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**The Relationship Between Money and
Income in Thailand: Some Evidence for
the 1980s Using a Cointegration Approach**

by

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Abstract

This paper uses cointegration and vector auto regression techniques to examine which,
if any, of the financial aggregates - the monetary base, M1, M2 or credit - is an
appropriate intermediate target for the Thai monetary authorities. From the spectrum
of monetary aggregates, M1 seems to be the best leading indicator of money income and
the most suitable intermediate target. M1 was found to have a cointegrating
relationship with nominal income in the long run and to *Granger*-cause nominal income
in the short run. Overall, the results suggest that a higher weight should be attached to
M1 than to other money/credit aggregates in the formulation and conduct of Thai
monetary policy.

Keywords: Thailand, money-income relationship, monetary policy, intermediate target,
cointegration, vector auto regression.

CONTENTS

THE RELATIONSHIP BETWEEN MONEY AND INCOME IN THAILAND: SOME EVIDENCE FOR THE 1980S USING A COINTEGRATION APPROACH[*]

I INTRODUCTION

The relationship between money and nominal income is one of the most important and enduring issues in macroeconomics; one which has traditionally been associated with the Keynesian-monetarist debate over the effectiveness of monetary policy. At least partly persuaded by the monetarist argument that changes in the money stock directly cause changes in nominal income, the central banks of many industrialised countries opted, during the 1970s and early 1980s, to control monetary aggregates to achieve income and price stability. However, structural change in many economies during the 1980s, particularly financial deregulation, cast doubt on the interpretation of monetary aggregates and on their relationships with economic activity. These developments created considerable debate about the stability and predictability of the money supply-income relationship, and caused many central banks to de-emphasise monetary aggregates and rely on a wider range of variables as indicators of monetary policy.

Although monetary targeting has yet to be adopted officially, the Bank of Thailand (BOT) has for some time set a range of growth targets for both M1 and M2[1]. More importantly, during the 1980s, the Thai monetary authorities relied increasingly on monetary policy for stabilisation purposes. This has enhanced the role of monetary aggregates as intermediate targets and indicators of monetary policy.[2] However, it has been suggested that, as in many developed countries, the behaviour of the money-income relationship in Thailand may have been affected, albeit to a lesser degree, by

[1] See, for example, Wibulswadi (1986 p. 28) and Bank of Thailand (1988). These targets are set as a range and not announced. During the year, the Bank may decide to change the targets when the objectives change or when there are strong indications of a change in the relationship between targeted variables and objectives.

[2] See, inter alia, Supinit (1985) and Wibulswadi (1986 and 1987).

the financial innovation and deregulation of the late 1980s.[3] The potential adoption of monetary targeting, therefore, calls for a more detailed analysis of whether there exists a uni-directional relationship running from money to nominal income in Thailand. If this relationship is well established and stable, the adoption of monetary targeting may be feasible and perhaps desirable.

There is an extensive empirical literature on the relationships between money and income in developed countries. Sims (1972) was a pioneering study which found some evidence in support of *Granger*-causality from money to income for the USA. Sims' approach has been applied extensively in a large number of subsequent studies of both developed and developing countries with mixed results. The results obtained seem to have varied from country to country, but the issue appears not to have been settled even within countries. For example, Friedman and Kuttner (1992) found empirical evidence supporting the use of the spread between commercial paper and Treasury bill rates rather than money as a leading indicator of US economic activity. However, in more recent work, Becketti and Morris (1992) and Feldstein and Stock (1993) report empirical findings different from those of Friedman and Kuttner. According to the Becketti and Morris study, money was found to be a good indicator of future economic activity except during the early 1980s. In a similar vein, Feldstein and Stock claim that M2 is a useful indicator of nominal GDP. However, there have been few empirical studies of the money-income relationship for Thailand and only one which uses even relatively modern econometric techniques. Setrakul (1991) examined the relationship between money and income using the methodologies developed by Granger and Sims. This study seemed to reveal *bi*-directional causation between the two variables. There are, however, a few problems with Setrakul's study. First, it did not take into account the order of integration of the variables concerned and thus ignored testing for cointegration. Second, some of the quarterly data used were interpolated from the corresponding annual data using mechanical mathematical techniques which may not reflect the underlying economic processes associated with the variable of interest.

