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THE MONEY-PRICES NEXUS FOR MALAYSIA: FRESH EMPIRICAL EVIDENCES FROM THE ROLLING SUBSAMPLES

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ABSTRACT

THE MONEY-PRICES NEXUS FOR MALAYSIA: FRESH EMPIRICAL EVIDENCES FROM THE ROLLING SUBSAMPLES

The main objective of this study is to empirically re-investigate the money-prices nexus for Malaysia through the Johansen multivariate cointegration and MWALD causality techniques. This study covered the monthly dataset from 1971:M1 to 2008:M11. The Johansen cointegration test suggests that the variables under investigation are co-move in the long run. Furthermore, the MWALD causality test shows a bidirectional causal relationship between money supply (M2) and aggregate prices, meaning that both the monetarist's and also the structuralists' views vindicate in the Malaysian economy. However, the time-varying cointegration and causality tests indicate that the cointegrating and also the causal relationships are not stable over the analysis period. These results suggest that inflation in Malaysia is not purely monetary phenomenon. Therefore, implementing tighten monetary policy may not be an effective macroeconomic instrument in managing the inflationary behaviour in the Malaysian economy.

JEL CLASSIFICATION CODES: C22; E31; E51

KEYWORDS: Cointegration; Inflation; Money; MWALD test; Rolling regression

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1. INTRODUCTION

Over the past decades, the empirical question of whether inflation is purely monetary phenomenon or not has been a central issue in a growing body of research in the monetary and economic literature. This is also refers to the causal relationship between money supply and aggregate prices. The issue of whether inflation is a monetary phenomenon is of concern because it is directly relate to the formulation and implementation of appropriate monetary policies in curbing inflation. Hence, it is essential for this study to verify the causal relationship between money supply and aggregate prices or inflation. Theoretically, there are two competing schools of thought (i.e. monetarists and structuralists) have essentially rooted this causal relationship. First, based on the Quantity Theory of Money (QTM) suggested by Friedman (1956), the monetarists believe that inflation is purely monetary phenomenon. They claimed that a continuing increase of aggregate prices in an economy is caused by the excessive rate of expansion of the supply of money. This implied that the direction of causality should runs from money supply to aggregate prices. Therefore, the monetarists view that the contractionary monetary policy should be an effective anti-inflationary instrument. Second, the structuralists' school of thought has challenged the monetarists' famous dictum – "inflation is purely monetary phenomenon". They argued that the excessive money supply is a consequence rather than cause of inflation, particularly in less developing economies. According to structuralists' school, the root cause of inflation is the structural bottlenecks in the development process (Masih and Masih, 1998). Pinga and Nelson (2001) noted that policymakers and central banks are in interest to expand the money supply by ratifying the inflationary pressures, rather than high unemployment rate or jeopardise the consumption and investment behaviour. For this reason, the causal relationship between money supply and aggregate prices is expected to run from aggregate prices to money supply.

In order to resolve the theoretical controversy between monetarists and structuralists, researchers have spent amount of time to investigate the causal relationship between money supply and aggregate prices in the developed and developing countries. However, the existing empirical studies thus far failed to produce consensus causal link evidence. Brillembourg and Khan (1979) investigate the money-prices nexus for the United States over the period of 1870 to 1975. Using the Sims (1972) causality test, they found unidirectional causality runs from money to aggregate prices. They surmised that the one way causality result is in line to Friedman and Schwartz (1969) assertion that money causes prices. Turnovsky and Wohar (1984) found that the causality between money supply and aggregate prices in the United States is rather neutral over the analysis period of 1929 to 1979. Hence, they surmised that these variables are not related in the context of the United States. On the contrary, using the United States data from 1953 to 1984, Jones and Uri (1987) found a unidirectional causality runs from money supply to aggregate prices (see also Jones, 1985). In addition to that, Burdekin and Weidenmier (2001) found that a drastic money supply changes will lead to drastic aggregate prices changes in the United States. This positive relationship is consistent with the conventional monetarists' wisdom that inflation is a monetary phenomenon.

For the case of developing country like Malaysia, empirical studies on the causal relationship between money supply and aggregate prices or inflation is relatively scarce, in addition their finding also failed to reach unanimous results. A summary of the causality evidence between money supply and aggregate prices in Malaysia is delineated in Table 1. The general conclusion that can be drawn from Table 1 is that the causal relationship between money supply and aggregate prices is remains controversial.

Using the monthly dataset from 1974:M1 to 1986:M6, Gan (1992) conducted an empirical study on the relationship between stock return, inflation, money supply and economic activity in Malaysia within the vector autoregressive (VAR) framework. The author found that the causal relationship between money supply and aggregate prices is bidirectional in nature. Similarly, Abdullah and Yusop (1996) analysed the causal relationship between growth rate of money supply and inflation rate in Malaysia using the quarterly data from 1970:Q1 to 1992:Q4. They discovered that regardless of the lag structure incorporated into the testing equation the causality evidence is consistently showed bidirectional causal relationship between money supply and inflation rate.

Table 1: Summary of selected empirical studies on the money-prices nexus for Malaysia

No.	Authors	Research Period	Econometric Methods		Empirical Results				
			Cointegration	Causality	Cointegrated	Causality			
						$P \rightarrow M$	$M \rightarrow P$	$P \leftrightarrow M$	$P \not\leftrightarrow M$
1.	Lee and Li (1985)	1971:Q1 – 1981:Q1	–	Granger (1969) – VAR	–			✓	
2.	Gan (1992)	1974:M1 – 1986:M12	–	Granger (1969) – VAR	–			✓	
3.	Tan and Cheng (1995)	1984:Q1 – 1994:Q2	–	Granger (1969) – VAR	–	✓			
				Geweke (1982)				✓	
4.	Abdullah and Yusop (1996)	1970:Q1 – 1992:Q4	–	Granger (1969) – VAR	–			✓	
5.	Masih and Masih (1998)	1961:M1 – 1990:M4	Engle and Granger (1987)	Granger (1969) – VAR	✓		✓		
				Geweke et al. (1983) – Modified Sims test			✓		
				Granger (1988) – ECM			✓		
6.	Tan and Baharumshah (1999)	1975:M1 – 1995:M12	Johansen and Juselius (1990)	Granger (1988) – VECM	✓		✓		
7.	Pinga and Nelson (2001)	–	–	Granger (1969) – VAR	–				✓
8.	Karim et al. (2001)	1975:Q1 – 1995:Q3	–	Toda and Yamamoto (1995) – Augmented VAR	–		✓		
9.	Cheng and Tan (2002)	1973:Q1 – 1997:Q2	Johansen and Juselius (1990)	Granger (1988) - VECM	✓				✓
10.	Tang (2004)	1970:Q1 – 1998:Q4	–	Toda and Yamamoto (1995) – Augmented VAR	–		✓		
11.	Majid (2007)	1979:M1 – 2000:M12	–	Toda and Yamamoto (1995) – Augmented VAR	–		✓		

Note: The $\rightarrow$ denotes unidirectional causality, $\leftrightarrow$ represent bilateral or bidirectional causality, and $\not\leftrightarrow$ denotes non-causal link. P and M represent the aggregate prices and money, respectively.

