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Monetary Velocities in Malaysia: an Empirical Note[#]

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Abstract: This paper has a dual objective of first assessing the stability of the income velocity of circulation of money and then relating its behaviour to real and monetary factors. Quarterly data from 1991.1 through 2006.1 are mobilised for the purpose with money defined as M0, M1, M2 and M3. The conventional unit root test techniques such as the Dickey-Fuller and the Phillips-Perron are found to be reliable in terms of yielding accurate inferences about the non stationary characteristic of the velocity. This follows the findings that the application of the Perron's innovational outlier model would similarly reveal that there is at least one unit root in all the data series. Moreover, seasonal unit roots are ruled out by the HEGY test. Variance decomposition provides evidence favouring Friedman's monetary uncertainty hypothesis in the case of narrower monetary aggregates while real output could wield substantial influence on the velocities of three of the four monetary aggregates. Monetary factors, specifically money growth variability, are more predominant than output in dictating velocities of narrower monetary aggregates.

Keywords: Money, stability, velocity
JEL classification: E40, E49, E52

1. Overview

The purpose of this paper is two-fold, namely to assess the stability of the velocity of circulation of money, variously defined as M0, M1, M2 and M3 and then to relate its behaviour to real and monetary factors. The significance of such a study can never be over-emphasised as Malaysia has won acclaims including from international agencies such as the World Bank, IMF and UNCTAD as a country with prudent macroeconomic management. It contributes to the existing literature on developing economies as it may be of academic interest to appreciate better the behaviour of the velocity of money in such an economy.

Monetary targeting would call for understanding of the velocity behaviour. A stable and stationary velocity is integral to the quantity theory of the relationship between money and nominal income. Instability in the velocity would imply an unstable relationship between money and nominal income. Thus monetary aggregates could not be relied upon as targets of monetary policy. It casts doubts on the monetarist conviction about the predictability of the link between money growth and nominal output growth.

Though the issue of monetary velocity may no longer be critical in monetary policy administration with the adoption of interest rate targeting, it is stress worthy that over a long run, it remains worthy of attention. It is always worthwhile to persist in exploring the factors that dictate or do not dictate velocity movements. This is because financial and

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macroeconomic circumstances change quite frequently like a pendulum. In certain instances, interest rate targeting may be an optimal operating procedure while at other times, monetary targeting may be appropriate. In fact, the Bank of Canada had even, in the 1950s and 1960s, adopted short term interest rates as operational targets before switching to monetary aggregates in the 1970s in line with the monetarists. It, however, reverted to interest rates in the early 1980s (Handa 2000). These switches were driven by changing circumstances and were in fact observed in the United States and Britain as well.

Moreover, when Keynes' notion of liquidity trap and animal spirit prevail, interest rate targeting would be rendered futile. It is well known in monetary economics that economic stability could be better maintained or aggregate demand fluctuations minimised by targeting money supply when shocks originate in the commodity market while interest rate targeting is appropriate for addressing shocks emanating from the money market (Poole 1970). Both types of shocks do occur randomly in the real world at different times. In practice, central banks do still monitor monetary aggregates as indicators of the economy even if they are not control targets.

The rest of the paper is configured as follows. Section 2 presents a brief review of past studies. The stability of the velocity in Malaysia is examined in Section 3 while the possible roles of monetary and real factors in influencing the velocity are the subject of Section 4. The paper concludes with remarks in Section 5.

2. Literature Review

Interest in the stability of the income velocity of money was sparked off by its observed decline in the US in the 1980s after two or more decades of upward trend. The sharp declines have cast doubts on the monetarist contention of a predictable link between money growth and nominal output growth. Gordon (1983) sees the 1982 velocity decline as a velocity recession and the demise of monetarism. However, Friedman (1984) counter argues that the sharp decline is attributable to increased monetary variability induced by the change in the operating procedure of the Federal Reserve in October 1979 as it began targeting non borrowed reserves until 1982. The volatility of money growth rendered interest rates, prices and output less certain which in turn raised the demand for money as a buffer amid an uncertain macroeconomic environment. This spelt a decline in income velocity. Hence according to Friedman (1984), the 1982 experience did not actually render monetarism invalid.

