Jurnal Ekonomi Malaysia 33 (1999) 123 - 140

Using P-Star Model to Linking Money and Prices in A Financial Liberalised Developing Economy: The Case for Malaysia

Muzafar Shah Habibullah

ABSTRACT

The P-Star approach of modelling inflation proposed by Hallman et al. has been widely tested in the United States and other developed countries. The applicability of the P-Star model for the developing countries is yet to be determined. The main purpose of the present study is to add to the current literature on the robustness of the P-Star model with respect to a developing country – Malaysia. Using a sample period from 1981:1 to 1994:4, our results suggest that Malaysian monetary data support the P-Star model. We conclude that there is a close relationship between money and the price level in Malaysia despite the occurences of financial liberalisation in the 1980s and 1990s.

ABSTRAK

Kaedah 'P-Star' yang diutarakan oleh Hallman et al. untuk membentuk model inflasi meluas digunakan di Amerika Syarikat dan negara-negara maju yang lain. Walaubagaimana pun, penggunaan model ini terhadap negara-negara membangun amatlah kurang sekali. Justeru itu, tujuan utama kertas kerja ini adalah untuk menguji kesesuaian model 'P-Star' ini terhadap data negara membangun seperti Malaysia dengan menggunakan data siri masa suku tahunan daripada 1981:1 hingga 1994:4. Keputusan kajian mencadangkan bahawa data kewangan Malaysia menyokong penggunaan model 'P-Star'. Kesimpulan kajian menunjukkan terdapat hubungan yang rapat antara penawaran wang dengan tingkat harga walau pun berlaku liberalisasi kewangan dalam tahun-tahun 1980-an dan 1990-an di Malaysia.

INTRODUCTION

In the 1980s changing financial markets had disrupted the historical relationships between monetary aggregates, income and prices. The reliability of monetary aggregates as intermediate variables for monetary policy purposes has been questioned and subjected to various empirical testing. For a broad general survey of these issues from an international perspective, see Akhtar (1983) and Argy et al. (1989). Studies have concluded that the experience in the industrialised countries such as Australia, Canada, France, Italy, Japan, the United Kingdom and the United States, suggest that as a result of financial deregulation and innovations, the relationships between money and economic activities have been distorted. As a consequence, monetary aggregates, notably the narrow money M1 in those countries were dropped, and the emphasis shifted to broader monetary aggregates for policy purposes.

Among the developed countries, the experience in the United States provides a good example of the importance of financial deregulation in destabilising a particular monetary aggregate, one which had previously been the most stable. Friedman (1988:440), for example, claims that "money growth has simply been irrelevant to any outcome that matters for monetary policy". Friedman and Kuttner (1996) found that the growth of M1 had been unable to explain the price behaviour in the United States in the early 1980s. Friedman and Kuttner (1996:120) conclude that "the evidence drawn from this more structural analysis of the four-variable autoregression system suggests that increasing instability of money demand is the most consistent explanation for the fact that, sometime during the mid- to late 1980s, fluctuations in money growth cease to anticipate subsequent fluctuations in either output or prices".

Despite the voluminous literature that has cast doubt on the role of money in predicting output or prices, studies using the simple quantity theory are able to explain the long-run relationship between money and inflation. For example, Vogel (1974) finds that there is a proportional relationship between the rate of growth of the money supply and the rate of inflation with a lagged period of two years. Using cross-country data, Duck (1993), Dwyer and Hafer (1988) and McCandles and Weber (1995) concluded that the quantity theory was able to establish the long-run behaviour between money and the price level. Further, Dwyer and Hafer point out that countries which experience high rates of inflation also have high rates of money growth. According to McCandles and

Weber (1995) and Bullard (1994) the above conclusion is robust to using different measures of money. In studying the United States data, McCandles and Weber (1995) use M0, M1 and M2, while Bullard (1994) uses M1, M2, M3 and L and their Divisia counterparts.

More recently, Hallman et al. (1989, 1991) at the Federal Reseve Board of the United Sates have ingeniously proposed a simple "new" model that links money and prices in the so-called P-star approach based on the quantity theory. The P-Star model approach in linking money and prices advocated by Hallman et al. has resulted in widespread empirical applications in other developed countries. Generally, results of multi-country studies by Hoeller and Poret (1991) and Kool and Tatom (1994) indicate that the data are supportive of the P-Star model and are able to track inflation movements successfully. Hoeller and Poret (1991) investigate the OECD countries, while Kool and Tatom (1994) investigate on five European countries-Austria, Belgium, Denmark, the Netherlands and Switzerland.

