Testing the Neutrality of Money in Japan Using ARIMA Models and Cointegration Analysis

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Abstract This paper analyses the neutrality of money in Japan using postwar data for real GNP, nominal money supply, the price level and the nominal rate of interest. Reduced form ARIMA modelling and cointegration analysis are used with quarterly seasonally adjusted data to examine several long- and short-run hypotheses and the robustness of previous empirical results. Two sub-samples are used to accommodate a structural break associated with the first OPEC oil price shock. It is found that short-run neutrality of money is rejected by the data, the long-run neutrality results are mixed, and the long-run superneutrality of money is not supported by the data. Consequently, it is argued that greater attention should be paid to alternative econometric estimation and testing approaches because the findings have important policy implications.

1. INTRODUCTION

The classical theory of macroeconomics, whereby changes in nominal variables have no effect on real magnitudes and the nominal interest rate in the long run, has attracted considerable research interest over many years. Among several types of neutrality in macroeconomics, the neutrality between the nominal money supply and real output is both familiar and highly topical. To date, there does not seem to be a consensus as to the neutrality of money, in spite of the volume of econometric research in this area.

Several authors have considered various aspects of the above-mentioned neutrality relationship. Friedman (1968) stressed the importance of monetary policy in influencing real variables in an important paper entitled 'The role of monetary policy'. In Sims (1972), the causality and neutrality between money and income in the U.S. are considered in a vector autoregressive framework. His findings were that causality is unidirectional from money to income and that the neutrality hypothesis is rejected, thereby indicating a significant relationship between real GNP and the monetary base. Several years later, in Sims (1980), the neutrality of money in the U.S. was tested using both inter-war and post-war data. The outcome that the neutrality hypothesis is rejected for both periods was consistent with his earlier findings.

More recently, King and Watson (1992) applied their test for the long-run neutrality of money, under different structural assumptions, to seasonally adjusted quarterly U.S. data. They found that the post-war data were consistent with the neutrality hypothesis.

The seminal research by Fisher and Seater (1993), who found that long-run neutrality was rejected by U.S. annual data for the period 1869 to 1975, has led to numerous subsequent investigations. For example, Boschen and Otrok (1994) and Olekalns (1996) adopted Fisher and Seater's approach to analysing the money supply - output relationship in the U.S. and Australia, respectively, accommodating structural breaks with split samples and dummy variables. It was observed that the outcomes of the tests were not robust to structural breaks. Leong and McAleer (1996) tested the sensitivity of Fisher and Seater's approach to seasonal fluctuations using both seasonally unadjusted and adjusted Australian data, and found that the explicit modelling of seasonality did not alter qualitatively the results in Olekalns (1996).

Various econometric procedures are available for testing the neutrality hypothesis. The empirical testability of the hypothesis is important for policy formulation and design, such as the effectiveness of monetary policy. In the present paper, several types of short-run and long-run neutrality will be evaluated using postwar Japanese data, adopting both the Fisher and Seater ARIMA approach and the Johansen cointegration approach.

Okina (1986) surveyed empirical research based on the new classical hypothesis of Lucas-Sargent-Wallace using Japanese macroeconomic data. Drawing on the empirical research of Taniuchi (1982), Parkin (1984), and Hamada and Hayashi (1985), Okina rejected the neutrality of money hypothesis.

The purpose of this paper is to compare and contrast two approaches to testing the short- and long-run neutrality hypotheses, with an explicit focus of modelling a structural break which is present in the data. The plan of the paper is as follows. In Section 2, the neutrality of money is defined. Section 3 considers the issue of pre-testing and the characteristics of the data used in the empirical analysis. The formal empirical framework of Fisher and Seater is discussed in Section 4, and Section 5 considers the Johansen cointegration approach to test the various hypotheses. Some issues relating to the long-run superneutrality of money are raised in Section 6. Concluding comments are presented in Section 7.