Numerous studies on velocity behaviour largely centred on developed economies subsequently followed. They include *inter alia* Hall and Noble (1987), Brocato and Smith (1989), Mehra (1989), Payne (1992), Katsimbris and Miller(1993), Judd and Motley (1984), Goodhart (1986;1989), Bordo and Jonung(1981;1990), Thornton (1991) and Leao (2005). Apart from the traditional monetary factors commonly cited as possible determinants of velocity behaviour, there also exist institutional explanations. The institutionalist approach views the process of monetisation and development of the financial sector as major shapers of velocity behaviour. It has been observed that national money velocities have a tendency to follow a U-shape over a period of 100 years (see Bordo and Jonung(1981), Friedman and Schwartz(1982), Siklos(1993), and Bordo *et al.* (1997)). Basu and Dua (1996) explored whether fluctuations in the velocity in the US have been driven by real and or monetary factors. This question was not addressed by earlier studies plausibly because income velocity was viewed as primarily a monetary rather than a real phenomenon. To assess the impact of real versus monetary factors on the velocity, a four-variable vector autoregressive (VAR) model that encompasses money growth variability, the nominal interest rate, real output and velocity is estimated based upon quarterly data from 1973:1 to 1993:2. The inclusion of both real and monetary factors allows for the control of the possible influence of real factors on the velocity. Their variance decomposition analysis reveals little support for Friedman's monetary uncertainty hypothesis. Interest rate and real output changes appear more predominant in determining velocity movements.

Studies that focus solely on examining the stability of velocities exist. McDougall (1994) relies upon the seasonal integration and cointegration technique to assess the non-stationary characteristics of velocity in New Zealand based upon 25 years of quarterly unadjusted money (M1) and income data. The seasonal unit root test results distinctly suggest that velocity is non stationary with a changing seasonal pattern. The non stationarity of velocity is confirmed by the acceptance of the null hypothesis of non cointegration between money and income at both zero and biannual frequencies. Generally, the long run relationship between money and income is ruled out.

By employing the techniques developed by Zivot and Andrews (1992) and Perron (1997) that allow for stationarity around an endogenously determined structural break-point under the alternative hypothesis, Cakan and Ozmen (2002) investigated the integration properties of Turkish annual velocity series over the period, 1950-88. Their empirical results indicate that real currency balances and currency velocity are stationary around a broken trend. However, broad money velocity and real broad money balances are non stationary even after providing for the possibility of a broken trend.

There exist two notable past studies specifically on velocities in Malaysia. Mohamed (1996) explored the causal links between the velocity of money (M1 and M3) and money supply growth and its variability based upon annual data over the period, 1973-94. Via a simple VAR model, Mohamed found that money supply growth and its variability Granger-cause the growth of money velocity. Owoye (1997) examined whether variability of money (M1) growth does cause changes in the income velocity of money in 30 less developed countries inclusive of Malaysia based upon time series data over the 1961-90 period. Owoye found that the monetary growth rate regardless of origin could contribute to variability in the income velocity. However, these studies are glaringly tainted with weaknesses, greatest of all, limited degrees of freedom. They encompass a time period when major structural changes were taking place in the Malaysian financial system. In the case of the present study, the period covered is more 'settled' coupled with deployment of more rigorous econometric techniques such as the innovational outlier model attributable to Perron (1997) and the seasonal integration and cointegration technique of Hylleberg *et al.*(1990). Moreover, this study utilises quarterly data generally over 1991.1-2006.1 as opposed to annual and includes M0 and M2 apart from M1 and M3. The data are drawn from the monthly economic bulletins of the Central Bank of Malaysia.

3. The Stability Aspect

The income velocity of circulation of money may be derived based upon the Fisher equation of exchange as follows:

$$M_t V_t = P_t Y_t \tag{1}$$

where M refers to the nominal stock of money, V to its income velocity of circulation, P to the general price level, Y to real income and t to time subscript. In natural logarithmic terms, the velocity may be simply expressed as

$$v_t = p_t + y_t - m_t \tag{2}$$

where the small letters refer to the natural logs of corresponding variables. Herein, four alternative monetary aggregates (M0, M1, M2 and M3) with their respective velocities (V0, V1, V2 and V3) are examined.

The time series properties of variables are often explored on the assumption that the variables are invariant to any regime change or there is no structural break. However, if this assumption is violated, the application of the conventional unit root tests such as the augmented Dickey-Fuller (1979) and Phillips-Perron (PP) tests could yield misleading results. Such tests are noted for being biased in favour of accepting the null hypothesis of non-stationarity even if the data generation process is stationary around a broken mean and/or trend (Perron 1997; Lee *et al*. 1997; Silvapulle 1996; Cakan and Ozmen 2002).