Next, another group of researchers such as Tan and Cheng (1995) and Masih and Masih (1998) used different causality tests to examine the causal relationship between money supply and aggregate prices in Malaysia. Tan and Cheng (1995) employed causality tests based on Granger (1969) and Geweke (1982) to examine the causality direction between money supply and aggregate prices from 1984:Q1 to 1994:Q2. The causality results are not consistent among the causality tests employed. Specifically, the Granger (1969) causality test result revealed that aggregate prices Granger cause money supply, but there is no evidence of reverse causation. However, the Geweke (1982) causality test result shows bilateral causality evidence. In line to that, Masih and Masih (1998) employed the Engle and Granger (1987) residuals-based cointegration test together with three causality approaches based on Granger (1969), Geweke et al. (1983) – modified Sims causality test and the error-correction model (ECM) suggested by Granger (1988) to examine the relationship between money supply and aggregate prices in the Southeast Asia economies (i.e. Malaysia, the Philippines, Singapore and Thailand). For the case of Malaysia, they found that money supply and aggregate prices are cointegrated. Furthermore, all causality tests are consistently implied unidirectional causality runs from money supply (M1 and M2) to aggregate prices (see also Lee and Li, 1985). These results implied that the money-prices nexus for Malaysia is not sensitive to the causality tests employed to determine the causal relationship. Further, they suggest that inflation is a monetary phenomenon.

Using monthly data from 1975 to 1995, Tan and Baharumshah (1999) employed the Johansen's multivariate cointegration test and vector error-correction modelling (VECM) approach to investigate the dynamic linkages between money, output, interest rate and prices in Malaysia. An interesting finding emerged from their study is that the causal effect runs from money supply to aggregate prices in the short run, but there is no evidence of reverse causality. Hence, they surmised that monetary policy may be a good choice for price stability in Malaysia.

More recently, Tang (2004) employed the relatively new causality testing procedure developed by Toda and Yamamoto (1995) – modified Wald (MWALD) test to re-investigate the causal relationship between money supply and aggregate prices in Malaysia. The sample period covers the quarterly data from 1970 to 1998.

The MWALD test result shows that money supply (M2) leads aggregate prices in Malaysia; however aggregate prices do not Granger cause money supply (see also Karim et al., 2001). Majid (2007) employed the monthly dataset from 1979:M1 to 2000:M12 to re-examine the causal link between money supply, output and aggregate prices in Malaysia within the augmented-VAR framework proposed by Toda and Yamamoto (1995). The author discovered a strong unidirectional causality runs from money supply to aggregate prices irrespective of the lag order selected. This finding is corroborated to Tang's (2004) study; therefore the author surmised that inflation in Malaysia is a monetary phenomenon.

Extremely, Pinga and Nelson (2001) found that money supply and aggregate prices in Malaysia do not Granger cause each other. Then, Cheng and Tan (2002) employed the Johansen's multivariate cointegration test and VECM approach to examine the long run equilibrium relationship and the causality direction between inflation and its determinants (i.e. money supply, output, interest rate, exchange rate and trade balance) in Malaysia. They found that the variables are cointegrated, but there is no evidence of direct causal effect runs from money supply to inflation in Malaysia. Their finding suggests that external forces such as the ASEAN[1] inflation rate and exchange rate have significant influences on inflation rate in Malaysia. Recently, Tang and Lean (2007) found that the effect of money supply (M1) on inflation in Malaysia is negative and statistically significant at the 1 per cent level. This finding did not support the monetarists' view that inflation is a result of excessive rate of expansion of money supply.

The goal of this study is to re-investigate the money-prices nexus for Malaysia over the period of 1971:M1 to 2008:M11. The main motivation for revisiting the Malaysia's money-prices nexus is initiated by the weaknesses in the estimation techniques used in the earlier empirical studies. First, a weakness relate to the existing studies in Malaysia is that none of a research effort has considered the implication of structural break(s) in unit root tests. Perron (1989) argued that if the estimated series contained structural break(s), the power of standard unit root test decreases tremendously and lead to spurious rejection of null hypothesis of a unit root when the

[1] ASEAN refers to the Association of South East Asian Nations.

structural break(s) is ignored. Second, we observed that the Johansen (1988), and Johansen and Juselius (1990) cointegration tests have been widely used to examine the long run equilibrium relationship between aggregate prices and its determinants (e.g. money supply, output and exchange rate) in Malaysia. However, couple studies (e.g. Reimers, 1992; Cheung and Lai, 1993) have conducted Monte Carlo analysis to examine the small sample performance of Johansen cointegration test. These studies found that in small sample Johansen's cointegration test is bias toward rejecting the null hypothesis of no cointegration. Furthermore, Gonzalo and Lee's (1998) simulation results show that Johansen's likelihood ratio (LR) test tends to find spurious cointegration with probability approaching to one if the order of integration of the variables are not purely $I(1)$ process. Hence, the Johansen test results provided by the existing studies (e.g.Tan and Baharumshah, 1999; Cheng and Tan, 2002) may be biased owing to the aforementioned shortcomings.

Third, until now causality testing in most empirical studies in Malaysia were based on VAR and VECM approaches, except Karim et al. (2001), Tang (2004) and Majid (2007). He and Maekawa (2001) pointed out that the use of *F*-statistics for Granger causality test within the VAR framework often leads to spurious causality result when one or both of the estimated series are non-stationary. Granger (1988) stated that if the first differenced variables are used such as Abdullah and Yusop's (1996) and Pinga and Nelson's (2001) studies, the Granger causality test result may be bias owing to loss of long run causality information. In addition to that, Zapata and Rambaldi (1997) argued that both likelihood ratio test and Wald test are very sensitive to the specification of short run dynamics in the error-correction models (ECMs) even in the large samples. In this context, the use of either VAR or VECM for causality tests is not without question.