2. THE NEUTRALITY OF MONEY

The key feature of the classical model, which underlies the long-run neutrality of money, is perfect foresight. In the long-run, when the labour force has had sufficient time to revise errors in its expectations-formation mechanisms, there is an absence of money illusion. Consequently, the aggregate supply curve is vertical. In an expansionary monetary policy regime, a perfectly inelastic supply schedule implies that the general price level will increase, with no change in equilibrium employment and the nominal interest rate. Hence, an increase in the nominal money supply has the effect of equi-proportionate increases in the price level, so that real money supply, real output and the nominal interest rate remain unchanged.

A formal definition of the long-run neutrality (LRN) of money is that permanent, exogenous changes to the level of money supply have no effect on the level of real output and the nominal interest rate in the long run. As real money balances remain unchanged under the neutrality hypothesis, there will be a one-to-one correspondence between money and the price level, ensuring that real magnitudes do not change.

Also consistent with classical macroeconomics is the absence of neutrality in the short run. In the short to medium term, when expectations of the price level are naive, money illusion is prevalent among economic agents. Thus, there is scope for discretionary monetary policy to control the economy in the short run, but not in the long run. This hypothesis is also tested in the paper.

3. PRE-TESTING AND CHARACTERISTICS OF THE DATA

In evaluating the various neutrality hypotheses for Japan, quarterly seasonally adjusted data are used for the period 1955Q2 to 1990Q3. The variables considered are:
1) real GNP (y);
2) nominal money supply (m), which is defined as money supply M2 plus the certificates of deposit: M2 comprises cash in circulation, deposit money, and quasi-money (the total of private and public deposits, less demand deposits);
3) nominal interest rate (r); and
4) the price level, namely the GNP deflator for Japan.
As in standard in the literature, all variables except the nominal interest rate are transformed using natural logarithms.

The time series of the variables suggest a structural break between 1973 and 1975, with both real GNP and the nominal money supply having kinks in the data during this period. There is a period between 1973Q4 and 1975Q1 during which real GNP did not seem to grow. A similar pattern can be observed for the money supply and price level. After 1973, the nominal interest rate exhibits cyclical behaviour. Kitasaka (1993) presents evidence that a structural change was prevalent in the Japanese economy in the early 1970s, which largely coincides with the first OPEC oil price shock. For the empirical analysis of the various neutrality concepts, the data from 1955Q2 to 1990Q3 cannot be taken as a single regime. Hence, two sub-samples of 1955Q2-1973Q2 (pre-shock) and 1975Q1- 1990Q3 (post-shock) are used.

Both the ARIMA and cointegration approaches to testing the neutrality of money depend on the orders of integration of the variables. Using the two sub-samples, augmented Dickey-Fuller (ADF) tests are used to determine the orders of integration of the variables y, m, p and r. The ADF test is based on the auxiliary regression:

$$\Delta y_t = \mu + \beta y_{t-1} + \sum_{j=1}^{J} \delta_j \Delta y_{t-j} + u_t$$

where the test statistic is the t-statistic of the OLS estimate of β, which follows a non-standard Dickey-Fuller distribution. J is the number of lags of the dependent variable (y), included so as to remove any serial correlation in the error term.

The outcomes of the ADF tests for the two sub-samples are presented in Table 1, where the results suggest that all the variables considered are I(1) in both sub-samples, with the exception of the nominal interest rate for the pre-shock period, which is I(0).

Seasonally adjusted data are considered in this paper, so that no residual seasonality should be present. The HEGY test for seasonal integration is performed, and the results (available upon request) indicate that there is no stochastic seasonality in the data. Hence, the use of the ADF test for a unit root at the zero frequency is appropriate for seasonally adjusted data.

4. THE ARIMA FRAMEWORK

Following the approach developed by Fisher and Seater (hereafter FS), it is assumed that the relationship between the two variables, namely the nominal money supply and either real GNP, the price level, or the nominal interest rate, can be represented by a stationary and invertible bivariate log-linear ARIMA model. The focus variables are m_t, which represents the natural logarithm of nominal money supply, and x_t, which represents the natural logarithm of one of real output, the price level, or the nominal interest rate.