Hence to examine the time series properties of the Malaysian velocity series, the innovational outlier (IO) model of Perron (1997) that provides for the possibility of a structural break and the seasonal unit root test technique of HEGY are employed here apart from the ADF and the PP tests. The IO model is based on the following regression:

$$y_t = \mu + \beta t + \theta DU_t + \delta D(T_b)_t + \alpha y_{t-1} + \sum_{i=1}^{k} c_i \Delta y_{t-i} + e_t \tag{3}$$

where T_b denotes the time at which the change in the trend function occurs, $DU_t = 1(t>T_b)$ and $D(T_b)_t = 1(t = T_b + 1)$ with I(.) being the indicator function. Perron (1997) advocates three methods for the endogenous selection of T_b. First, T_b is chosen such that the t-statistic for testing $\alpha = 1$ satisfies the minimum condition, i.e. $t^*_\alpha = Min_{T_b \in (k+1,T)} t_{\hat{\alpha}}(T_b, k)$.

Second, T_b is chosen to minimise the t-statistic on the parameter associated with the change in the intercept (θ). The corresponding t-statistic for testing the null hypothesis that $\alpha = 1$ may be written as $t^*_{\alpha,\theta} = t_{\hat{\alpha}}(T^*_b, k)$ where T^*_b is such that $t_{\hat{\theta}}(T^*_b) = Min_{T_b \in (k+1,T)} t_{\hat{\theta}}(T_b, k)$.

The third involves selecting the break date based upon the maximum absolute value of $t_{\hat{\theta}}$ with the corresponding α-related hypothesis denoted as $t^*_{\alpha,|\theta|}$.

The regression is run sequentially for $T_b = k_{max}+1, \ldots\ldots T-1$, where k_{max} represents the maximum order of the lag truncation parameter, k. In this study, k_{max} is set at 8 and the final k is determined based upon the general-to-specific procedure following Perron (1997).

Table 1 presents the results of the unit root tests on seasonally adjusted data based upon this approach with the estimated possible breakpoints. It is interesting to note that except for m1-p, at least two of the three test statistics $(t^*_\alpha, t^*_{\alpha,\theta}, t^*_{\alpha,|\theta|})$ invariably suggest that the variously defined real money balances specifically m0-p, m2-p and m3-p and real

Table 1: Innovational outlier model test results

Series	T_b	K	t^*_ε	$t^*_{\alpha,\theta}$	$t^*_{\alpha,\|\theta\|}$
m0-p	1997.4	0	-5.023	-5.023*	-5.023
m1-p	1997.3	8	-6.121*	-6.121*	-6.121*
m2-p	1995.3	8	-4.173		-4.173
	1997.2	8		-1.201	
m3-p	1995.3	8	-4.561		-4.561
	1997.2	8		-0.069	
y	1997.3	7	-3.366	-3.366	-3.366
m0-p-y	1998.2	7	-4.587	-4.587	-4.587
m1-p-y	1997.2	4	-4.696	-4.696	-4.696
m2-p-y	2001.4	8	-4.094	-4.094	-4.094
m3-p-y	1995.4	5	-1.975		
	1998.4	5		0.137	0.137

Notes: The 5 per cent critical values (for T = 60, nearest to the sample size) of $t_\alpha, t^*_{\alpha,\theta}$ and $t^*_{\alpha,|\theta|}$ are -5.23, -4.92 and -5.18 respectively. * indicates rejection of the null hypothesis.

Table 2: Conventional unit root test results

Series	DF/ADF						Phillips-Perron		
	AIC			SBC					
	Levels	1st	2nd	Levels	1st	2nd	Levels	1st	2nd
m0-p	-2.390	-7.635*	-5.003*	-2.390	-7.635*	-8.731*	-2.208	-8.791*	-47.641*
m1-p	-3.788*	-2.627	-3.369*	-3.788*	-3.988*	-5.757*	-2.074	-6.759*	-29.609*
m2-p	-3.216	-1.863	-2.989*	-3.216	-1.863	-2.989*	-1.293	-9.415*	-28.144*
m3-p	-2.553	-1.476	-3.778*	-2.184	-1.166	-7.093*	-0.913	-8.257*	-27.066*
y	-2.092	-3.468*	-5.335*	-2.092	-3.468*	-4.954*	-1.644	-9.445*	-29.245*
m0-p-y	-2.969	-8.488*	-5.283*	-2.969	-8.488*	-8.309*	-3.330	-10.337*	-38.985*
m1-p-y	-2.649	-3.959*	-4.337*	-2.209	-5.823*	-6.808*	-2.047	-6.583*	-40.041*
m2-p-y	-1.776	-2.639	-3.316*	-2.095	-4.648*	-6.220*	-1.961	-7.218*	-27.252*
m3-p-y	-0.862	-2.713	-5.247*	-1.598	-6.004*	-5.973*	-0.886	-6.605*	-33.299*

