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THE EMPIRICAL INVESTIGATION OF THE EFFECTS OF MONETARY SHOCKS ON AGRICULTURAL PRICES: USING KOREAN DATA

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I. Introduction

Since it has been theoretically shown that monetary shocks may have different effects on sectoral prices,[1] many studies have empirically investigated the effect of monetary shocks on agricultural prices relative to industrial prices(see Barnett, Bessler and Thompson(1983), Chambers(1984), Bessler(1984), Orden(1986), and Saunders and Bailey(1986) Devadoss and Meyers(1987), and Han, Jansen and Penson(1990)).

Except for Han, et al., all the studies mentioned above have estimated the dynamic effects of monetary shocks on relative agricultural prices using the vector autoregression(VAR) models. However, Han, et al. have investigated the interrelationship among the variances of agricultural prices, industrial prices, and money using the multivariate ARCH model in the VAR specification.

To investigate the dynamic responses of economic variables to structural disturbances, the VAR needs to identify orthogonal structural disturbances from the reduced form disturbances (Which are disturbances in the estimated VAR). But, because the VAR uses an arbitrary orthogonal decomposition, Cholesky decomposition, to identify structural disturbances, the interpretations about the effects of structural disturbances on economic variables cannot be justified.

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[1] For details, see Bordo(1980), Frankel and Hardouvelis (1985), and Frankel(1986).

Because a Cholesky decomposition uses a lower triangular matrix to identify structural disturbances, it is equivalent to including current variable 1 to (i-1) in the regression of the ith variable. Obviously, there is no economic rationale behind this decomposition.

But, when an orthogonal decomposition of the covariance matrix in the VAR is done within an economically structural context, it is possible to analyze the dynamic effects of structural disturbances within that context using impulse response functions, forecast error variance decomposition, and historical decomposition. This approach is called structural VAR methodology.[2]

The main goal of this paper is to study the dynamic effects of monetary disturbances on agricultural prices and industrial prices in Korea using a structural VAR method. To be specific, this study examines whether agricultural prices are more responsive to monetary shocks than industrial prices. In addition, we also investigate the relative contributions of structural disturbances to the fluctuations of agricultural prices and industrial prices.

Based on the simple price setting equations for agricultural products and industrial products,[3] it is assumed in this paper that the movement of agricultural prices is influenced by four independent disturbances: agricultural price disturbance (ε^{pa}), industrial price disturbance (ε^{pi}), money disturbance (ε^{m}), and output disturbance (ε^{y}). Agricultural price and industrial price disturbances are shocks to price setting equations for agricultural and industrial commodities, respectively. Money disturbances to the money supply rule, and output disturbances are considered shocks to the real GNP process.

To identify the dynamic effects of structural disturbances on agricultural prices and industrial prices, we examine a multivariate system that includes agricultural price, industrial prices, money and real GNP. Technically, we use not only long-run identification restrictions but also contemporaneous identification restrictions so that disturbances identified are interpreted as structural disturbances.

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2 Recently, many studies have been done using a structural VAR approach. Among them, see Blanchard and Watson(1986), Shapiro and Watson(1988), Blanchard and Quah(1989), Blanchard(1989), King, Plosser, Stock and Wstson(1991), and Gali(1992).

3 Here, a commodity price is assumed to be affected by prices of relevant commodities, money supply, and real GNP.

The paper is organized as follows. Section II presents the results of the preliminary data analysis. Section III discusses the model specification, including the identification restrictions and the relationship between the structural and reduced forms. Section IV presents and discusses empirical results. Finally, section V is a brief summary and conclusion.

II. Preliminary Data Analysis

Quarterly data on the agricultural product price index, the industrial product price index, the money supply, and the industrial production index[4] for the period 1972:1 to 1993:1 are used for the analysis. The price index data are measured at the wholesale level. All variables are transformed into natural logs before estimation. *pa* is the logarithm of the agricultural price index, *pi* is the logarithm of the industrial price index, *pi* is the logarithm of *M*1, and *y* is the logarithm of the industrial price index. All data are collected from the various issues of *Economic Statistics Yearbook.*

As a preliminary step, all variables are tested for *nonstationarity*. The augmented Dickey-Fuller test is done by running regression:[5]

$$\Delta x_t = \alpha_0 + \alpha_1 t + \beta x_{t-1} + \gamma \Delta x_{t-1} + \theta_t \tag{1}$$

The null hypothesis of a unit root in x_t is inconsistent with a large negative estimate of β. Table 1 shows the results of the augmented Dickey-Fuller regression. The results are consistent with the hypothesis that *pa, pi, m* and *y* are first-difference stationary, i.e., I (1) processes.

