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ANTICIPATED MONEY, UNANTICIPATED MONEY AND OUTPUT VARIATIONS IN SINGAPORE

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Abstract

This paper examines the effectiveness of anticipated and unanticipated money in the variations of output in Singapore over the periods 1971-72 to 2007-08. The study has found that money supply and output in Singapore are cointegrated. No cointegration is found between output and anticipated money. Short-run dynamics of the cointegrated variables testifies that money supply of the immediate past period leads to rise in output. The study also examines the invariance proposition of rational expectations and found the evidence that the unanticipated part of money supply has significant role in the variations of output growth. Therefore monetary surprises may be successful in promoting output growth.

Keywords: Anticipated money, Cointegration, Monetary surprise, Rational Expectation, Unanticipated Money,

JEL Classifications: E51, E52, C32

1. Introduction

One of the most important objectives of macroeconomic policy modeling is to achieve sustained output growth. Formation of effective macroeconomic policy requires examination of underlying relationship among the policy variables. The functional relationship between money supply and output variations has been a controversial theoretical issue of interest for economists. Empirically this relation is still inconclusive in countries concerned.

In the classical setup money is neutral. The quantity theory of money postulates that change in money supply leads to a rise in general price level and output level remains fixed at full employment level. Keynesians do believe in an indirect link between money supply and real output. They hold the view that expansionary monetary policy increases the supply of loanable funds through the banking system which leads to fall in interest rates. With lower interest rates aggregate expenditures on investment and interest-sensitive consumption goods usually increase and cause real output to rise. Hence, monetary policy can affect real output indirectly. Friedman holds that money supply entails output effect, inflation effect and liquidity effect. Expectations

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being adaptive actual wage/inflation rate exceed adaptively expected wage/inflation. This causes the Phillips curve a negatively sloping in the short-run. Consequently, money supply becomes successful in the short-run in generating output variations. *Frederic S. Mishkin (1996)* analyzed different monetary transmission channels through which monetary growth affects the level of output

According to rational expectationists, (*Sargent 1975, Lucas 1976, Wallace 1975*) change in anticipated money supply has no affect on the real output, employment or any other real variables of the economy but it affects price level. On the other hand, the unanticipated part of the money supply affects output.[2] The idea can be explained as:

$$m_t + v_t = p_t + y_t \quad \text{... (1)}$$

where, m_t = log of the money supply, v_t = log of the velocity of money (assumed constant, detail in the Appendix), p_t = log of the price level, y_t = log of the real output.

The aggregate supply curve is given by the Lucas supply equation as

$$y_t = y_p + \beta(p_t - {}_{t-1}p_t^e) \quad \text{... (2)}$$

where, y_p = log of full employment output, ${}_{t-1}p_t^e$ = log of the price level that the public expects to occur in time t viewed from period t-1.

Let the monetary rule used by the policy authorities be

$$m_t = \alpha_1 y_{t-1} + \varepsilon_t \quad \text{... (3)}$$

where, $E(\varepsilon_t) = 0$

Under rational expectations, the price expectations are determined within the model in the light of past and present developments of the money supply. This can be expressed as

$${}_{t-1}p_t^e = E[p_t / I_{t-1}] \quad \text{... (4)}$$

This equation asserts that people's subjective and psychological expectation of the price level (p_t^e) equals the mathematical expectation of the price level, given both the structure of the model and the information available at time 't-1'. From (1) and (2) we have

$$m_t + v_t - p_t = y_p + \beta(p_t - {}_{t-1}p_t^e) \quad \text{... (5)}$$

$$\text{or, } \alpha_1 y_{t-1} + \varepsilon_t + \bar{v} - p_t = y_p + \beta(p_t - {}_{t-1}p_t^e) \quad \text{... (6)}$$

Taking mathematical expectations, we have

$$\alpha_1 y_{t-1} + E(\varepsilon_t) + \bar{v} - E(p_t) = y_p + \beta[E(p_t) - {}_{t-1}p_t^e]$$

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2 This idea of Rational Expectationists is popularly known as 'Invariance Propositions'.

