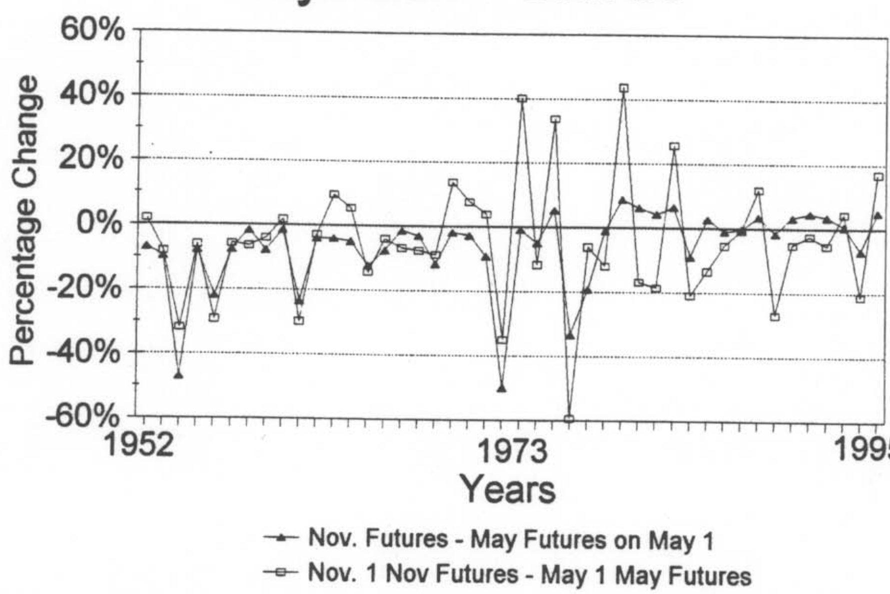

Table 1. Selected Statistics for Corn and Soybean Prices, 1952-1995

Price Variable by Time Period	Unit	Mean	Standard Deviation	F-Ratio for Variance
Corn: 1952-1972				
December Futures				
May 1	cents	128.6	14.5	
December 1	cents	126.6	19.0	1.71
Differences				
Basis On May 1	percent	-2.4	5.1	
Cash Price Change	percent	-4.4	10.2	4.04**
Corn: 1974-1995				
December Futures				
May 1	cents	262.9	38.0	
December 1	cents	258.6	54.7	2.08*
Differences				
Basis On May 1	percent	-0.9	7.3	
Cash Price Change	percent	-3.6	20.4	7.88**
Soybeans: 1952-72				
November Futures				
May 1	cents	253.3	26.2	
November 1	cents	263.7	37.1	2.01*
Differences				
Basis On May 1	percent	-9.4	10.5	
Cash Price Change	percent	-5.8	12.4	1.38
Soybeans: 1974-95				
November Futures				
May 1	cents	633.5	83.7	
November 1	cents	630.5	115.0	1.89*
Differences				
Basis On May 1	percent	-1.1	9.5	
Cash Price Change	percent	-2.2	23.9	6.29**

* indicates significance at the 10 percent level

** indicates significance at the 5 percent level

Table 2. Regression Between Harvest and Spring-time Futures Prices, December Corn and November Soybeans, 1952-95

Crop	Period	α	β	R^2	D.W.	F-test α=0,β=1	F-test R^2
			VARIABLES IN LEVELS				
Corn	1952-72	7.38 (27.32)	0.93 (0.21)	0.50	2.56	0.29	19.27**
	1974-91	102.43 (80.38)	0.59 (0.30)	0.19	1.75	1.07	3.86*
	1974-95	100.63 (75.84)	0.59 (0.29)	0.18	1.85	1.28	4.24*
Beans	1952-72	-40.55 (43.87)	1.20 (0.17)	0.72	1.57	3.48*	48.61**
	1974-91	485.35 (213.77)	0.24 (0.33)	0.03	2.38	2.65*	0.52
	1974-95	461.64 (197.48)	0.26 (0.31)	0.04	2.33	2.90*	0.72
			VARIABLES IN CHANGES				
Corn	1952-72	-3.41 (2.47)	0.44 (0.45)	0.05	2.68	1.20	0.96
	1974-91	-3.18 (4.45)	1.09 (0.59)	0.18	1.68	0.30	3.41*
	1974-95	-3.61 (3.99)	1.21 (0.55)	0.20	1.80	0.55	4.73**
Beans	1952-72	3.13 (2.22)	0.95 (0.16)	0.65	1.40	2.52	35.44**
	1974-91	-0.16 (4.92)	1.56 (0.49)	0.39	2.15	0.69	10.33**
	1974-95	-0.97 (4.25)	1.57 (0.45)	0.39	2.14	0.90	12.38**

* indicates significance at the 10 percent level
** indicates significance at the 5 percent level