Then, from the *cointegration* theory, it is possible that *pa, pi, m* and *y* are cointegrated. Engle and Granger(1987) show that when they are cointegrated, the vector autoregressive representation of those variable cannot be used to analyze dynamic effects. But using the error correction model(ECM), it is possible to have the vector

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[4] The industrial production index is used for a proxy for real GNP.

[5] Augmented Dickey-Fuller tests with different lags do not change results.

TABLE 1 Unit Root and Cointegration Tests

A. Unit Root Tests

	$t(\hat{\beta})$
pa_t	-1.14
pi_t	-0.63
m_t	-2.32
y_t	-2.38
Δpa_t	-15.12
Δpi_t	-14.27
Δm_t	-13.56
Δy_t	-13.41

B. Cointegration Test

J(0)	5% Critical Value
43.4	48.4

Note: The augmented Dickey-Fuller regression equation is $\Delta x_t = \alpha + \beta\, x_{t-1} + \gamma \Delta x_{t-1} + \theta_t$. The 5 and 10 percent critical values for 100 observations are -2.89 and -2.58, respectively (Fuller (1976), Table 8.5.2, p. 373). J(0) is the statistic of Johansen's test of the null of 4 unit roots against at most 3 unit roots, the 5% critical value is computed by Johansen and Juselius (1990).

autoregressive presentation among some variables in the difference form and a linear combination of cointegrating variables. However, when there are N first-difference stationary processes, there may exist r cointegrating vectors between variables with $r = N$-1. Therefore, the test of cointegration is done using the procedure developed by Johansen(1988). The null hypothesis in the test is that all variables are $I(1)$ processes but not cointegrated, so that there are four unit roots in the companion matrix. We test the null against the alternative hypothesis of at most three unit roots. The result in Table 1 shows no evidence of cointegration between variables.[6]

[6] Han et al. also checked the cointegration of the farm product price index, the industrial price index, and the money supply using U.S. data. Using the cointegration test suggested by Engle and Yoo (1987), they found no evidence of cointegration.

III. Empirical Methodology

Because the first differences of pa_t, pi_t, m_t and y_t are covariance stationary and not cointegrated, a vector, Δx_t (= $[\Delta pa_t, \Delta pi_t, \Delta m_t, \Delta y_t]'$) follows a covariance stationary process such as

$$\Delta x_t = A(L)\varepsilon_t \tag{2}$$

where $A(L)$ is a matrix of lag polynomials,[7] Δ denotes the first difference operator, and ε_t is the vector of structural disturbances, $[\varepsilon_t^{pa}, \varepsilon_t^{pi}, \varepsilon_t^{m}, \varepsilon_t^{y}]'$. It is assumed that structural disturbances are serially and mutually uncorrelated and their covariance matrix is the identity. This vector moving average representation is called a structural vector moving average representation.

Because Δx_t is covariance stationary, it also has an unique moving average representation by the Wold theorem.[8] Compared to the structural vector moving average representation, this vector moving average representation is called the reduced form vector moving average representation.

$$\Delta x_t = B(L)\,\eta_t \tag{3}$$

where $\mathrm{Cov}(\eta_t) = \sum$, $E(\eta_t \eta'_s) = 0 \;\; \forall t \neq s$, and $B_0 = I$.[9] η_t is called the reduced form disturbance, and formally defined by $\eta_t = x_t - E[x_t \mid x_{t-j}, j > 0]$.