To date, the P-Star model approach has only been widely tested in the developed countries except for South Korea, Singapore, Indonesia, Nepal and the Philippine (see Corker and Haas 1991; Habibullah 1998, 1997a, 1997b; Habibullah and Smith 1998). The empirical results obtained for the majority of the developed countries are supportive of the P-Star approach. This implies that in the long-run, some monetary aggregates (either narrow or broad or both measures) are closely linked to the price level and the rate of inflation. Clearly, the quantity theory and the equation of exchange have provided a useful framework to empirically analyse the relevance of money in an economy. However, one neglected aspect of this area of research is the applicability of the P-Star approach in linking money and the price level in the developing countries. Therefore, the purpose of this study is to assess the usefulness of the P-Star model for Malaysia.

In the estimation of the relationship of prices to monetary aggregates, the P-Star approach is preferred because in the standard reduced-form approach, the inflation equation is sensitive to the specification of its determinants such as on long distributed lags of past growth rates of money and on other factors such as supply shocks, price control or expectation variables (see Tatom 1990). On the other hand, to determine inflation, the P-Star model depends on the level of the money stock in the previous level and the equilibrium price level (p^*).

THE P-STAR (P*) MODEL: THE QUANTITY THEORY APPROACH

In a standard reduced-form model, the determinants of inflation range from money supply, wages, productivity, import prices, exchange rates, etc. Modelling inflation becomes more complicated when expectations are incorporated in the model and long lags of each independent variables are allowed. Hagger (1977) and Frisch (1976) provide a survey and empirical modelling of the inflationary process in the developed countries. For Malaysia, see for example Ibrahim (1995) and Yusoff (1985). However, Hallman et al. (1989) have proposed a more simplistic modelling of inflation. In the Hallman et al. model, the discrepancy between actual price level and the equilibrium price level is the key determinant of inflation. The equilibrium price level or the so-called P-Star (P*) is determined by the level of money stock, the equilibrium velocity (V*) and the potential output (Q*). Using quarterly data covering the period 1870 to 1988 for the United States, Hallman et al. (1989, 1991) found that "P* ties together the level of money and prices" very well, and seem to support the contention that "inflation is a monetary phenomenon". Hallman et al. (1991: 857) conclude that, "P* through its dependence on long-run values of velocity and output can be used to indicate long-term price developments".

The P* approach is based on the equation of exchange. According to the equation of exchange

$$PQ = MV \tag{1}$$

where the product of the price level (P) and real GNP (Q) equals the stock of money (M), multiplied by its velocity (V). Taking logarithms (lower-case notation) for equation (1) gives

$$p + q = m + v. \tag{2}$$

From equation (2), the price level can be expressed as

$$p = m + v - q. \tag{3}$$

According to Hallman et al. (1991), the equilibrium price level (p*) is written as follows:

$$p^* = m + v^* - q^* \tag{4}$$

where v^* is the equilibrium level of velocity and q^* is the real potential output. Equation (4) says that the equilibrium price level, p^*, is defined as money stock per unit of real potential output and the long-run equilibrium level of the velocity of money. In other words, p^* is therefore the price level which will emerge when output and velocity are at their equilibrium levels. The long-run price level p^* can then be compared with the actual price level p. The difference between the price level p^* and the actual price level p, that is, any negative or positive gaps $p-p^*$, then suggest that the future price level will slow down or accelerate. The short-run dynamic model of inflation is therefore given by the following error-correction model,

$$\Delta p_t = \alpha_0 + \alpha_1 (p_{t-1} - p^*_{t-1}) + \sum_{i=1}^{K} \beta_i \Delta p_{t-i} + \eta_t. \tag{5}$$

From equation (5), the theory of cointegration suggests that if the P-Star approach is to qualify as a valid empirical model, p and p^* must be cointegrated. In other words, there must be a long-run relationship between the two, and the difference between p and p^* must be stationary. To illustrate this point, using equation (2) we can express v, as

$$v = p - m + q. \tag{6}$$

Now we define the equilibrium velocity v^* by estimating a model for v as follows

$$v = \varpi_0 + \varpi_1 r_t + \mu_t \tag{7}$$

where r_t is the nominal interest rate, ϖ's are estimated parameters and μ is a stationary error term. We then can define v^* as the long-run equation given below

$$v^* = \varpi_0 + \varpi_1 r_t \tag{8}$$

that is, v^* is the forecast for equation (7).