Because of the paucity of research on the subject, this paper aims to improve our understanding of the role of money and credit aggregates in Thailand's monetary

[3] See Hataiseree *et al* (1991a) and Hataiseree (1993).

policy.[4] In particular, it aims to explore, within the context of the familiar IS-LM model, the long-run relationships between particular money aggregates and nominal income. Special emphasis is given to two issues relevant to Thailand: first, whether or not various money and credit aggregates have leading relationships with economic activity and, second, whether or not money has a long-run, stable relationship with nominal income.

Our study improves on the earlier one by Setrakul in a number of ways. First, unlike that study which employed a bivariate framework, this study analyses the relationship between money and income using a multivariate model including additional variables, exports and government expenditure, which are deemed relevant to economic activity in Thailand. Second, the estimation techniques used here are based on cointegration. The methodology adopted is in general similar to that used in a number of recent studies of the money-income relationship eg Friedman (1988) and Friedman and Kuttner (1992). The approach used allows us to distinguish between the long-run and short-run relationships among the set of variables contained in the money (credit)-income system. The existence of a cointegrating vector among the variables can be taken as evidence in support of a close long-run relationship between money and income, while the existence of a reasonable error-correction (EC) model with *Granger*-causality running from money to income may be interpreted as evidence in support of a reliable short-run relationship. Finally, this study utilises relatively high quality data. For instance, data on income employed here are obtained from the official source, thus reducing the sort of measurement error which appeared to be a problem in Setrakul's study.

The rest of this paper is divided into three sections. The first provides a brief discussion of the theoretical framework. This is followed by a discussion of the econometric techniques used and the empirical results obtained. The final section contains summaries of conclusions and policy implications.

[4] For an intermediate target strategy, the criteria for the choice of monetary aggregates for monetary policy are: (i) the closeness or stability of the relationship between the monetary aggregate used as the intermediate target and the ultimate objective such as GDP or prices; (ii) the controllability of the intermediate target by the Central Bank; (iii) the exogeneity of the former to the latter; and (iv) the promptness of reporting and the accuracy of monetary statistics.

II THE MONEY-INCOME RELATIONSHIP

The conventional IS/LM model is used to derive a reduced-form model characterising the relationship between money (credit) and income. A detailed exposition of this model seems to be unnecessary as it is described in most standard textbooks on macroeconomics. The *IS* and *LM* equations may be expressed log linearly as:

$$y_t = -\alpha i_t + \beta g_t + \gamma x_t + u_{1t} \tag{1}$$

$$m_t = \phi y_t - \delta i_t + u_{2t} \tag{2}$$

Solving (2) for the interest rate, i_t, and substituting it into (1) yields:

$$y_t = \left(\frac{\alpha}{\delta + \alpha\phi}\right)m_t + \left(\frac{\beta\delta}{\delta + \alpha\phi}\right)g_t + \left(\frac{\gamma\delta}{\delta + \alpha\phi}\right)x_t + u_{3t} \tag{3}$$

Consolidating coefficients, (3) can be written as:

$$y_t = \varphi_0 + \varphi_1 \overset{(+)}{m_t} + \varphi_2 \overset{(+)}{g_t} + \varphi_3 \overset{(+)}{x_t} + \varepsilon_t \tag{4}$$

where y is nominal income, measured by GDP, m is a monetary aggregate, say M1 or M2, g is government expenditure, x is export revenue, i is the interest rate and u_i and ε are error terms. All lower-case letters are logarithms. The relationship (4) maintains that income (y) has a positive relationship with money (m), government expenditure (g) and exports (x). The export variable is included because the Thai economy is regarded as very open, with a relatively high ratio of foreign trade to GDP (approximately 60 per cent during the 1980s). It will help to shed light on whether the causal relationship between money and economic activity has been affected by the openness of the Thai economy. The money-income relationship, as characterised by equation (4), will be tested for the presence of cointegrating vectors with Thai data in the next section. The reduced-form approach in equation (4) has the advantage of

being able to encompass a wide range of monetary/financial aggregates deemed to have a potential link with economic activity. However, estimating the reduced-form equation (4) involves the cost of being unable to identify the exact transmission mechanism from money to income. Despite this caveat, equation (4) remains useful because the main focus of this paper is the overall stability of the long-run relationships between money and income.