* The null hypothesis of unit root can be rejected at the 5 per cent significance level.

income (y) are inherently non stationary even after providing for the possibility of a broken trend. Both real balances and real income do not appear to be cointegrated to yield stationary velocities, given that the ratios of real balances to real income (m0-p-y, m2-p-y and m3-p-y) are non stationary as indicated by the *t*-statistics.[1]

Such results in fact corroborate those based merely on conventional tests and therefore share the same conclusion about the non stationarity of these variables. Table 2 furnishes the Dickey-Fuller-based and the Phillips-Perron unit root test statistics up to the second difference of the variables. The optimal order of lag augmentation in the Dickey-Fuller-

[1] In fact, strictly based upon equation (2), nominal money balances must be cointegrated with p and y with a cointegrating vector (1, -1, -1) to yield stable velocities.

based tests is determined based upon the Akaike Information Criterion (AIC) and the Schwarz Bayesian Criterion (SBC). The Phillips-Perron tests neatly rule that the variously defined real money balances and output are integrated of order one, I(1) but are not cointegrated as the ratios between them are also I(1), thus suggesting instability in the income velocities of money. This is affirmed by the Dickey-Fuller based tests that allude to (m0-p-y) and (m1-p-y) as being I(1) with (m2-p-y) and (m3-p-y) being even possibly I(2). Hence in so far as the velocities of money in Malaysia are concerned, one does not risk making incorrect inferences about non stationarity by mere reliance on conventional unit root tests.

Next in order to address the possibility that the variables are seasonally integrated and cointegrated instead, the HEGY (Hylleberg *et al.* 1990) is employed. Seasonally unadjusted data are mobilised in this exercise. Under this alternative approach, the velocity of circulation can only be established as stationary if and only if both real money balances and real output are integrated of the same order at the same seasonal or non seasonal frequencies and that they are cointegrated at corresponding frequencies.

The HEGY test is a test for seasonal and non seasonal unit roots applicable to quarterly data series. It is based on the following auxiliary regression:

$$\Delta_4 y_t = \sum_{i=1}^{4} \alpha_S D_{St} + \gamma T_t + \pi_1 y_{1,t-1} + \pi_2 y_{2,t-1} + \pi_3 y_{3,t-2} + \pi_4 y_{3,t-1} + \sum_{i=1}^{k} \phi_i \Delta_4 y_{t-i} + \varepsilon_t$$

where D_{st} and T_t refer to the deterministic seasonal dummies and the time trend respectively and

$$y_{1t} = (1+L+L^2+L^3)y_t$$
$$y_{2t} = -(1-L+L^2-L^3)y_t$$
$$y_{3t} = -(1-L^2)y_t$$

If $\pi_1 = 0$, the series has a non seasonal stochastic trend. Two cycles per year is implied if $\pi_2 = 0$. The series contains the roots i and $-i$ if $\pi_3 = 0$ and $\pi_4 = 0$, implying the presence of seasonal unit roots at the annual frequencies. Simulated critical values for the various tests of significance of $\pi 1$ and $\pi 2$ and the joint significance of $\pi 3$ and $\pi 4$ under different specifications with respect to the deterministic terms are tabulated in Hylleberg *et al.* (1990).

Table 3 furnishes the outcomes of seasonal unit root tests under two alternative assumptions pertaining to the deterministic terms. No lag augmentation is found necessary to purge the auxiliary regression of serially correlated errors. The various real money balances, real output and the associated velocities appear to be integrated at the zero frequency when all the deterministic terms are included in a regression. This is generally consistent with the two preceding tests. Integration of these series at biannual and annual frequencies is ruled out. The possibility that real money balances and real output are seasonally cointegrated and by implication yielding seasonally integrated velocities, can thus be dismissed.

In fact, the validity of the unit root test results that suggest instability of the velocity of money can be verified albeit casually by inspection of the plots of the velocity of money variously defined (Figures 1, 2, 3 and 4). The figures reveal unstable velocities. While the velocity of M0 assumes an upward trend and that of M2 downward, those of M1 and M3 display no definite trend over the sample period. One could however infer that the velocity of M1 is more stable than the others.

