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Testing the long run neutrality of money based on the seasonal cointegration theory: The case of Iran

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ABSTRACT

This article uses seasonal integration and cointegration techniques to test the hypothesis of neutrality of money, using data from the Iranian economy. Seasonal data for the three variables of money supply, output and prices show that (increase in) money supply and the price level are cointegrated at zero frequency, but one does not see such a relationship between (increase in) money supply and output. These results imply that in the long run changes in money supply only influence nominal variables not real ones. We can thus say that in the long run, money is (super) neutral.

1. Introduction

The hypothesis of neutrality of money derives from the quantity theory of money. It postulates that changes in the quantity of money will not have any impact on real variables, and will only produce nominal macro-economic changes. This hypothesis has an important role in predictions of monetary theories, such as the theory of inflation. Most of these theories take the long run neutrality of money as a given, while they agree that in the short run monetary changes can produce real results. There is widespread consensus regarding the non-neutrality of money in the short run. The main reason for this difference is that phenomena such as nominal and real rigidities and imperfect information in goods and labor

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markets are more pervasive in the short as opposed to the long run.

Economic literature is full of both theoretical and empirical studies of neutrality of money. In terms of empirical studies of the relationship between monetary and real variables, once can refer to Lucas (1980) Mills (1982) Duch (93) Hsing (90) Weber (94) and Moosa (97). The results of these studies are not uniform. Some of the above authors have categorically rejected the neutrality of money hypothesis, while some others have simply rejected the super-neutrality of money in the long run. This article aims to empirically test the super-neutrality of money in the long run for the Iranian economy. One of the distinguishing features of this article compared to other studies of super-neutrality of money is the use of the seasonal cointegration technique.

The theoretical underpinnings of the neutrality of money in developing countries is not very solid. All the same, there is some evidence that the economy of these countries, that are characterized by weak financial systems and underdeveloped capital markets have certain tendencies towards neutrality of money (Duck, 1988). These evidences are consistent with the peculiar structural features of developing countries such as non-existence of certain factors that lead to non-neutrality of money. As an example, at least three of the main causes of non-neutrality, namely rigid prices, rigid nominal wages and fixed nominal costs, are not prevalent in developing countries. It is for this reason that Kalcsar (92) postulates that the more advanced and complicated an economy, the less likely that money will be neutral. As an example the introduction of bonds into an economy will influence the money transition mechanisms and will lead to non-neutrality of money, because under these conditions the supply and demand of money, as well as the relative prices of different goods are variable. It is for this reason that the likelihood of money being neutral is higher in developing countries, given the limited range and reach of monetary assets. In these countries the money transition mechanism is direct and a monetary shock will affect both price and output levels in the short run and only the price level in the long run.

This article uses the technique of seasonal cointegration, which is most appropriate for this purpose, in order to test for neutrality of money. Empirical studies normally follow one of the three following methodologies: 1) some researchers use cross-country data that have been averaged over a relatively long period. 2) The second is use of time series data of frequency domain data. 3) The third is use of time series, multi variate data (normally two variables) and testing for restrictions on multiple factors in VAR models. In this methodology, one proves the neutrality of money through testing a zero restriction on the sum of coefficients of the current and lagged monetary variables in a regression on real variable.

With the development of cointegration analysis, the findings of empirical studies that have ignored time series aspect of variables have been thrown in doubt. For example, King & Watson (1992) hold that the restrictions imposed on current and lagged monetary variables in case of neutrality of money are only valid if the order of integration of monetary and real series are the same and at least one.

The above point relates to the seasonal cointegration technique and justifies its use, since that technique not only takes into account integration in zero frequencies, but also for seasonal frequencies and makes use of information regarding the seasonal behavior of variables. It is for this reason that the technique of seasonal cointegration is considered appropriate for testing the long run neutrality of money. It can be argued that lack of cointegration between money and real output at zero frequency indicates neutrality of money in the long run. But not necessarily neutrality of money in the short run, which is associated with lack of cointegration in other frequencies.

This article, in addition to testing for neutrality of money (namely lack of effect of changes in nominal money supply on real variables) also tests for super-neutrality of money (i.e. no effect of changes in the rate of growth of nominal money on real variables). There are three reasons for relative neglect of super neutrality in economic literature: 1) The theoretical underpinnings of super-neutrality have been seriously challenged. For example, Patinkin (1992) holds that while there are strong theoretical grounds for neutrality of money, the same is not true for super-neutrality. 2) Available empirical evidence largely confirms neutrality of money as against super-neutrality. And 3) The third reason relates to econometric theory, as testing for super-neutrality requires the order of integration of money variables to be one more than the order of integration of real variables. However, in the current case, the statistical properties of time series data make it possible for us to test for super neutrality of money.

In the second part of this article, we explain the importance of the neutrality on money for the monetarist school's simple inflation model. In the third part, we briefly explain the econometric methodology of seasonal cointegration. In the fourth part, after introducing the data and their seasonal behavior, we offer the empirical results of the tests of seasonal integration and cointegration. In the fifth part, we draw our conclusion based on the above discussions.