The model is given as follows:

$$\begin{aligned} a(L)(1-L^{<m>})m_t &= b(L)(1-L^{<x>})x_t + u_t \\ d(L)(1-L^{<x>})x_t &= c(L)(1-L^{<m>})m_t + v_t \end{aligned} \qquad (1)$$

where L is the lag operator, a(L), b(L), c(L) and d(L) are distributed lag polynomials, and <m> and <x> are, respectively, the orders of integration of the money stock and the other variable of interest, namely y, p, or r. The vector $(u_t\ v_t)'$ is assumed to be independently and identically distributed. For the distributed lags a(L) and d(L), it is convenient to set the initial values $a_0 = d_0 = 1$, while the parameters b_0 and c_0 are not restricted. Equation (1) can be rewritten as

$$(1 - a_1L - a_2L^2 - \ldots - a_kL^k)(1 - L^{<m>})m_t =$$
$$(b_0 - b_1L - b_2L^2 - \ldots - b_kL^k)(1 - L^{<x>})x_t + u_t$$

$$(1 - d_1L - d_2L^2 - \ldots - d_kL^k)(1 - L^{<x>})x_t =$$
$$(c_0 - c_1L - c_2L^2 - \ldots - c_kL^k)(1 - L^{<m>})m_t + v_t.$$

This system of equations reflects the interaction between m_t and x_t, with k being the autoregressive lag length.

For the test of LRN, the parameters of the second equation in (1) are of interest, in which the stationary values of x over time are explained by stationary values of m over time. Thus, a test for the LRN of money can be derived from the normalised coefficients of the endogenous explanatory variables. This leads to the concept of the Long-Run Derivative (LRD), which is a measure of the dynamics of the partial effects of m_t on x_t. With $z_t \equiv (1 - L^j)x_t$ and $w_t \equiv (1 - L^i)m_t$, where i and j equal 0 or 1, the general form of the LRD is given by:

$$LRD_{z,w} = \lim_{k\to\infty} \frac{\partial z_{t+k} / \partial u_t}{\partial w_{t+k} / \partial u_t}$$

where $\lim_{k\to\infty} \partial w_{t+k} / \partial u_t \neq 0$. Apart from the mathematical requirement that this inequality has to hold for the LRD to be defined, the inequality implies that there must be permanent stochastic shocks to the money supply, otherwise LRN cannot be considered.

The numerator of the LRD provides a measure of the ceteris paribus effect of a shock to the money supply on real output, the price level or the nominal interest rate. This shock can be regarded as an exogenous monetary disturbance. Similarly, the denominator of the LRD provides a measure of the ceteris paribus effect of a shock to the money supply on the money supply variable itself.

Thus, the LRD can be expressed as

$$LRD_{z,w} = \lim_{k\to\infty} \frac{\partial z_{t+k}}{\partial w_{t+k}}$$

which is interpreted as the long-run impact on real output, the price level, or the nominal interest rate, of a monetary disturbance, that is, unanticipated changes in the nominal money stock. The specific value of the LRD depends on <m> and <x>, namely, the orders of integration of m_t and y_t, p_t, or r_t.

Of particular interest in examining the LRN of money is the case where $<x> = <m> = 1$. This case is important because it implies that there are permanent changes in both m_t and x_t. Using the impulse response representation of the ARIMA system, FS determined the values of the LRD under the LRN hypothesis to derive implications that are empirically testable. Specifically, when $<w> - <z> = 0$, or when $<x> = <y> = 1$, $LRD_{z,w} = c(1)/d(1)$. The LRN of money can now be defined in terms of the LRD: money (any nominal variable m except for the nominal interest rate) is long-run neutral with respect to output, the price level, or the nominal interest rate, if $LRD_{y,m} = 0$.