$$\text{or, } \alpha_1 y_{t-1} + \bar{v} - {}_{t-1}p_t^e = y_p + \beta[{}_{t-1}p_t^e - {}_{t-1}p_t^e]$$

$$\text{or, } \alpha_1 y_{t-1} + \bar{v} - {}_{t-1}p_t^e = y_p$$

$$\text{or, } {}_{t-1}p_t^e = \alpha_1 y_{t-1} + \bar{v} - y_p \qquad \text{... (7)}$$

From (6) and (7),

$$p_t = \alpha_1 y_{t-1} + \bar{v} + \beta(p_t - {}_{t-1}p_{t-1}^e) + \varepsilon_t - y_p$$

$$\text{or, } p_t + \beta p_t = \alpha_1 y_{t-1} + \bar{v} + \beta.{}_{t-1}p_t^e + \varepsilon_t - y_p$$

$$\text{or, } (1+\beta)p_t = (\alpha_1 y_{t-1} + \bar{v}) + \beta(\alpha_1 y_{t-1} + \bar{v} - y_p) + \varepsilon_t$$

$$\text{or, } (1+\beta)p_t = (1+\beta)(\alpha_1 y_{t-1} + \bar{v} - y_p) + \varepsilon_t$$

$$\text{or, } p_t = \alpha_1 y_{t-1} + \bar{v} - y_p + \varepsilon_t / 1 + \beta \qquad \text{... (8)}$$

Therefore, the gap between the actual price and the expected price is

$$P_t - {}_{t-1}p_t^e = \varepsilon_t / 1 + \beta \qquad \text{... (9)}$$

Using the Lucas supply equation, we find that output will equal

$$Y_t = y_p + \varepsilon_t \beta / 1 + \beta \qquad \text{... (10)}$$

Equations (8) and (10) indicate that both the anticipated and unanticipated parts of money supply affect price level but not output level. Equation (10) shows that unanticipated part of money supply (ε_t) affects output level. One may, therefore, expect monetary policy to be helpful in managing output variations. Monetarists following Friedman and Phelp, may hold that monetary authority might control principal macroeconomic variables through the introduction of *monetary surprises* in the short-run. However, if such surprises are introduced successively, these would entail an autoregressive structure which may be exploited by the market agents in the formation of their expectations for future money supply. Monetary policy, as a result, would fail to have any effect on output variations in the long-run. This means that monetary policy will be effective in its design provided surprises are white noise. However, white noise surprises may suffer from *Autoregressive Conditional Heteroscedasticity* (ARCH). In such case, this autoregressive structure in error variance may also hinder the efficacy of the monetary policy. All these indicate that monetary policy may affect macroeconomic variables provided the errors transmitted through the monetary channel are white noise given that their variances are free from ARCH. It, therefore, follows that monetary policy may effectively be used to manage variations in output levels and this can only be done through the introduction of surprises in money supply provided this monetary innovations are white noise by nature and also free from ARCH.

Number of empirical studies has been done on this issue for different periods of time, where most of the studies have examined the *causal links* between money supply and output. In this context the study by Milton Friedman and Schwartz (1963) is influential. Taking the U.S. historical data on money and output, Friedman and Schwartz (1963) provocatively contend the strong effect of money on output. However, economists such as Benjamin Friedman and Kuttner (1992), Tobin (1970) have challenged the view of Friedman and Schwartz (1963). Benjamin Friedman and Kuttner (1992) re-examine the postwar evidence of significant relationship between money and income using time-series approach on extended data through the 1980s for the U.S. economy. Their findings do not support the relationship as stated by Benjamin Friedman and Kuttner (1992). Applying Granger (1969) method of causality, Sim's (1972) found that money supply Granger causes output. Again, Sims (1980) study employed VAR model on money supply, output level and rate of interest and found the evidence that interest rate accounted for the significant part of output variations previously attributed to money supply. The findings of Sims (1980) study has challenged by Bernanke (1986) and others in the following periods. Christiano and Ljungqvist (1988) and Krol and Ohanian (1990) showed that the lack of Granger causality from money to output was due to the econometric misspecification of data generating process. Stock and Watson (1989) argued that detrended money Granger cause output. Eichenbaum and Singleton (1986) and Stock and Watson (1989) found that the causal role for money is much weaker in a sample that excludes data from the 1980's than in dataset that includes the 1980's. Walsh (1998) study indicates variations in the rate of money growth cause variations in economic growth. Barro (1977) holds that unanticipated monetary shocks affect output while anticipated shocks do not. Cochrane (1998) argues that a reasonable assumption specifying the relative effects of anticipated and unanticipated money should be used to study the effect of money on output. In the Indian context Sharma (1984), Singh (1989), Ghani (1991), Verma and Kumar (1994), Jha, R and K. Donde (2001), Maitra B (2010) were among the few studies.