2. A Simple Theoretical Model of the Long run Neutrality of Money

We can show the importance of the assumption of neutrality of money for monetary theories through a simple model. We define the dependent variable of demand for money by means of the following equation

$$m^d = py^\beta \tag{1}$$

Where m^d equals nominal demand for money, p the price level, y real output and β the output elasticity of demand for money. If we consider the supply of money as exogenous, then under equilibrium conditions we will have:

$$m^d = m \tag{2}$$

therefore:

$$m = py^\beta$$

Through taking logarithms and differentiations of both sides we get

$$dp/p = dm/m - \beta dy/y \tag{3}$$

In the above case, dp/p is the rate of inflation, dm/m is the rate of growth of money supply and dy/y is the rate of increase in output. The equation (3) says that the rate of inflation equals the rate of increase in money supply minus the rate of increase in the demand for money due to changes in real output. Should money not be neutral, increases in money supply will lead to increases in real output and hence demand for money. In this case, the price level will rise by less than the rate implied by equation (3). The Phillips Curve indicates that the difference between actual and long run rates of increase in real output are positively correlated with positive inflationary expectation error.
Therefore:

$$(dy/y)^n - dy/y = \phi[(dp/p)^e - dp/p] \tag{4}$$

Where $(dy/y)^n$ is the long run rate of output growth and $(dp/p)^e$ is the anticipated rate of inflation. Thus the Phillips Curve would lead one to expect that growth of money supply will influence growth of real output. Through substituting equation (3) into equation (4) we will have.

$$-1/\beta[dm/m-dp/p] = -(dy/y)^n + \phi[(dp/p)^e - dp/p] \quad (5)$$

or

$$dp/p = 1/1 + \phi\beta[dm/m - \beta(dy/y)]^n + \phi\beta/1 + \phi\beta(dp/p)^e$$

In the long run $dp/p=(dp/p)^e$ and thus equation (6) will be replaced by equation (3). Thus, changes in money supply will, through the real balances effect, influence both output and prices in the short run and only prices in the long run.

3. Econometric Methodology

In this article we use seasonal cointegration to test for the relationship between money supply and real output and the price level. This test allows us to distinguish among cointegration at different frequencies. Since zero frequency indicates a long run relationship among the model's variables, in case money is neutral money supply should not be cointegrated with real output at zero frequency. On the other hand, the model set out in the previous section assumes that money supply and price level are cointegrated at zero frequency.

A time series is seasonally integrated of order (d,b) or $x_t \sim \pm(d,b)$ if:

$$(1 - L)^d \ (1 - L^s O^b x_t\ ) = \Delta^d \ \Delta^b{}_s x_t - I(0)$$

Meaning that with d times differencing, and b times differencing, x_t will be transformed into a stationary series. S is the number of instances in a year, for example for seasonal data s=4 and for monthly data s=12. In this article we use HEGY technique to test seasonal integration. In this test, we break down the seasonal operator as follows:

$$(1 - L^4) = (1 - L)(1 + L^2)x_t$$

In which L is the lag operator. In this test, we first calculate three variables from the main series as follows:

$$Z_1(x_t) = x_t(1 + L + L^2 + L^3) = x_t + x_{t-1} + x_{t-2} + x_{t-3}$$

$$Z_2(x_t) = - x_t (1 - L + L^2 + L^3) = -(x_t - x_{t-1} + x_{t-2} + x_{t-3})$$

$$Z_3(x_t) = - x_t(1 - L^2) = -(x_t - x_{t-2})$$

The test statistics are derived from the following regression:

$$\Delta_4 x_t = \gamma + \pi_1 z_1(x_{t-1}) + \pi_2 z_2(x_{t-1}) + \pi_3 z_3(x_{t-2}) + \pi_4 z_4(x_{t-1}) + \sum_{i=1}^{k} = \phi_i \Delta_4 x_{t-i} + \varepsilon_t \quad (7)$$

We then perform unit root tests at frequencies of zero (long run), 1/2 two cycles year), and 1/4 (one cycle year) on the basis of t ratios on coefficients of π_1 and π_2, and the F statistic for the hypothesis $\pi_3=\pi_4=0$. The hypothesis of $\pi_1=0$ implies a non-seasonal unit root. We test for the common base with the semi-annual frequency based on the condition that $\pi_2=0$. And finally to test for annual frequency we use the F statistic with the condition that $\pi_3=\pi_4=0$. It should be noted that the above three null hypothesis do not replace another. As time series can contain non- seasonal, semi-anuual and annual unit root. the table for the confidence interval of this test is given in the 1990 study of Hyllbergan and *et al* (1990). The augmentation terms $\sum_{i=1}^{n} \phi_i \Delta_4 x_{t-i}$ in Equation (7) are added to convert the residuals into white noise without affecting the distribution of the test statistics under the null hypothesis.