The ARIMA approach to LRN is appealing because it involves a time series model and does not require any structural assumptions; specifically, the parameters of the distributed lags c(L) and d(L) need not be estimated. When the error terms u_t and v_t in the ARIMA model are uncorrelated, or when money is exogenous, c(1)/d(1) is the coefficient in a regression of $(1-L^{<x>})x_t$ on $(1-L^{<m>})m_t$. Hence, the term c(1)/d(1) can be approximated by $\lim_{k\to\infty} \beta_k$, where β_k is the slope coefficient in the following regression:

$$\left[\sum_{j=0}^{k}(1-L^{<x>})x_{t-j}\right] =$$

$$\alpha_k + \beta_k\left[\sum_{j=0}^{k}(1-L^{<m>})m_{t-j}\right] + \varepsilon_{kt}. \qquad (2)$$

From the above specification, $\hat{\beta}_k$ is, in fact, the Bartlett estimator of the frequency-zero regression coefficient, where the Bartlett estimator is the infinite limit of the slope coefficient . If $<m> = <x> = 1$, which is the case applicable for testing LRN, the estimator is the slope coefficient in

$$(x_t - x_{t-k-1}) = \alpha_k + \beta_k(m_t - m_{t-k-1}) + \varepsilon_{kt}. \qquad (3)$$

Equation (3) is estimated for the two sub-samples, with x given as real GNP (y), the price level (p), or the nominal interest rate (r). Outcomes for LRN can be observed by examining a plot of the estimates of β_k against the lag length, k, for the two sub-samples. The plots are presented in Figures 1 - 5 for the money supply and the other three variables considered, with the starting value of k being 2 and the terminal value set at 30. Of primary interest in the estimation of equation (3) is the estimated value of β_k. As such, the residuals from the regression for the various lags may be non-spherical, possibly leading to biased t-ratios and outcomes of the LRN tests. Following FS, the 95 percent confidence intervals derived for the estimated coefficient of money supply are obtained using standard errors that are adjusted using the Newey-West (1987) procedure. The t-distribution with n/k (n = 73 for the sample 1955Q2-1973Q2 and n = 63 for the sample 1975Q1-1990Q3) degrees of freedom is used to construct the confidence intervals.

The pre- and post-shock outcomes indicate that money is neutral with respect to real GNP. In Figures 1 and 2, the plots of the estimated values of β_k converge toward zero. The confidence interval bands include zero for all lag lengths in the pre-shock sample, and include zero in the post-shock sample for high values of k. This suggests that money does not affect real GDP in the long-run. With reference to the LRD, its zero value is warranted empirically.

With regard to the long-run effect of money on the nominal interest rate, consider Figure 3. In the pre-shock sample, the nominal interest rate was found to be stationary, in which case determination of LRN is immediate as money is neutral with regard to the nominal interest rate. The intuition is that permanent changes in the level of money supply cannot be associated with permanent changes in the interest rate because the interest rate is stationary. Thus, no testing within the ARIMA framework is necessary to determine neutrality in the pre-shock sample. In the post-shock sample, the confidence interval bands include zero for all lags, which suggests that permanent, exogenous changes to the level of money supply ultimately leave the nominal interest rate unchanged. This serves to support the standard IS-LM model of macroeconomics.

In testing the proposition that *real* money balances remain unchanged in the long-run as a result of a monetary disturbance, consider Figures 4 and 5. In this case, equation (3) is estimated with x as the price level. The outcome before the shock is that money is neutral with respect to prices, which is inconsistent with classical macroeconomics. However, after the shock there is evidence that money is not neutral with respect to prices. The lower confidence interval band rises slightly above zero at high lags, indicating that there is a non-zero effect on prices as the money supply increases. In fact, the confidence interval bands include one for all values of k, thereby providing support for the one-to-one relationship between nominal money supply and the price level in the long run. The LRD is non-zero after 1975, indicating the sensitivity of the results to the oil price shock of 1973/1974. Given the neutrality outcome with respect to price changes before and after the oil price shock, it would appear that Nelson and Plosser's (1982) claim that the oil price shock is a significant event in economic history is clearly warranted.