Lee and Li (1983) concluded that the relationship between money and real income in Singapore are generally two-way and quite complicated. Ong Chin Huat, David Wan Tai Wai (2000) found the evidence that the relationship between M_1 and GDP (quarterly) in Singapore support the feedback causal relationship as concluded by Lee and Li (1983) and Ong (1990). However, the study found the unidirectional causal relation running from GDP and M_2 money supply and GDP and M_3 money supply by 8 quarters. The objective of the present study is to examine if the money supply variations has any link with the variations in output level in the economy of Singapore over the period 1971-72 to 2007-08. The study also attempts to enquire if the invariance proposition holds good in the economy of Singapore over the period of the study.

2. Variables, Data, Stationarity and Cointegration

Keeping in view the objectives mentioned above, we have taken output, M_1 money supply in Singapore. We have derived the anticipated and unanticipated components of the M_1 money supply. Annual time series dataset has been used in this study where the period ranges from 1971-72 to 2007-08. The dataset has been collected from *International Financial Statistics* (IFS). We use the logarithm of the time series.

Output:

The output is measured in this study in terms of Gross Domestic Product (GDP) at factor cost. The nominal GDP is converted in to real terms by the Consumer Price Index (CPI, 2000 = 100). In this study (natural) logarithm of real GDP is shown by y_t. First difference of logarithmic series actually implies ‘growth’ of the variable concerned. Output growth in this study is denoted by $\dot{Y}_t$.

Money Supply:

In this study M_1 money supply is taken. We have converted the nominal money supply into real money. Logarithm of real money is denoted by m_t. Growth of real money is denoted by $\dot{m}_t$.

Anticipated and Unanticipated Money Supply:

In order to test the invariant proposition of rational expectation, anticipated and unanticipated parts of money supply are required. Applying Box-Jenkins (BJ) methodology appropriate Autoregressive and Integrate Moving Average (ARIMA) structure of the m_t series is identified and anticipated and the unanticipated components are decomposed. It is found that the m_t follows ARIMA (2, 1, 0) structure. The anticipated and the unanticipated parts of m_t are denoted by m_t^a and m_t^u respectively.

Standard regression with non-stationary data makes all regression coefficients misleading, and therefore, leads to spurious relationships with erroneous conclusions. It, therefore, becomes pertinent to enquire into the stationarity of the macroeconomic time series concerned. If the dataset be non-stationary at level, the study of cointegration is required or appropriate filtering of dataset is required before using them in econometric model building. In this study stationarity of the time series dataset has been studied through Augmented Dickey-Feller (ADF, 1979, 1981) and Phillips, P.C.B. and P. Perron (PP, 1988) unit-root tests. Unit-root tests necessitate appropriate specification of the time series about their trend, intercept etc. These specifications have been testified through the time plots of the series concerned shown in the Appendix. Figure 1 shows that output, money supply and its anticipated component (Figure 4) follow trend having positive intercept. Unanticipated money has no trend. Considering these natures of the series concerned, ADF and PP unit root test have been performed. Results are summarized in the Table 1.

ADF and PP unit-root tests testify that real output, M_1 money supply and its anticipated component are non-stationary at level and becomes stationary upon first differencing (growth series). In other words output, money and its anticipated component are I(1) series. But unanticipated component of M_1 money is I(0). Under this situation in order to enquire into the existence of long-run relation between output and money supply it is essential to study cointegration. Tests for cointegration explicitly support or accept the prior belief that the long-run movements of the relevant variables are related. We have applied the VAR-based cointegration tests developed by *Johansen (1991, 1995)*. In this case test results are highly sensitive with the specification of the time series. To identify appropriate number of cointegration ranks linear deterministic trend in data and intercept and trend in cointegrating equation[3] has been taken. Results are summarized in Table 3.