The number of terms or correct lag length in the equation (7) has to be selected based on criteria of model selection such as AIC of SBC, or by reference to the importance of coefficient ϕ_i in equation (7). If we choose too large a value for k this will reduce the power of the test, while if we choose too small a value the validity of the test will be questioned due to specification error. Engel *et al* (1993) suggest to allow holes in the lag distribution. If the available time series data have the same seasonal integration then we can test for cointegration amongst the transformed variables ($z_i(x_t)$, i=1,2,3) in the following manner:

(1) The vector time series x_t is cointegrated at the single period cycle (the long-run or zero frequency), corresponding to the factor (l-L) of the seasonal if a cointegrating vector α exists such that.

$$\alpha' z_1(X_t) = u_t \, , \; u_t \sim I(0) \quad (8)$$

In this case, the bivariate regression for seasonal cointegration at frequency 0 can be written as:

$$z_1(x_t) = \alpha_0 + \alpha_1 z_1(m_t) + u_t \quad (9)$$

where x_t is either output or price level, the auxiliary regression to test for unit root in residuals u_t is given by

$$\Delta u_t = \phi u_{t-1} + \sum_{i=1}^{n} \theta_i \Delta u_{t-i} + \varepsilon_t \qquad (10)$$

which is similar to the Dickey-Fuller regression in the standard cointegration test.

(2) The vector time series x_t is cointegrated at the biannual cycle (frequency 1/2), corresponding to the factor (1+L) of the seasonal process, if a cointegrating vector β exists such that

$$\beta' z_c(X_t)\ u_t,\ u_t \sim I(0) \qquad (11)$$

The bivariate regression for seasonal cointegration at this frequency can be written as:

$$z_c(x_t) = \beta_0 + \beta_1 z_2(m_t) + u_t \qquad (12)$$

The auxiliary regression to test for unit root in the residuals u_t is written as:

$$u_t + u_{t-1} = \phi(-u_{t-1}) + \sum_{i=1}^{n} \theta_i (u_{t-i} + u_{t-i-1}) + \varepsilon_t \qquad (13)$$

the negative sign is added to u_{t-1} in order to make the distribution of the test statistic similar to that in case (1). Otherwise, it will be the mirror image of that distribution.

(3) The vector time series x_t is cointegrated at the four period or annual cycle (frequency 1/4), corresponding to the factor $(1+L^2)$ of the seasonal process, if a polynomial cointegrating vector $(\gamma+\delta)$ exists such that.

$$(\gamma' + \delta' L)\ L_3(x_t) = w_t,\ w_t \sim I(0) \qquad (14)$$

The bivariate regression for seasonal cointegration at this frequency is given by:

$$z_3(x_t) = \gamma_0 + \gamma_1 z_3(m_t) + \delta_0 z_3(x_{t-1}) + \delta_1 z_3(m_{t-1}) + w_t \qquad (15)$$

In this case testing for unit root in the residuals is not straightforward because it involves complex unit roots. Engle *et al* (1993) suggest a method to test for cointegration at this frequency based on the auxiliary regression

$$w_1 + w_{t-2} = \lambda_1(-w_{t-2}) + (-w_{t-1}) + \sum_{i=1}^{k} \mu_i (w_{t-i} + w_{t-2-i}) + \varepsilon_t \qquad (16)$$

the test statistics in this case are the rations of γ_1 and γ_2 and the F statistics for $g_1=g_2=0$. Critical values for this test are tabulated in Engle *et al* (1993) for various model specifications(1).

4. Data and Empirical Results

The empirical tests of the this article are based on 112 quarterly observations over the period 1350 (1) to 1377 (4) for the three variables of money supply (m), output (y) and price level (p). Money supply is measured by private sector liquidity (M2), output by the output index of large industrial enterprises and the price level by the consumer price index (CPI). The data for the variables are obtained from Central Bank publications. We use the logarithmic value of all the variables in the model.

We plot the auto-correlation function of first differences of (logarithms) money supply (Δm), real output (Δy), and price level (Δp) respectively in the fig. 1, 2 and 3 of the annex. We can clearly observe seasonal variations in output and money supply and to a lesser degree for prices. As can be seen, the value of self-correlation function for the above series in multiples of four have meaningful spikes and reduce very slowly. These series are influenced by seasonal factors, which need to be seasonally differenced. results of seasonal integration tests based on the HEGY test appear in table1.

This test is used to determine the order of integration of seasonal data for variables and their seasonal first differences. As can be seen, the results indicate that all three variables have meaningful seasonal components.

Table 1: HEGY test for seasonal integration

	$\pi_1 = 0$	$\pi_2 = 0$	$\pi_3 = \pi_4 = 0$	K
M	-0.999	-0.319	0.910	7
Y	-1.450	-1.873	3.233	5
P	2.655	-2.484	1.299	8
$\Delta_4 m$	-1.694	-10.006	232.627	5
$\Delta_4 y$	-3.202	-8.001	56.064	4
$\Delta_4 p$	-1.980	-8.546	38.115	5

The hypothesis of a unit root at zero frequency, $\pi_1=0$ is not rejected by any of the series. We get similar results for the hypothesis of $\pi_2=0$ for the

1- Model specification here refers to both the cointegrating regression and the auxiliary regression particularly whether or not they contain deterministic components.

alternative $\pi_2<0$. Thus the hypothesis of a seasonal unit root at semi-annual frequency is accepted.