5. COINTEGRATION APPROACH

A potential problem with the ARIMA approach is that only two variables can be considered at one time in testing the neutrality hypothesis. Moreover, by its very nature, the ARIMA approach is not designed to test the short-run neutrality hypothesis. An alternative approach to test the hypothesis, namely the Johansen cointegration approach, is appealing because it considers a vector autoregressive framework which can accommodate the interactions between real GNP, the nominal money supply, the price level, and the nominal interest rate. In addition, the use of an error correction model for the variables permits an analysis of the short-run neutrality hypothesis.

Consider two time series y and x, where both series are I(1). If the scalar β exists such that $y_t - \beta x_t$ is stationary, the two variables y and x are cointegrated. The intuition for testing the neutrality hypothesis is that, if the nominal money supply and real output are cointegrated, for example, money is not neutral with respect to real output in the long run because the two series are linearly related.

The neutrality of money hypothesis can be tested using cointegration analysis on the function y = f(m, p, r) for the two estimation periods, namely 1955Q2 - 1973Q2 and 1975Q1 - 1990Q3.

In analysing the short-run neutrality hypothesis, the error correction representation of the model can be used. The dynamic relationship comprises the long-run equilibrium component, plus a short-run error correction component. In the Johansen and Juselius (1990) framework, a test for the statistical significance of the error correction component constitutes a test of the short-run neutrality of money.

For implementing the Johansen maximum likelihood estimation and cointegration likelihood ratio tests, a vector autoregressive model of order 4 is considered.

In the first sub-sample, it is found that the nominal interest rate (r) is I(0). Using Johansen's approach to determine the cointegration rank, both the maximal eigenvalue and trace tests indicate that there is one cointegrating relationship among the four variables, namely $y = -0.00081m + 1.922p$.

Hypothesis testing for the significance of the coefficients of y, m and p can reveal the exact nature of the cointegrating relationships between the variables. The relevant LR test statistics for a zero restriction on the three appropriate variables are as follows (with probability values in brackets):

p: $\chi^2(1) = 14.42$ [0.000];

m: $\chi^2(1) = 0.00031$ [0.996];

y: $\chi^2(1) = 9.38$ [0.002].

The test outcomes suggest that the price and income effects are significant in the long run in a vector autoregressive framework. Of interest is the empirical result for money, where the LR test suggests that a zero restriction on the coefficient of money is not rejected, thereby indicating that money is neutral in the long run.

Short-run neutrality of money can be examined via the error correction formulation for the variables. With respect to real GNP, the empirically adequate error correction model is as follows:

$$\begin{aligned}\Delta\hat{y}_t = {} & -1.729 - 0.439\Delta y_{t-1} - 0.043\Delta y_{t-2} \\ & - 0.042\Delta y_{t-3} - 0.302\Delta m_{t-1} - 0.029\Delta m_{t-2} \\ & + 0.556\Delta m_{t-3} + 0.211\Delta p_{t-1} - 0.100\Delta p_{t-2} \\ & + 0.082\Delta p_{t-3} - 0.030ECM_{t-1}.\end{aligned}$$

The t-statistic for the error correction term is -2.273 which, at the 5 percent level, is statistically significant. This implies that, in the short run, money is not neutral.

Overall, the findings for the pre-shock period of 1955Q2 - 1973Q2 are that money is neutral in the long run, but not the short run. This is consistent with classical macroeconomics whereby money illusion is prevalent in the short run, so that money is not neutral. In such cases, monetary policy can be effective in influencing the business cycle. However, when expectations are realised and there is perfect foresight in the long run, money is neutral, thereby rendering monetary policy ineffective in controlling the economy. Thus, the pre-shock Japanese economy is dichotomous in the long run.

For the second regime, namely the post-shock period of 1975Q1 - 1990Q3, Johansen's cointegration test found three cointegrating relationships among the four I(1) variables, namely y, m, p and r. The cointegrating relationships, normalised with respect to real GNP, are as follows:

$y = 0.268m + 1.006p - 0.038r$;

$y = 0.475m - 0.150p - 0.002r$;

$y = 0.730m - 1.876p - 0.087r$.

