CAUSALITY LINK BETWEEN MONEY, OUTPUT AND PRICES IN MALAYSIA: AN EMPIRICAL RE-EXAMINATION

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Abstract

This paper re-examines the causality relationship between monetary aggregates, output and prices in the case of Malaysia. The study is based upon a vector autoregression (VAR) model applying the Granger no-causality procedure developed by Toda and Yamamoto (1995). The results indicate a two-way causality running between monetary aggregates, M2 and M3 and output which is consistent with theoretically conjecture by Keynesian and Monetarist views whereas there is a one-way causality running from monetary aggregate, M1 and output. In addition, the results suggest that all monetary aggregates have a strong one-way causality running from money to prices but no evidence for the opposite causality. Thus, the results add the empirical support to the argument in the literature that inflation is a monetary phenomenon.

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Keywords: money-output, causality, Toda-Yamamoto, prices

1. Introduction

The questions whether money causes output and prices appear to be important for many economists working in the area of macroeconomics. The direction of causation between money and output is an important issue for many policymakers and economists since it reveals appropriate monetary policy. The linkages have been focused extensive debate and analysis macroeconomics literature has been the precise relationship between money and output (Blanchard, 1990; Lucas, 1996; Sargent, 1996). Theoretically, models are constructed to show that money can affects output via different channels, including unanticipated monetary shocks, real and nominal rigidities and menu costs. Most economists accept that the causal ordering runs from nominal monetary aggregates to nominal income. However, the issue of how variation in nominal income is manifested between real output and prices remains unresolved.

The motivation of this study comes firstly from the fact that despite the importance of the monetary aggregate to the Malaysian economy, there are only a few macroeconomic studies performed in this area of research in the case of Malaysian economy. The present study thus addresses an important gap in the literature. Secondly, in order to appraise the effectiveness of the conduct of monetary policy in Malaysia, it is therefore essential to conduct a formal analysis on the issue of why does money influence output or vice versa. This study thus attempts to provide empirical evidence on the causality relationship between monetary aggregates, output and prices. By utilising the causality test proposed

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by Toda and Yamamoto (1995) the relationship is investigated over the longer period 1979 to 2000 to take into account the changes in policy regimes.

This paper also seeks to find out which of these theories is more in accord with the fast-growing Malaysian economy. Hence, the paper raises two important fundamental questions. 1) Did the money supply process in Malaysia contribute to the changes in output and prices and vice-versa 2) What is the implication of this relationship between monetary aggregate, output and prices with respect to the conduct of monetary policy in Malaysia. This paper is organised as follows. Section 2 and 3 reviews the theoretical framework and previous empirical studies on money-output relationship. Section 4 describes data set and methodology, and also presents estimation results. Finally Section 5 provides conclusions and policy implications.

2. Theoretical framework

There are two very different theories which explain the direction of causation. The first, monetary-business-cycle theory explains that changes in growth of the money supply cause changes in output growth, i.e., money causes output. Models in this category are known as new Keynesian models or sticky-wage models, which consider wage contracts as a central feature of the economy. Individuals sign long-term wage contracts that fix their money wage over the length of the contract. If money supply grows at a faster rate than it was predicted at the time of the contract negotiation, inflation will be higher than expected, so individuals' real wage will decrease. This, in turn, influences firms' behavior and they demand for more workers, which leads an increase in the economy's output. Thus, the sticky-wage theory with unanticipated changes in money describes a positive relationship between money growth and output growth (Fisher, 1977; Taylor, 1980).

Another explanation by monetary-business-cycle theorists for non-neutrality of money stems from a class of models known as imperfect information models (Lucas, 1975; Barro, 1976). These models explain that monetary changes can have real effects because individuals have limited information and thus may misperceive aggregate and relative changes. In other words, in these models, if the money supply increases, prices will tend to rise throughout the economy but individuals attribute part of the price increase to a shift in demand toward their own product and away from the goods produced by other sectors. This implies that an increase in the relative demand as a result of the misperception leads to a rise in production.