The F statistic, which is used to test for the hypothesis of $\pi_3=\pi_4=0$ in the case of seasonal frequency (yearly cycle) confirms a seasonal root of one in the frequency of 1/4 (one cycle year) for m and p, but the same is in some doubt for y. In actual fact, the hypothesis of a seasonal root of one in an annual cycle is only rejected for y. therefore, m and p variables are consistent with the hypothesis of a seasonal root of one for zero, biannual and annual frequencies, and the y variable with the hypothesis of a root of one in zero and semiannual frequencies. In addition, seasonally differenced variables, $\Delta_4 m$ & $\Delta_4 p$, still have a unit root at zero frequency, while $\Delta_4 y$ is stationary and does not have a unit root in any of the frequencies. Therefore, the order of integration of y is the same as that for m and p, so that.

$$(1 - L^4) = \Delta_4 y \sim I(0)$$
$$(1 - L)(1 - L^4)m = \Delta\Delta_4 m \sim I(0)$$
$$(1 - L)(1 - L^4) = \Delta\Delta_4 p \sim I(0)$$

It, thus appears that the order of integration of the m and p variables (at zero frequency) is one more than the order of integration of the real variable y. Therefore, in addition to testing for neutrality of money, we also test for the hypothesis of the long run super neutrality of money (the long run causal relationship between growth of money supply and output), which is more consistent with the statistical properties of available data. Long run super neutrality of money means that there is no cointegration at zero frequency (the long run) between the growth rate of money supply (dm) and output (y), as well as between dm and dp (rate of inflation). We test for cointegration at zero frequency, which is the focus of attention in this study, through the transformed variable z_1 The graph of variables z_1 (y) , z_1 (m) and z_1 (p) is shown in figure 4 of the annex. As can be seen there is a much closer relationship between z_1 (m) than with z_1 (y).

In fact, the test results for seasonal cointegration given in table 2 confirm this point. Money supply and output level are only cointegrated at semiannual frequencies. We get a similar result for growth in money supply (dm) and output. The non of cointegration at zero frequency between money supply and output indicates lack of a long run relationship between the given variables, i.e. long run neutrality of money. We are also able to reject the hypothesis of cointegration at zero frequency between the variables or rate of growth in money supply and output level, and thus the hypothesis of super neutrality of money is also accepted. Cointegration between output and growth of money supply in other frequencies shows that there is a causal link between growth of money supply and output in the short run, confirming that money is not super neutral in the short run. On the other hand, the price level and money supply (and the rate of the

Table 2: Testing for Seasonal Cointegration

Dependent variable	Regressors	t_ϕ	t_{λ_1}	t_{λ_2}	$F(\lambda_1,\lambda_2)$	K
$Z_1(y)$	$Z_1(m)$	-1.577				6
$Z_1(P)$	$Z_1(m)$	-3.281				5
$Z_2(y)$	$Z_1(m)$	-2.461				5
$Z_2(p)$	$Z_2(m)$	-2.572				5
$Z_3(y)$	$Z_3(m)$					
	$Z_3(y_{t-1})$					
	$Z_3(m_{t-1})$					
	$Z_3(m)$					
$Z_3(p)$	$Z_3(p_{t-1})$					
	$Z_3(m_{t-1})$					
	$Z_1(dm)$					4
	$Z_1(dm)$					
$Z_1(y)$	$Z_1(dm)$					
$Z_1(dp)$	$Z_2(dm)$					
$Z_2(y)$	$Z_3(dm)$		-4.211	-2.451	7.556	
$Z_2(dp)$	$Z_3(y_{t-1})$					5
$Z_3(y)$	$Z_3(dm_{t-1})$					4
	$Z_3(dm)$	-2.891				5
	$Z_3(dp_{t-1})$	-4.153				4
	$Z_3(dm_{t-1})$	-3.721				5
$Z_3(dp)$		-4.721				
						6
			-1.521	-3.792	6.916	
			-7.192	-3714	34.992	

change of these two variables) are cointegrated at all possible frequencies(1).

What is more important in this study is the cointegration at zero frequency between money supply and the price level. Therefore, money supply only influences nominal variables in the long run, and not real ones, and is thus neutral.

