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AGRICULTURAL PRICES AND MONEY SUPPLY : EVIDENCE FROM PAKISTAN

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ABSTRACT

The objective of the study is to explore the direction of causality between money supply and agricultural prices in Pakistan. Two definitions of money supply, i.e., Ml and M2, and three measures of agricultural prices, i. e., prices of wheat, rice and food are used. The annual data for the period 1960-61 to 1996-97 is analyzed to check the causal relationship between money supply and agriculture prices. The econometric techniques of cointegration and error-correction modelling are employed to analyze the direction of causality. We find evidence of feedback relationship between money supply (M2) and prices of wheat and food. The unidirectional causality runs from money supply (Ml) to price of wheat. The money supply (MI) as well as (M2) affect the price of rice hut no feedback is found.

1. INTRODUCTION

Agriculture sector of Pakistan is the largest sector of the economy. It contributes 24% to GDP and accounts for half of employed labor force. It is also the largest source of foreign exchange earnings. The growth rate of agriculture sector over the last five decades has remained around 4% per annum. During the current year 1996-97 this sector suffered a setback in growth. Realizing the importance of the sector the Government has announced a comprehensive package of incentives to induce growth in this sector. This package is expected to reduce the country's dependence on food imports which is of $ 2.00 billion per year on the average. In recent literature on macroeconomics of agriculture, there has been a growing interest in the dynamic responses of farm output prices and change in money supply. During 1960s Pakistan economy witnessed low inflation, whereas the 1970s and early 1980s have observed prices, for example CPI, increasing at an annual rate of about l2%. It was also concluded that the real farm prices of wheat and rice during 1967-71 rose significantly [Mohammad (1985)]. Following reasons of the high rate of inflation were offereed by Jones and Khilji (1988) :

i) There was considerable worldwide inflation during the 1970s and early 1980s. it was possible that a large part of inflation in Pakistan was imported.

ii) The services sector increased in size relative to other sectors of the economy during that period, and it is generally assumed that the services sector is more liable to experience inflation than the commodity producing sectors of the economy.

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iii) It could be that the increase in money supply due to monetization of high government deficits has caused the prices to rise.

In case of agricultural prices, one type of inflation is crop push inflation. i.e., due to failure of' a crop in a season. Money supply is expanded to accomodate crop failure that leads to rise in food prices and as a result the general price level rises (Porter *1962).* Another reason of' increase in agricultural prices was that the farmers were paid better prices to facilitate the adoption of new varieties of crops [Mohammad (1985)].

The issue of causality between money supply and farm prices is important because policies to stabilize agricultural markets must consider the sources of volatility in the sector. Numerous studies have been conducted to study the behaviour of farm prices for countries other than Pakistan 1.

Hathaway ((974) argued that real supply shocks were the most influential in effecting the agricultural prices in US whereas Schuh (1974) emphasized that exchange rate was responsible for rise in farm prices. Houthkker (1975) and Van Stolk (1976) argued that rapid growth in international monetary reserves in the late 1960s was the cause of inflation in US.

Shei (1978), using an open four sector general equilibrium model for US economy, showed that the dollar devaluation was a significant source of increase in crop and livestock prices. whereas domestic monetary expansion had a greater effect on the sectoral prices and the aggregate price level. Chamber and Just (1982) were of the view that an increase in US money supply caused an increase in general price level than a depreciation in exchange rate and finally an increase in exports, which raises domestic agricultural prices.

Some economists. for example Bordo (1980), Bessler (1984), and Devdoss and Meyer (1987), tested the proposition that farm prices respond more rapidly than industrial prices to money supply shock. Bordo (1980) was of the view that agricultural commodity prices were more responsive to monetary changes than manufactured product prices because agricultural products are traded in well-developed auction markets on shorter contracts.

Bessler's (1984) empirical results for the Brazilian economy over the period 1964-8 1 were inconsistent with the Bordo (1980) theory that agricultural prices adjusted faster than industrial prices. however. Devadoss and Meyer (1987) study about US economy strongly supported the proposition of Brn•do (1980).