III DATA AND EMPIRICAL RESULTS

Data and Unit Root Tests

For the purpose of comparing alternative intermediate targets of monetary policy, a number of financial and monetary aggregates, namely, the narrow definition of money (M1), a broader definition (M2), the monetary base (MB) and a credit aggregate (CR) are employed in this study.[5] Details of the data sources and definitions are provided in the Appendix. The choice of monetary aggregates used in this study is influenced by the framework of monetary policy in Thailand. As documented elsewhere, the Thai monetary authorities have used two types of monetary aggregates, M1 and M2[6], as indicators of monetary policy. In conformity with such practice, the money-income systems will be estimated separately for M1 and M2. Others have suggested that the much narrower MB could usefully be used as an intermediate target while alternatively the much broader aggregate CR could be targeted. For the sake of completeness, systems involving MB and CR are also estimated. The estimation period is from 1980.Q1 to 1990.Q4 during which time Thailand experienced a number of important changes relating to its financial system and its conduct of monetary policy.[7] It is important to test for the stability of any money-income relationship in the face of such changes.

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[5] Indeed, it is often important to decompose nominal income into real income and the price level in order to see which of the two components responds to the change in financial aggregates. However, we focus on nominal income (total spending) here because it is an important variable in the context of the formulation of monetary policy in Thailand.

[6] In Thailand, currency comprises about 70% of M1. Consequently, M1 and MB are very closely related through the common currency component. Further, M1 is easier to control then M2 since the latter additionally contains savings and time deposits (*quasi money* in the Thai context).

[7] Chief among these were: (i) the rising pace of financial deregulation and innovation as evidenced by the introduction of various new financial instruments by local financial institutions; (ii) the moves towards an increasing use of indirect instruments of monetary control as characterised, for instance, by

Table I Tests for Unit Roots

Variables	Levels τ_τ	Levels τ_μ	First-Differences τ_μ
ml	-1.03 [0] (6.79)	1.25 [0] (7.05)	-7.09 [0] (7.35)
m2	-1.33 [1] (5.40)	1.01 [0] (7.19)	-4.25 [0] (4.90)
cr	-1.41 [1]	0.29 [1]	-3.51 [0]
y	-0.58 [0] (4.46)	1.29 [0] (4.02)	-4.17 [0] (9.07)
g	-2.75 [0] (7.32)	-0.51 [0] (5.58)	-5.06 [1] (4.22)
x	-2.69 [0] (6.40)	-0.76 [0] (5.69)	-6.61 [0] (5.22)

Notes: (i) All variables in the Table are in logs. (ii) Figures in square brackets represent the number of lagged dependent variables used in the autoregression to ensure the residual terms are white noise. (iii) The selection between zero and non-zero lags was based on the Lagrange Multiplier (LM) test for fourth-order serial correlation of the residuals. Figures in parentheses refer to the values of the LM (4) statistic. (iv) The respective critical values at the 5% significance level for τ_τ and τ_μ are -3.50 and -2.93 for N = 50 (Fuller 1976, Table 8.5.2, p.373). (v) The unit root tests were conducted using MICROFIT 3.0 of Pesaran *et al.* (1991).

The first step in any application of cointegration techniques is to establish the order of integration of the variables concerned. To accomplish this, all variables in (4) are pre-tested for the presence of a unit root using the Augmented Dicky-Fuller (ADF) test.[8] The results of applying the ADF procedure to the data are reported in Table I. The evidence suggests that the 'levels' of all the time series concerned are characterised by unit root, non-stationary processes. As indicated by the DF and ADF tests, the null hypothesis of a unit root cannot be rejected for any variable. In the case of 'first differences', on the other hand, the null hypothesis of non-stationarity is easily rejected at the 5 per cent significance level for all variables.

an increasing reliance on open market operations as a means to influence domestic liquidity conditions; and (iii) a rapid surge in capital inflows, especially after 1987. For a more detailed account of these, see Hataiseree, (19901 a and b), Robinson, *et al.* (1991).