In this study, we attempt to revisit the money-prices nexus for Malaysia through the multivariate cointegration and causality techniques. This study differs from the extant literature in at least four dimensions. First, we undertake a thorough investigation of the time series properties of the data. Apart from using the conventional unit root test – Augmented Dickey Fuller (ADF, 1979; 1981) and Phillips and Perron (PP, 1988), we also employ the Zivot and Andrews (1992) unit root test with one structural break and Lumsdaine and Papell (1997) unit root test with two structural breaks to affirm the order of integrated for each series. This is because the standard unit root tests such as ADF and PP are low power when the estimated series are confronted with structural break(s) (see Perron, 1989).

Second, we employ the Johansen multivariate cointegration test to examine the potential long run equilibrium relationship. Masih and Masih (1998) stated that causality tests in the Granger sense actually is merely a predictability test if the variables are not cointegrated. Moreover, a well known seminal paper written by Friedman (1968) documented that monetary policy take long time to influence the aggregate price level in a nation. Hence, it is of paramount important to establish the presence of cointegrating relationship between the variables under investigation. Hooker (1993) and Hu (1996) demonstrated that using high frequency data will increase the power of cointegration tests. Thus, this study uses larger sample size (T = 455) to avoid the small sample bias and size distortion problem associated with Johansen's test. Third, given the policy relevance, this study uses the MWALD causality test developed by Toda and Yamamoto (1995) to verify the causality direction between money supply and aggregate prices in Malaysia within the augmented-VAR framework. Finally, this study will accommodate the rolling regression procedures into the Johansen cointegration test (see Hansen and Johansen, 1999; Rangvid and Sørensen, 2000; Kutan and Zhou, 2003) and the MWALD causality test to investigate the persistency or stability of the cointegrating and the causal relationships between money supply and aggregate prices in Malaysia, respectively. By doing this, we are able to assess the effectiveness of monetary policy in combating inflation problem in Malaysia. This exercise is corroborated to a requirement to conduct an effective monetary policy given by Friedman (1968). If the cointegrating relationships are stable over time, this reveal that monetary policy is effective in curbing inflation phenomenon because the demand for money and velocity of money are highly predictable. Furthermore, if causality results for monetarist view (i.e. money supply Granger causes aggregate prices) is true and stable, monetary policy will be the effective price stability instrument. Otherwise, the use of contractionary monetary policy to combat inflation will detrimental the economics development in Malaysia. Therefore, it is vital to incorporate the rolling regression procedure into the cointegration and causality tests to yield more information on the issue of money-prices nexus and the effectiveness of monetary policy to minimise the inflation problem.

The remaining of the paper is organised as follows. The next section gives a brief outline of the data, model and econometric techniques used in this study. The empirical results are presented and discussed in Section 3. Finally, Section 4 presents the conclusion and policy implications that are drawn.

2. DATA, MODEL AND ECONOMETRIC TECHNIQUES

2.1 Data and Model

The data uses in this study are the monthly data from 1971:M1 to 2008:M11. These data were extracted from International Monetary Funds (IMF) *International Financial Statistics* (IFS) and Bank Negara Malaysia (BNM) *Monthly Statistical Bulletin*. The data for money supply (M2), Consumer Price Index (CPI, 2000), Industrial Production Index (IPI, 2000) and nominal exchange rate are used in this study. The series IPI is used as a proxy for output due to unavailability of monthly data for Gross Domestic Products (GDP). However, all data are transformed into natural logarithm form.

In order to investigate the money-prices nexus for Malaysia, we use the multivariate model specification which has been derived from the QTM. However, Cheng and Tan (2002) noted that in a small open economy such as Malaysia, external factor such as exchange rate played an important role in determining the growth of aggregate prices. Granger (1986) suggests that money and aggregate prices could still cointegrated if other series, which may have affected aggregate prices, were included into the cointegrating regression. Furthermore, he noted that others variables should be added into the model under investigation. Owing to this motivation, we extend the conventional model by include the exchange rate variable into the model. The estimate model is expressed as follow:

$$\ln P_t = \alpha_1 + \alpha_2 \ln M2_t + \alpha_3 \ln Y_t + \alpha_4 \ln EX_t + \varepsilon_t \qquad (1)$$

where ln denotes as the natural logarithm. $\ln P_t$ is the aggregate prices, $\ln M2_t$ is the money supply M2, $\ln Y_t$ represents the output level proxy by IPI and $\ln EX_t$ is the exchange rate. The residuals ε_t are assumed to be white noise and spherical distribution.

2.2 Econometric Techniques

2.2.1 Zivot and Andrews (1992) and Lumsdaine and Papell (1997) unit root tests

To determine the order of integration, we use the Zivot and Andrews (1992) and Lumsdaine and Papell (1997) unit root tests with one and two structural breaks. For Zivot-Andrews unit root tests, we employed Model A and Model C for one structural break and the testing models can be written as follow:

Model A: $$\Delta y_t = \kappa + \alpha y_{t-1} + \beta t + \theta_1 DU1_t + \sum_{i=1}^{k} d_i \Delta y_{t-i} + \xi_t \tag{2}$$

Model C: $$\Delta y_t = \kappa + \alpha y_{t-1} + \beta t + \theta_1 DU1_t + \gamma_1 DT1_t + \sum_{i=1}^{k} d_i \Delta y_{t-i} + \xi_t \tag{3}$$

where Δ is the first difference operator $(y_t - y_{t-1})$, the residuals ξ_t are assumed to be spherically distributed and white noise. As per the standard ADF unit root test, we incorporate the Δy_{t-i} terms into the testing equations (2) and (3) are to correct serial correlation problem. The dummy variables $DU1_t = 1$ and $DT1_t = t - TB1$ if $t > TB1$ and 0 otherwise. $TB1$ $(\text{with } 1 < TB1 < T, \text{ where } T \text{ is the sample size})$ denotes the time at which the structural break occurs. The optimal lag order (k) is determine by the "*t*-significance" method and the breakpoint ($TB1$) is selected where the ADF *t*-statistic $t\left(\hat{\lambda}_{\inf}\right)$ is maximised in absolute term. In addition, the breakpoints search is carried out over the 70 per cents trimming region (0.15*T*, 0.85*T*), where *T* is the total numbers of observations.