Table 1. Stationarity of Time Series

Variables	*Without Trend* *ADF*	*PP*	*With Trend* *ADF*	*PP*
y_t	-0.91(-2.94)	-0.88 (-2.94)	-1.62 (-3.54)	-1.626 (-3.54)
$\dot{y}_t$	-4.95 (-2.94)	-4.96 (-2.94)	-4.82 (-3.55)	-4.84 (-3.54)
m_t	-0.10 (-2.94)	0.40 (-2.94)	-2.64 (-3.54)	-2.68 (-3.54)
$\dot{m}_t$	-6.90 (-2.94)	-7.25 (-2.94)	-6.89 (-3.54)	-7.04 (-3.54)
m_t^a	-1.12 (-2.95)	-0.60 (-2.95)	-2.64 (-3.55)	-3.06 (-3.55)
m_t^u	-5.63 (-2.95)	-5.66 (-2.95)	-5.54 (-3.55)	-5.57 (-3.55)

Notes:
1. Figures given in the parenthesis indicate 5% critical values.
2. Lag-lengths in the ADF test are determined based on SIC
3. Maximum Bandwidth in the PP test are decided based on Newey-West (1994)

Table 3. Results of *Johansen (1991, 1995)* Cointegration Tests

Variables	*Trace Test*			*Max-Eigen Test*			*Decision*
	H_0	*Eigen value*	*Trace Statistic*	*H_0*	*Eigen value*	*Max-Eigen Statistic*	
y_t , m_t	$r = 0$ $r \leq 1$	0.559 0.153	**35.52 (25.32)** 5.99 (12.25)	$r = 0$ $r = 1$	0.599 0.153	**29.53** (18.96) 5.99 (12.25)	$r = 1$
y_t , m_t^a	$r = 0$ $r \leq 1$	0.425 0.080	21.08 (25.32) 2.78 (12.25)	$r = 0$ $r = 1$	0.425 0.080	18.304 (18.96) 2.78 (12.25)	$r = 0$

Notes:
(i) *r* denotes no of cointegration(s) exists,
(ii) The critical values are taken from *Osterwald-Lenum (1992),* which differs slightly from those reported in *Johansen and Juselius (1990).*

Both the Trace and Max-Eigen Statistics under Johansen cointegration tests accept one cointegrating relation between output and M_1 money supply (even at 1% level). However, no

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[3] Initially five alternative specifications were taken and corresponding numbers of cointegrating ranks were obtained. Then applying model selection criterion namely, *Akaike Information Criteria* (AIC) and *Schwarz Criteria (*SC) appropriate specification and number of cointegrating ranks are identified (shown in the Table 2, Appendix). It is found that values of AIC and SC are least when Johansen test has been done with the specification linear deterministic trend in data and intercept and trend in cointegrating equation.

cointegration is found between output and anticipated money supply. Implication of the findings of the cointegration study is that there exists long-run relation between output and M_1 money supply in Singapore. This cointegrating relation suggests the causal relation between output and money at least in one direction. The short-run dynamics of cointegrated variables is enquired in the following section.

3. Short-Run Dynamics between Money Supply and Output

We study the short-run dynamics between the cointegrated variables, namely money supply and output through the estimation of *Vector Error Correction Model (VECM)* derived from the Johansen cointegration tests mentioned above. The estimable model consists of following equations:

$$\Delta y_t = \alpha_1 + \rho_1 Z_{1t-1} + \beta_{1i}\sum_{i=1}^{n}\Delta y_{t-i} + \gamma_{1i}\sum_{i=1}^{n}\Delta m_{t-i} + \omega_t \qquad \text{... (11)}$$

$$\Delta m_t = \alpha_2 + \rho_2 Z_{2t-1} + \beta_{2i}\sum_{i=1}^{n}\Delta m_{t-i} + \gamma_{2i}\sum_{i=1}^{n}\Delta y_{t-i} + \Im_t \qquad \text{... (12)}$$

where Z_{1t-1} and Z_{2t-1} are error correction terms. ω_t ~ i i d N $(0, \sigma_w^2)$, and υ_t ~ i i d N $(0, \sigma_3^2)$. In this estimation one lag has been taken as suggested by the *AIC*. The results are presented below:

$$\Delta y_t = 0.052 - 0.026 Z_{1t-1} - 0.039\,\Delta y_{t-1} + 0.254\,\Delta m_{t-1} \qquad \text{... (13)}$$

t [3.048] [–0.58] [1.98] [1.97]