With three cointegrating relationships for the four variables, the LR tests of the zero restrictions on the cointegrating vectors are as follows (with probability values in brackets):

p and r: $\chi^2(6) = 21.71$ [0.001];

m: $\chi^2(3) = 13.35$ [0.004];

y: $\chi^2(3) = 16.42$ [0.001].

These results suggest that the joint price and interest rate effect is significant in the cointegrating relationships. Real GNP is also statistically significant in the long run. Of special interest is the effect of the nominal money supply. In contrast to the pre-shock period, money is not long-run neutral in the period 1975Q1 - 1990Q3.

The empirically adequate error correction representation for real GNP is:

$$\Delta\hat{y}_t = 1.572 - 0.267\Delta y_{t-1} - 0.189\Delta y_{t-2} - 0.195\Delta y_{t-3} + 0.155\Delta m_{t-1} + 0.207\Delta m_{t-2} + 0.015\Delta m_{t-3} - 0.271\Delta p_{t-1} + 0.229\Delta p_{t-2} - 0.173\Delta p_{t-3} - 0.001\Delta r_{t-1} - 0.001\Delta r_{t-2} + 0.011\Delta r_{t-3} - 0.009ECM_{t-1} + 0.013ECM_{t-2} - 0.013ECM_{t-3}.$$

A test of zero restrictions imposed on the three error correction terms yields the statistic $\chi^2(3) = 11.379$ [0.010], which is significant at the 5 percent level. Hence, money is not neutral in the short run in the period 1975Q1 - 1990Q3. To summarise, in the post-shock period, money is not neutral in either the short run or the long run, and the policy implication is that monetary policy is effective in controlling the economy. Hence, in the post-shock period, there appears to be scope for the Japanese monetary authority to influence real variables.

6. THE SUPERNEUTRALITY OF MONEY

The theory of the long-run superneutrality of money has been somewhat overshadowed by the neutrality concept in the rapidly expanding monetary economics literature. A formal definition of the long-run superneutrality of money is that permanent, exogenous changes to the growth rate of money supply ultimately leave the level of real output unaffected, but lead to equal changes in the nominal interest rate.

Money can be superneutral with respect to real output in periods of hyperinflation, when there are rapid changes in the growth rates of money and prices. Empirical testing of the superneutrality concept can be accommodated within the ARIMA and cointegration frameworks considered in this paper.

In the ARIMA framework of Fisher and Seater, superneutrality of money implies that the long-run derivative $LRD_{x,\Delta m} = \lim_{k\to\infty} \frac{\partial x_{t+k}}{\partial \Delta m_{t+k}} = 0$ if x is real GDP (y), and $LRD_{x,\Delta m} = 1$ if x is the nominal interest rate (r). Hence, the counterpart of equation (3) for testing the superneutrality hypothesis is:

$$(x_t - x_{t-k-1}) = \alpha_k + \beta_k(\Delta m_t - \Delta m_{t-k-1}) + \varepsilon_{kt}.$$

Following the definition of long-run superneutrality of money above, the superneutrality hypothesis is testable only if there are permanent, stochastic changes to the growth rate of nominal money supply. Permanent stochastic changes in the growth rate of money imply that $\Delta m_t \sim I(1)$. Consequently, money supply must be I(2) for the superneutrality proposition to be empirically testable.

In both the pre- and post-shock periods considered in this paper, the nominal money supply is I(1). Therefore, the superneutrality hypothesis is rejected by the data and nominal money supply is not superneutral with respect to real output, an outcome which is consistent with previous empirical work. For example, Fisher and Seater (1993) considered monthly data from the German hyperinflationary episode following World War I. Preliminary testing determined that the money supply is I(2) and real money balances are I(1), so that the long-run superneutrality proposition is testable. Using the ARIMA approach, it was found that money is not superneutral with respect to real balances in Germany.

7. CONCLUDING REMARKS

This paper has considered the neutrality of money hypothesis in Japan. Fisher and Seater's (1993) ARIMA modelling approach and Johansen's cointegration testing approach are used with quarterly seasonally adjusted data. As there is a structural break associated with the first OPEC oil price shock, two sub-samples are considered to avoid the potential bias associated with ignoring the break.