In fact, the Zivot-Andrews unit root test is specifically designed to handle one structural break, it is low power when the estimated series confronted with more than one structural breaks. In this respect, we apply the Lumsdaine and Papell (1997) unit root test for two structural breaks to affirm the order of integration for each series under investigation $\left[\ln M2_t,\ \ln Y_t,\ \ln P_t,\ \ln EX_t\right]$. Similarly, this study also uses Model AA and Model CC. The testing models for Lumsdaine-Papell unit root tests can be written as follow:

$$\text{Model AA: } \Delta y_t = \kappa + \alpha y_{t-1} + \beta t + \theta_1 DU1_t + \psi_1 DU2_t + \sum_{i=1}^{k} d_i \Delta y_{t-i} + \varepsilon_t \tag{4}$$

$$\begin{aligned} \text{Model CC: } \Delta y_t &= \kappa + \alpha y_{t-1} + \beta t + \theta_1 DU1_t + \gamma_1 DT1_t + \psi_1 DU2_t \\ &\quad + \omega_1 DT2_t + \sum_{i=1}^{k} d_i \Delta y_{t-i} + \varepsilon_t \end{aligned} \tag{5}$$

where, $DU1_t = 1$ and $DT1_t = t - TB1$ if $t > TB1$ and 0 otherwise. Similarly, $DU2_t = 1$ and $DT2_t = t - TB2$ if $t > TB2$ and 0 otherwise. $TB1$ and $TB2$ represent the time at which the structural breaks one and two occurs, respectively, where $TB2 > TB1 + 2$. The optimal lag order (*k*) is determined by the "*t*-significant" method and the breakpoints $(TB1 \text{ and } TB2)$ are selected where the ADF *t*-statistics $t\left(\hat{\lambda}_{\inf}\right)$ is maximised in absolute term. Finally, the GAUSS™ programming codes will be used to compute the Zivot-Andrews and Lumsdaine-Papell unit root tests for one and two structural break(s).

2.2.2 Johansen multivariate cointegration test

In this section, we will briefly discuss the Johansen test because the estimation procedure has been well defined in the literature. To implement the Johansen's cointegration test, the following VECM is estimated.

$$\Delta X_t = \Phi D_t + \sum_{i=1}^{k-1} \Gamma_i \Delta X_{t-i} + \Pi X_{t-1} + \varepsilon_t \tag{6}$$

where Δ is the first difference operator $(X_t - X_{t-1})$. X_t is a vector of endogenous variables ($\ln M2_t$, $\ln P_t$, $\ln Y_t$ and $\ln EX_t$). D_t is the deterministic vector (constant and trend, etc); Φ is a matrix of parameters D_t. The matrix Π contains information about the long run relationship between X_t variables in the vector. If all the variables in X_t are integrated of order one, the cointegrating rank, *r*, is given by the rank of $\Pi = \alpha\beta'$ where α is the matrix of parameters denoting the speed of convergence to the long run equilibrium and β is the matrix of parameters for cointegrating vector. To determine the number of cointegrating rank, we use the likelihood ratio (LR) tests statistics that is trace test $LR(\lambda_{\text{trace}}) = -T\sum_{i=r+1}^{k}\ln(1-\lambda_i)$ and the maximum eigenvalue test statistics $LR(\lambda_{\max}) = -T\ln(1-\lambda_{i+1})$, where λ_i are the eigenvalues $(\lambda_1 \geq \lambda_2 \ldots \geq \lambda_k)$ and *T* is the numbers of observations (see Johansen, 1991 for more details).

2.2.3 MWALD causality test

To verify the direction of causality between money supply (M2) and aggregate prices in Malaysia, this study employs the MWALD test developed by Toda and Yamamoto (1995). To implement the MWALD test, we estimate the augmented-VAR model as presented in equations (8) and (9).

$$\begin{aligned}\ln M_t = \alpha_1 &+ \sum_{i=1}^{k}\phi_i \ln M_{t-i} + \sum_{j=k+1}^{p}\phi_j' \ln M_{t-j} + \sum_{i=0}^{k}\psi_i \ln P_{t-i} + \sum_{j=k+1}^{p}\psi_j' \ln P_{t-j} \\ &+ \sum_{i=0}^{k}\theta_i \ln Y_{t-i} + \sum_{j=k+1}^{p}\theta_j' \ln Y_{t-j} + \sum_{i=0}^{k}\eta_i \ln EX_{t-i} + \sum_{j=k+1}^{p}\eta_j' \ln EX_{t-j} + \varepsilon_{2t} \qquad (8)\end{aligned}$$

$$\begin{aligned}\ln P_t = \alpha_0 &+ \sum_{i=1}^{k}\beta_i \ln P_{t-i} + \sum_{j=k+1}^{p}\beta_j' \ln P_{t-j} + \sum_{i=0}^{k}\delta_i \ln M_{t-i} + \sum_{j=k+1}^{p}\delta_j' \ln M_{t-j} \\ &+ \sum_{i=0}^{k}\gamma_i \ln Y_{t-i} + \sum_{j=k+1}^{p}\gamma_j' \ln Y_{t-j} + \sum_{i=0}^{k}\lambda_i \ln EX_{t-i} + \sum_{j=k+1}^{p}\lambda_j' \ln EX_{t-j} + \varepsilon_{1t} \qquad (9)\end{aligned}$$

where ln is the natural logarithm and the residuals $(\varepsilon_{1t}, \varepsilon_{2t})$ are assumed to be spherical distribution and white noise. The optimal lags' order *k* is determined by

Schwarz Bayesian Criterion (SBC) and the order of lag p is actually $(k + d_{\max})$. Furthermore, we use $d_{\max} = 1$ as the simulation results showed that it perform better than any other order of $d_{\max}$ (see Dolado and Lütkepohl, 1996). From equation (8), $\psi_i \neq 0 \ \forall_i$ implies that there is causality from aggregate prices to money supply; while from equation (9), $\delta_i \neq 0 \ \forall_i$ indicate that money supply Granger cause aggregate prices. This means that the money supply is a source for inflation, thus support the monetarists view. However, according to Toda and Yamamoto (1995) the extra lag i.e. $d_{\max}$ in equations (8) and (9) are unrestricted as its inclusion is to ensure that the asymptotic χ^2 - distribution critical values can be used when the causality test is conducted with the non-stationary variables.