[8] Dickey and Fuller (1979, 1981).

The Cointegration of Money and Income

Having established that all variables in (4) are integrated of the same order, I(1), the next step is to test whether the time series in question are cointegrated. This was done using the method suggested by Johansen (1988) and Johansen and Juselius (1990). The Johansen method was chosen because there is some evidence that it performs better than single-equation and alternative multivariate methods (Gonzalo, 1994). As a preliminary to the Johansen analysis, it is important to determine an appropriate lag length for use in the VAR model.[9] To ascertain this, the Sims (1980) likelihood ratio test was applied. The results of this test (not shown here) indicate the adoption of five as the optimal number of lags for both the M1 and M2 VAR models. The selected VAR models were also free from autocorrelation problems as indicated by the Ljung-Box test statistic. It should be noted, however, that although the Sims test statistic pointed to the selection of five lags in the case of MB, four lags were chosen for use in further estimation. This was because the five-lag VAR model appeared to suffer from autocorrelation problems as indicated by the Ljung-Box test statistic. In the case of CR, the test indicated that three lags were appropriate.

Table II reports the results of cointegration tests for M1 based on the Johansen and Juselius procedure. The two tests for the presence of cointegrating vector(s) provide conflicting results. At the 95 percent confidence level, the test based on the maximal eigenvalue (panel A) indicates that there is one cointegrating vector (test statistic of 55.02 against a critical value of 28.14), while the test based on the trace suggests that there are at most two cointegrating vectors (panel B). Panel C reports the coefficient estimates of the two possible cointegrating vectors. The coefficients in parentheses are normalised on y. In the first cointegrating vector, all of the estimated coefficients have the expected signs and are of sensible magnitudes. In the second cointegrating vector, the estimated coefficients are of plausible magnitudes but some are incorrectly signed (eg the minus sign on the export variable). In the light of these results, and given that the existence of two cointegrating vectors is rejected by the maximal eigenvalue test, the first cointegrating vector is taken as the preferred estimate of the money-income relationship for M1.

[9] This practice is becoming standard, as it is widely recognised that inferences from causality tests tend to be sensitive to the choice of lag in a VAR model.

Table II   Johansen and Juselius Cointegration Tests for a Stationary

M1/Nominal-Income Relation

1981.Q2 to 1990.Q4 (39 observations). Maximum lag in VAR = 5.
Variables included in the cointegrating vector: y, m1, g, x, intercept
Eigenvalues in descending order: .75607 .39373 .26771 .091281 .0000

A. Cointegrating LR Test Based on *Maximal Eigenvalue* of the Stochastic Matrix

Null	Alternative	Statistic	95% Cr. Value	90% Cr. Value
r = 0	r = 1	55.0240	28.1380	25.5590
r <= 1	r = 2	19.5169	22.0020	19.7660
r <= 2	r = 3	12.1514	15.6720	13.7520

B. Cointegrating LR test Based on *Trace* of the Stochastic Matrix

Null	Alternative	Statistic	95% Cr. Value	90% Cr. Value
r = 0	r >= 1	90.4253	53.1160	49.6480
r <= 1	r >= 2	35.4013	34.9100	32.0030
r <= 2	r >= 3	15.8844	19.9640	17.8520

C. Estimated cointegrating vectors, coefficients normalized on *y* in parentheses

Vector	y	m1	g	x
1*	10.69	-6.68	-3.95	-1.63
	(-1.00)	(0.62)	(0.37)	(0.15)
2	-9.25	4.86	6.88	-0.77
	(-1.00)	(0.52)	(0.74)	(-0.08)

Notes: *r* denotes the number of cointegrating vectors. * indicates the preferred cointegrating vector.

The analogous results from the cointegration tests for the M2-income relation are presented in Table III. As for the M1-income relationship, the two tests for cointegration give conflicting results. The test based on the maximal eigenvalue indicates the existence of two cointegrating vectors, whereas the results of the trace test point to three cointegrating vectors. As may be seen in panel C, however, only the estimated coefficients of the first cointegrating vector seem to have correct signs and interpretable magnitudes, although the coefficient on M2 looks rather low. The results from Tables II and III are of interest for several reasons. First, exports seem to have played an important role in explaining economic activity in Thailand during the period under review. In light of this, it may be argued that a foreign trade variable should be included as an additional variable in explaining changes in economic activity in

Thailand. The omission of this variable may cause bias in the regression results. Second, the estimated coefficients on government expenditure were statistically significant and positively signed.