Table 3: Seasonal unit root test results

Variables	$\Pi_1 = 0$	$\Pi_2 = 0$	$\Pi_3 \cap \pi_4 = 0$	K
m0-p				
I, S	-1.727	-3.854*	35.285*	0
I, S, T	-2.331	-3.921*	37.106*	0
m1-p				
I, S	-1.802	-2.992	48.315*	0
I, S, T	-2.753	-3.090*	49.362*	0
m2-p				
I, S	-2.105	-3.524*	32.219*	0
I, S, T	-1.975	-3.542*	31.434*	0
m3-p				
I, S	-3.247*	-3.992*	23.800*	0
I, S, T	-1.728	-3.971*	23.430*	0
y				
I, S	-1.533	-4.276*	27.982*	0
I, S, T	-1.821	-4.320*	28.050*	0
v0				
I, S	-0.614	-3.507*	18.578*	0
I, S, T	-2.170	-3.618*	20.345*	0
v1				
I, S	-2.304	-3.649*	34.206*	0
I, S, T	-2.413	-3.666*	33.721*	0
v2				
I, S	-1.490	-3.939*	26.690*	0
I, S, T	-1.841	-3.962*	26.272*	0
v3				
I, S	-2.491	-4.182*	24.875*	0
I, S, T	-1.132	-4.114*	24.306*	0

* 5 per cent significance level test passed.

Table 4: Unit root test results of variables in the VAR

Series	DF/ADF						Phillips-Perron		
	AIC			SBC					
	Levels	1st	2nd	Levels	1st	2nd	Levels	1st	2nd
m0gv	-1.039	-3.783*	-3.454*	-1.516	-7.094*	-6.295*	-1.750	-7.524*	-56.732*
m1gv	-1.778	-5.759*	-6.114*	-1.398	-6.074*	-7.148*	-1.605	-6.801*	-22.144*
m2gv	-2.176	-6.120*	-5.939*	-1.753	-6.120*	-10.854*	-2.096	-6.347*	-33.487*
m3gv	-2.402	-4.907*	-7.646*	-2.402	-5.598*	-7.646*	-2.210	-5.909*	-27.919*
r3tb	-1.523	-4.017*	-10.312*	-1.499	-7.969*	-10.312*	-1.528	-8.273*	-15.537*
y	-2.092	-3.468*	-5.335*	-2.092	-3.468*	-4.954*	-1.644	-9.445*	-29.245*
v0	-0.905	-8.772*	-5.435*	-1.166	-8.772*	-8.345*	-3.359	-10.412*	-38.664*
v1	-2.777	-3.899*	-4.326*	-2.796	-5.527*	-11.037*	-2.031	-6.417*	-33.305*
v2	-1.655	-5.403*	-5.374*	-1.603	-5.403*	-6.428*	-1.915	-6.159*	-21.805*
v3	-2.505	-5.343*	-6.159*	-2.572	-5.343*	-6.159*	-0.840	-6.018*	-27.884*

* The null hypothesis of unit root is rejected at the 5 per cent significance level.