To know the dynamic effects of structural disturbances, especially monetary disturbances, on the agricultural price and industrial price processes, it is needed to identify structural disturbances from reduced form disturbances, i.e., it is needed to identify a transformation matrix, S, such that

$$S\,\varepsilon_t = \eta_t \tag{4}$$

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7 $A(L) = A_0 I + A_1 L + A_2 L^2 + \ldots$

8 Here Δx_t is assumed to be purely indeterministic. For details of the Wold theorem, see Sargent (1987).

9 $B(L) = I + B_1 L + B_2 L^2 + \ldots$

where $SS' = \sum$[10]

From $SS' = \sum$, ten restrictions on the matrix, S, are obtained. To identity S, we need to impose several restrictions on the structural moving average representation of x_t . In this paper, identification is achieved through the following restrictions.

First, based on the common assumption in the empirical macro papers that the demand shocks do not have the permanent effects on real output, it is assumed that agricultural price, industrial price and money shocks do not have permanent effects on real output. This assumption does not rule out any possible permanent effects of agricultural price, industrial price and money shocks on real output. Instead, as Blanchard and Quah(1989) point out, it emphasizes that the importance of those shocks relative to output shocks is very small. Then, we have the following restriction on the matrix of lag polynomials, $A(L)$.

$$A_{41}(1) = A_{42}(1) = A_{43}(1) = 0 \tag{5}$$

Second, because it has been shown empirically that the effects of monetary shocks on GNP occur with long lags,[11] it is assumed that money does not have the contemporaneous effect on real output (at least within a quarter). The presence of such outside lags imposes the following restriction.

$$A_{43}(0) = 0 \tag{6}$$

Finally, we assume that the money supply does not respond contemporaneously to agricultural price and industrial price shocks because of inside lags (i.e., recognition, decision, and action lags).[12] These assumptions imply that

$$A_{31}(0) = A_{32}(0) = 0 \tag{7}$$

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[10] Because

$$\Delta x_t = A(L)A_0^{-1}A_0\varepsilon_t = B(L)\eta_t$$

where A_0 is the contemporaneous effect of the structural disturbance, ε_t, on Δx_t it is easily known that the unique transformation matrix, S, is actually A_0.

[11] For details, see Friedman and Schwartz(1963).

[12] Similar restrictions are also used in Sims(1986).

Then, the transformation matrix, *S*, is exactly identified using above six additional restrictions on *A(L)*. Using S, the reduced form vector moving average representation[13] can be rewritten into the structural vector moving average representation. However, because the structural vector moving average representation is in the difference form, it is transformed into the level form of $[pa_t, pi_t, m_t, y_t]'$ to find dynamic responses of agricultural prices and industrial prices to one standard deviation shocks of monetary disturbances.

IV. Empirical Results

Before the estimation, the data are detrended. We estimate the reduced form vector autoregression (VAR) model of $[\Delta pa_t, \Delta pi_t, \Delta m_t, \Delta y_t]'$ with four lags as a basis for the analysis.[14]

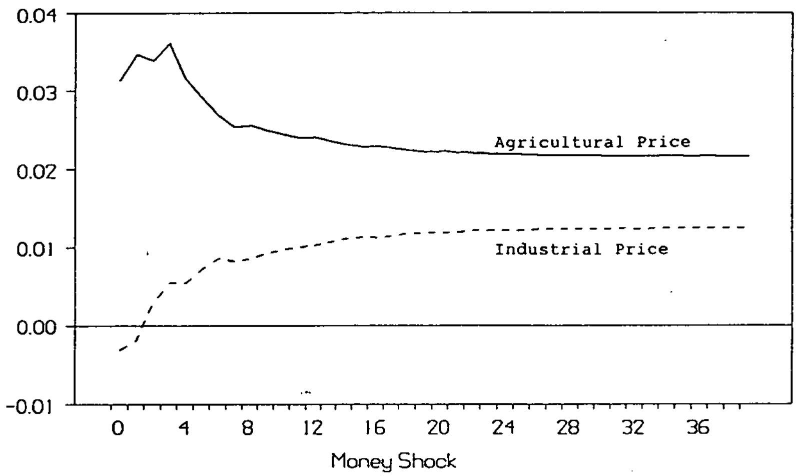
First, we investigate how monetary shocks affect agricultural prices and industrial prices over various horizons. Figure 1 depicts the impulse responses of agricultural prices and industrial prices to nominal money shocks. Money disturbances initially raise the agricultural price. After four quarters, the agricultural price reaches to the peak, and gradually falls to a permanently higher level over the next five years. In response to the monetary shock, industrial prices initially fall a little bit, but then gradually rises over the next six years before settling down at a new permanently higher level.