We then define p^* as follows

$$p^* = m + v^* - q. \tag{9}$$

Now, the cointegration theory says that, for equation (5) to be a valid model or if p and p^* is to be cointegrated then $p - p^*$ must be stationary. Thus

$$p - p^* = \tau_t \tag{10}$$

where τ_t is stationary. Now by substituting equations (9) into (10), we have the following

$$p - m - v^* + q = \tau_t. \tag{11}$$

Using equation (6), equation (11) can be written as follows

$$v - v^* = \tau_t \tag{12}$$

and using equations (7) and (8), we can show that

$$\mu_t = \tau_t. \tag{13}$$

Equation (13) implies that for τ_t (i.e. $p - p^*$) to be stationary we require that μ_t is stationary. For μ_t to be stationary we will require that r (or any set of relevant determinants of velocity) and v or r (or any set of relevant determinants of velocity), p, q and m form a cointegrating set of variables.

MODEL SPECIFICATION

Let specify the standard velocity function as (see for example, Bordes et al., 1993)

$$v_t = \alpha_0 + \alpha_1 q_t + \alpha_2 r_t + \varepsilon_t \tag{14}$$

Substituting equations (14) into (3), we have the following reduced form equation,

$$p_t = \alpha_0 - (1 - \alpha_1) q_t + \alpha_2 r_t + m_t + \varepsilon_t \tag{15}$$

In the long-run the price level, p, should be cointegrated with its determinants – q, r and m. According to the Granger Representation Theorem, not only does cointegration imply the existence of an error-correction model but also the converse is true, that is the existence of an error-correction model implies cointegration of the variables (Engle and Granger 1987). Therefore it follows that from equation (15), the p* model can be represented by the following error-correction representation

$$\Delta p_t = \beta_0 + \beta_1 \varepsilon_{t-1} + \sum_{i=1}^{K} \beta_i \Delta p_{t-i} + \pi t \tag{16}$$

where ε_{t-1} is the lagged residuals (i.e. $p_{t-1} - p^*_{t-1}$) saved from running the static cointegrating equation (15). The hypothesis that p_t is not cointegrated with m_t, q_t and r_t can be rejected if the coefficient on the error-correction term, β_1 is significant, regardless of the joint significance of the β_i coefficients. Thus, our point of interest is that $\beta_1 < 0$ and significantly different from zero implies that p and p* are cointegrated.

Our main concern is regarding the appropriate specification of the velocity function. It has been shown that the standard velocity function (or money demand) as specified in equation (14) is inadequate to represent a long-run velocity function for a financially liberalised economy like Malaysia. Studies in the 1980s in the majority of the developed countries have indicated that income velocity has been variable. In other words the movement of monetary aggregates cannot be used to predict the movements in income. The breakdown in the historical relationship between monetary aggregates and income to a greater extent reflects structural changes and financial innovations in the financial system. This has led reseachers to re-specify the money demand or velocity function to take into account 'new' variables that could better explain the recent behaviour in money and velocity.

Attempts at explaining why conventional models have failed to accurately predict the behaviour of velocity has led Bordo and Jonung (1987) to propose institutional and financial factors as determinants in a velocity function. According to the so-called institutional approach, velocity is influenced by two sets of institutional factors, namely; the monetisation and financial development variables. In the former, Bordo and Jonung propose using two sets of proxies, that is the share of the labor force in non-agricultural pursuits and currency-money ratio. For the latter, Bordo and Jonung have used the ratio of total non-bank financial assets to total financial assets. Apart from these variables, Bordo and Jonung also propose including a proxy for economic stability in the velocity function. Bordo and Jonung (1990) explained that the process of monetisation accounts for the downward trend in velocity. With the spread of banking (reflected by the currency-money ratio) and growing urbanisation (measured by the share of labor force in non-agricultural pursuit), velocity falls at first because of the growing dependence on money for conducting transactions (monetisation of the economy). In a later stage of development, velocity will rise as a result of financial sophistication and improved economic stability. Financial sophistication refers both to the emergence of close substitutes for money and to the development of methods of economising on cash balances. Economic stability will reduce the precautionary demand for money and thus raises velocity. Bordo and Jonung (1990: 167) stressed that, "these institutional explanatory variables are additional to or supercede the standard determinants of velocity, including real income and interest rates". Studies by Siklos (1993) and Raj (1995) have supported the institutional hypothesis of the velocity of money and they conclude that these institutional factors are necessary to maintain a long-run relationship.

In this study, we specify the following velocity function

$$v_t = f(q_t, r_t, cm_{kt}) \tag{17}$$

It follows that, the price equation can then be specified as follows:

$$p_t = g(q_t, r_t, m_{kt}, cm_{kt}) \tag{18}$$

where p and q are respectively price level and real output. Variable r is the interest rate to proxy for opportunity cost, m_{kt} is money supply with k refer to narrow M1 and broad money M2. cm refers to monetisation variable proxy by currency-money ratio. All variables were transformed into logarithm except for the interest rate.