The second, real-business-cycle theory, differs primarily in the direction of causation between money growth and output growth. Real business-cycle-models assign a causal role to real economic activity in affecting money supply. That is, changes in output growth cause changes in growth of the money, not vice versa. Shocks can affect supplies of real resources and relative prices that individuals expect to face over time. These shocks include technological innovations, other sources of productivity changes, environmental conditions, the world price of energy, developments in the labour market, and government spending and taxes. Thus, in real business-cycle-theory, output growth is determined by real shocks, not by money growth (Kydland and Prescott, 1982; Long and

Plosser, 1983). In real-business-cycle-models, money is related to output because it reacts to the same real shocks that output responds to.

The advocates of real-business-cycle models offer two reasons why money reacts to real shocks. The first reason rests on the idea that developments in the real sectors of the economy influence individuals' financial decisions. This, in turn, affects the quantity of money demanded. So long as the financial system reacts to the changes in money demand, changes in output growth create changes in money growth. This implies that output causes money, not vice versa. The second reason stems from the assumption that individuals have information about economic activity that cannot be quantified. For example, higher expected output might create a rise in the demand for money and credit. Policymakers will permit the money supply increase to accommodate the rise in money demand so that interest rate does not change. This implies that there is a unidirectional causality between output growth and money growth, running from output to money supply.

3. Empirical studies

The money-output relationship has been documented by casual and rigorous empiricism in a number of studies employing a variety of data sets. Sophisticated empirical models have been devised to examine the implication of anticipated and unanticipated (Barro, 1977), positive and negative (Cover, 1992; Thoma, 1994), and large and small monetary shocks (Ravn and Sola, 1996) on output fluctuations. While some studies have supported unidirectional causality, running from money to income (Sims 1972; Devan and Rangazar, 1987), other studies have provided evidence on unidirectional causality, running from income to money (Cuddington, 1981; King and Plosser, 1984). There is also empirical evidence of bi-directional causality between money and output for a number of countries (Hayo, 1999).

However, the existing empirical evidence based on testing of causality between money growth and output growth is, at best, mixed and contradictory (Ahmad, 1993; Hayo, 1999). The instability of results in Granger causality test simply stems from (i) whether the variables are modelled as (log-) level variables or growth rates (Christiano and Ljungquist, 1988) and (ii) whether they are modeled as trend- or difference stationary (Hafer and Kutan, 1997). Christiano and Ljungquist (1988) argue in favour of using level variables, since they find that power of the tests on growth variables is very low. Hafer and Kutan (1997) assert that the variables, which are assumed to be trend stationary, money Granger causes output and if the variables are assumed to be difference stationary, output Granger causes money.

While there has been much of empirical work on the linkages between money and economic activity in industrialised countries, there have been few analyses for fast growing Malaysian economy. These analyses include Tan and Baharumshah (1999) and Tan and Cheng (1995) who examined the bi-variate causal relationship between the important macroeconomic variables. These studies to some extend have contributed to the understanding of the direction of money-output causality in Malaysia but only utilised a short time-framework.

4. Data and model specification

The VAR model is estimated using monthly data in logarithms term except interest rate over the period 1979 – 2000. The size of the VAR model requires quarterly rather than annual series to generate enough degree of freedom for estimation. Thus, by using monthly data would improve the degree of freedom and reduce small sample bias. The data source is from Monthly Statistical Bulletin published by Bank Negara Malaysia. Based upon the review in the previous section, the money-output-prices hypothesis are tested according to four macroeconomic variables which is built upon the following augmented money-output function:

$$M_t = f\,(Y_t\,, P_t\,, R_t) \tag{1}$$

where M_t is monetary aggregates (*m1, m2, m3*); Y_t is industrial production index as a proxy for output; R_t is interest rates; and P_t is consumer price index. All variables are transformed into log-formed except interest rates.

Testing for Granger no-causality in multiple time series has been the subject of considerable recent research in the literature of econometrics. It has been argued that the traditional F-test in a regression context for determining whether some parameters of the model are jointly zero, for instance in the form of a causality test (in a stable VAR model), is not valid when the variables are integrated and the test statistic does not have standard distribution (Gujarati, 1995). Therefore, several alternative procedures have been developed attempting to improve the power of Granger no-causality tests (Toda and Phillips, 1993). Unfortunately, these tests are cumbersome and the simplicity and ease of application have been largely lost (Rambaldi and Doran, 1996).