Suppose that all prices are flexible. A monetary shock changes the prices of all goods in the market in the same proportion. That is, the relative prices are unchanged. But, when it is assumed that agricultural prices are flexible (and storable) while prices of manufactured goods are sticky, the overshooting model predicts that agricultural prices may overshoot their long-run

[13] The reduced form vector moving average representation is obtained by inverting a (reduced form) vector autoregressive representation in the usual way.

[14] As a preliminary step, the VARs with eight and twelve lags were estimated and tested as to whether the VAR with four lags is a significant restriction of either the VAR with eight lags or the VAR with twelve lags. At the conventional significance level of 5%, the VAR with four lags is not a significant restriction of the model with longer lags.

FIGURE 1 Responses of Agricultural and Industrial Prices



equilibrium level.[15] Interestingly, the evidence shown in Figure 1 supports such a theoretical prediction of the overshooting model.

In order to find the extent to which each shock contributes to the fluctuations of agricultural prices and industrial prices, forecast error variance decompositions and historical decompositions of the time series of these variables are examined below.

Tables 2 and 3 show the forecasting error variance decompositions of agricultural prices and industrial prices at forecasting horizons of 1 - 24 quarters. The following observations come from these tables.

First, the monetary shocks are important to the fluctuation of agricultural prices at the short horizon. Up to the first four quarters, over 50 percent of variance in agricultural prices is explained by monetary shocks. However, while the importance of monetary shocks becomes less as the forecasting horizons are longer, the relative

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[15] If the prices of manufactured goods are sticky in the short run, an increase in the nominal money supply is also an increase of the real money supply. Then, to have an equilibrium in the money market, interest rates should fall. The arbitrage condition requires that the expected rate of return on agricultural goods is equal to the interest rate plus storage costs, and this implies that commodity prices may overshoot their long run equilibrium. For details of the overshooting model, see Frankel(1986).

TABLE 2 Variance Decomposition of Agricultural Prices

Horizon (Quarters)	Agricultural Price Shock(ε^{pa})	Industrial Price Shock(ε^{pi})	Monetary Shock(ε^{m})	Output Shock(ε^{y})
1	25.9	0.0	61.2	12.9
2	28.8	0.5	58.2	12.5
3	28.8	1.0	53.4	16.8
4	27.2	4.8	50.5	17.5
5	24.9	10.4	46.4	18.3
6	23.2	15.6	41.9	19.2
7	20.9	21.4	37.6	20.1
8	18.9	26.6	33.6	20.9
12	13.6	39.5	23.6	23.3
16	10.8	46.0	18.3	24.9
20	9.3	49.5	15.2	26.0

TABLE 3 Variance Decomposition of Industrial Prices

Horizon (Quarters)	Agricultural Price Shock(ε^{pa})	Industrial Price Shock(ε^{pi})	Monetary Shock(ε^{m})	Output Shock(ε^{y})
1	0.1	98.1	0.9	0.9
2	0.1	99.1	0.4	0.4
3	0.5	98.8	0.4	0.3
4	1.0	98.2	0.6	0.2
5	1.2	97.9	0.6	0.3
6	1.2	97.5	0.7	0.6
7	1.3	96.9	0.8	1.0
8	1.3	96.4	0.9	1.4
12	1.2	94.8	1.0	3.0
16	1.2	93.5	1.1	4.2
20	1.2	92.6	1.1	5.1

contribution of the industrial price shock rises, and explains about 51 percent of 24-quarter forecast error variance. The agricultural price and output shocks also account for the movement of agricultural prices significantly. But, while the contribution of the agricultural price shock decrease from about 26 percent at the first quarter horizon to about 8 percent at the 24-quarter horizon, the importance of the output shock increases from about 13 percent at the first quarter horizon to about 27 percent at the 24-quarter horizon.