Ironically, the econometric literature such as Shukur and Mantalos (2000), Mantalos (2000) and Hacker and Hatemi-J (2006) suggest that the MWALD test tend to reject the null hypothesis of non-Granger causality when the estimated sample size is relatively small, the residuals are not spherically distributed, and/or the residuals are heterogeneous – Autoregressive Conditional Heteroskedasticity (ARCH). With these regards, we apply the residuals-based bootstrapping approach to compute robust critical values for MWALD causality test. If the generated MWALD test statistic is greater than bootstrap critical values, the null hypothesis of non-Granger causality will be rejected; otherwise we failed to reject the null hypothesis. In order to save space, the residuals-based bootstrap procedure will not be discusses here, however interested reader can refer to Mantalos (2000) for details discussion on how to generate the bootstrap critical values.

2.2.4 Rolling regression procedure

Here, we briefly describe the rolling regression procedure for Johansen multivariate cointegration and MWALD causality tests. In general, the rolling regression procedure is that the tests are performed for the beginning subsample of T observations, i.e. with a rolling window size T. After that, the first observation is removed from the beginning subsample and a new observation is added into the end of the estimation sample period. The relationship is then re-estimated. For the case of

Johansen cointegration test, if we set the rolling window at 5 years, that is, $T = 60$ observations, the first likelihood ratio test statistics (i.e. trace test and maximum eigenvalues test) were estimated by using a subsample from 1971:M1 to 1974:M12 (i.e. $T = 60$). Then, the second likelihood ratio test statistics was computed by using data from 1971:M2 to 1975:M1. This rolling regression procedure will continue until the last observation was used to examine the cointegrating relationship. Similarly, for the case of MWALD causality test, if we set the rolling window at 10 years, that is, $T = 120$ observations, the first MWALD causality test statistic was obtained by using a subsample period from 1971:M1 to 1979:M12 (i.e. $T = 120$ observations). Then the second test statistic was obtained by using data from 1971:M2 to 1980:M1. This rolling regression process will continue until the last observation was employed to examine the causal relationship.

For interpretation, the estimated likelihood ratio tests statistics for cointegration and also the MWALD causality test statistics are normalised by the 5 per cent critical values. If the computed ratio is above one then the null hypothesis (i.e. not cointegrated and/or non-Granger causality) is rejected. For example, if the money-led prices hypothesis – monetarists' views is valid, then a large number of significant MWALD tests should be observed when the sample rolls forward.

3. EMPRICIAL RESULTS

3.1 Unit root test results

Prior to Johansen cointegration and also causality tests, it is necessary for this study to conduct unit root tests to determine the time properties for each series. This is because Monte Carlo experiment by Granger and Newbold (1974) and Phillips (1986) discovered that the regression result tends to be spurious if the estimated variables are non-stationary, e.g., $I(1)$ process and are not cointegrated (see also Engle and Granger, 1987). In order to ascertain the order of integration, we begin by applying the ADF and PP unit root tests. The testing results suggest that the variables $\left[\ln M2,\ \ln P_t,\ \ln Y_t,\ \ln EX_t\right]$ are integrated of order one, $I(1)$. To conserve space, the ADF and PP tests results are not reported here. Nevertheless, as we discussed in Section 1, the conventional ADF and PP unit root tests are low power when the series contained structural break(s). To circumvent this, we performed the Zivot-Andrews and Lumsdaine-Papell unit root tests with one and two structural break(s) to affirm the order of integration for each series and the results are presented in Table 2.

From Panel A, Table 2, the Zivot-Andrews unit root test with one structural break indicates that there is no additional evidence against the null hypothesis of a unit root compared to the ADF and PP tests results, except $\ln Y_t$ and $\ln EX_t$. The result shows that output $\left(\ln Y_t\right)$ and exchange rate $\left(\ln EX_t\right)$ are stationary at level. However, we have to perform the Lumsdaine-Papell unit root test with two structural breaks to ascertain the result because the one structural break unit root test may lose power when confronted with two or more structural breaks. The results for Lumsdaine-Papell unit root test with two structural breaks are reported in Panel B, Table 2. In line to the results for one structural break unit root test, the Lumsdaine-Papell unit root test statistics could not reject the null hypothesis of a unit roots for all the estimated variables, except $\ln Y_t$ and $\ln EX_t$. Therefore, we surmise that the order of integration for variables under investigation are mix (i.e. either $I(0)$ or $I(1)$ process). This result is inconsistent to the Nelson and Plosser's (1982) assertion that most of the macroeconomics series are integrated of order one, $I(1)$ process because they do not take into consideration the effect of structural break(s) on the test for unit root.

3.2 Johansen cointegration test result

Enders (1994, p. 396) noted that Johansen's test can handle variables with different orders of integration, $I(d)$. This is evidence that Johansen's cointegration test is valid even if the order of integration is not consistent (see Table 2). Cheung and Hung (1998) and Motinga (2001) noted that Johansen-Juselius cointegration test is nothing more than a multivariate generalisation of the ADF unit roots test. Therefore, as long as the variables are cointegrated, the variables under investigation are $I(1)$ and non-stationary at level (Holden and Perman, 1994, p. 89). Muscatelli and Hurn (1992) also pointed out that, given the problems with the testing procedures for order of integration and cointegration, as long as the chosen set of independent and dependent variables are cointegrated among themselves, we need to worry less about the order of integration of the individual variables. With this regards, although the degree of integration for variables under investigation are non-uniform, we proceed to examine the presence of long run equilibrium relationship between monetary aggregate M2, aggregate prices, output and exchange rate in Malaysia through the Johansen's cointegration test. A common practice in Johansen's test is that we have to decide the optimal lag order in the VAR system. In this study, the choice of the optimal lag order (k) of the VAR model employed in the Johansen's cointegration technique was determined by Schwarz Bayesian Criterion (SBC) owing to its superior properties (see Lütkepohl, 2005). The SBC statistic suggests one lags for our VAR model and the results for cointegration test are reported in Panel A, Table 3.

