Long-run Trend Analysis of Counter-cycle Program Commodity Prices in the Farm Security and Rural Development Act of 2002

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Abstract

This study provides empirical evidence on whether corn, sorghum, oat, barley, wheat, rice, soybeans, cotton, and peanuts exhibit cyclical patterns in their historical prices. The results of time-series analysis support a newly added counter-cyclical payment in the Farm Security and Rural Investment Act of 2002 for all crops except corn.

Introduction

Considerable research has been published on commodity price fluctuations (Fama and French, 1986; Cuddington, 1992; Labys and Maizels, 1993; Niccanke and Hewitt, 1993; Labys, Kouassi, and Terraza, 2000; among others). For policy purpose, reasonable estimates of short-term cyclical fluctuations of commodity prices are as important as estimates of their underlying long-term trends. A good understanding of the cyclical behavior of commodity prices is for instance, essential when considering counter-cyclical stabilization policies.

For example, U.S. House representatives in October 5, 2001 added a new "counter-cyclical payment" to the existing fixed decoupled payments and the marketing loan program to provide consistent and reliable support for farmers and their lenders. More specifically, the Farm Security and Rural Investment Act of 2002 included a counter-cyclical payment in government program crops (corn, sorghum, oat, barley, wheat, rice, soybeans, cotton, and peanuts).

It is important to notice that overwhelming amount of traditional business cycle research[1] on macroeconomic variables has provided a valid reasoning for monetary and fiscal policy implementation to reduce the amplitude of the cycle around a secular trend in macroeconomic variables. However, any formal research on cyclical behavior of prices for the U.S. government program crops has not been published to our knowledge. The current study is to examine whether the traditional government program crop prices exhibit cyclical behavior. It is an attempt to provide a valid reasoning for or against the newly added counter cyclical payments to the program crops.

Methodology and Data

To investigate any cyclical component in the commodity prices, the current research adopted time-series methods employed by Cuddington's (1992) study for primary commodity prices of less developed countries (LDCs). Most empirical tests of the secular trend of commodity prices examine the sign of the time coefficient *ß* in Trend Series (TS) models of the form:

(1) $\log y_t = a + b*\text{time} + e_t$ and

(2) $A(L)e_t = B(L)v_t$,

where log y_t is the natural logarithm of commodity prices and errors. e_t are further modeled as a mixed autoregressive moving-average (ARMA) process. $A(L)$ and $B(L)$ are lag polynomial.

For nonstationary process, Cuddington used a differences stationary (DS) model:

(3) $\text{dlog } y_t = b + u_t$ and

(4) $C(L)u_t = D(L)g_t$

where d is a difference operator, dlog y_t is simply the growth rate of commodity prices y_t, and errors, u_t is modeled as a ARMA process. $C(L)$ and $D(L)$ are lag polynomial. The first differencing (i.e., $d = 1$) is the typical case considered in agricultural commodity research. For the difference stationary model, the study employed Cuddington and Urzua (1989)'s gain function that are used to decompose nonstationary price series into trend, cyclical components,

[1] Typically, business cycle research decomposed macroeconomic variables into a deterministic secular trend, a cyclical, and an irregular component.

and permanent components. In particular, gain function shows how price shocks or innovations change the permanent component of commodity prices.

In addition, the study adopted the Beveridge-Nelson (1981) method to decompose the commodity prices into trend and cyclical components. One of good features of the Beveridge-Nelson decomposition is that graphical analysis can be easily done.

Annual price data on U.S. corn ($/bu.), sorghum ($/bu.), oats($/bu.), barley($/bu.), wheat($.bu.), rice($/cwt), soybeans ($/bu.), cotton (.1$/pound), and peanuts (.1$/pound) are obtained from various USDA publications, such as *Feed Yearbook*, ERS/USDA (2001) and *Rice: Situation and Outlook Yearbook*, ERS/USDA(2001). Sample period for U.S. corn, sorghum, oats, barley, wheat, rice, soybeans ranges from 1961 to 2000; cotton from 1970 to 2000; and peanuts from 1978 to 2000.