5. Conclusion

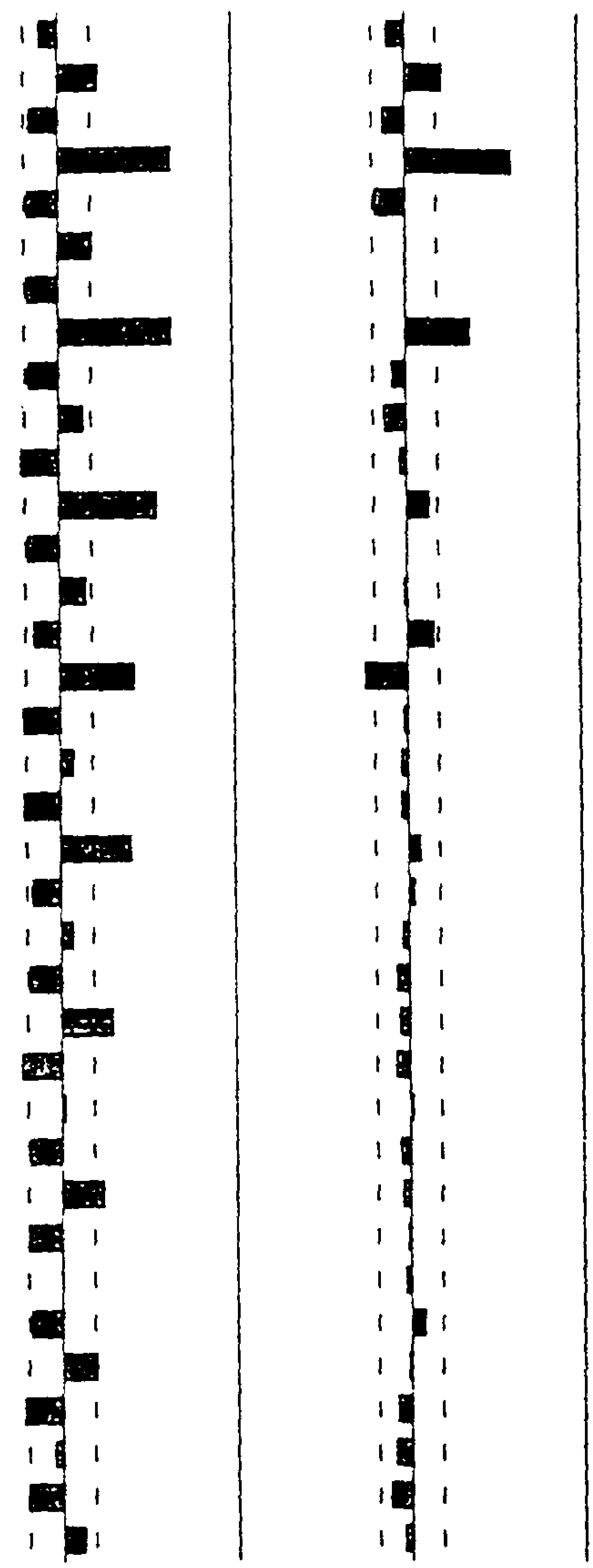
This study offers some evidence in support of super neutrality of money in Iran the empirical results have been extracted from tests of seasonal cointegration between money supply on the one hand and output and prices on the other hand. The cointegration test results show that (growth of) money supply and output at zero frequency (which represent the long run) are not cointegrated. While, the (growth of) money supply and price level are cointegrated at all frequencies, including zero. The result that (growth of) money supply in the long run influences nominal and not real variables supports the notion of long run super-neutrality of money.

The efficacy of monetary policy as an anti-inflationary tool is dependent on a significant relationship between money supply and the price level. The policy recommendations of this study are based on the above theory. The inflationary model of the monetarist school, which assumes long run neutrality of money, holds that an increase in money supply over its demand the price level and output and thus total expenditure will increases. In cases where output is at or close to the full employment level, there will be a direct relationship between money supply and the price level. Abstracting from non-monetary factors, it appears that this model is appropriate for projecting the real and nominal effects of monetary policy and shocks in Iran.

1- The estimated value of the cointegrating parameter in the long run relationship between price level and money supply is 0.71. This figure is consistent with the inflation model of the monetarist school. In addition, the estimated value of this parameter, is less than one, after taking into account the increase in demand for money that results growth of real output.

Correlogram of D(LM2)