$R^2 = 0.24$, Adj. $R^2 = 0.17$, AIC = -3.35, SC = -3.17

$$\Delta m_t = 0.034 + 0.2204 Z_{2t-1} + 0.360\,\Delta m_{t-1} + 0.084\,\Delta y_{t-1} \qquad \text{... (14)}$$

t [1.45] [3.56] [2.07] [0.33]

$R^2 = 0.34$, Adj-$R^2 = 0.28$, AIC = -2.74, SC = -2.57

The error correction term of the estimated equation (13) is statistically insignificant even at 10% level. It implies shocks transmitted through the output channel fail to disturb the long-run relationship that output maintained with the money supply. Positive and significant estimate of m_{t-1} implies that money supply of immediate past period leads to a rise in output of the current period. This significant estimate in the presence of lagged output indicates *money supply Granger causes output*. On the other hand $\hat{\rho}_2$, the error correction term of the estimated equation (14), is statistically significant at 1% level. It indicates short-run shocks, transmitted through the monetary channel, significantly affects the long-run relationship which money supply maintained with output. The positive sign of $\hat{\rho}_2$ indicates that output, following any positive shock transmitted through the channel of money supply, increases. Consequently, short-run positive money shock of past periods appeared to push up current output from its long-run equilibrium level. Here lagged period output fails to cause variations in current money supply. The evidence of Granger causality of this estimated error correction model has further been confirmed through the Wald tests.[4] The results of Wald tests are shown in the Table 4.

Table 4. VEC Pair-Wise Granger Causality/Block Exogeneity Wald Tests

Dependent variable: Δy_t			
Exclude	Chi-squire	df	Prob.
Δm_t	3.902	1	0.04
All	3.902	1	0.04
Dependent variable: Δm_t			
Exclude	Chi-sq	df	Prob.
Δy_t	0.107	1	0.74
All	0.107	1	0.74

The calculated Chi-squire statistic rejects (at 5% level) the possibility of block exogeneity of output. The rejection of null hypothesis of block exogeneity, therefore, indicates money supply cause output variations. However, a chi-square test statistic of 0.107 in the money equation indicates the null hypothesis that lagged coefficients of output being equal to zero can not be rejected. Thus the estimated vector error correction model testifies for the fact that in the economy of Singapore there exists *uni-directional causal relationship* running from money supply to output. Specifically, money supply of the immediate past period exerts significant impetus on current output. Implication of these findings is that variations in money supply succeed in generating the variations in output over the period of the study. These findings can further be confirmed through the *innovation accounting* involving *variance decomposition*[5] obtained from the estimated VEC model involving equation (13) and (14). The variance decompositions of output and money supply variances over 10 periods are being presented through the Table 5 shown below.

The variance decomposition study gives forth some interesting features about the relative importance of shocks transmitted through output and monetary channels in the explanation of variations in output and monetary profiles. Monetary shocks took the leading role in constituting the variations in both output and monetary profiles. On the other hand, output shocks explain significant variations in output profile only. All these observations implicitly indicate for the possibility of *uni-directional causality* running from money supply to output in Singapore over the period of the study.

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4 The Wald tests compute a test statistic based on the unrestricted regression. The test statistic measures how close the unrestricted estimates come to satisfying the restrictions under the null hypothesis. If the restrictions are in fact true, then the unrestricted estimates should come close to satisfying the restrictions.