The advantage of using Toda and Yamamoto's (1995) method of testing Granger causality lies in its simplicity and the ability to overcome many shortcomings of alternative econometric procedures - some studies have applied the cointegration technique by Johansen and Juseliues (1990). However, this method involves transforming the suggested relationship into an Error Correction Model (ECM) and identifying the parameters associated with the causality. If the case involves more than two cointegrating vectors, this is not simple. Further, there is growing concern among applied researchers that the cointegration likelihood ratio (LR) tests of Johansen (1988) and Johansen and Juselius (1990) have often not provided the degree of empirical support that might reasonably have been expected for a long-run relationship.

The procedure developed by Toda and Yamamoto (1995) utilises a modified WALD test for restrictions on the parameters of a VAR (k), or MWALD procedure (where k is the lag length in the system). This test has an asymptotic χ^2 distribution when a VAR (k + d_{max}) is estimated (where d_{max} is the maximal order of intergration suspected to occur in the system). Zapata and Rambaldi (1997), provides evidence that the MWALD test has comparable performance in size and power to the LR and WALD tests if (i) the correct number of lags for estimating k + d_{max} is identified and (ii) no important variables are omitted, provided a sample of 50 or more observations is available.

Rambaldi and Doran (1996) have proved that the MWALD method of testing Granger no-causality can be computationally simple by using a Seemingly Unrelated Regression (SUR). To examine the causality from money, output and prices, our structural VAR model consists of output (Y), prices (P) monetary aggregates (M^i) and interest rates (R). All variables are transformed into logarithm form. We have therefore built the following four variables VAR system in a SUR form:

$$\begin{bmatrix} M_t^i \\ Y_t \\ P_t \\ R_t \end{bmatrix} = A_0 + A_1 \begin{bmatrix} M_{t-1}^i \\ Y_{t-1} \\ P_{t-1} \\ R_{t-1} \end{bmatrix} + A_2 \begin{bmatrix} M_{t-2}^i \\ Y_{t-2} \\ P_{t-2} \\ R_{t-2} \end{bmatrix} + ... + A_k \begin{bmatrix} M_{t-n}^i \\ Y_{t-n} \\ P_{t-n} \\ R_{t-n} \end{bmatrix} + \begin{bmatrix} \varepsilon_m \\ \varepsilon_y \\ \varepsilon_p \\ \varepsilon_r \end{bmatrix} \qquad (2)$$

where M_t^i is money supply with $i = M1$, $M2$ and $M3$, A_0 is an identity matrix and $E(e_t) = [\varepsilon_m \, \varepsilon_y \, \varepsilon_p \, \varepsilon_r]' = 0$ and $E(\varepsilon_t \varepsilon_t') = \Sigma$ and the null hypothesis is $H_0 : \alpha_1^{12} = \alpha_2^{12} = ... = \alpha_k^{12} = 0$ where α_j^{12} the coefficients of M_t^i in the first equation of the system. The existence of a causality from money supply (m_t^i) to output (y_t) can be established through rejecting the above null hypothesis which requires finding the significance of the MWALD statistic for the group of the lagged independent variables identify above. A similar testing procedure can be applied to the alternative hypothesis for reverse causality running from output (Y_t) to money supply (M_t^i), is to test $H_0 : \alpha_1^{21} = \alpha_2^{21} = ... = \alpha_k^{21} = 0$, where α_j^{21} are the coefficients of Y_t, in the second equation of the system. In addition, a similar procedure can also be used to test the non-causality from interest rate to output and prices.

The advantage of this procedure, as argued by Zapata and Rambaldi (1997) is that it does not require the knowledge of cointegration properties of the system. It has a normal standard limiting chi-square distribution and a usual lag selection procedure to the system can be applied, even though there is no cointegration, stability and rank condition are not satisfied so long as the order of the integration of the process does not exceed the true lag length of the model. In addition, Toda and Yamamoto (1995) have shown how VARs can be estimated using data in levels and testing general restrictions even if the process may be integrated or cointegrated of an arbitrary order.