The Quantity Theory of money asserts that money is the causal variable and the price level is the resultant variable. Robertson and Orden (1990) argued by using the data from New-Zealand that monetary shocks shifted relative prices in favour of agriculture in the short run and permanently raised nominal prices. Lapp (1990) had tested the impact of monetary policy on relative prices of agricultural commodities and his results indicated that variations in the L'rowth rate of the nominal money supply had not been an important influence on the average level of prices received by farmers relative to other prices.

To examine the direction of causality between the US money supply and nominal agricultural prices, an important paper by Barnett, Bessler and Thompson [BBT] (1983) published in American Journal of Agricultural Economics. They deployed the direct Granger test of causation between money supply and agricultural prices.

This method involved an arbitrary lag selection in causality testing. Lag selection refers to the length of autoregressions used to perform causality tests. For the 1970 to 1978 period, the authors found a unidirectioned causal flow from US money supply (M_2) to both measures of agricultural prices used by them i. e. cash price for No. 2 Kansas City hard red winter wheat and the food component of CPI. Further, they found no significant lags more than sixteen months. Most causality tests[2] applied to US economy rely on arbitrary lag selection. Different criteria underline the specification of lag length. Hsiao (1979, 1981) stated that in cases where arbitrary restriction are used in causality testing, the distribution of test statistics are often sensitive to lag length.

To remove the arbitrariness of lag length, Saunders (1988) employed Final Prediction Error (FPE) criterion for selection of optimal lag length. He tested the causality between US money supply and agricultural prices. The results of the study supported a unidirectional causal relationship from monetary base to retail level agricultural prices. No such flow was found to exist from M_2 (other variable involved to approximate the money supply) to retail agricultural prices. When farm level agricultural prices were investigated, no causal flow was evidenced from any of the measures of the money supply to farm prices.

Oskeoee and Alse (1993) pointed out that time series studies as that of BBT (1983) and Saunders (1988) had two major shortcomings. First, these studies did not check the co-integrating properties of the time series involved in the analysis. Granger (1988) argued that any causal inference would be invalid if the time series involved in the study are co-integrated. Second, to avoid a spurious regression results because of non-stationarity tendencies of most economic time series, people used rates of change instead of levels. Miller (1991) argued that rate of change which was close to the concept of first differencing, filters out low-frequency (long-run) information. The co-integration technique and Error Correction Modelling (ECM) are recommended to remedy this problem.

We did not find any study in the litrature which directly addresses the issue of causality between money supply and agricultural prices in Pakistan, however, a few attempts have been made to investigate the relationship between money supply and general price level. Jones and Khilji (1988) tested the causality between money supply and inflation. By using direct Granger test to evaluate the causality for the period 1973-1985, they found that growth in money supply had a significant impact on inflation but it was also evidenced that inflation had also affected money growth during the period under study. Siddiqui (1990) found that both narrow and broad money were endogenous with respect to CPI but independence was observed with WPI. One study was made by Ali (1990) to examine the relationship between agricultural productivity and crop prices. He found little potential to enhance overall agricultural productivity by increasing single crop price. It is evident that in case of Pakistan the issue has not yet received any attention. An attempt is made in this study to fill this gap in the literature i.e. the causal relationship between money supply and agricultural prices in Pakistan.

Although, the direction of causality could be tested through the Granger and modified Sims tests only. But these tests ignore an additional channel of causation if two variables are cointegrated i.e. having long run relationship. To avoid the above noted shortcomings of simple Granger causality test, this study applies a methodology that is a little bit more scientific, i.e. cointegration and error correction modelling to check the causal relationship between money supply and agricultural prices in Pakistan. The rest of the study is organized as follows :

In the second section, we explained the methodology employed in the study. The results of the unit roots, co-integration and error-correction modelling are discussed in the third section. The brief summary and conclusion of the study are given in the last section.

II METHODOLOGY

The traditional practice in testing the direction of causation between two variables has been to utilize the Granger (1969), Sims (1972) and modified Sims tests suggested by Geweke et. al (1983). It is generally recognised that these tests are not strictly speaking causality tests. They are actually predictability tests. The basic idea is that a variable Y is said to have caused another variable X, if the past values of Y as a group improves significantly the predictability of X beyond what is possible by the past values of X alone.

Recent developments in econometric techniques have highlighted atleast two major shortcomings to the application of the standard Granger or Sims causality test. First, any causal inferences would be invalid if the involved time series are cointegrated (Granger (1988))], Second, due to non-stationarity tendencies of most of the economic time series, the regression would lead to spurious results.