Table 2: The results of unit root tests with structural break(s)

Panel A: Zivot and Andrews test for unit roots with one structural break

	Prices		Money M2		Output		Exchange rate	
	Model A	Model C	Model A	Model C	Model A	Model C	Model A	Model C
TB1	1979:06	1984:02	1998:01	2000:01	1988:04	1988:04	1997:06	1997:06
$t\left(\hat{\lambda}_{\text{inf}}\right)$	–4.127	–4.764	–3.334	–2.884	–5.129**	–6.202*	–6.403*	–6.981*
Lag length	11	12	12	12	12	12	7	12
Critical values								
1%	–5.34	–5.57						
5%	–4.80	–5.08						

Panel B: Lumsdaine and Papell test for unit roots with two structural breaks

	Prices		Money M2		Output		Exchange rate	
	Model AA	Model CC	Model AA	Model CC	Model AA	Model CC	Model AA	Model CC
TB1	1975:11	1984:02	1985:02	1978:11	1988:04	1988:04	1985:11	1984:08
TB2	1979:10	2002:03	2000:01	1993:07	1990:12	1994:03	1997:06	1997:07
$t\left(\hat{\lambda}_{\text{inf}}\right)$	–4.975	–5.498	–4.585	–4.301	–6.194	–7.420*	–8.410*	–8.355*
Lag length	12	12	12	12	12	12	7	12
Critical values								
1%	–6.94	–7.34						
5%	–6.24	–6.82						

Note: The asterisks * and ** denote significance level at 1 and 5 per cent level, respectively.

Table 3: The results of cointegration test

Panel A: Johansen-Juselius Cointegration Test

Hypothesis		Tests Statistics	Critical values	
			5 per cent	1 per cent
H_0	H_1			
$LR(\lambda_{\text{trace}})$				
$r=0$	$r\geq 1$	59.501*	47.856	54.682
$r\leq 1$	$r\geq 2$	22.099	29.797	35.458
$r\leq 2$	$r\geq 3$	9.727	15.495	19.937
$r\leq 3$	$r\geq 4$	1.317	3.841	6.635
$LR(\lambda_{\max})$				
$r=0$	$r=1$	37.410*	27.584	32.715
$r\leq 1$	$r=2$	12.370	21.132	25.861
$r\leq 2$	$r=3$	8.409	14.265	18.520
$r\leq 3$	$r=4$	1.317	3.841	6.635

Panel B: Normalised Cointegrating Vectors

$\ln P_t$	$\ln M2_t$	$\ln Y_t$	$\ln EX_t$	*Constant*
1.000	0.223*	0.061	–0.286*	1.791

Note: The asterisks * and ** denote significance level at 1 and 5 per cents, respectively. The Schwarz Bayesian Criterion (SBC) is used to determine the optimal lag length and the critical values are obtained from MacKinnon et al. (1999).

As shown in Panel A, Table 3, at the 1 per cents significant level both likelihood ratio test statistics – trace $LR(\lambda_{\text{trace}})$ and maximum eigenvalues $LR(\lambda_{\max})$ tests suggest that only one cointegrating vector exists among the four variables. This reveals that these four variables would not move too far apart from each other, hence displaying a co-movement phenomenon for aggregate prices, money supply (M2), output and exchange rate in Malaysia over the analysis period from 1971:M1 to 2008:M11.[2] Conceivably, the estimated models can thus be accepted as a tentatively adequate representation of the data generating process and can be used to explain the inflationary phenomenon in Malaysia. As the variables are cointegrated and the

[2] Nevertheless, as the order of integration for the variables under investigation are non-uniform that is either $I(0)$ or $I(1)$ process, this study has also employed the bounds testing approach to cointegration developed by Pesaran et al. (2001) to re-affirm the existence of a potential long run equilibrium relationship. The results of the bounds testing approach reveals that the variables under investigation $[\ln M2_t,\ \ln P_t,\ \ln Y_t,\ \ln EX_t]$ are cointegrated at the 1 per cent significant level. The bounds testing to cointegration result is corroborated to the Johansen multivariate cointegration test reported in Table 3. To conserve space, the estimation results for bounds testing approach to cointegration are not reported here, however it is available upon request from the author.

interest of this study is to evaluate the responses of aggregate prices to money supply (M2), output and exchange rate the cointegrating vectors are normalised by aggregate prices, $(\ln P_t)$. The normalised coefficients in Panel B, Table 3 show that the long run effect of money supply on aggregate prices is positive and statistically significant at the 1 per cent level. However, although the output is positively related to aggregate prices, this variable is not statistically significant at the 10 per cents level. Clearly, our finding consistent to the monetarists' view that in the long run output (Y) is constant; hence only change of money supply will lead to prices change. However, this result is contrary to the finding of Tang and Lean (2007) who found that money supply and inflation is negative relation in Malaysia. Corroborating to Cheng and Tan (2002), our empirical finding also suggests that the relationship between aggregate prices and exchange rate is negative, implying that inflation rate in Malaysia reacts negatively to depreciation in exchange rate.

3.3 MWALD causality test results

Based on the Granger Representation Theorem, if the variables are cointegrated, there must be at least one direction of causal relationship to hold the existence of long run equilibrium relationship. Therefore, we proceed to estimate the augmented-VAR model to investigate the causality direction between money supply and aggregate prices in Malaysia. As the VAR model is sensitive to the choice of lag structure, measures such as Schwarz Bayesian Criterion (SBC) is used to select the appropriate lag structure (see Thornton and Batten, 1985; Xu, 1996). The SBC statistic shows that VAR(2) is the best, and the selected maximum order of integration $(d_{\max})$ is one, thus we estimate the VAR(3) as an augmented model for MWALD causality tests.

The estimated MWALD test statistics together with the bootstrap critical values are reported in Table 4. Strictly speaking, at the 5 per cent significant level, the estimated MWALD test statistics shows that the causal relationship between money supply and aggregate prices is neutral. This neutral causality result is consistent to the finding of Pinga and Nelson (2001) and Cheng and Tan (2002). Nevertheless, at the 10 per cent significant level, the MWALD test statistics reject both the null hypotheses of non-Granger causality, implying that money supply (M2) and aggregate prices are Granger causes each other (i.e. bidirectional causality).