SOURCES OF DATA

In this study, we used quarterly time series data for the period 1981:1 to 1994:4. For the purpose of this study, we have used the consumer price index as a measure of the price level. Since there is no *a priori* evidence as to which measure of money should be used – narrow or broad money, we examined both monetary aggregates M1 and M2 in the construction of p*. Furthermore, empirical studies have shown that different monetary aggregates used to construct p* have different implications for the performance of the p* approach. For example, in the United States, Hallman et al. (1991) have indicated that M2 can be a good anchor for the price level, but Tatom (1990) on the other hand, suggests that money and the price level are linked when M1 is used to construct p*. For France, Bordes et al. (1993) used the monetary aggregates M1, M2 and M3 to calculate p*, and found that a long-run relationship between money and the price level was established using

M1 and M2. On the contrary, Todter and Reimers (1994) found that between the three monetary aggregates (M1, M2 and M3), "the best results were obtained when M3 was used to estimate the equilibrium price".

As for output variable, since GNP for Malaysia is only available in annual form, we employ Gandolfo's (1981) technique in interpolating quarterly series for GNP from its annual observations. Interpolated quarterly GNP series are then deflated by consumer price index to arrive at the real GNP. Data on the consumer price index, GNP and monetary variables were compiled from various issues of *SEACEN Financial Statistics–Money and Banking* published by the SEACEN Centre, and *International Financial Statistics* published by the International Monetary Fund.

DISCUSSIONS

STATISTICAL PROPERTIES OF THE SERIES

In recent years, discussion in econometric analysis has focused much attention on the time series properties of economic variables. A key concept underlying much of econometric theory is the assumption of stationarity. This assumption has important consequences for the interpretation of economic models and data. This is so because the level of a stationary series, for example, will not vary greatly with the sampling period and has a tendency to return to its mean value (Granger 1986). On the other hand, the properties of non-stationary series, which are more interesting to study, are quite different from those of stationary ones because the former will be characterised by a time varying mean which have a tendency to drift away from its mean. Some possible sources of non-stationarity, deal with polynomial time trends, unit roots and integrated series (Granger 1986; Engle & Granger 1987).

It is generally argued that testing for the presence of unit roots in the autoregressive representation of a time series can be considered as testing for stationarity. This is because the test amounts to test whether certain coefficient of the representation are unity. Accordingly, the question of how many times we should difference the series or whether to detrend a series to achieve stationary may also be answered.

The standard procedure for determining the order of integration of a time series is the application of augmented Dickey-Fuller test (Dickey & Fuller 1979) which requires regressing Δy_t on a constant, a time trend,

y_{t-1} and several lags of the dependent variables to render the disturbance term white-noise. Then the *t*-statistic on the estimated coefficient of y_{t-1} is use to test the following null and alternative hypothesis:

$$H_0 : y_t \sim I(1) \qquad vs \qquad H_1 : y_t \sim I(0)$$

The null hypothesis is saying that variable y_t is stationary to the order one or it is integrated of order one compared to the alternative that y_t is integrated of order zero. If the null cannot be rejected, it is said that y_t probably need to be difference once to achieve stationarity. If on the other hand, the null is rejected then y_t is stationary in its level form. The critical values are called the 'ADF statistics' and are available in Fuller (1976), Engle and Yoo (1987) and in MacKinnon (1991).

If the null hypothesis cannot be rejected then y_t is non-stationary and it may be I(1) or I(2), or have an even higher order of integration. To find out the order of integration, the test is repeated with Δy_t in place of y_t, thus regressing $\Delta^2 y_t$ on a constant, Δy_{t-1} and several lags of $\Delta^2 y_t$. The ADF statistic therefore tests the following:

$$H_0 : \Delta y_t \sim I(1) \qquad vs \qquad H_1 : \Delta y_t \sim I(0)$$

$$\text{i.e.} \qquad H_0 : y_t \sim I(2) \qquad vs \qquad H_1 : y_t \sim I(1)$$

If the ADF statistic is not large and negative then we cannot reject H_0 and y_t cannot be I(1). In this case the test is repeated with $\Delta^3 y_t$ as the dependent variable and so on, until the order of integration is determined. To supplement the ADF unit root test, we also estimate the Phillips and Perron (1988; hereafter the PP test) unit root test. The PP unit root test is a non-parametric method of detecting whether a time series contain a unit root. This test is robust to a wide variety of serial correlation and time dependent heteroskedasticity.