To remedy these problems, the cointegration technique and error-correction modelling are recommended. Error correction models try to establish causality between two variables after reintroducing the low frequency information through the error correction terms into the analysis.

If two variables are found to be cointegrated, the possiblity of no causation terms into them is ruled out and there must be at least one way causation. Two or more variables are cointegrated (i.e. have an equilibrium relationship) if they share common trend (s). So long as the two variables have a common trend, causality must exist in at least one direction [Granger (1988)].

Two variables are said to be cointegrated if the following three conditions are satisfied:

(a) The variables must be integrated of the same order. The order of integration is the number of times each variable has to be differenced in order to turn the series stationary.

(b) There should be a liner relationship between the variables that is in an equation, say

$$Y_t = \beta x_t + m_t$$

where m_t is error term. For linear relationship between Y and X, β coefficient should be significant.

(c) Finally, the residuals in the above equation i. e. the extent by which the two variables deviate from the long run equilibrium relationship should be stationary. Cointegration and error correction modelling techniques involve following steps:

Step 1 : Testing for Order of Integration:

Two prominent procedures to determine the order of integration are a) Dickey Fuller (DF) test and b) Augmented Dickey-Fuller (ADF)[3] test. The DF test is based on the regression.

$$\Delta x_t = \alpha + \beta x_{t-1} + E_t$$

Where x_t is a variable involed and Δ denotes the difference operator; α and β are parameters to be estimated. E_t is stationary random error.

The null hypothesis (Ho) is: x_t is not I(O). The ADF test is based on the regression:

$$\Delta x_t = \alpha + \beta x_{t-1} + \sum_{i=1}^{t} Y_i \Delta X_{t-i} + E_t$$

Where t is selected such that E_t is white noise. α, β and Y_i are parameters. The DF and ADF statistics are calculated by dividing the estimaties of β by its standard error, i.e.

$$t(1) = \frac{\hat{\beta}-1}{S.E(\hat{\beta})}$$

If the calculated DF and ADF statistics are less than their critical values from Fuller's table then the null hypothesis (Ho) is rejected and the series are stationary.

Step 2 : Cointigration Regression

In this step we estimate cointegration regression using variables having the same order of integration. Cointegration regressions for two variables X_t and Y_t are give as:

$$X_t = \alpha + \beta Y_t + Z_t \quad (3)$$

$$Y_t = \Psi + \lambda X_t + Z'_t \quad (4)$$

Where α and φ are constants, β and λ are cointegrating parameters and Z_t and Z'_t are residual. Estimating equations 3 and 4 by OLS, the stationarity of the residuals from both regression equations can be tested by ADF test. Cointegration Regression Durbin- Watson statistics (CRDW) in addition to ADF can also be used to test the stationarity of the residuals. If residuals are found to be cointegrated of same order, i.e. I (o), it would confirm the long run stable equilibrium relationship between two variables.

Step 3 : Error Correction Modelling

If two series are cointegrated of the same order then there always exists a system of equations having error correcting form which represents the dynamics of the series. If X_t and Y_t are both integrated of order one, and they are cointegrated so that $Z_t=X_t-AY_t$ is I (O) then Engle and Granger (1987) demonstrated that it must be the case that following error correction mechanism is correct:

$$\Delta Y_t = \alpha_1 Z_{t-1} + \beta_1 \text{ lagged } [\Delta X_t, \Delta Y_t] + E_{1t} \qquad (5)$$

$$\Delta X_t = \alpha_2 Z'_{t-1} + \beta_2 \text{ lagged } [\Delta X_t, \Delta Y_t] + E_{2t} \qquad (6)$$

The error-correction terms (i.e. Z_{t-1} and Z'_{t-1}) in equation (5) and (6) provide an additional channel through which causality can be detected. For example in equation (5) the null hypothesis is that X does not Granger cause Y, is rejected not only if the lagged values of ΔX are jointly significant, but also if the coefficient or error term (i.e.α_1) is significant. In other words, unlike the Granger test, the Error correction model states the X Granger causes Y, even if the coefficients on lagged changes in X are not, as a group, significant.