Empirical Results

Trend Analysis in Commodity Prices

As a formal unit root test, the Phillips-Perron procedure is used and the summary results are reported in Table 1. First, the Phillips-Perron *Z*-statistic was used in evaluating whether the variables had a unit root. The PP procedure runs two regression models:

Model 1: $y_t = \hat{b}_1 + \hat{w}_1 y_{t-1} + n_{1t}$,

Model 2: $y_t = \hat{b}_2 + \hat{t}\,(t-T/2) + \hat{w}_2 y_{t-1} + n_{2t}$,

where y_t is a time series and ($\hat{b}_1, \hat{w}_1$) and ($\hat{b}_2, \hat{t}, \hat{w}_2$) are the conventional least-square regression coefficients. The first hypothesis tested is that the variable is deterministic nonstationary in Model 2. If the series was found to be nonstationary with trend, Model 1 is then applied to test whether it is stochastic nonstationary. Critical values for t_m statistics in Model 1 and t_t statistics in Model 2 are -2.57 and 5.34, respectively. Table 1 shows that the test statistics for the corns, sorghum, oats, barley, wheat, and cotton were smaller than the critical

Table 1. Phillips-Perron Unit Root Test Results for Corn (CR), Sorghum (SR), Oats (OT), Barley (BL), Wheat (WH), Rice (RS), Soybeans (SY), Cotton (CT), and Peanut (PN)

Variables	t_m statistics	t_t statistics	Test Results
	H_0(Model 1): $\hat{w}_1=1$	H_0(Model 2): $\hat{t} = \hat{w}_2 = (0,1)$	
CR	-2.1017	2.5744	*I*(*1*)
SR	-1.9952	2.3918	*I*(*1*)
OT	-2.0139	2.7018	*I*(*1*)
BL	-1.8283	2.5376	*I*(*1*)
WT	-1.9879	2.9303	*I*(*1*)
RC	2.7791*	3.9988	*I*(*0*)
SY	-1.9639	1.8819	*I*(*1*)
CT	-3.6020*	6.2593*	*I*(*0*)/*t*
PN	-3.5703*	6.0194*	*I*(*0*)/*t*

Note: Model 1 (M1):$y_t = \hat{b}_1 + \hat{w}_1 y_{t-1} + n_{1t}$ and model 2 (M2):$y_t = \hat{b}_2 + \hat{t}\,(t-T/2) + \hat{w}_2\, y_{t-1} + n_{2t}$. *I*(*1*), *I*(*0*), and *I*(*0*)/*t* denote nonstationary, stationary, and trend stationary, respectively. Critical values for t_m statistics and t_t statistics are -2.57 and 5.34, respectively. Asterisk (*) indicates rejection of the unit root hypothesis at the 10% significance level.
Source: White (1993).

values for the unit root tests with trend (Model 2) and no trend (Model 1). It thus shows that the null hypothesis of a unit root could not be rejected for any of these variables, indicating that U.S. corns, sorghum, oats, barley, wheat, and cotton were stochastic nonstationary. For these commodities, the DS models were used to estimate *ß*.

Table 1 also shows that the hypothesis of a unit root with trend (M2) was rejected for cotton and peanuts since the test statistic was larger than the critical value. This implies that the variables were stationary around a linear trend. Thus, the TS models were estimated for empirical analysis. For rice price, the test statistic was less than the critical value for the unit root tests with trend. However, the test statistic was greater than the critical value for the unit root tests without trend. Thus, the rice price is stationary.

Estimates for regression equation (1) for the TS models are provided in the first two columns in Table 2 (with *t*-statistics in parenthesis). The time coefficients for cotton and peanuts indicate that both commodities have statistically significant positive trends. To ensure that error processes were appropriately specified, the *Q*-statistics (Ljung and Box, 1978) were computed. Smaller *Q*-statistics in Table 2 compared to $?^2$ critical values indicates that the residuals are white noise, reflecting that the AR(1) model has adequately described the error processes.

Table 2. Estimated Trend Stationary (TS) models for Cotton and Peanut: 1961-2000.