Table 1 presents the results of the unit root tests on the levels and first-differences of the series. In order to choose the appropriate lag length, we follow the procedure suggested by Campbell and Perron (1991). According to this approah, we start with some upper bound on k, say k_{max}, chosen a priori. Estimate an autoregression of order k_{max}. If the last included lag is significant (using the standard normal asymptotic distribution), select $k=k_{max}$. If not reduce the order of the estimated autoregression by one until the coefficient on the last included lag is significant. If none is significant, select k=0. Results in Table 1 clearly

TABLE 1. Results of integration tests

Series	Series in levels		Series in first differences	
	ADF	PP	ADF	PP
p	-0.70 (2)	-2.46 (3)	-5.42* (1)	- 7.89* (3)
m1	-1.73 (4)	-0.27 (3)	-3.31* (2)	- 7.07* (3)
m2	-0.62 (4)	-0.31 (3)	-3.83* (2)	- 6.64* (3)
q	-1.77 (1)	-2.01 (3)	-3.73* (1)	- 5.59* (3)
r	-1.95 (1)	-1.72 (3)	-5.79* (0)	- 5.72* (3)
cm1	-0.46 (1)	-1.33 (3)	-3.24* (2)	-10.96* (3)
cm2	-1.61 (1)	-2.09 (3)	-5.46* (1)	- 8.10* (3)

Notes: The variables are defined as follows: p = price level, m1 = money supply M1, m2 = money supply M2, cm1 = currency-money M1 ratio, cm2 = currency-money M2 ratio, q = real output and r = interest rate. Asterisk (*) denotes statistically significant at 5 percent level.

indicate that price, money, real output, interest rate and monetisation variables are I(1). In other words, their first differences are stationary, that is, I(0).

COINTEGRATION ANALYSIS

After determining the order of integration among the series involved, we will determine the long-run equilibrium for the p* described by relation (18). To test this proposition, we run the cointegrating regressions with all I(1) variables and the results are presented in Table 2. The null hypothesis of no cointegration can be inferred from the ADF statistics. The ADF statistics for both money series used to construct p* are

TABLE 2. Results of cointegration tests

Money series used to construct p*	Cointegrating regressions	R-squared	CRDW	Unit root test on residuals	
				ADF	lag
M1	p = f(q, r, m1, cm1)	0.95	0.35	-2.03*	4
M2	p = f(q, r, m2, cm2)	0.98	0.53	-2.65*	11

Notes: CRDW denotes cointegrating regression Durbin-Watson statistic. Asterisk (*) denotes statistically significant at 5 percent level.

significantly different from zero. This tests results suggest that the residual (18) are I(0) and hence lend evidence supporting cointegration and also implying a long-run equilibrium relationships between p_t and m_{kt}, q_t, r_t and cm_{kt}.

P* AND THE ERROR-CORRECTION MODEL

The estimated error-correction model described the p* model equation where the rate of inflation – measured by the quarterly variation in p, depends on its own lagged values and on the gap between the actual value of the price level and its value corresponding to the long-term equilibrium of the economy ($p_t - p^*_t = ecm_t$). In Table 3 we present the estimates of the error-correction models. Interestingly, our results show that the error-correction regressions for both monetary aggregates used to form p* performed satisfactorily for Malaysia. In both cases the coefficients of the error-correction terms are significantly different from zero and show correct negative signs. Furthermore, none of the diagnostic test statistics are significant at the 5 percent level suggesting no evidence of misspecification or of autocorrelated, heteroscedastic, or non-normal errors. Thus, both estimated error-correction equations appear as a data admissible simplification of the general model.

To summarise the results presented above it appears that; (i) the price level and money stocks are I(1) variables and thus need first differencing to achieve stationarity, (ii) a velocity function that comprises of money supply, real output and interest rate, and a monetisation variables as additional regressors does constitute a cointegration vector – as determinant in the price equation, (iii) the estimates of the Engle-Granger two-step method and the error-correction model suggest that in both cases, exhibit cointegration between p_t and q_t, r_t, m_{kt} and cm_{kt}, (iv) the satisfactory results of the cointegration analysis and the error-correction models clearly suggest that the Malaysia's monetary data support the P-Star approach of modelling inflation, and (v) comparing the estimated price equations between the two monetary aggregates used to construct p*, our results indicate that both monetary aggregates performed equally well, in that the p* significantly influences the price development in Malaysia.