In the pre-shock period, the ARIMA modelling approach found that money is neutral with respect to real GNP and the nominal interest rate. However, there does not appear to be an equi-proportionate relationship between nominal money supply and the price level in the long run. In the post-shock period, money is found to be neutral with respect to real GNP and the nominal interest, but not with respect to prices.

With the cointegration approach, it is found that money is long-run neutral with respect to real GNP in the pre-shock period, which is consistent with the outcome of the ARIMA approach. However, in the post-shock period, it is found that money is not long-run neutral with respect to real GNP. The error correction representation enables an analysis of short-run money neutrality. In both periods, it is found that the nominal money supply is not short-run neutral with respect to real output in Japan. As the money supply is not integrated of order two, the long-run superneutrality of money hypothesis is rejected by the data.

The differing outcomes of the ARIMA and cointegration approaches suggest that greater attention should be devoted to alternative econometric estimation and testing approaches because the findings have important policy implications.

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TABLE 1: ADF Test Statistics for Pre-shock and Post-shock Japan

(a) Pre-shock: 1955Q2 - 1973Q2

Variable	Trend	Lag	ADF Statistic	Order of Integration
y	yes	0	-2.53	1
Δy	no	0	-10.61	0
m	yes	1	-2.40	1
Δm	no	2	-11.30	0
p	yes	0	-1.87	1
Δp	no	0	-7.11	0
r	yes	1	-5.64	0
Δr	no	3	-6.30	0

(b) Post-shock: 1975Q1 - 1990Q3

Variable	Trend	Lag	ADF Statistic	Order of Integration
y	yes	2	-0.23	1
Δy	no	0	-8.52	0
m	yes	0	-3.51	1
Δm	no	0	-5.00	0
p	yes	3	-3.20	1
Δp	yes	2	-6.62	0
r	yes	1	-3.38	1
Δr	no	1	-3.82	0

FIGURE 1: Money on GNP (1955Q2-1973Q2)

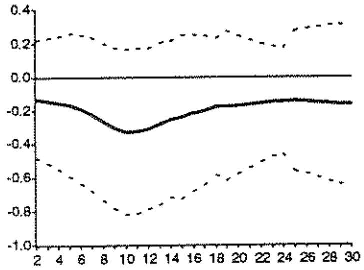


FIGURE 2: Money on GNP (1975Q1-1990Q3)

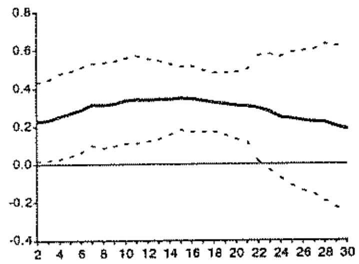


FIGURE 3: Money on Int. (1975Q1-1990Q3)

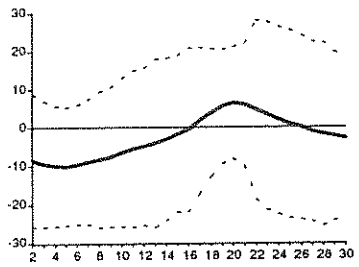


FIGURE 4: Money on Price (1955Q2-1973Q2)

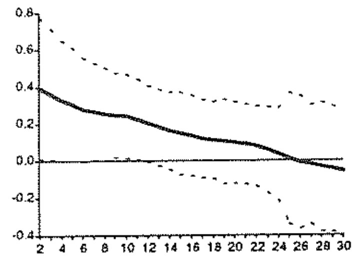
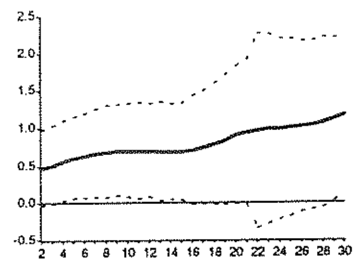


FIGURE 5: Money on Price (1975Q1-1990Q3)



Note: The solid lines are plots of the estimated coefficients over the lag length (k). The dotted lines represent the 95 percent confidence intervals.