Table III   Johansen and Juselius Cointegration Test for a Stationary

M2/Nominal-Income Relation

1981Q2 to 1990Q4 (39 observations). Maximum lag in VAR = 5.
Variables included in the cointegrating vector: y, m2, g, x, intercept
Eigenvalues in descending order: .81701 .48548 .38686 .11792 .0000

A. Cointegrating LR test Based on *Maximal Eigenvalue* of the Stochastic Matrix

Null	Alternative	Statistic	95% Cr. Value	90% Cr. Value
r = 0	r = 1	66.2348	28.1380	25.5590
r <= 1	r = 2	25.9160	22.0020	19.7660
r <= 2	r = 3	19.0772	15.6720	13.7520
r <= 3	r = 4	4.8935	9.2430	7.5250

B. Cointegrating LR test Based on *Trace* of the Stochastic Matrix

Null	Alternative	Statistic	95% Cr. Value	90% Cr. Value
r = 0	r >= 1	116.1216	53.1160	49.6480
r <= 1	r >= 2	49.8867	34.9100	32.0030
r <= 2	r >= 3	23.9707	19.9640	17.8520
r <= 3	r >= 4	4.8935	9.2430	7.5250

C. Estimated cointegrating vectors, coefficients normalized on *y* in parentheses

Vector	y	m2	g	x
1*	6.59	-0.61	-2.35	-3.34
	(-1.00)	(0.09)	(0.36)	(0.51)
2	6.12	-6.09	6.54	-0.82
	(-1.00)	(0.99)	(-1.07)	(0.13)
3	-6.09	1.35	4.83	-0.39
	(-1.00)	(0.22)	(0.79)	(-0.06)

Notes: *r* denotes the number of cointegrating vectors. * indicates the preferred cointegrating vector.

For purpose of comparison, analogous systems using the credit aggregate (CR) or the monetary base (MB) rather than the monetary aggregates (M1 and M2) were

also estimated.[10] The results of the tests, which failed to reveal any cointegrating vectors, are not presented here to conserve space. This lack of cointegrating relationships may have important implications for the conduct of monetary policy as discussed later in the section on short-run analysis.

The finding that there are sensible cointegrating vectors in the money-income systems for M1 and M2 is encouraging for policy designs which place emphasis on the use of money as an economic indicator to predict economic activity in the long run. As Friedman and Kuttner (1992, p.485) have suggested, "... for some questions of potential importance in the practical conduct of monetary policy, especially those that arise in a multiyear context, what matters is the long-run relationship between the *level* of money and the *level* of income or prices...". The remaining task is to characterise the short-run dynamic adjustment processes among the variables.

Granger-Causality Tests

Having established the long-run relationship among monetary aggregates and nominal income, it is of interest to investigate the question as to whether or not, under the present monetary policy regime, money provides useful information about short-run, future movements of income. To this end, *Granger*-causality tests are conducted to shed light on the causal relationships between money and output. In light of cointegration, the short-run relationships of variables in the M1 and M2 systems can be written in an autoregressive form as:

$$\Delta y_t = \sum_{i=1}^{4} \theta_i \Delta m_{t-i} + \sum_{i=1}^{4} \varphi_i \Delta g_{t-i} + \sum_{i=1}^{4} \omega_i \Delta x_{t-i} + \sum_{i=1}^{4} \delta_i \Delta y_{t-i} + \lambda EC_{t-1} + \varepsilon 1_t \qquad (5)$$

The definitions of all variables in (5) are the same as those in (4), except that (m_i) in (5) refers to a set of alternative financial aggregates, including M1, M2, MB and CR. For M1 and M2, where cointegrating vectors were established, the error-