5 The variance decomposition separates the variations in an endogenous variable into the component shocks.

Table 5. Variance Decomposition

Forecast Period Ahead	Variance Decomposition Output		Variance Decomposition Money Supply	
	y_t	m_t	m_t	y_t
1	68.35	31.65	100.00	0.00
2	48.82	51.18	97.52	2.48
3	47.70	52.30	94.57	5.43
4	49.86	50.14	92.61	7.39
8	53.57	46.43	87.88	12.12
10	54.12	45.88	85.67	14.33
Cholesky Ordering: m_t, y_t				

4. Money Supply and Output Variations: A Test of Invariance Propositions

In the previous section it is found that output has responded to the variations in money supply. It is a matter of interest to know if such positive response is due to unanticipated component of money supply. We have sought to enquire into this issue through the estimation of the model incorporating unanticipated money supply with output growth. The study testified that output growth and unanticipated money supply are I(0). Therefore study of cointegration and then error correction model are inappropriate[6] to enquire the underlying causal relation (if any). Alternatively, causality tests can exclusively be used on the standard Granger procedure with the I(0) series. For this, pair-wise Granger causality involving output growth and unanticipated money has been followed. Results are shown in the Table 6.

Table 6. Pair wise Granger Causality/Block Exogeneity Test

Null Hypothesis	*Lag(s)*	*F-statistic*	*Prob.*
Unanticipated money does not Granger cause output growth	1	17.429	0.00
Unanticipated money does not Granger cause output growth	2	9.308	0.00
Unanticipated money does not Granger cause output growth	3	5.44	0.00
Unanticipated money does not Granger cause output growth	4	4.647	0.00
Unanticipated money does not Granger cause output growth	5	4.213	0.01
Unanticipated money does not Granger cause output growth	6	2.863	0.04

The null hypothesis *unanticipated money does not Granger cause output growth* in Singapore is tested over the period of the study taking lag 1 to the lag 6.[7] For testing this model appropriate test statistic, the F-statistic, has been calculated and its level of significance is examined. It is found that up to lag 6 calculated F-statistic for the null hypothesis is rejected. Therefore the valid inference is *unanticipated money Granger causes output growth* in Singapore.

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6 Cointegration tests such as *Engle and Granger's (1987*), *Johansen and Juselius (1990)*, etc require I(1) variables.

7 Beyond lag 6, both null hypotheses are accepted.

However, one problem of this pair wise Granger causality test is that it does not allow us to examine the nature of causality[8] of the valid inference derived from this test. To address this problem, we estimate following equation incorporating output growth and unanticipated money which re-examine the presence of Granger causality and its direction.

$$\dot{y}_t = \alpha + \sum_{i=1}^{k} \beta_i \dot{y}_{t-1} + \sum_{i=1}^{k} \gamma_i m^u_{t-i} + u_{1t} \quad \text{... (13)}$$

We seek to examine whether invariance propositions holds in Singapore over the period of the study. The *invariant proposition* holds that $\hat{\gamma}_i \neq 0$. Thus output fluctuates randomly around the existing level following unanticipated fluctuations in money stock. Equation (13) is estimated with lag one as suggested by the lag selection criterion AIC and SC. The results are shown below.

$$\dot{Y}_t = 0.071 + 0.062\dot{Y}_{t-1} + 0.539 m^u_{t-i} \quad \text{... (14)}$$

SE	(0.012)	(0.143)	(0.128)
t	[5.91]	[0.43]	[4.21]

$R^2 = 0.404$, Adjusted $R^2 = 0.315$, $F = 10.19$, $DW = 1.95$

In the estimated model positive and significant estimate $\hat{\gamma}$, in the presence of lagged output growth in the vector of regressors, implies a rise in output growth following a rise in unanticipated money supply. It also indicates that *a variation of output growth is Granger caused by variations in unanticipated money.* The unanticipated money exerts positive impetus in output growth. It, therefore, appears that positive response of output growth is due to the positive response of unanticipated money supply. These observations uphold the *invariance propositions* of rational expectations.

5. Concluding Remarks

The study shows that money supply is not neutral in the economy of Singapore. Output level variations are found to be positively and significantly related to those in previous period money supply. Output growth is less than proportionately related to money supply growth.

ARIMA (2, 1, 0) structure is found to capture the univariate stochastic process for M_1. The series generated by the ARIMA (2, 1, 0) structure give forth the series of anticipated part of the money supply. Output growth, given such division of money supply, is found to be significantly related to unanticipated part of money supply only. Anticipated part of money growth fails to exert any significant effect on output growth. This is in conformity with the tenets of rational expectations that output variations are related to unanticipated money supply provided these surprises are white noise.