Commodity	Constant	Time	Error Process	Q(6)	R^2
Cotton (CT)	3.7098 (42.093)	0.0174 (3.6079)	$(1\text{-}0.6401L)e_t = u_t$ (-5.2411)	5.2580	0.87
Peanuts (PN)	3.1860 (77.0869)	0.0096 (3.1777)	$(1\text{-}0.3418L)e_t = u_t$ (-1.7334)	5.7270	0.99

For the six commodity prices where the unit root hypothesis could not be rejected, ARIMA models for log y_t were fitted. The results are reported in Table 3. It is important to

Table 3. Estimated Difference Stationary Models for Corn, Sorghum, Oats, Barley, Wheat, and Soybean Prices.

Commodity	Constant	Error Process	Q(6)	R^2	Gain Function
Sorghum (SR)	-0.0104 (-0.7121)	$e_t = (1\text{-}0.6521\mathrm{L})u_t$ (-5.1345)	3.211	0.48	$\mathrm{dlogy_p(t)} = -.0104 + .3480u_t$
Oats (OT)	0.0165 (0.7938)	$e_t = (1\text{-}0.3864\mathrm{L})u_t$ (-2.4675)	2.952	0.27	$\mathrm{dlogy_p(t)} = -.0165 + .6136u_t$
Corn (CR)	0.0133 (0.4312)	$e_t = u_t$	4.821	0.23	$\mathrm{dlogy_p(t)} = .0133 + u_t$
Barley (BL)	0.0217 (0.8235)	$(1\text{-}.3332\mathrm{L}+.3691\mathrm{L}^2)e_t = u_t$ (-2.0894) (2.3186)	5.107	0.18	$\mathrm{dlogy_p(t)} = .0217 + .0367u_t$
Wheat (WH)	0.0102 (0.4027)	$(1+0.3480\mathrm{L}^2)e_t = u_t$ (2.2073)	3.136	0.26	$\mathrm{dlogy_p(t)} = .0102 + .3480u_t$
Soybeans (SB)	-0.0167 (0.4027)	$e_t = (1\text{-}0.5541\mathrm{L})u_t$ (2.2073)	7.2580	0.21	$\mathrm{dlogy_p(t)} = -.0167 + .4459u_t$

notice that estimated constant terms in Table 3 represent estimated stochastic time trends under the DS specification. Notice that the estimates for time trend are insignificantly different from zero in all cases.

Cyclical Movements in the Commodity Prices

Similar to the estimation of long-term trends, the estimation of cyclical components in commodity prices crucially depends on whether the TS or DS model is most appropriate. The traditional business cycle research relies on the TS model and defines the cyclical component of log y_t as the deviation between log y_t and the long term trend line. Cuddington (1992) indicates that since the error process e_t in the TS model is stationary, price shocks (or innovations) of u_t have no persistent effect. Therefore, effects of innovations on commodity prices are entirely cyclical. For example, cotton price in Table 2 follows a simple AR(1) process around a time trend of 1.74% per year. Cyclical fluctuations can be quite persistent in Figure 1. On the other hand, peanut price follows a time trend of 0.96% per year. Cyclical fluctuations are not persistent.

For the six commodities that follow nonstationary processes, the study takes the first differencing to the variables and then estimates the best fitted ARMA models for the variables. In addition, the study estimates gain functions for each of the commodities (see Cuddington and Urzua, 1989 for algebraic derivation), which allow one to see how price shocks of u_t change the permanent component of stochastic trend. The gain functions in Table 3 are obtained by setting the lag operator L in the estimated DS model equal 1. All gain functions reported in Table 3 were computed using the point estimate for the commodity price's stock trend. For instance, all estimates for constant in the first column in Table 3 are identical values in the first terms in gain functions in the last column.

For exposition purpose, consider sorghum in the first row of Table 3. The constant term in the DS model indicates a point estimate of the trend in sorghum prices equal to -0.0104. As indicated by Cuddington (1992), the coefficient on u_t in the gain function helps determine whether a shock should be viewed as permanent or cyclical. For sorghum, 34.8% of the typical price shock [i.e., u_t] is permanent; the remaining 65.21% is cyclical. Without additional price shock, there would be no further shifts in the trend path of sorghum prices. Eventually, actual prices would reach to the new trend path. In addition, the second column of Table 3 indicates that price shocks are disappeared in one year [i.e., MA(1) process].