111. EMPIRICAL RESULTS

To determine the direction of causation between money supply and agricultrual prices in Pakistan, four steps are involved as outlined earlier. The money supply is approximated by M1 and M2 definitions of money supply whereas wholesale price indices of wheat, rice and food are used to present the agricultural prices. The data on all variables used in the analysis are collected from various issues of Economic Survey. The wholesale price indices of wheat, rice and food were not available on one base year for the period under analysis. They were converted into one base year by using splicing method. The natural logarithm of all variables involved in the study is used. The results are presented in the order of the steps involved.

Testing for the Order of Integration

The degree of integration of each variable involved in our analysis is determined by using both the DF and ADF tests for unit roots. The results of unit roots are reported in Table 1. In the level form both the DF and ADF tests show that all the series are non-stationary since the calculated values of both DF and ADF test statistics are greater than their critical values. However, both DF gand ADF test statistics rejects the null hypothesis of non-stationarity for all the variables when first differenced variables are used. This indicates that all the series are stationary in the first difference and are integrated of order 1, i. e.I(1).

Testing for Cointegration

The variables which are found to have same order of integration are coupled to estimate cointegration regression with the help of OLS. The ADF[4] test is applied to the residuals of the cointegration equations to test their stationarity. The results of cointegration regressions along with cointegration Regression Durbin-Watson (CRDW) statistics and slope coefficients are reported in Table 2.[5] The results show that slope coefficients are positive and statistically significant and adjusted R^2 are high, so variations in dependent variables well explained by explanatory variable which is not against the theory. The positive sign of all the slope coefficients shows that money supply and agricultural prices approximated by wholesale price indices for wheat, rice and food are positively related with each other.

It is clear from Table 2 that the calculated ADF statistics for residuals of cointegration regression No., 3,4,7,8,9,10, 11 and 12 are less than their critical values at 5% significance level[6]. Although Engle and Granger (1987) recommended ADF test owing to its higher power yet for quick check they have also recommended CRDW statistics. For the residuals to be stationary, the CRDW must be singnificantly different from Zero. If it approaches Zero, the residuals are non-stationary. The calculated CRDW statistics for cointegration regression No. 1 & 2 and 7 & 8 are different from zero at 1% level. The ADF and/or CRDW statistics suggest that there exists a stable long-run relationship between money supply (M2) and wholesale price indices of rice, wheat and food. The money supply (M1) has long-run relationship only with price indices of wheat and rice. No evidence of long run relationship between money supply M1 and price of food is found.

For variables which have long-run relationship, we constructed the error correction modelling to check the causality, whereas the variables which did not show long-run relationship are not considered for error correction modelling.

Error Correction Modelling

Upto now we have confirmed the stationarity of the series and then checked the cointegration property of variables involed, but the question that still remains to be answered is which variable Granger causes the other and provides the short run dynamic adjustment towards the long run equilibrium. In other words, the issue of the direction of causation still remains to be answered. To provide the answer error correction models are constructed and estimated by using first differences of the series which showed long run relationship since stationarity was achieved in first difference of actual variables.

It is important to note that Granger causality test is highly sensitive to the choice of lag-lenth. Since Error Correction models of equations (5) and (6) in the text involves lagged variables, one must determine the optimal number of lags for each variable. We determined the optimum lag length with the help of final Prediction Error (FPE)[7] developed by Hsiao (1979, 1981). The optimal lag selection involves two steps. In the first step, one dimensional autoregressive process of say X, is performed and the optimum lag length (n) is determined so that FPE value minimum. In the second step, keeping the optimal lag selected in the first step (n) constant, the other variable Y is inducted and the optimum lag length is chosen on the criterion of the minimum value of EPE. The optimum lag length for each variable is reported in the square brackets in Table 3.

The results of error correction models reported in Table 3 show clearly that there exists bidirectional causality between money supply (M2) and prices of wheat and food. What these results suggest is the fact that an increase in money supply (M2) will increase the prices of wheat and food, which in turn, will increase the money supply (M2). There is unidirectional causal relationship from M2 to price of rice that indicates when money supply (M2) increases the price of rice will also rise. The results of error correction models also show one way causation from money supply (M1) to prices of wheat and rice. There is no feedback causation from prices of wheat and rice to money supply (M1).