These findings also indicate that monetary policy, which is usually related to anticipated part of money supply, may not have any bearing of output growth. In such case monetary growth

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8 One variable Granger causes other variable *positively or negatively*.

mentioned at any level may be adequate for the market equilibrium. Friedman's K% rule for monetary growth may be pointer to this effect.

APPENDIX

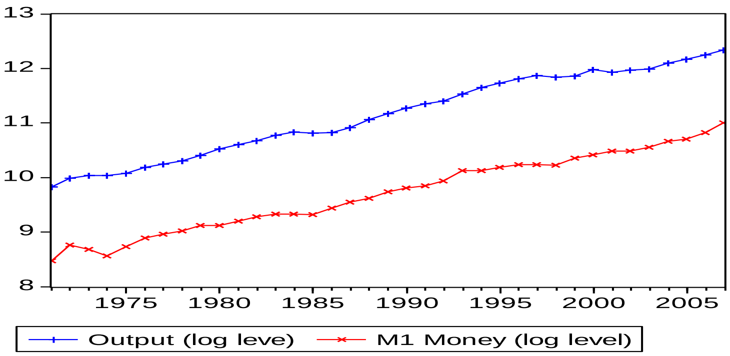

Figure 1. Time Plots of Output and M_1 Money Supply at Levels

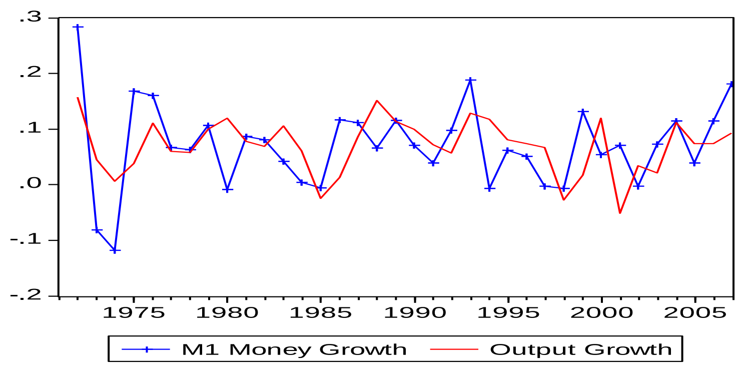

Figure 2. Time Plots of Output Growth and M_1 Money Supply Growth

Velocity of Circulation of M_1 Money in Singapore (1971-72 to 2007-08)

J. M. Keynes and many other economists have challenged the classical assumption of constant velocity of money, 'V'. The determinants and consequent stability of 'V' is a subject of controversy across and within school of macroeconomics. Notionally it is well documented that 'V' may affect output, price or other macro-economic variables. If this be the case, it is pertinent to corroborate the effect of 'V' in the formation of macroeconomic policy.

Objective of this study is to enquire the role of anticipated and unanticipated money supply in the variations in output in Singapore. Underlying theoretical background has been painted by a mathematical model, where 'V' is assumed constant. If dataset denied this assumption, inferences drawn from the mathematical exposition (the anticipated and unanticipated parts of money supply affect price level but not output level. Unanticipated part of money supply affects output level) remain unaltered. In such a case mathematical model can easily justify that output variations may be affected by 'V' also. However, we have calculated 'V', dividing output (nominal, without logarithm) by M_1 money supply of Singapore over the period of the study. Time plot of calculated velocity of M_1 money is shown in the Figure 3.