Second, the industrial price shock dominates the movement of industrial prices, and explains over 90 percent of the error variance throughout all forecasting horizons. However, the output shock increases its contribution over the forecasting horizon, but its importance is much less than that of the agricultural price case. The contributions of the agricultural price and money shocks are negligible over the forecasting horizon.

These findings about the variance decompositions suggest that while both monetary and industrial price shocks are the main source of variation in relative farm prices at short horizons, industrial price shocks become much important in the long run.

By setting three innovations to zero at a time, we can decompose the time series of the agricultural price and industrial price forecast errors into four components, associated with agricultural price, industrial price, money and output disturbances, respectively. Figures 2 and 3 display historical decompositions of agricultural price and industrial price forecast errors into four components (dotted line) with the actual forecast error series (solid line).

As for agricultural prices, Figure 2 shows that all components explain fluctuations in agricultural prices. However, as expected from the variance decomposition of industrial prices, Figure 3 shows that the industrial price shocks are a dominant source in movements of industrial prices.

V. Summary and Concluding Remarks

One of the main goals of this paper was to explore the degree to which fluctuations in agricultural prices and industrial prices were the result of monetary shocks. To do that, this paper assumed that there

FIGURE 2a

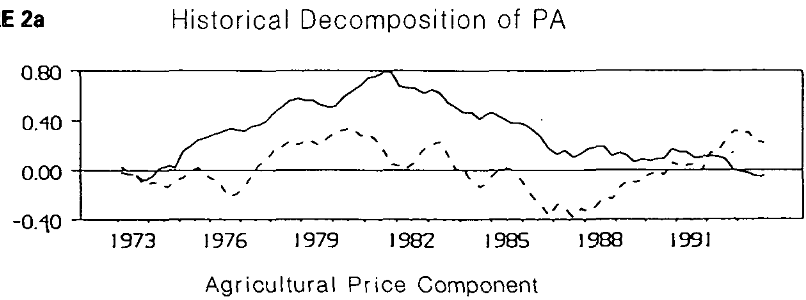


FIGURE 2b

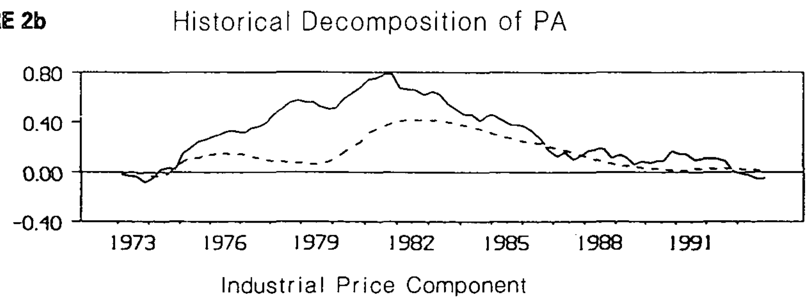


FIGURE 2c

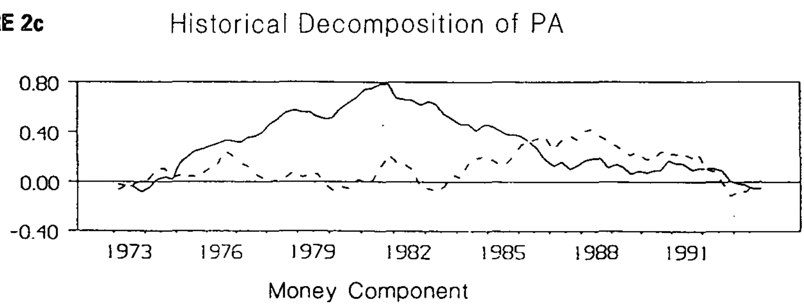


FIGURE 2d

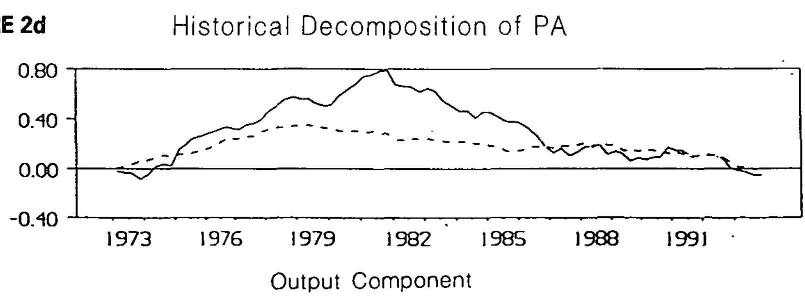
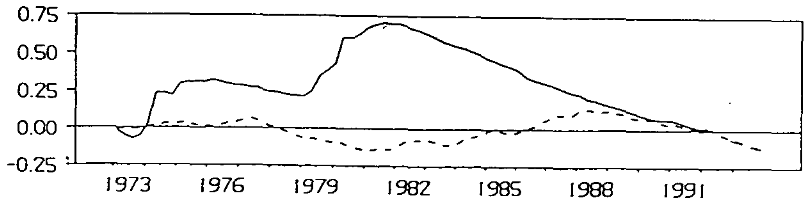
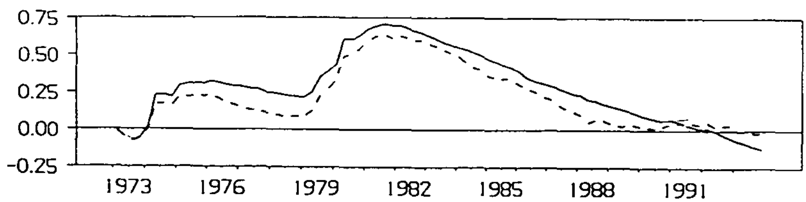


FIGURE 3a Historical Decomposition of PI