More specifically, a price shock of u_t unit shifts the trend line up by 0.348 u_t and leaves log y_t above its trend by (1-0.348)u_t in the current period t. In the following period $t+1$, both the actual price and the permanent component decreases at the rate $ß$ = 0.0104 and at the same time, e_{t+1} changes by the amount $ß - 0.6521u_t$, as reflected by the one-period lag [i.e., the MA(1) term] of the error processes. In other words, cyclical effects last for one period. To illustrate cyclical effect of price shock, the Beveridge-Nelson decomposition of sorghum is included in Figure 2. The bottom panel shows strong cyclical fluctuation.

In case of Oats, the current actual price and the permanent component grow at the rate of 1.65%. The price shock of u_t shifts the trend line up by 0.6136u_t, leaves log y_t above its trend by (1-0.3864)u_t in the current period t. In the following period $t+1$, both the actual price and the permanent component growth changes by the amount $ß - 0.3864u_t$, as reflected by the one-period lag (i.e., the MA(1) term) of the error processes. Again, this returns log y_t to its new stochastic trend path. Similar to sorghum, cyclical effects of price shock on oats last for only one period.

For corn, the estimate of stochastic trend indicates that the current corn prices grow at the rate of about 1.33%. The typical price shocks of u_t are entirely permanent and there are no cyclical fluctuations. However, in case of Barley, only 3.7% of the typical price shock is permanent; the remaining 96.3% is cyclical. For wheat and soybeans, more than 50 % of price shock is cyclical.

Summary and Concluding Remark

The empirical validity of newly added counter-cyclical payments in the Farm Security and Rural Investment Act of 2002 has been examined by considering nine government program crops. Based on unit root test result, two-step procedures are applied for stationary variables, cotton and peanuts. Both commodities are suggested to have a statistically significant positive trend. Price series exhibits cyclical component.

For six non-stationary variables, Nelson-Plossor and Cuddington methods were used to decompose the commodity price series into trend and cyclical components. Although the degree of permanence of price shocks and the pattern of cyclical movements varies greatly across commodities, they have cyclical components ranging from 38.64% to 96.33%. One exception is corn which does exhibit no cyclical component. To sum up, our findings support an inclusion of the new counter-cyclical payment into the 2002 Farm Bill.

Lastly, one remark is, as suggested by Cuddington, that because the current methodology depends on univariate technique, it provides only statistical descriptions of the behavior of commodity prices. It is not easy to answer to the question of what causes the underlying trends and cyclical movements. To draw additional conclusion on these issues, one can employ structural time series model, such as structural vector autregressive model (SVAR) to simultaneously capture market fundamentals and government policy shocks which are considered to be determinant factors for the program crop prices.

References

Cuddington, John T. "Long-run Trends in 26 Primary Commodity Prices: A Disaggregated Look at the Prebisch-Singer Hypothesis." *Journal of Development Economics* 39(1992): 207-227.

Cuddington, John T. and C.M. Urzua. "Trends and Cycles in the Net Barter Terms of Trade: A New Approach." *Economic Journal* 99(1989): 426-442.

Fama, Eugene F. and Kenneth R. French. *Business Cycles and the Behavior of Metals Prices*. University of California at Los Angeles Anderson Graduate School of Management Finance Working Paper: 31-86.

Labys, Walter C. and Alfred Maizels. "Commodity Price Fluctuations and Macroeconomic Adjustments in the Developed Economies." *Journal of Policy Modeling* 15(1993): 335-52.

Labys, Walter C., Eugene Kouassi, and Michel Terraza. "Short-Term Cycles in Primary Commodity Prices." *Developing Economics* 38(2000): 330-42.

Ljung, G. and George Box. "On a Measure of Lack of Fit in Time Series Models." *Biometrica* 65(1978): 297-303.

Nelson, C.R. and C.I. Plosser. "Trends and Random Walks in Macroeconomic Time Series: Some Evidence and Implications ." *Journal of Monetary Economics* 10(1982): 139-62.

Nissanke, Machiko and Adrian Hewitt. *Economic Crisis in Developing Countries: New Perspectives on Commodities, Trade, and Finance*. London:St. Martin's Press, 1993.