Table 4: The results of MWALD causality tests

Null Hypothesis		MWALD statistics test	Bootstrap critical values		
			1 per cent	5 per cent	10 per cent
$\ln M2 \nrightarrow \ln P$	(Monetarists)	5.014***	12.841	7.359	4.750
$\ln P \nrightarrow \ln M2$	(Structuralists)	4.977***	11.461	6.225	4.480

Note: The asterisks *, ** and *** denote statistically significance at 1, 5 and 10 per cents level, respectively. The optimal lag order is determined by using SBC. Follow the Davidson and MacKinnon (2004, p. 164) suggestion, 1000 times of bootstrap were used to compute the critical values.

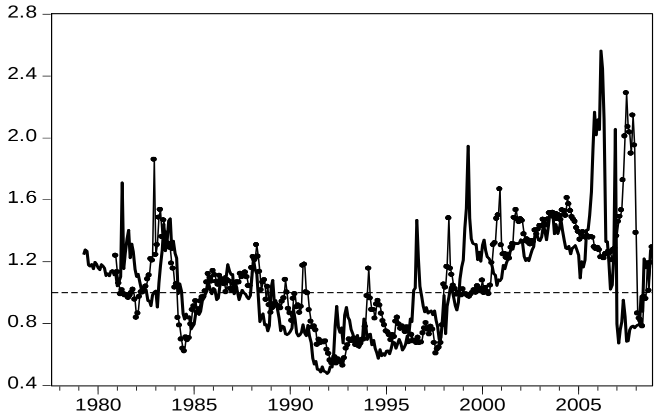
These results show that within the entire sample period the monetarists' and also the structuralists' assertion are vindicated in Malaysia. However, this result supports the assertion that inflation is a monetary phenomenon in Malaysia. This bidirectional causality results are in line to the causality evidence provided by Lee and Li (1985), Gan (1992), Tan and Cheng (1995) and Abdullah and Yusop (1996), but contrary to the finding of Masih and Masih (1998), Tan and Baharumshah (1999), Karim et al. (2001), Tang (2004) and Majid (2007). A potential explanation for the contrary result is that, we considered longer sample period (i.e. 1971:M1 to 2008:M11) compared to the existing studies that only involved dataset up to year 2000. Engle (1996) documented that apart from the method employed, different sample period used for analysis will yield different estimation result. Furthermore, Tang (2008) noted that causality test result may vary over time owing to the frequent changes in the global economic and political environments. In this respect, the MWALD causality test using the entire sample period will not reflect such changes. Thus, the test may not accurately measure for causality between money and aggregate prices as it is possible that the causal relationship exists in certain periods but does not exist in other periods. For this reason, we investigate the stability of the cointegrating and the causal relationships in the next section through the rolling regression procedure.

3.4 The rolling cointegration and causality tests results

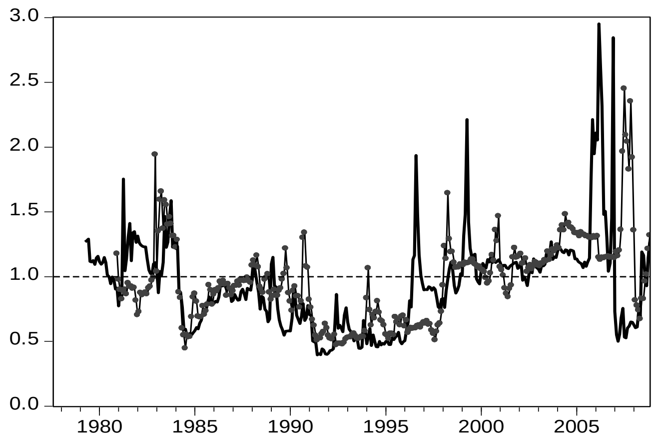
In this section, we report the results of the rolling Johansen cointegration and MWALD causality tests. To implement the rolling regression procedure, we have to pre-determine the rolling window size because different size of rolling window will yield different estimation results. In the literature the rolling window size is selected arbitrarily because there is no formal statistical procedure to select the optimal rolling window size. According to the economic theory, money-prices nexus is a long run phenomenon. Moreover, Friedman (1968) pointed out that the effect of monetary policy on the economy tends to be delay about fifteen months. For this reason, we used two different rolling window sizes corresponding to 100 and 120 observations which is equivalent to 10 years are relatively long to capture the money-prices relationship.

The results for rolling Johansen cointegration test are presented in Figure 1. The rolling cointegration tests for rolling window sizes of 100 and 120 observations are represented by the thick and dotted lines, respectively.

Figure 1: The results of rolling Johansen cointegration test



Panel A: Trace test $LR(\lambda_{\text{trace}})$



Panel B: Maximum eigenvalues $LR(\lambda_{\max})$

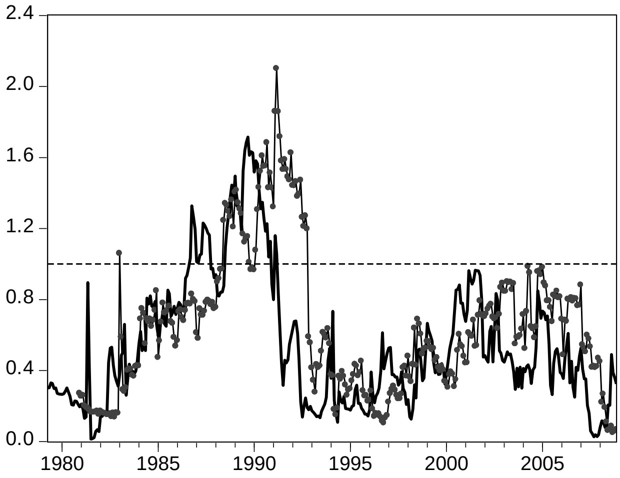
Note: The thick and dotted lines represent the rolling window sizes of 100 and 120 observations, respectively.