Date: 12/24/01 Time: 20:23
Sample: 1350:1 1379:4
Included observations: 111

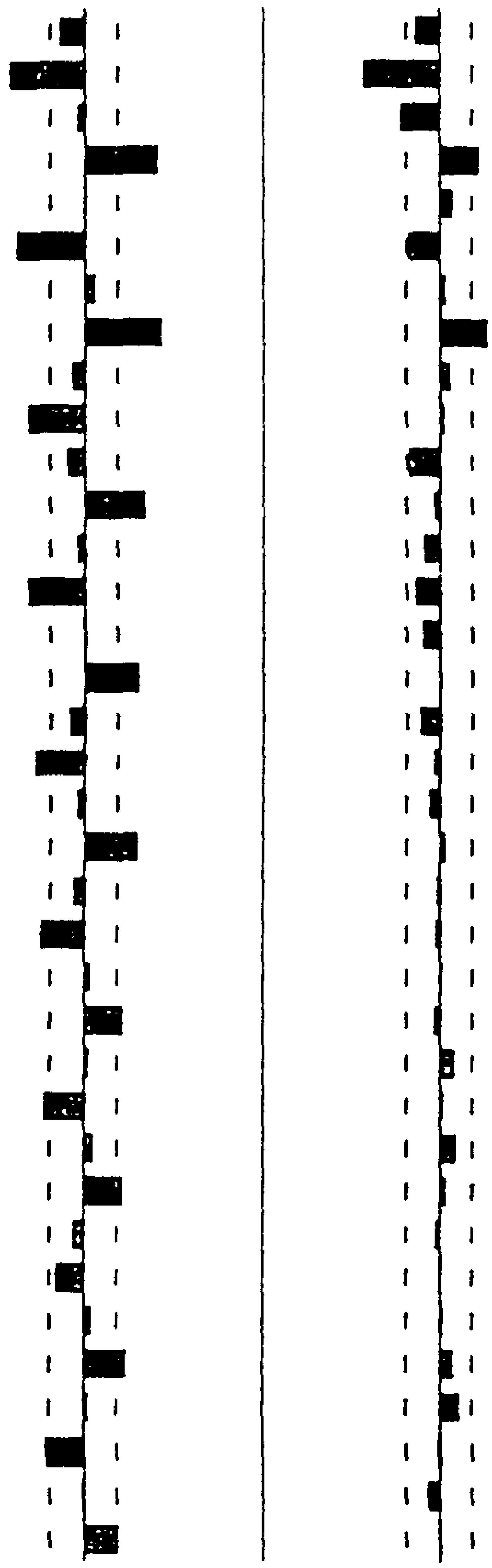


Lag	AC	PAC	Q-Stat	Prob
1	-0.103	-0.103	1.2212	0.269
2	0.236	0.228	7.6280	0.022
3	-0.159	-0.124	10.553	0.014
4	0.667	0.644	62.714	0.000
5	-0.177	-0.176	66.401	0.000
6	0.200	0.001	71.190	0.000
7	-0.175	0.006	74.885	0.000
8	0.665	0.387	128.74	0.000
9	-0.168	-0.074	132.23	0.000
10	0.146	-0.129	134.86	0.000
11	-0.218	-0.040	140.82	0.000
12	0.580	0.135	183.48	0.000
13	-0.179	0.000	187.58	0.000
14	0.149	-0.014	190.44	0.000
15	-0.140	0.160	192.99	0.000
16	0.439	-0.252	218.43	0.000
17	-0.205	-0.018	224.05	0.000
18	0.077	-0.040	224.84	0.000
19	-0.209	-0.040	230.78	0.000
20	0.416	0.068	254.66	0.000
21	-0.160	0.036	258.22	0.000
22	0.067	-0.040	258.85	0.000
23	-0.180	-0.066	263.46	0.000
24	0.303	-0.051	276.69	0.000
25	-0.227	-0.080	284.17	0.000
26	0.020	0.023	284.23	0.000
27	-0.184	-0.051	289.31	0.000
28	0.240	-0.045	298.01	0.000
29	-0.190	-0.015	303.52	0.000
30	0.004	-0.031	303.52	0.000
31	-0.180	0.081	308.61	0.000
32	0.201	-0.009	315.00	0.000
33	-0.217	-0.076	322.58	0.000
34	-0.049	-0.096	322.98	0.000
35	-0.199	-0.126	329.50	0.000
36	0.125	-0.042	332.10	0.000

Figure 1: Autocorrelation function of log difference of money supply

Correlogram of D(LYIND)