Phillips, Peter and Pierre Perron. "Testing for a Unit Root in Time Series Regression." *Biometrica* 75(1988): 335-46.

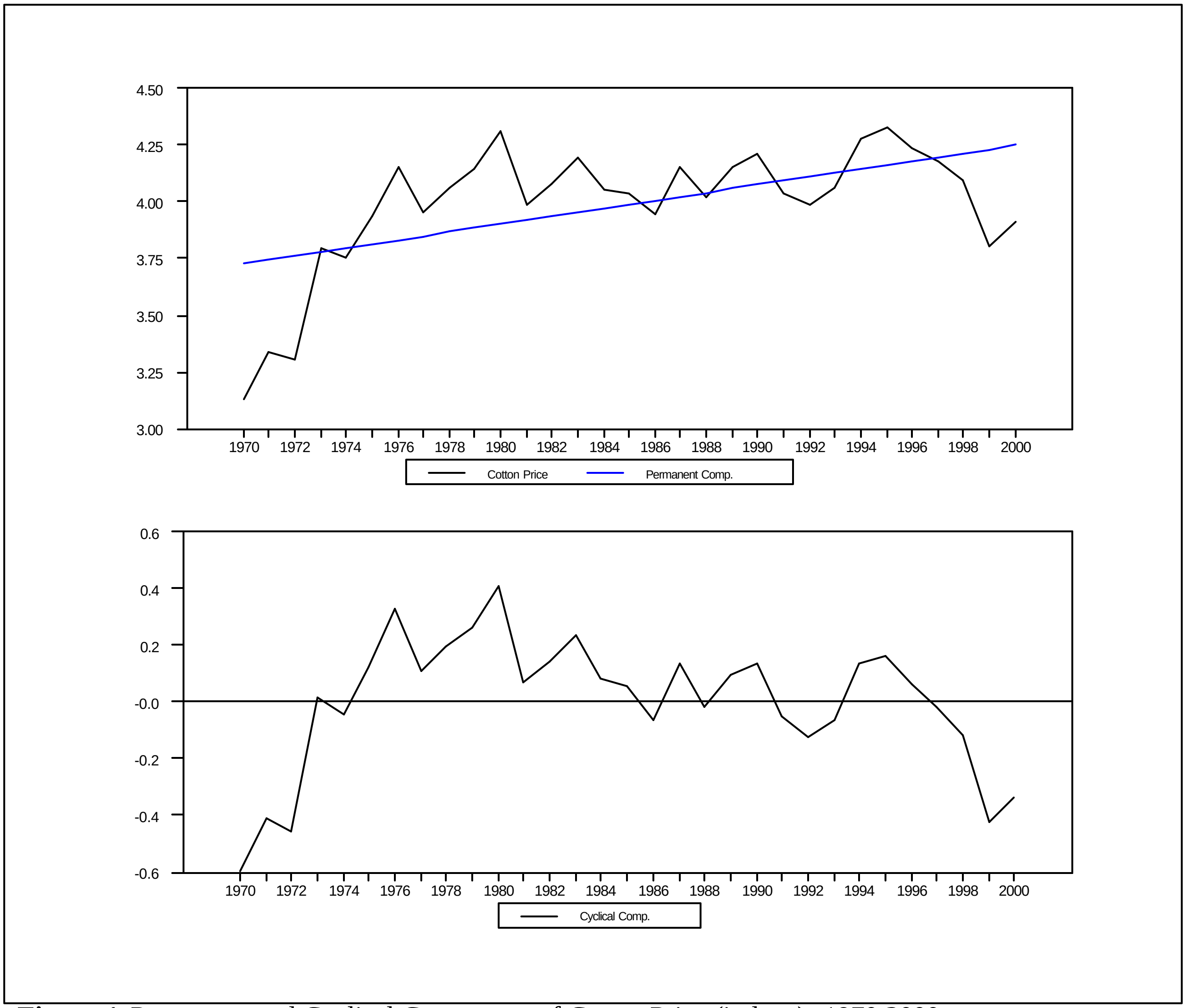

Figure 1. Permanent and Cyclical Component of Cotton Price (in logs): 1970-2000.