It should be added that by using a SUR type VAR model, we can compromise between theory-driven and data-driven approaches, since we have included the relevant set of variables in our VAR system following the recent literature and at the same time, the simultaneity bias can be overcome by the VAR model. Gujarati (1995) points out that the VAR model is truly a simultaneous system in that all variables regarded as endogenous considering the feedback effects in the system that it can be estimated using OLS without resorting to any system methods such as two-stage least squares (2SLS).

5. Empirical results

Prior to testing for a causality relationship between the time series, it is necessary to establish whether they are integrated of the same order. To this end, the Augmented Dickey-Fuller (ADF) and Philips-Perron tests (PP) test were carried out on the time series in levels and differenced forms. We carry out the tests on monthly time series of monetary aggregates, output, and prices for Malaysia for the period 1979 to 2000. If we accept the null hypothesis that a time series is non-stationary (has at least one unit root), we then re-apply the procedures after transforming the series into the first differenced forms. If the null hypothesis of non-stationarity (when the time series is expressed in the first differenced form) can be rejected, we then may establish that the time series is integrated of order one. The number of the lags included was determined using Akaike Information Criteria (AIC). In order to confirm the results of the traditional unit root test, the variables are also subjected to further examination by means of the stationary test suggested by Kwiatkowski *et al.* (1992).

Table 1 reports the results for testing the null hypothesis of unit root using ADF tests with constant and time trend variables as well as constant without time trend variables were included in the regression.

Table 1. Results of Unit Root Tests: 1979 - 2000

Variable	***Augmented Dickey-Fuller (ADF) and Philips-Perron (PP)***			
	Level		***First Difference***	
	Constant	***Constant & trend***	***Constant***	***Constant & trend***
M3	-0.469 [15] -1.887 [7]	-2.484 [12] -1.562 [7]	-3.192 15]** -14.253 [6]**	-3.496 [15]** -14.393 [6]**
M2	0.408 [12] 0.989 [3]	-2.020 [12] -1.590 [3]	-2.970 11]** -14.967 [2]**	-3.725 [11]** -14.976 [2]**
M1	0.116 [15] 0.019 [12]	-2.495 [15] -2.067 [8]	-3.627 15]** -16.357 12]**	-3.626 [15]** -16.273 [12]**
Y	-0.085 [13] -0.137 [10]	-3.973 [14] -7.891 [9]	-4.488 15]** -36.292 [9]**	-4.523 [15]** -36.304 [9]**
P	0.886 [12] 2.067 [4]	-2.963[12] -2.309 [4]	-2.892 11]** -14.986 [5]**	-3.945 [11]** -15.115 [4]**
R	-2.868 [1] -2.777 [6]	-2.797 [1] -2.072 [6]	-14.387 [0]** -15.446 [5]**	-14.438 [0]** -14.454 [4]**

Notes: ** denotes statistically significant at 5 percent level. Number in brackets [ ] are the lag lengths based on Akaike Information Criteria (AIC). The critical values for rejection of the ADF tests are –2.86 (constant) and –3.41 (constant and trend) of significance level of 5 percent.

As shown in Table 1, ADF test statistics fail to reject the null of a unit root at five percent level of significance in the log-level of all variables. However, test statistics clearly indicate a rejection of the null for the first difference and thus they are integrated of order one, *I*(1) except for output with constant and trend which is *I*(0). Furthermore, the results based on Kwiatkowski *et al.* (1992) test fail to reject the null hypothesis of stationarity at level for all variables.

After the ADF tests and having determined that d_{max} = 1, we then proceeded in estimating the lag structure of a system of VAR in levels and our results indicate that the optimal lag length based on AIC is 2, that is k = 2. Therefore, the estimated VAR model is using 3 lag as the optimum lag lengths. The results of the Granger no-causality and MWALD statistics are presented in Table 2.

Even though we have used AIC to aid the choice of lag length, we have estimated the models using several different lag structures to ensure that results are not sensitive to the choice of the lag length. As Pindyck and Rubinfeld (1991) point out, it is best to run the test for a few different lag structures and makes sure that the results are not sensitive to the choice of lag length. Our estimation indicates that the results are consistent with each other for different lag lengths, so we conclude that our results as in Table 2 are robust.