Date: 12/24/01 Time: 20:27
Sample: 1350:1 1379:4
Included observations: 107

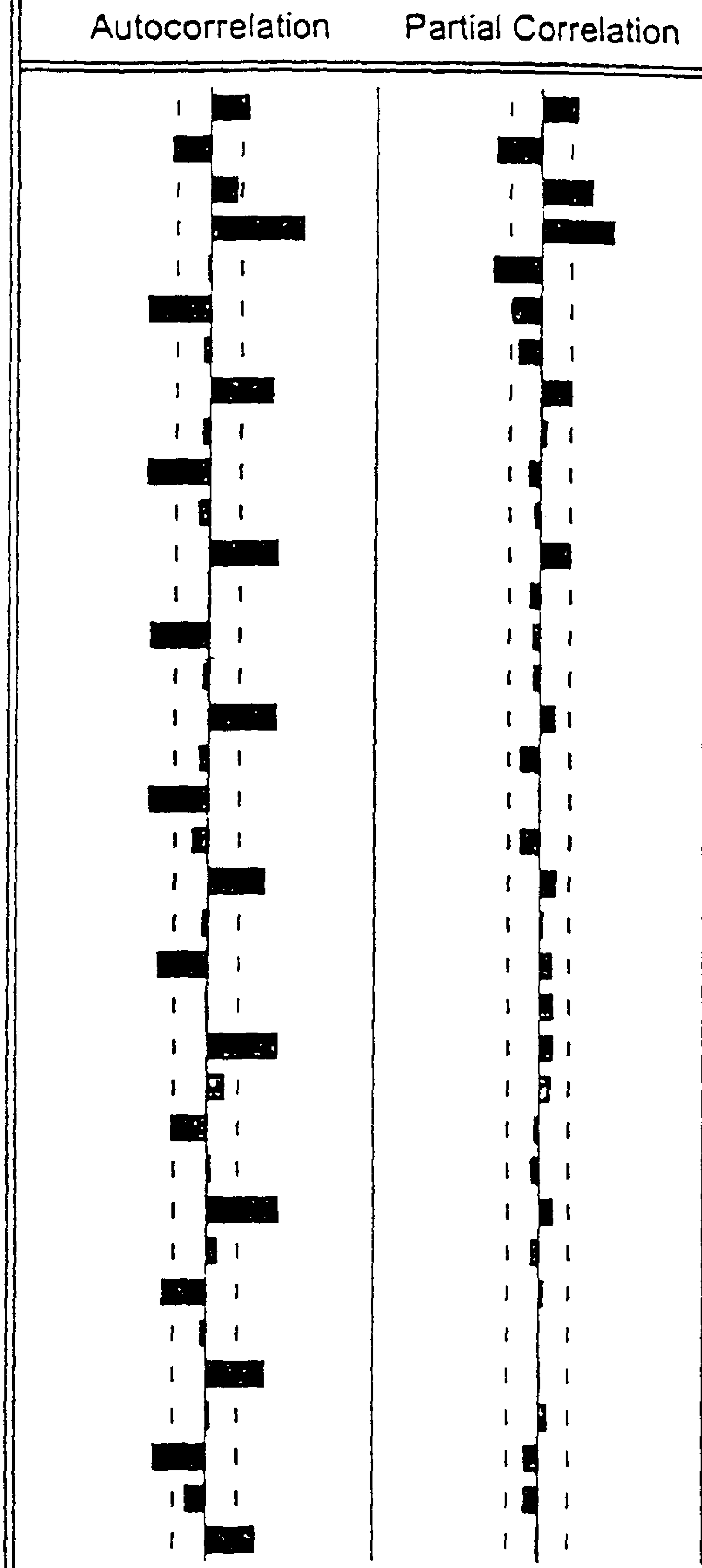


Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.135	-0.135	1.9961	0.158
		2	-0.419	-0.445	21.465	0.000
		3	-0.039	-0.228	21.631	0.000
		4	0.412	0.222	40.887	0.000
		5	0.002	0.071	40.888	0.000
		6	-0.382	-0.177	57.774	0.000
		7	0.054	0.027	58.115	0.000
		8	0.438	0.273	80.767	0.000
		9	-0.064	0.056	81.251	0.000
		10	-0.315	0.019	93.170	0.000
		11	-0.096	-0.175	94.282	0.000
		12	0.339	-0.027	108.37	0.000
		13	-0.033	-0.086	108.51	0.000
		14	-0.316	-0.139	121.02	0.000
		15	0.001	-0.094	121.02	0.000
		16	0.309	0.005	133.23	0.000
		17	-0.077	-0.107	134.01	0.000
		18	-0.271	-0.032	143.62	0.000
		19	-0.037	-0.055	143.80	0.000
		20	0.295	0.026	155.49	0.000
		21	-0.055	-0.013	155.89	0.000
		22	-0.243	-0.021	163.99	0.000
		23	0.025	0.001	164.08	0.000
		24	0.218	-0.033	170.73	0.000
		25	0.022	0.074	170.79	0.000
		26	-0.224	0.013	178.00	0.000
		27	0.044	0.086	178.29	0.000
		28	0.216	0.028	185.17	0.000
		29	-0.053	-0.021	185.58	0.000
		30	-0.155	0.005	189.24	0.000
		31	0.039	0.016	189.47	0.000
		32	0.237	0.069	198.22	0.000
		33	0.019	0.115	198.27	0.000
		34	-0.215	-0.006	205.64	0.000
		35	-0.003	-0.063	205.64	0.000
		36	0.193	0.004	211.79	0.000

Figure 2: Autocorrelation function of log difference of industrial output

Correlogram of D(LCPI)