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[10] Considerable attention in recent years has been directed towards exploring the link between measures of credit and measures of income and prices. The main argument associated with this new paradigm is that the interest rate effect is not the only channel relating money and income: the credit effect also has important implications for output. This argument was put forward using the conventional IS-LM model with a modified assumption that there is an additional third asset called "bank loans" instead of only two assets, money and bonds, as in the traditional version (see, for example, Bernanke and Blinder, 1988 and Bernanke, 1992). It is beyond the scope of this study to examine this new development in detail here.

correction term (EC_{t-1}), is incorporated to take account of the possible long-run effect of the system. The rationale for this specification is the Granger Representation Theorem which states that the stationary linear combination of levels of variables must cause the change in at least one of the cointegrated variables (Engle and Granger, 1987). In light of this, the EC term from the most significant cointegrating vectors reported in Tables II and III are included in the estimation of the equations employing M1 and M2 aggregates. However, in the case of CR and MB, where no cointegrating vectors were found, λ is constrained to be zero and, in consequence, expression (8) is used for 'standard' Granger-causality tests. Note that using a 'standard' *Granger*-causality test instead of a *Granger*-causality test 'modified' by the inclusion of the EC term may lead to misspecification if the variables in question are in fact cointegrated (Engle and Granger, 1987).

Table IV reports the results of *Granger*-causality tests. The first row in each panel (A to D) of Table IV presents the F-statistic for the test of the null hypothesis that all of the coefficients on the lagged growth of either M1, M2, MB and CR are zero in the autoregression characterised by (5). The reported F-statistics point to the rejection of the null hypothesis - in each case at significance levels less than 2 percent - implying that each of the financial aggregates (M1, M2, MB and CR) contained information about future movements of income that is not contained in income itself. The finding that changes in M1, M2, MB and CR *Granger*-caused changes in income may be useful in the conduct of Thai monetary policy, provided that the monetary authorities are able to exploit this information by reacting to observed movements of these variables. We also conducted *Granger*-causality tests to see whether there is any reverse causality from nominal income to the monetary aggregates M1 and M2. The F-statistics presented in the fifth row of panels A and B of Table IV indicate the non-rejection of the null hypothesis that the summation of the lagged values on changes in nominal income do not cause changes in the monetary aggregates M1 and M2. These results, coupled with the findings that changes in monetary aggregates *Granger*-caused changes in nominal income, suggest that there is a unique causality running from money to nominal income.[11] The evidence reported here contrasts sharply with that presented in the Setrikul study. The previous finding that there is bi-directional

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[11] These interpretations are generally similar in kind to those of the "information-variable approach" suggested by Friedman (1988) and Friedman and Kuttner (1992).

causality between money and income rather than uni-directional causality from money to nominal income may be due to model misspecification. When the cointegrating relationship among money, income, exports and government expenditure is accounted for, money appears to cause economic activity.

Table IV Tests for Granger-Causality Between Financial Aggregates and Nominal Income

Four-Variable System (y, m1 or m2 or mb or cr, g and x).

A. Equation with M1:

H_0: lagged values of $\Delta m1$ do not cause Δy	$F(4, 21) = 4.17$ [.012]
H_0: lagged values of Δg do not cause Δy	$F(4, 21) = 4.15$ [.012]
H_0: lagged values of Δx do not cause Δy	$F(4, 21) = 3.99$ [.015]
H_0: lagged values of Δy do not cause Δy	$F(4, 21) = 4.51$ [.009]
H_0: lagged values of Δy do not cause $\Delta m1$	$F(4, 21) = 0.98$ [.438]

B. Equation with M2:

H_0: lagged values of $\Delta m2$ do not cause Δy	$F(4, 21) = 5.79$ [.003]
H_0: lagged values of Δg do not cause Δy	$F(4, 21) = 4.38$ [.010]
H_0: lagged values of Δx do not cause Δy	$F(4, 21) = 3.34$ [.029]
H_0: lagged values of Δy do not cause Δy	$F(4, 21) = 4.03$ [.014]
H_0: lagged values of Δy do not cause $\Delta m2$	$F(4, 21) = 1.09$ [.385]

C. Equation with MB:

H_0: lagged values of Δmb do not cause Δy	$F(4, 23) = 4.21$ [.011]
H_0: lagged values of Δg do not cause Δy	$F(4, 23) = 0.73$ [.579]
H_0: lagged values of Δx do not cause Δy	$F(4, 23) = 0.56$ [.694]
H_0: lagged values of Δy do not cause Δy	$F(4, 23) = 2.21$ [.100]