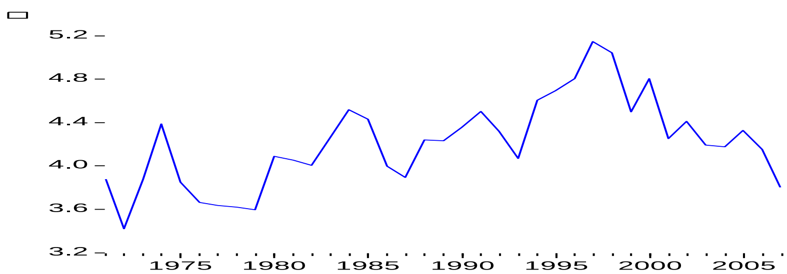

Figure 3. Time Plot of Velocity of M_1 Money in Singapore

Figure 3 depicts 'V' has cyclical pattern with changing amplitude over the period. Growth of 'V' is unstable. We enquired the stationarity of the series (by ADF, PP unit-root tests) and testified that V (at log level) follows non-stationary random walk process (but stationary upon first differencing). Johansen cointegration tests reject the possibility of cointegrating relationship between velocity of M_1 money and output at level. However, Pair-wise Granger causality tests confirmed the *bi-directional Granger causality* between output growth and growth of velocity of money as shown in the Table 7.

Table 7. Pair wise Granger Causality Test between $\dot{Y}_t$ and Growth of V

Null Hypothesis	*Lag(s)*	*F-statistic*	*Prob.*
Growth of 'V' does not Granger cause $\dot{Y}_t$ $\dot{Y}_t$ does not Granger cause growth of 'V'	1	7.9.0 8.966	0.008 0.005
Growth of 'V' does not Granger cause $\dot{Y}_t$ $\dot{Y}_t$ does not Granger cause growth of 'V'	2	6.942 4.953	0.003 0.01
Growth of 'V' does not Granger cause $\dot{Y}_t$ $\dot{Y}_t$ does not Granger cause growth of 'V'	3	5.412 3.715	0.004 0.02
Growth of 'V' does not Granger cause $\dot{Y}_t$ $\dot{Y}_t$ does not Granger cause growth of 'V'	4	5.288 2.542	0.003 0.067
Growth of 'V' does not Granger cause $\dot{Y}_t$ $\dot{Y}_t$ does not Granger cause growth of 'V'	5	3.44 2.06	0.02 0.11

ARIMA (2, 1, 0) Forecasts and Anticipated Money Supply

The time plots of M_1 money supply and the corresponding forecasts are being presented through the Figure 4, which shows that the ARIMA (2, 1, 0) forecasts almost coincide with the time plot of actual money supply M_1.

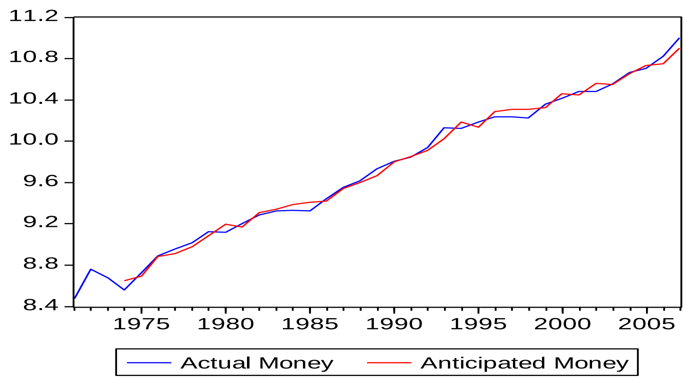

Figure 4. Actual Money and ARIMA (2, 1, 0) Forecast

Table 2. Results of *Johansen (1991, 1995)* Cointegration Tests

Variables: Output, M_1 Money

Data Trend	*None*		*Linear*		*Quadratic*
Assumption for Cointegration	*No intercept, no trend*	*Intercept, no trend*	*Intercept, no trend*	*Intercept, trend*	*Intercept, trend*
Ranks by λ_{trace}	2	1	1	**1**	2
Ranks by $\lambda_{\max}$	2	1	1	**1**	2
Akaike Information Criteria by Rank (rows) and Model (columns)					
0	-4.551	-4.551	-5.616	-5.616	-5.530
1	-5.545	-5.699	-5.835	**-6.159***	-6.107
2	-5.451	-5.614	-5.614	-6.048	-6.048
Schwarz Criteria by Rank (rows) and Model (columns)					
0	-4.551	-4.551	-5.528	-5.528	-5.354
1	-5.369	-5.479	-5.571	**-5.851***	-5.755
2	-5.099	-5.174	-5.174	-5.520	-5.520
'*' statistically significant value at 5% level					

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