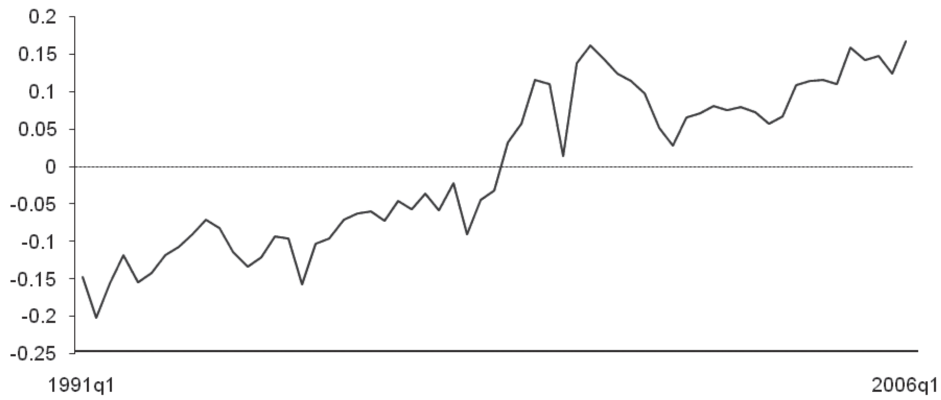

Figure 1: *Velocity of M0*

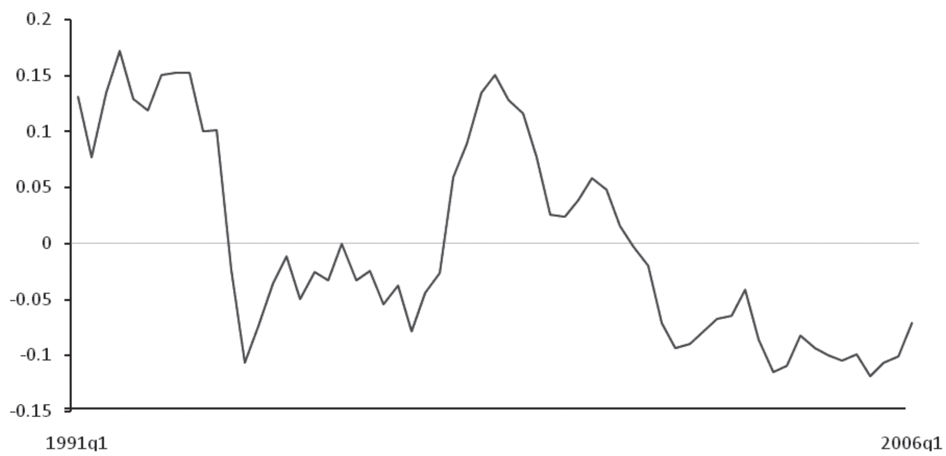

Figure 2: *Velocity of M1*

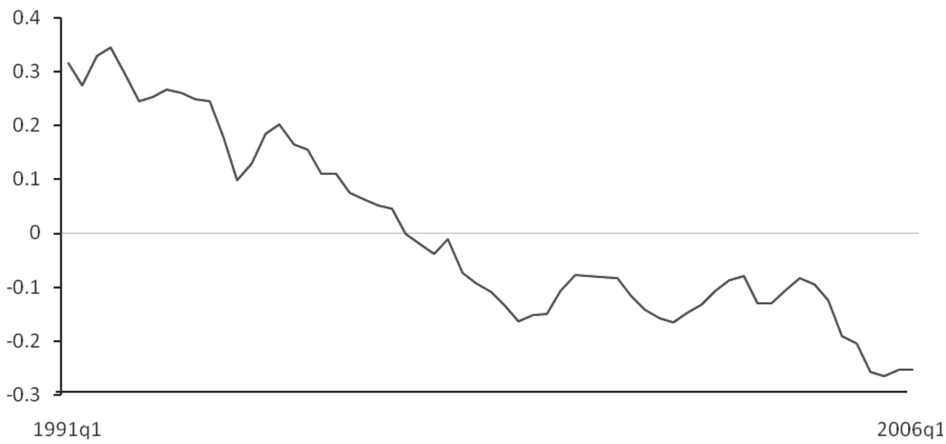

Figure 3: *Velocity of M2*

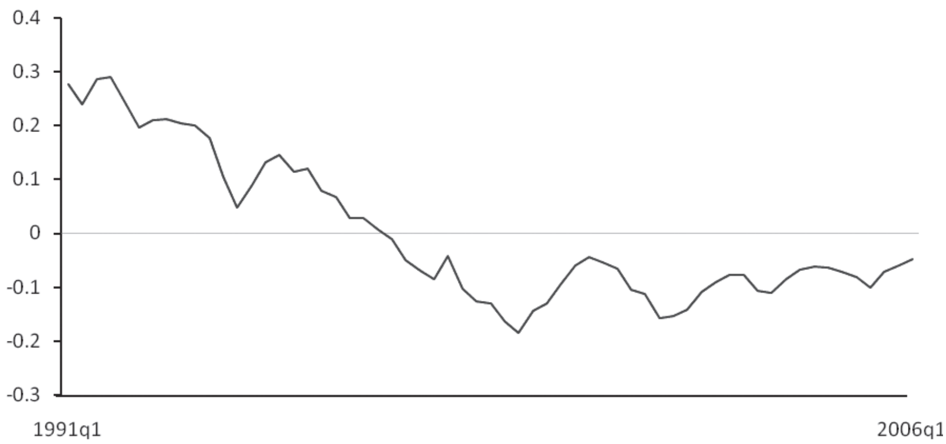

Figure 4: *Velocity of M3*

4. Real and Monetary Influences

For the purpose of assessing the potential influence of monetary *vis-à-vis* real factors on the velocity, a 4-variable VAR system is estimated with seasonally adjusted data. A major advantage of employing the VAR technique is that it regards each variable in the system as potentially endogenous as opposed to the single equation technique. Broadly following Basu and Dua (1996), the variables included are money growth variability, the 3-month Treasury Bill rate, real GDP and the income velocity of money. Such is the ordering of the variables followed when performing the Choleski decomposition, justified by the prior conviction that velocity movements are preceded by the other variables. Since monetary growth variability can be policy-induced and movements in interest rates may generally be a good monetary policy indicator, it is logical to expect movements in policy-related variables to come before those of others. The monetary growth variability is captured by the moving standard deviation of eight (current and seven lags) quarterly growth rates in the monetary aggregates following Leao (2005) and Basu and Dua (1996).[2]

The question arises as to whether the VAR system should be couched and estimated in levels or in first differences. The question is resolved by establishing whether the variables are cointegrated via the Johansen maximum likelihood procedure. Table 4 furnishes the results of the unit root tests on individual series that constitute the system. Both the Phillips-Perron and the Dickey-Fuller-based tests consistently suggest that they are I(1), thus giving rise to the possibility that at least one cointegrating relationship exists amongst money growth variability, the interest rate, real income and velocity.

Table 5 shows the results of the Johansen cointegration tests based upon an optimal order of VAR of 8 as determined by the AIC. The SBC is not adopted as it would suggest an optimal order of 1 which is perceived as being too low. Both the maximal eigenvalue and trace statistics are consistent on the number of cointegrating relationships present. Two cointegrating relationships appear to be the case for M0 and M1 while three for M2 and M3.