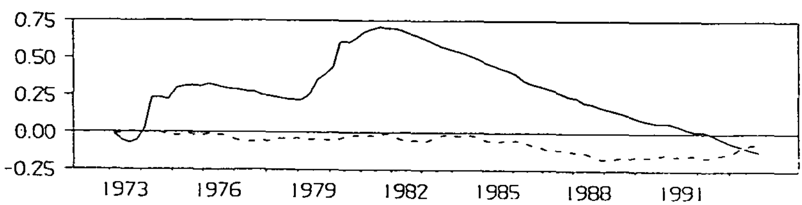
Agricultural Price Component

FIGURE 3b Historical Decomposition of PI



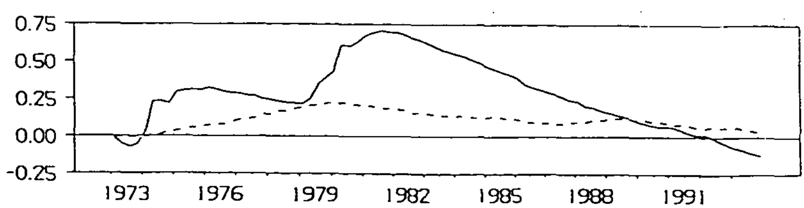
Industrial Price Component

FIGURE 3c Historical Decomposition of PI



Money Component

FIGURE 3d Historical Decomposition of PI



Output Component

are only four independent disturbances. Then, using Korean data, we investigated the dynamic effects of these disturbances, including monetary disturbances, on agricultural prices and industrial prices. The four disturbances have been identified by imposing identification restrictions on the reduced VAR of $[\Delta pa_t, \Delta pi_t, \Delta m_t, \Delta y_t]'$.

Some interesting observations from estimated results have been summarized below. First, as predicted in the overshooting model, agricultural prices are more responsive to monetary shocks than industrial prices, and overshoot the long-run equilibrium level. Second, while all structural shocks explain the movement of agricultural prices, industrial price disturbances are the dominant source of fluctuations in industrial prices. Third, while the movement of relative agricultural prices is largely explained by monetary and industrial price shocks in the short run, industrial price shocks become the dominant source of variation in the long run.

The findings in this paper also show that monetary shocks affect the movement of relative agricultural prices in favor of producers of agricultural goods, at least in the short run.

However, because we used the simple price setting equations for agricultural and industrial goods to identify the effects of monetary shocks on agricultural prices and industrial prices, our conclusions about the role of structural disturbances on the movements of agricultural price and industrial prices are limited. This suggests that a more structural and extended model is required to assess the relative contributions of other shocks on the movement of agricultural and industrial prices.