IV. CONCLUSION

In the literature available so far, no attempt has been made to analyse the causal relationship between money supply and agricultural prices in Pakistan. For other countries attempts have been made to examine the direction of causality between money supply and farm prices for example, a number of studies were conducted for US economy, which showed mixed results. This study attempts to explore the causal relationship between money supply and agricultural prices in Pakistan. The money supply was approximated by two definitions of money supply, i. e. M1 and M2 and to present agricultural prices we took wholesale price indices of wheat, rice and food. After pointing out the shortcomings of simple Granger causalty test, we examined the issue of causality between money supply and agricultural prices by employing cointegration and error-correction modelling which is an advanced technique to anlayse the causality.

We found feedback relationship between money supply (M2) and prices of food and wheat. However, the relationship between money supply (M1) and prices of wheat and rice, and money supply (M2) and price of rice is unidirectional from money supply to agricultural prices. No causal relationship is found between money supply (M1) and food prices.

Our results don't support findings of Saunders (1988) that there is no causal flow from money supply to farm level prices. Our findings are also not in conformity with that of Barnett, Bessler and Thompson (1983) that causation runs only from money supply (M2) to price of wheat.

It is clear from the results that if government is interested to check the prices of agricultral products like wheat and rice (the important food items in Pakistan) then it is suggested to control the money supply, because in case of M2 (wider approximation of money supply) and prices of wheat and food, there exists bi-directional causality. So if money supply increases at a low rate then prices of wheat and food would grow at low rate and inflation rate would be less in the economy.

Table 1. Results of the test for the order of integration

Variables	Dickey-Fuller (DF)		Augmented Dickey-Fuller (ADF)	
	Without Trend	With Trend	Without Trend	With Trend
ln M1	0.202	-2.290	-0.185 [1]	-2.016 [1]
ln M2	0.704	-2.184	-0.398 [1]	-2.382 [1]
ln P_W	0.420	-3.140	-0.252 [1]	-2.830 [1]
ln P_R	0.594	-2.457	-0.204 [1]	-3.012 [1]
ln P_F	1.420	-2.493	-0.366 [1]	-2.812 [1]
(1-L) ln M1	-5.497*	-5.360*	-4.350* [1]	-4.253* [1]
(1-L) ln M2	-5.344*	-5.301*	-4.177* [1]	-4.203* [1]
(1-L) ln P_W	-6.178*	-6.150*	-5.010* [1]	-4.959* [1]
(1-L) ln P_R	-4.357*	-4.364*	-4.427* [1]	-4.428* [1]
(1-L) ln P_F	-3.601*	-3.642**	-3.312** [1]	-3.253 *** [1]

Note : The critical Values of DF/ADF statistics in the vicinity of 50 observations from Fuller (1976) are -3.58/- 2.93 without trend and -4.15/3.50 with trend at 1% and 5% significance level respectively.

P_W = Wholesale price index of wheat
P_R = Wholesale price index of rice
P_F = Wholesale price index of food
* Significant at the 1% level.
** Significant at the 5% level.
*** Significant at the 10% level.

-Figures in square brackets are the number of Lags used in the ADF test.

Table 2. Results for the test of Co-integratiron

Cointegration equation	Values of Slope	t-states. of slope	$\bar{R}^2$	ADF	CRDW
(1) ln M1 = f(ln P_W)	1.642	34.323	0.970	-2.944 [1]	0.844*
(2) ln P_W= f(ln M1)	0.592	34.323	0.970	-2.790 [1]	0.863*
(3) ln M1 = f(lnP_R)	1.493	39.241	0.977	-3.678** [1]	0.638
(4) ln P_R = f(ln M1)	0.655	39.241	0.977	-3.566** [1]	0.646
(5) ln M1 = f(ln P_F)	1.436	43.562	0.981	-3.027***[1]	0.483
(6) ln P_F = f(ln M1)	0.684	43.562	0.981	-2.867 [1]	0.483
(7) ln M2 = f(ln P_W)	1.753	38.157	0.976	-3.466** [1]	0.912*
(8) ln P_W = f(ln M2)	0.557	38,157	0.976	-3.305** [1]	0.923*
(9) ln M2 = f(ln P_R)	1.590	39.514	0.977	-3.667** [1]	0.564
(10) ln P_R = f(ln M2)	0.615	39.544	0.977	-3.563** (1)	0.571
(11) ln M2 = f (ln P_F)	1.530	45.330	0.983	-3.393** [1]	0.459
(12) ln P_F = f(ln M2)	0.643	45.330	0.983	-3.238*** [1]	0.482

Note : The Critical values of ADF statistics in the vicinity of 50 observations from Fuller (1976) are -3.17 and -2.91 at 5% and 10% significance level respectively.