TABLE 3. The P-Star model from the error-correction mechanism

Independent variables	P* model derived from narrow M1	P* model derived from broad M2
Constant	0.0051	0.0002
	(3.8933)*	(0.1451)
ecm_{t-1}	-0.1247	-0.3211
	(2.4549)*	(3.3300)*
Δp_{t-2}		0.3537
		(2.5691)*
Δp_{t-4}	0.2624	
	(2.2165)*	
Δp_{t-5}		0.2444
		(1.7742)
Δp_{t-11}	0.2689	0.2903
	(2.2672)*	(2.7997)*
Δp_{t-15}	-0.1731	
	(1.7549)*	
R-squared	0.39	0.33
SER	0.004	0.005
D.W.	2.24	1.70
LM χ^2 (4)	1.313	3.354
	[0.859]	[0.500]
ARCH χ^2 (4)	6.625	6.694
	[0.157]	[0.153]
Normality χ^2 (2)	1.479	0.841
	[0.477]	[0.657]
RESET χ^2 (2)	1.299	2.835
	[0.522]	[0.242]

Notes: ecm denotes error correction term, i.e. the residuals from running the cointegrating regression. The regressors in the cointegration relation include real output, interest rate, money supply and monetisation variables. SER and DW denote standard error of regression and Durbin-Watson statistic respectively. The diagnostic tests presented above are broadly defined as follows. LM(4) is the lagrange multiplier test for residual serial correlation of the fourth-order process based on Breusch (1978) and Godfrey (1978). Arch (4) is the fourth-order autoregressive conditional heteroscedasticity test of Engle (1982). Normality (2) is a test for the normality of the residuals based on Jarque and Bera (1980). RESET (2) is based on Ramsey (1969), is used to test whether the coefficients of powers of predicted dependent variables (Y^2, Y^3) are jointly zero. This test may also be regarded as tests of heteroscedasticity but usually regarded as general tests for detection of missing explanatory variables or incorrect functional form. Numbers in parentheses (.) are *t*-statistics and numbers in the square brackets [.] are *p*-values. Asterisks (*) denote statistically significant at 5 percent level.

FURTHER RESULTS: MODEL FORECASTS EVALUATION

The above results clearly suggest that both monetary aggregates can be used as an anchor for the price level in Malaysia. Our question is can we discriminate between the two competing P-Star models? Since one of the criteria of a 'good' model is its forecasting ability, then do either of the model perform better than the other in terms of forecasts? In their study, Hallman et al. (1991) suggested using the method proposed by Chong and Hendry (1986) in order to discriminate between models by comparing competing forecasts. Using this approach, we determine whether forecast error from a given model can be explained ("encompassed") by the forecasts of another model. For example, let f_{it} and f_{jt} denote the forecasts made by models i and j, and let the model-i forecast error be denoted by e_{it}. Define $t(i,f)$ as the statistic for β in the following regression

$$e_{it} = \beta(f_{jt} - f_{it}) + \eta_t. \qquad (19)$$

Model i is said to forecast-encompass model j if $t_\beta(i,j)$ is not significantly different from zero but $t_\beta(j,i)$ is. Table 4 show the $t(j,i)$ and $t(i,j)$ from running between the competing models – narrow M1 versus broad M2, and to determine whether p* model derived from narrow M1 "forecast-encompassed" the p* model derived from broad M2 or otherwise. Results from Table 4 suggests that M2 forecast-encompasses M1. Thus, M2 can be used as a better anchor for the price level compared to the other competing p* model which was derived using narrow M1 in Malaysia.

TABLE 4. Results of forecast-encompassing tests for narrow money M1 versus broad money M2

Competing p* models	$t_\beta(f_j - f_i)$	$t_\beta(f_i - f_j)$
Narrow money M1 (e_i) vs	1.15	–
Broad money M2 (e_j)	–	4.22*

Notes: Asterisk (*) denotes statistically significant at 5 percent level.

CONCLUSIONS

The growth rate of the money supply has been a major instrument of central banks, targeted either directly or indirectly through the reserve money, interest rate or exchange rate of a country. In the 1970s the United States, United Kingdom, Canada, Germany, France and Australia were among the developed countries adopting monetary aggregate targeting. However, by late 1980s most of these countries except for Germany had de-emphasised monetary targeting. Money has been "downgraded" from 'intermediate target' to merely an 'information variable' (see Friedman 1997).

In recent years, there has been increasing interest among researchers to investigate the long-run relationship between money and inflation using the simple Fisher-quantity equation. Studies conducted on cross-section of countries found that the growth rates of the money supply and the rate of inflation were highly correlated with a correlation of close to one. Apart from the cross-country data, evidence on the United States and other develop nations using time series data has also supported the quantity theory.

The primary aim of this study is to investigate the long-run relationship between money and the price level in Malaysia. Using quarterly time series data for the period 1981:1 to 1994:4, we have employed the P-Star model approach (based on the quantity theory) in linking money and the price level. In this study we used both narrow money M1 and broad money M2 to construct p*.

Generally, the results presented in this study are supportive of a long-run relationship between money (via p*) and the price level in Malaysia. The results indicate that both narrow money M1 and broad money M2 can be an anchor to the price level and therefore implies that both monetary aggregates (M1 and M2) can be useful intermediate indicators for monetary policy purposes in Malaysia. Thus, the evidence here supports the view that inflation in Malaysia is a monetary phenomenon.