D. Equation with CR:

H_0: lagged values of Δcr do not cause Δy	$F(3, 28) = 3.99$ [.017]
H_0: lagged values of Δg do not cause Δy	$F(3, 28) = 1.27$ [.303]
H_0: lagged values of Δx do not cause Δy	$F(3, 28) = 0.95$ [.429]
H_0: lagged values of Δy do not cause Δy	$F(3, 28) = 0.81$ [.501]

Notes: (i) Estimated regressions use four lags of each variable. (ii) Equations with M1 and M2 were estimated with the inclusion of EC terms. Those with MB and CR were not. (iii) Figures in square brackets denote *p*-values.

IV CONCLUSIONS AND POLICY IMPLICATIONS

This paper has investigated the key link between money and nominal income in Thailand during the 1980s using the techniques of cointegration and vector autoregression. The main points to emerge form the empirical work are: First, the monetary aggregates M1 and M2 were each found to be cointegrated with nominal income, government expenditure and exports and to have significant roles to play in dynamic, short-run EC models of changes in nominal income. Second, there is no evidence to support the existence of cointegration for MB and CR with nominal income. Finally, government expenditure and exports were also found to have a significant impact on nominal income

Taken together, the empirical evidence reported above has a number of implications for the design and conduct of monetary policy in Thailand. First, the findings that M1 and M2 have cointegrating relationships with nominal income in the long-run[12] and that they both *Granger*-cause nominal income in the short run, coupled with the fact that both contain a high degree of exogeneity, suggest that they could usefully be used as indicators of nominal income. However, while they both possess useful information for future movements in nominal income, the evidence suggests that M1 would be a better indicator of monetary policy because the coefficient on M2 in the cointegrating vector is rather too low to be credible and the EC model containing M2 appears to suffer from serial correlation.

Second, it appears that the monetary aggregate (M1) has a more reliable role to play than credit (CR) in the transmission of monetary policy to nominal income. Although monetary policy appears to work through M1 and CR in the short run, only M1 seems to be connected closely with nominal income in the long run. This suggests that a relatively higher weight should be attached to M1 rather than to CR in the formulation and conduct of monetary policy in the long run. However, the finding that CR *Granger*-causes nominal income indicates that the monetary authorities can also

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[12] Although the evidence suggests the existence of stable and predictable relationships between money and nominal income in the 1980s and early 1990s, we must continually question such stability in the face of continuing changes to the financial environment.

exploit the information contained in CR in the design and conduct of short-run monetary policy.

Finally, our findings seem to provide additional empirical evidence in support of the BOT's use of monetary aggregates as intermediate targets for the conduct of monetary policy. They indicate that monetary targeting is feasible and perhaps desirable. However, the usefulness of monetary targeting also hinges crucially upon the controllability of the intermediate target by the central bank. This is an important issue which needs to be addressed before this approach is adopted officially. Generally, the monetarist view which advocates the use of money to stabilise income seems to have been supported by the Thai data.

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APPENDIX

Definitions of Variables and Sources of Data

The quarterly and seasonally unadjusted data employed in this paper cover the period 1980.Q1-1990.Q4. They were obtained from the Bank of Thailand Monthly Statistical Bulletin (hereafter BOT) or the BOT's in-house data base. Original data on money/credit aggregates (MB, M1, M2 and CR) and nominal income (Y), government expenditure (G) and exports (X) are expressed in billions of baht. All lower-case letters represent logarithms of the corresponding upper case variable. The data series employed are:

m1 *Narrow definition of money*, defined as currency in circulation plus demand deposits.

m2 *Broader definition of money*, defined as M1 plus quasi-money (savings and time deposits at commercial banks).

cr A proxy for a *credit aggregate*, defined as financial claims on the business and household sectors.

y *Nominal national income = Gross Domestic Product (GDP) at Current Prices.* Since this data exists only on an annual basis in official statistics, it is necessary to interpolate quarterly figures. This is done using the method described in Bank of Thailand (1991) which involves interpolating consumption and investment separately.

g *Government expenditure.*

x *Export revenue* .

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