Overall, both normalised likelihood ratio tests $-LR(\lambda_{\text{trace}})$ and $LR(\lambda_{\max})$ in Figure 1 reveals strong evidence for the instability of cointegrating relationship over the analysis period irrespectively of the window sizes employed. This may shed some light that the causal relationship between money and aggregate prices in Malaysia may also volatile over time. Thus, monetary policy may be not effective in curbing inflation phenomenon in Malaysia. Furthermore, our estimation results is contrary to the Friedman and Schwartz (1969) postulation that the relationship is "highly stable" over the entire period of their analysis. Specifically, the strongest cointegration between the money, aggregate prices, output and exchange rate occurred in the late 1970s until mid-1980s and in the late 1990s up to year 2008. These imply that the variables under investigation are moving together in the long run although deviation may occur in the short run. Nevertheless, at the 5 per cent significant level, the null hypothesis of no cointegrating relation cannot be rejected for the period of early 1985 till 1997, indicating that the estimated series are moving apart from each other. Obviously, this non-cointegrating relationship exist may attributed to the economic recession in the mid-1980s and the Asian currency crisis in 1997. However, the implementation of Ringgit pegged regime and capital control measures in 2nd September 1998 have stabilised the economic shock and thus re-established the cointegrating relationship after the late 1999.

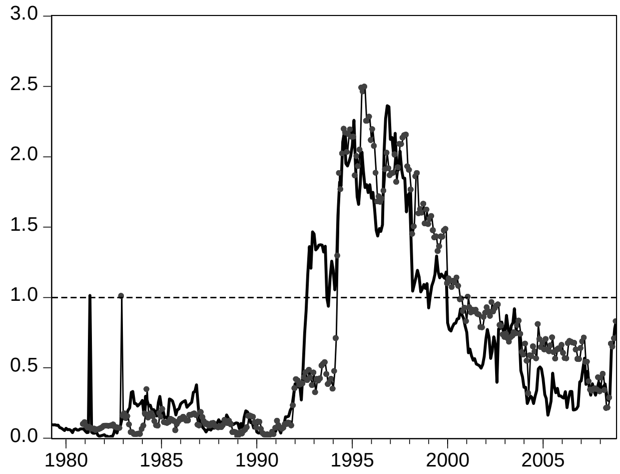
Apart from that, we also analyse the time-varying causality test within the augmented-VAR framework. Similar to the cointegration test, we also use two rolling window size that is 100 and 120 observations. The rolling MWALD causality tests statistics for $H_0 : \ln M2 \nrightarrow \ln P$ and $H_0 : \ln P \nrightarrow \ln M2$ are reported in Figure 2. The normalised rolling MWALD test statistics for window sizes of 100 and 120 observations are denoted by the thick and dotted lines, respectively.

From the estimated rolling results, we observed that the normalised causality test statistics are varied over the sample period of analysis irrespectively of the window size employed. Thus, the causal relationship between money supply and aggregate prices is not stable. This is consistent to the results provided by rolling Johansen cointegration test (see Figure 1) and also the evidence for the United States reported by Brillembourg and Khan (1979). From the visual inspection, most of the MWALD test statistics failed to reject the null hypothesis of non-Granger causality between money supply aggregate prices. Specifically, the structuralists' view is vindicated from the period of 1995 to 2000, whereas the monetarists' view is true merely from the period of late 1988 to early 1990s.

Figure 2: The results of rolling MWALD causality test



Panel A: $H_0 : \ln M2 \nrightarrow \ln P$
(Monetarist's view)



Panel B: $H_0 : \ln P \nrightarrow \ln M2$
(Structuralists' view)

Note: The thick and dotted lines represent the rolling window sizes of 100 and 120 observations, respectively.

With this evidence, we may conclude that inflation is a monetary phenomenon in Malaysia as shown by the causality tests (e.g. Table 4), nevertheless this is not always the case because the time-varying causality test shows that the causal relationship is volatile or not stable over time. Remarkably, the unstable causality behaviour that we observed from Figure 2 may potentially explain the reason why causal relationship between money and aggregate prices thus far are not consensus. Therefore, the implementation of contractionary monetary policy in combating inflation may not be a wise strategy for the Malaysian economy as the money-prices relationship is not stable. Moreover, Tang (2004) has also noted that although the empirical evidence shows that money caused the prices to change, it does not mean that money supply is an effective monetary instrument to address inflation pressures.

4. CONCLUSION AND POLICY IMPLICATIONS

This paper has re-examined the money-prices nexus for Malaysia through the Johansen's cointegration and MWALD causality techniques. In particular, we are interested to know whether inflation is always a monetary phenomenon in Malaysia. There are some remarkable findings discovered by this study. First, the results of unit root tests with one and two structural breaks indicate that all series are $I(1)$ process, except output and exchange rate are $I(0)$ process. This implies that shock(s) on aggregate prices, money supply in Malaysia will have a permanent effect, while shock(s) on output and exchange rate seems to be transitory. Second, the evidence from Johansen's cointegration test suggests that the variables under investigation money supply, aggregate prices, output and exchange rate are cointegrated. This implies that the variables are moving together in the long run, although deviation may occur in the short run. The normalised cointegrating coefficients show that the effect of money supply (M2) on aggregate prices is positive and statistically significant at the 1 per cent level. In addition, exchange rate is negatively related to aggregate prices in Malaysia and this relationship is statistically significant at the 1 per cent level. Third, we performed the MWALD causality test to affirm the causality direction between money supply and aggregate prices. The result of MWALD test suggests bidirectional causality runs from both money supply and aggregate prices. This implies that both the monetarist's and structuralists view vindicate in the Malaysian economy. Nevertheless, using time-varying Johansen cointegration and MWALD causality tests (i.e., rolling regressions), we have found that the cointegrating and also the causal relationships are not stable over the analysis period. Hence, we surmise that inflation is not always a monetary phenomenon in Malaysia even the cointegration and causality test within the entire sample period supports the monetarists' view.

With the interesting empirical findings of this study, it is worth pointing out to the decision makers and the Central Bank of Malaysia (i.e., Bank Negara Malaysia, BNM) that the implementation of contractionary monetary policy alone may not be an effective anti-inflationary instrument because the empirical evidence indicates that inflation is not always a result of monetary policy – M2 in Malaysia. Strictly speaking, the used of money supply M2 as monetary instrument for price stability in Malaysia may detrimental to economic growth. Therefore, in order to achieve a balance between prices stability and sustainable economic growth, other policies such as fiscal and also supply-sides economy should be appropriate to accommodate into the management of inflationary behaviour in Malaysia. Interestingly, the uses of supply-sides economy may simultaneously decrease the macroeconomics monsters, inflation and unemployment rates, in the same time this strategy may also increase Malaysia's output level. In sums, the supply-sides economy may lead to low inflation and unemployment rates and also sustainable economic growth and development for the Malaysian economy.

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