The above results suggest that an indicator of inflationary pressures based on p* can be successfully constructed for Malaysia. However, the construction of p* depends crucially on the long-run stability of the income velocity of money. Comparing the results from the forecast-encompassing tests between the two competing monetary aggregates used for the construction of p*, our results indicate that the p* model with M2 "forecast-encompassed" the other competing p* model – M1. This means that the p* model constructed using M2 can better track inflation in Malaysia compared to M1. This evidence supports the move made by Bank Negara Malaysia (the Malaysian Central Bank) to emphasizing broad money for monetary policy purposes.

REFERENCES

Akhtar, M.A. 1983. Financial Innovations and their Implications for Monetary Policy: An International Perspective. BIS Economic Papers No. 9. Basle: Bank for International Settlement.

Argy, V., A. Brennan & G. Stevens. 1989. Monetary Targeting: The International Experience. In *Studies in Money and Credit: Proceedings of a Conference*, edited by I. Macfarlane and G. Stevens. Australia: Reserve Bank of Australia.

Bordes, C., E. Girardin & V. Marimoutou. 1993. An Evaluation of the Performance of P-Star as an Indicator of Monetary Conditions in the Perspective of EMU: The Case of France. In *Money and Banking: Issues fot the Twenty-First Century*, edited by P. Aretis, Basingstoke and London: MacMillan.

Bordo, M.E. & L. Jonung. 1987. *The Long-Run Behaviour of the Velocity of Circulation: The International Evidence*. Cambridge: Cambridge University Press.

Bordo, M.E. & L. Jonung. 1990. The Long-Run Behaviour of Velocity: The Institutional Approach Revisited. *Journal of Policy Modeling* 12(2): 165-197.

Breusch, T.S. 1978. Testing for Autocorrelation in Dynamic Linear Models. *Australian Economic Papers* 17: 334-355.

Bullard, J.B. 1994. Measures of Money and the Quantity Theory. *Federal Reserve Bank of St. Louis Review* 76(1): 19-30.

Campbell, J.Y. & P. Perron. 1991. Pitfalls and Opportunities: What Macroeconomists Should Know About Unit Roots. In *NBER Macroeconomics Annual 1991*, edited by O.J. Blanchard and S. Fischer. Cambridge, Mass: MIT Press.

Chong, Y.Y. & D.F. Hendry. 1986. Econometric Evaluation of Linear Macro-Economic Models. *Review of Economic Studies* 53: 671-690.

Corker, R.J. & R.D. Haas. 1991. Price Pressure Gaps: An Application of P* Using Korean Data. IMF Working Paper WP/91/26. Washington, D.C.: International Monetary Fund.

Dickey, D.A. & W.A. Fuller. 1979. Distribution of the Estimators for Autoregressive Time Series with a Unit Root. *Journal of the American Statistical Association* 74: 427-431.

Duck, N.W. 1993. Some International Evidence on the Quantity Theory of Money. *Journal of Money, Credit and Banking* 25(1): 1-12.

Dwyer, G.P. & R.W. Hafer. 1988. Is Money Irrelevant? *Federal Reserve Bank of St. Louis Review* 70(3): 3-17.

Engle, R.F. 1982. Autoregressive Conditional Heteroscedasticity with Estimates of the Variance of United Kingdom Inflations. *Econometrica* 50: 987-1007.

Engle, R.F. & C.W.J. Granger. 1987. Cointegration and Error Correction: Representation, Estimation and Testing. *Econometrica* 55: 251-276.

Engle, R.F. & B.S. Yoo. 1987. Forecasting and Testing in Cointegrated Systems. *Journal of Econometrics* 35: 143-159.

Friedman, B.M. 1997. The Rise and Fall of Money Growth Targets as Guidelines for US Monetary Policy. In *Towards More Effective Monetary Policy*, edited by I. Kuroda. Basingstoke and London: MacMillan Press Ltd.

Friedman, B.M. 1988. Monetary Policy Without Quantity Variables. *American Economic Review* 78: 440-445.

Friedman, B.M. & K.N. Kuttner. 1996. A Price Target for U.S. Monetary Policy? Lessons from the Experience with Money Growth Targets. *Brookings Papers on Economic Activity* 1: 77-125.

Frisch, H. (ed.). 1976. *Inflation in Small Countries*. Berlin: Springer-Verlag.

Fuller, W.A. 1976. *Introduction to Statistical Time Series*. New York: John Wiley & Sons.