The critical value of CRDW statistics in the vicinity of 50 observations are 0.78 and 0.69 at 1% and 5% significance level respectively. These are from Engle and Granger (1987).

CRDW in cointegration Regression Durbin-Watson statistic.

* Indicate significance at 1 percent significance level.
** Indicate significance at 5 percent significance level.
*** Indicate significance at 10 percent significance level.

Figures in square brackets are number of Lags used in the ADF test.

Table 3. Results for error correction models

Equations	t-statis. for EC_{t-1}	F-statistic for	F-statistic for	Direction of
$(1-L)InM1=f\{(1-L)InM1,(1-L)InP_W,EC_{t-1}\}$	1.236(1.050)	1.349 [8]	0.705 [7]	
				$M1 \rightarrow P_W$
$(1-L)InP_W=f\{(1-L)InP_W,(1-L)InM1, EC_{t-1}\}\}$	-0.888**(-2332)	1.043 [4]	7.427*** [10]	
$(1-L)InM1 = f\{(1-L)InM1,(1-L)InP_R,EC_{t-1}\}$	0.545(0.633)	0.755 [4]	1.724 [7]	
				$M1 \rightarrow P_R$
$(1-L)InP_R=f\{(1-L)InP_R, (1-L) InM1, EC_{t-1}\}$	3.373** (3.294)	4.082** [7]	3.979** [7]	
$(1-L)InM2=f\{(1-L)InM2,(1-L)InP_W, EC_{t-1}\}$	-0.464(-1.627)	4.690** [8]	1.673 [7]	
				$M2 \leftrightarrows P_W$
$(1-L)InP_W=f\{(1-L)InP_W,(1-L)InM2,EC_{t-1}\}$	-0.906***(-2.10)	1.898 [4]	1.920 [10]	
$(1-L)InM2 = f\{(1-L)InM2,(1-L)InP_R,EC_{t-1}\}$	0.034(0.104)	1.342[4]	0.798 [7]	
				$M2 \rightarrow P_R$
$(1-L)InP_R=f\{(1-L)InP_R,(1-L)InM2,EC_{t-1}\}$	1.540***(3.58)	2.704*[7	3.510** [7]	
$(1-L)InM2=f\{(1-L)InM2,(1-L)InP_F,EC_{t-1}\}$	-0.618**(1.825)	3.743** [5]	2.123 [7]	
				$M2 \leftrightarrows P_F$
$(1-L)InP_F = f\{(1-L)InP_F,(1-L)InM2,EC_{t-2}\}$	-0.310(-1.408)	4.160**[1]	10.585*** [10]	

Note:

Ec denotes the Error-Correction term, numbers inside the square brackets are optimal number of lags used in regression.

Number in parentheses are t-statistics for the value of error-correction term.

*** shows significance at 1 percent level.

** shows significance at 5 percent level.

* shows significance at 10 percent level.

Footnotes :

1. Some important studies are Hathaway (1974,1975), Schuh (1974), Stolk (1976), Bordo (1980),Chamber & Just (1982), Barnett, Bessler and Thompson (1982), Bessler (1984) Lapp (1990) and Robertson and Orden (1990) etc.
2. For example Belongina and King (1983), Lombra and Mehra (1983), and Chamber (1984) Etc.
3. Dickey., D.A., And Wayne A. Fuller (1979)
4. Engle and Granger (1987) have recommended ADF test for its superiority.
5. Table 2 does not report staandard t-statistics since standard error is misleading in co-integration equation [Engle and Grager (1987)].
6. The value of ADF statistics for the residual of equation No. 12 is significant at 10% level.
7. The Final Prediction Error is defined as :

   $FPE (n)= [\{(T+n+1)/ (T-n-1)\}/\{SSR(n)/T\}]$

   Where T is total No. of observations, SSR is some of squared residuals and n is optimal No. of lags. If FPE (n+1) > FPE(n) then (n+1) lag must be dropped from the model. See Hsiao (1981)

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