Given the presence of cointegrating relationships, a VAR in levels could suitably approximate the short run dynamics of the system (Basu and Dua 1996). Estimation of an unrestricted VAR in first differences could be a mis-specification in the case of cointegrating variables (Campbell and Perron 1992; McMillin 1991). Moreover, Phillips and Durlauf (1986), Stock (1987), West (1988) and Sims *et al.* (1990) contend that differencing is unnecessary if non stationary series are cointegrated as estimation with such series could yield consistent parameter estimates.

Hence the VAR system can generally be estimated in levels.[3] Based upon the estimated VAR system, variance decomposition is performed. Variance decomposition is an innovation accounting technique that breaks down the variance of the forecast error of a variable into components ascribable to each of the explanatory variables in the system. Table 6 presents the outcomes of the variance decomposition, giving the proportion of the *n*-period ahead

[2] In fact, reserve money should be preferable to monetary aggregates as it constitutes a more reliable indicator of monetary policy. But its quarterly series only starts in 1996. However, if the money multiplier is stable over time, variability in the monetary aggregates would be an adequate reflection of the variability in the monetary base.

[3] This study has not proceeded with the Vector Error Correction (VEC) model due to the findings of at least two cointegrating vectors in the system. The complexity arising from the presence of more than one cointegrating vector is commonly acknowledged.

Table 5: Cointegration test results: money growth variability, velocity, interest rate and real income

Monetary Definition	Null	Statistic	
		Max eigenvalue	Trace
M0	r=0	60.756 (28.270)	122.829 (53.480)
	r < or = 1	42.100 (22.040)	62.073 (34.870)
	r < or = 2	12.063 (15.870)	19.973 (20.180)
M1	r = 0	46.636 (28.270)	94.157 (53.480)
	r < or = 1	27.430 (22.040)	47.521 (34.870)
	r < or = 2	13.344 (15.870)	20.090 (20.180)
M2	r = 0	42.026 (28.270)	99.349 (53.480)
	r < or = 1	27.975 (22.040)	57.323 (34.870)
	r < or = 2	20.774 (15.870)	29.348 (20.180)
	r < or = 3	8.575 (9.160)	8.575 (9.160)
M3	r = 0	70.396 (28.270)	132.588 (53.480)
	r < or = 1	35.571 (22.040)	62.192 (34.870)
	r < or = 2	17.838 (15.870)	26.621 (20.180)
	r < or = 3	8.783 (9.160)	8.783 (9.160)

Note: Figures in parentheses refer to 95 per cent critical values.