Date: 12/24/01 Time: 20:25
Sample: 1350:1 1379:4
Included observations: 107



	AC	PAC	Q-Stat	Prob
1	0.222	0.222	5.4068	0.020
2	-0.221	-0.284	10.823	0.004
3	0.160	0.326	13.678	0.003
4	0.580	0.466	51.777	0.000
5	-0.015	-0.301	51.804	0.000
6	-0.365	-0.177	67.164	0.000
7	-0.035	-0.144	67.308	0.000
8	0.386	0.196	84.869	0.000
9	-0.037	0.041	85.035	0.000
10	-0.365	-0.070	101.08	0.000
11	-0.050	-0.038	101.38	0.000
12	0.421	0.185	123.19	0.000
13	0.005	-0.060	123.19	0.000
14	-0.338	-0.046	137.54	0.000
15	-0.028	-0.035	137.64	0.000
16	0.414	0.093	159.64	0.000
17	-0.044	-0.117	159.89	0.000
18	-0.351	0.000	176.08	0.000
19	-0.087	-0.117	177.07	0.000
20	0.349	0.104	193.43	0.000
21	-0.028	0.021	193.53	0.000
22	-0.295	0.075	205.44	0.000
23	-0.001	0.083	205.44	0.000
24	0.428	0.084	231.16	0.000
25	0.099	0.070	232.55	0.000
26	-0.212	-0.023	239.01	0.000
27	0.019	-0.043	239.07	0.000
28	0.443	0.086	267.99	0.000
29	0.066	-0.048	268.63	0.000
30	-0.259	0.028	278.77	0.000
31	-0.026	0.008	278.88	0.000
32	0.359	0.009	298.96	0.000
33	0.024	0.050	299.05	0.000
34	-0.307	-0.088	314.12	0.000
35	-0.116	-0.090	316.30	0.000
36	0.296	-0.005	330.65	0.000

Figure 3: Autocorrelation function of log difference of CPI

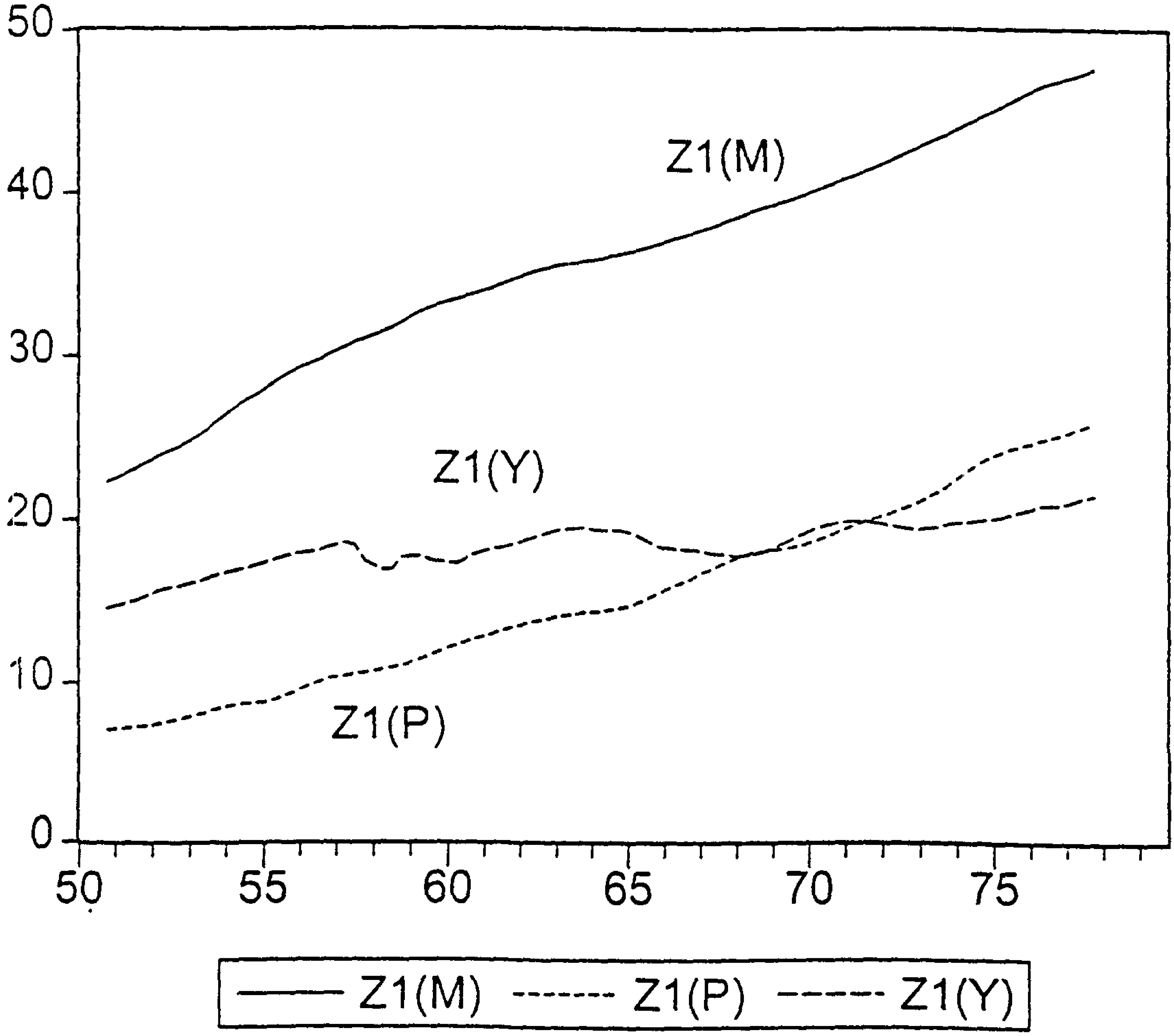


Figure 4: The transformed z variable

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