REFERENCES

Bank of Korea. various issues *Economic Statistics Yearbook*, Seoul.

Barnett, R. C. D. Bessler and R. L. Thompson. 1983. "The Money Supply and Nominal Agriculture Prices." *American Journal of Agricultural Economics* 65 : 301-307.

Bessler, D. 1984. "Relative Prices and Money: A Vector Autoregression on Brazilian Data." *American Journal of Agricultural Economics* 66 : 25-30.

Blanchard, O. J. 1989. "A Traditional Interpretation of Economic Fluctuations."

American Economic Review 79 : 1146-1164.

Blanchard, O. J. and D. Quah. 1989. "The Dynamic Effects of Aggregate Demand and Supply Disturbances." *American Economic Review* 79 : 655-673.

Blanchard, O. J. and M.W. Watson. 1986. "Are Business Cycles All Alike?" in R. J. Gordon (ed.), *The American Business Cycle: Continuity and Change*. University of Chicago Press.

Bordo, M. 1980. "The Effects of Monetary Changes of Relative Commodity Prices and the Role of Long-Term Contracts." *Journal of Political Economy* 88 : 1088-1109.

Chambers, R. G. 1984. "Agricultural and Financial Market Interdependence in the Short Run." *American Journal of Agricultural Economics* 66 : 12-24.

Devadoss, S. and W. H. Meyers 1987. "Relative Prices and Money: Further Results for the United States." *American Journal of Agricultural Economics* 69 : 838-842.

Engle, R. F. and C. W. Granger. 1987. "Co-integration and Error Correction: Representation, Estimation and Testing." *Econometrics* 55 : 251-276.

Engle, R. F. and B. S. Yoo. 1987. "Forecasting and Testing in Co-Integrated Systems." *Journal of Econometrics* 35 :143-159.

Frankel, J. A. 1986. "Expectations and Commodity Price Dynamics: The Overshooting Model." *American Journal of Agricultural Economics* 67 : 344-348.

Frankel, J. A. and G. A. Hardouvelis. 1985. "Commodity Prices, Money Surprises and Fed Credibility." *Journal of Money, Credit, and Banking* 17 : 425-438.

Friedman, M. and A. J. Schwartz. 1963. *A Monetary History of the United States*, 1867-1960. Princeton University Press.

Fuller, W. A. 1976. *Introduction to Statistical Time Series*. New York: Wiley.

Gali, J. 1992. "How Well Does IS-LM Model Fit Postwar U.S. Data?" *Quarterly Journal of Economics* 107: 710-738.

Han, D. H., D. W. Jansen and J. B. Penson, Jr. 1990. "Variance of Agricultural Prices, Industrial Prices, and Money." *American Journal of Agricultural Economics* 71: 1066-73.

Johansen, S. 1988. "Statistical Analysis of Cointegration Vectors." *Journal of Economic Dynamics and Control* 12: 231-254.

Johansen, S. and K. Juselius. 1990. "Maximum Likelihood Estimation and Inference on Cointegration - with Applications to the Demand for

Money." *Oxford Bulletin of Economics and Statistics* 52 : 169-210.

King, R. G., C. I. Plosser, J. H. Stock and M. W. Watson. 1991. "Stochastic Trends and Economic Fluctuations." *American Economic Review* 81 : 819-840.

Orden, D. 1986. "Money and Agriculture: The Dynamics of Money-Financial Market-Agricultural Trade Linkages." *Agricultural Economic Research* 38 : 14-28.

Sargent, T. 1987. *Macroeconomic Theory*. Academic Press.

Saunders, P. J. and D. Bailey. 1986. "Effects of Monetary Changes on the Price Level and Output in the U.S. Agricultural Sector." *Agricultural Financial Review* 46 : 58-68.

Shapiro, M. D. and M.W. Watson. 1988. "Sources of Business Cycle Fluctuations." in S. Fischer (ed.), *NBER Macroeconomics Annual* 3, M.I.T. Press.

Sims, C. A. 1986. "Are Forecasting Models Usable for Policy Analysis?" *Federal Reserve Bank of Minneapolis Quarterly Review* : 2-15.