forecast error variance of the monetary (M0, M1, M2 and M3) velocity attributable to each of the variables in the VAR system.[4] The ensuing discussion is based upon a forecast horizon of 6 quarters. At that forecast horizon, 28.1 per cent of the error variance in the velocity of M0 is explained by innovations in its growth variability. Whilst in the case of M1 velocity, 21.5 per cent of its error variance is accounted for by its growth uncertainty. Thus there is some support for Friedman's monetary uncertainty hypothesis in so far as M0 and M1 velocities are concerned. However, variability in the growth of M2 and M3 does not account significantly for the variation in their velocities. Only 6.1 per cent and 2.7 per cent of the error variance of M2 and M3 velocities respectively can be attributed to their growth variability. Such results are rather interesting as it suggests substitution possibilities between narrowly defined money and quasi money in the face of monetary growth variability. Any such process of substitution would affect holdings of M0 and M1 but not M2 and M3 given that the former set of aggregates form part of the latter set. Innovations in the interest rate tend to explain a substantial portion of the error variance of M0, M1 and M2 velocities, generally exceeding 30 per cent in the case of M0 and M1 and 20 per cent in respect of M2. Interest rates do not appear to weigh much on M3 velocity. However, this velocity is very much influenced by real output as innovations in real output explain 38.7 per cent of its variance. The influence of real output is also quite substantial, albeit to a smaller extent on the velocities of M0 and M2 though not so on M1 velocity as suggested by their forecast error variances attributable to real output.

In fact, the table also permits us to compare the weights of monetary (money growth variability and the interest rate) and real (real output) variables in determining velocity movements. It is interesting to note that the monetary variables together seem to explain about 58 per cent of the forecast error variance of M0 and M1 velocities and 29 per cent and

[4] The results of the variance decomposition of the other variables in the system are not reported to economise on space as this paper is concerned with monetary velocity.

Table 6: Variance decomposition (%)

Monetary definition	Forecast horizon	Money growth variability	Interest Rate	Real income	Velocity
M0	1	2.09	29.94	33.27	34.71
	2	4.61	28.31	31.60	35.48
	3	11.80	26.39	29.26	32.55
	4	22.21	29.53	22.67	25.58
	5	28.91	30.09	19.17	21.83
	6	28.05	30.18	18.72	23.05
M1	1	0.01	48.42	1.05	50.51
	2	2.71	43.17	2.06	52.06
	3	12.00	39.63	1.76	46.62
	4	16.90	39.24	1.59	42.27
	5	19.50	37.80	2.40	40.30
	6	21.46	36.58	2.52	39.44
M2	1	4.40	27.24	17.67	50.69
	2	3.90	24.20	24.25	47.66
	3	3.68	24.82	23.85	47.65
	4	6.37	23.37	22.31	47.95
	5	6.00	24.39	21.37	48.24
	6	6.09	23.08	25.20	45.64
M3	1	0.38	4.96	34.61	60.05
	2	0.31	3.81	44.13	51.75
	3	2.24	4.27	45.73	47.75
	4	3.02	6.01	44.07	46.91
	5	2.91	9.71	42.20	45.17
	6	2.67	10.11	38.67	48.55

13 per cent in the case of M2 and M3 respectively. Thus it is interesting to note that the role of monetary factors in explaining monetary velocities generally declines with the level of monetary aggregation.

5. Concluding Remarks

This paper has first established that the velocity of circulation of money variously defined as M0, M1, M2 and M3 in Malaysia is indeed unstable beyond the use of conventional unit root test techniques. It has highlighted that in the Malaysian context, the conventional techniques such as the Dickey-Fuller and the Phillips-Perron are generally robust to the possibility of a trend break in the velocity and its component series. Moreover, seasonal integration and cointegration need not be a factor to reckon with in appreciating the behaviour of monetary velocities given the absence of stochastic seasonals.

Given the non stationary characteristic of the velocity, the paper then assesses the relative extent to which real and monetary factors could possibly explain the behaviour of velocities. A number of interesting points emerged from the vector autoregression analysis. First, some support is found for Friedman's monetary uncertainty hypothesis in M0 and M1 velocities. Second, velocities of M2 and M3 are not being influenced significantly by their growth variability and that monetary variables explain less these velocities. An upshot of such findings is that there is some wisdom on the part of the monetary authority to manipulate M2 and M3 if it chooses to do so in order to meet certain economic growth targets. Specifically, it could achieve greater precision in maintaining the targets. But third, however, the influence of real output is quite considerable on the velocities of M0, M2 and M3. Thus the monetary authority has to take cognizance of the feedback from economic growth induced by policy changes in the money supply on the relationship between M0, M2 and M3 on the one hand and nominal income on the other.

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