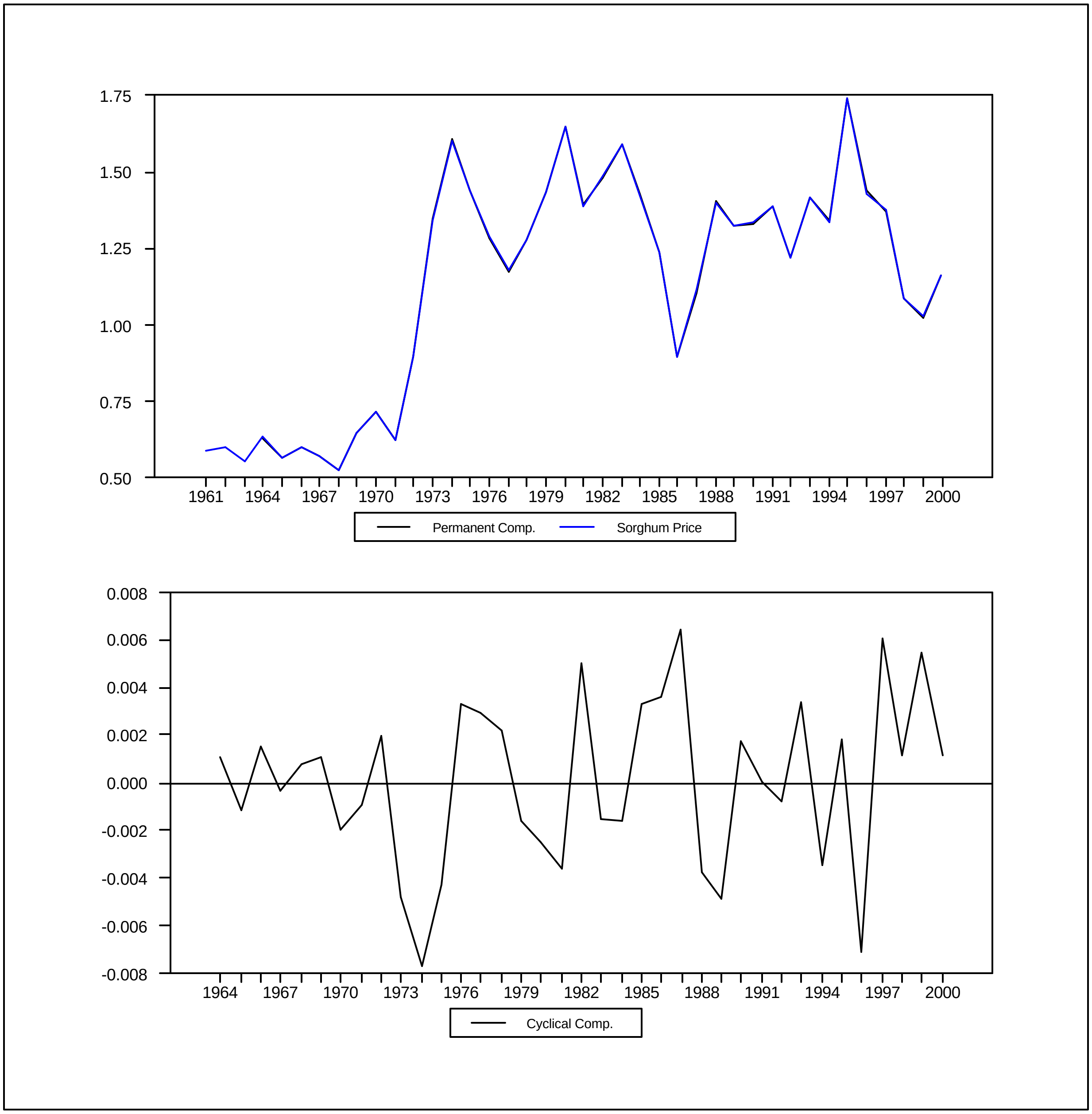

Figure 2. Nelson-Plossor Decomposition of Permanent and Cyclical Component of Sorghum Price (in logs): 1961-2000.