Gandolfo, G. 1981. *Qualitative Analysis and Econometric Estimation of Continuous Time Dynamics Models*. Amsterdam: North-Holland.

Granger, C.W.J. 1986. Developments in the Study of Cointegrated Economic Variables. *Oxford Bulletin of Economics and Statistics* 48: 213-228.

Godfrey, L.G. 1978. Testing for Higher Order Serial Correlation in Regression Equations when the Regressors include Lagged Dependent Variables. *Econometrica* 46: 1303-1310.

Habibullah, M.S. 1998. Is Inflation a Monetary Phenomenon in Singapore? Some Results Using the P-Star Model Approach. *The Indian Journal of Economics* LXXVIII: 499-514.

Habibullah, M.S. 1997a. Can the P-Star Approach be used to Model Inflation in Indonesia? Some Empirical Evidence. *Economics and Finance in Indonesia* XLV(3): 413-430.

Habibullah, M.S. 1997b. Linking Money and Prices in Nepal: The P-Star Model Approach. *The Economic Journal of Nepal* 20: 169-185.

Habibullah, M.S. & P. Smith. 1998. Modelling Inflation in the Philippines: The P-Star Model Approach. *The Philippine Review of Economics and Business* 35(1): 87-96.

Hagger, A.J. 1977. *Inflation: Theory and Policy*. London and Basingstoke: The MacMillan Press Ltd.

Hallman, J.J., R.D. Porter & D.H. Small. 1991. Is the Price Level Tied to the M2 Monetary Aggregate in the Long Run? *American Economic Review* 81(4): 841-858.

Hallman, J.J., R.D. Porter & D.H. Small. 1989. M2 per Unit of Potential GNP as an Anchor for the Price Level. Staff Study No. 157. Washington, D.C: Board of Governors of the Federal Reserve System.

Hoeller, P. & P. Poret. 1991. Is P-Star a Good Indicator of Inflationary Pressure in OECD Countries? *OECD Economic Studies* 17 (Autumn): 7-29.

Ibrahim, M.H. 1995. Inflationary Behaviour in Malaysia: An Empirical Evaluation of its Determinants. *Malaysian Journal of Economic Studies* 32: 29-41.

International Monetary Fund. *International Financial Statistics*. Washington, D.C.: International Monetary Fund.

Jarque, C.M. & A.K. Bera. 1980. Efficient Tests of Normality, Homoskedasticity and Serial Independence of Regression Residuals. *Economics Letters* 6: 255-259.

Kool, C.J.M. & J.A. Tatom. 1994. The P-Star Model in Five Small Economies. *Federal Reserve Bank of St. Louis Review* 76(3): 11-29.

MacKinnon, J.G. 1991. Critical Values for Cointegration Tests. In R.F. Engle and C.W.J. Granger (eds.). *Long-Run Economic Relationships: Readings in Cointegration*. Oxford: Oxford University Press.

McCandles, G.T. & W.E. Weber. 1995. Some Monetary Facts. *Federal Reserve Bank of Minneapolis Quarterly Review* 19(3): 2-11.

Phillips, P.C.B. & P. Perron. 1988. Testing for a Unit Root in Time Series Regression. *Biometrica* 75: 335-346.

Raj, B. 1995. Institutional Hypothesis of the Long-Run Income Velocity of Money and Parameter Stability of the Equilibrium Relationship. *Journal of Applied Econometrics* 10: 233-253.

Ramsey, J.B. 1969. Tests for Specification Errors in Classical Linear Least Squares Regression Observations. *Journal of the Royal Statistical Society*, Series B, Part 2: 350-371.

SEACEN Centre. *SEACEN Financial Statistics-Money and Banking*. Kuala Lumpur: The South East Asian Central Bank (SEACEN) Research and Training Centre.

Siklos, P.L. 1993. Income Velocity and Institutional Change: Some New Time Series Evidence, 1870-1986. *Journal of Money, Credit and Banking* 25(3), Part 1: 377-392.

Tatom, J.A. 1990. The P-Star Approach to the Link Between Money and Prices. Working Paper No. 90-008. St. Louis: Federal Reserve Bank of St. Louis.

Todter, K.H. & H.E. Reimers. 1994. P-Star as a Link between Money and Prices in Germany. *Weltwirtschaftliches Archiv* 130: 273-289.

Vogel, R.C. 1974. The Dynamics of Inflation in Latin America, 1950-1969. *American Economic Review* 64(1): 102-114.

Yusoff, M.B. 1985. Inflation and Controls: Malaysian Experience in 1970's. *Jurnal Ekonomi Malaysia* 11: 35-54.

Department of Economics
University Putra Malaysia
43400 UPM Serdang
Selangor Darul Ehsan
Malaysia