Table 2. Results of Granger Test (Var Model: m, p, y, R)

Hypothesis	***MWALD Statistics***				
	3(4)	**4(5)**	**5(6)**	**6(7)**	**7(8)**
a. Model 1					
M1−/→ Y	28.55***	29.24***	31.13***	39.69***	38.46***
Y −/→ M1	4.04	3.63	5.38	6.07	8.84
M2−/→ Y	18.95***	19.49***	25.49***	21.60***	24.33***
Y −/→ M2	18.26***	11.57***	18.40***	29.49***	26.03***
M3−/→ Y	12.83**	12.61**	11.98**	17.51**	22.73**
Y −/→ M3	23.32***	28.21***	30.96***	30.79***	31.85***
b. Model 2					
M1−/→ P	18.65***	19.71***	26.47***	28.89***	33.82***
P −/→ M1	7.51	6.89	7.61	6.32	7.92
M2−/→ P	6.67*	6.58**	14.64**	18.09**	23.53***
P −/→ M2	4.15	4.46	5.96	5.42	8.32
M3−/→ P	6.34*	8.75*	10.37**	13.54**	17.16**
P −/→ M3	3.43	3.65	8.33	8.72	10.92

Notes: *** denotes statistically significant at 1 percent level ** denotes statistically significant at 5 percent level * denotes statistically significant at 10 percent level −/→ denotes unidirectional Granger-no-causality. ( ) indicates optimum lags

The results in Table 2 (Model 1) suggest, in the case of Malaysia, that both null hypothesis of Granger no-causality from money to output and the null hypothesis that no-causality from output to money can be rejected at the one percent level of significant. These indicate a two-way causality running between monetary aggregates, M2 and M3 to output and output to monetary aggregates, M2 and M3 are consistent as theoretically conjecture by Keynesian and Monetarist views. However, there is a one-way causality between monetary aggregate, M1 and output.

All monetary aggregates seem to have strong feedback towards output. Such empirical facts can be rationalised through both the money view and credit view. The former sees expansionary money supply lowering real interest rates which in turn leads to an increase in business investment and more consumer spending. The latter explains higher aggregate demand as more loanable funds become available at lower interest rate. This in turn increases deposit and hence expands the quantum that bank-dependent borrowers could borrow and spend at any real interest rate.

The results in Table 2 (Model 2) suggest that all monetary aggregates have a strong one-way causality for the money-prices relationship in Malaysia that is the level of money supply Granger-cause the level of prices but the opposite causality is not found. In addition, M1 has the strongest causality effect on prices but the other monetary aggregates, M2 and M3 seem to have weak causality effect on prices. Thus, the results add some empirical support to the argument in the literature that inflation is a monetary phenomenon.

6. Concluding remarks

The purpose of this paper is to test empirically the relationship between money, output and prices in Malaysia by employing Granger no-causality developed by Toda and Yamamoto (1995). The results are broadly consistent with Tan and Baharumshah (1999). They suggest that monetary stability can contribute towards price stability in the Malaysian economy since the variation in price level is mainly caused by its own lagged and money supply and also concluded that inflation in Malaysia to some extent is a monetary phenomenon and to a lesser extent is imported.

Accordingly, we find empirical support in context the money-output-prices hypothesis for Malaysian economy. Among the various definitions of money stock, M3 appears to have the strongest causal effect on the real output and a moderate effect on prices whereas M1 seems to have strongest causal effect on prices. Thus, if the principle objective of the authorities is to sustain high rate of economic growth, then monetary aggregate, M3 will be the most suitable intermediate target. On the other hand, if the objective is only to curb inflation, then contracting M1, which has a more intense causal effect on prices, will be more effective.

It is worth pointing out that monetary authority should have a balance between price stability and high economic growth. A tight monetary measure is also likely to soften the economy since monetary aggregate, M1 is found to Granger cause output. In other words, monetary authorities have to balance between price stability and high economic growth to avoid overheating and dampening the state of the economy. The effective coordination between monetary and fiscal policy would enable to achieve price stability within the environment of high and sustainable economic growth.

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