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Causality Relationship between Money, Income, Price and Exchange Rates in a Small Open Economy: the Case of Hong Kong

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Abstract. This paper investigates the direction of causation among income, price, exchange rates and money supply in Hong Kong. We use the Granger (1969; 1980) causality concept to find the existence of such a relationship. The paper presents the results of two separate bivariate analyses: on involving money and income, and the other involving money and exchange rates. A notable result to come out of the paper is that there is no causality relationship between them.
Keywords. Causality, Money, Income, Price, Exchange rates.
JEL. C01, C10.

1. Introduction

Causality testing is an important area of empirical economic research. Consequently, test procedures and the implications of results obtained need to be clearly understood. Many tests have been conducted for economic questions that can be stated as temporal causation. The tests have been conducted using the concepts known in the literature as 'Granger-causation'. Hong Kong is a small open economy. The openness of Hong Kong's economy is indicated by the very large shares of exports and imports in GDP. The most likely source of inflation in the case of a small open economy is imported inflation, which can be considered as a special type of cost-push inflation originating from abroad. There is no central bank in Hong Kong. The government only fixed exchange rate of banknotes – M1, and the exchange rate of deposit – M2 was still determined by market mechanism. The linked exchange rate system is a hybrid form of the fixed and floating rate system. Under the exchange rate US$1 = HK$7.8, the note-issuing banks must buy the Certificate of Indebtedness with US dollars from the Exchange Fund for issuing banknotes. The note issuing banks must pay US dollar to Exchange Fund as reserves, according to the official rate, for issuing new bank notes and the balance of payments determine the supply of Hong Kong dollars. So, the supply of Hong Kong dollars will then be controlled automatically and the related inflation problem will be solved because it possesses an automatic adjustment mechanism. The objective of this study is to investigate the causality relationship between money, income, price and exchange rates in Hong Kong.

This paper is organized as follows. Section 2 reviews the related literature; section 3 explains the methodology of the present study and the data; section 4 reports the results; and section 5 provides the conclusion.

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2. Literature Review

Mills & Wood (1978) show that the monetary authorities in non-reserve centers can fully control domestic monetary conditions only under a completely freely floating rate regime. Enoch (1979) find that an exchange rate changes causes a change in relative retail price; however, it cannot tell whether this initial exchange rate change was truly exogenous or whether it is responding to money supply changes which will themselves cause the relative price change. Atesoglu & Tillman (1980) support the causal implication of the simply Keynesian approach that autonomous expenditures cause income. Osborn (1983) bivariate results support the Hsiao (1979) conclusion that a feedback relationship exists between GNP and M1, while GNP causes M2 unidirectionally. The results agrees with Sims (1972). Layton (1985) obtain results for two separate bivariate analysis: one involving money and nominal income and the other involving money and real income. Sheehan (1986) finds that the expectation formation process may differ by country or monetary authorities may have differing abilities or propensities to generate unexpected money changes. Serlets (1990) conclude that there may be more than one avenue of influence from monetary growth to velocity growth. Since monetary growth (in particular unanticipated monetary growth) appears to influence both velocity growth and real GNP growth in causal sense, it seems that the behavior of velocity can be explained in terms of monetary growth but in a complex way that probably involves more than the demand for money. Causal reading of a seminal paper by Sims (1972) and an earlier paper by Granger (1969) has left many economists with the contrary impression that observed correlations can be used to infer the direction of causation. Cooley & Leroy (1985) state that to understand the Granger and Sims tests, support that the Federal Reserve determines the money stock by spinning a roulette wheel. The money stock can depend on past as well as present spins of the wheel, but assume that the Federal Reserve pays no attention whatever to income in setting the money stock. Now, if in this environment one regresses the money stock on its own past values and past income, in large samples the latter will take on a zero coefficient.

3. Method and Data

Co-integration theory is first used to test whether a long-run equilibrium relation exists between the two variables. After co-integration has been established, causality measures are constructed to quantify various types of feedback between the variables. It is then examined whether the causality measures are longitudinally related to certain basic economic indicators in Hong Kong. The theory of co-integration was developed by Granger and others in a series of papers such as Engle & Granger, (1987). Co-integration of a pair of variables may be defined as follows. A series, x_t which has a stationary, invertible, non-deterministic ARMA (autoregressive- moving average) representation after differencing d times is integrated of order d, denoted $x_t \approx I(d)$. Thus a series which is integrated of order zero (I(0)) is itself stationary, whilst the simplest example of an I(1) series is a random walk. For a pair of variables to be cointegrated, a necessary (but not sufficient) condition is that they be integrated of the same order. If both x_t and y_t are I(d) then the linear combination

$$z_t = x_t - \alpha y_t$$

Will generally also be I(d). However, if there exists a constant scalar α such that $z_t \approx I(d-b)$, b>0, x_t and y_t are said to be cointegrated of order d, b denoted $(x_t y_t)' \approx CI(d,b)$.

In this paper, we are most concerned that x_t and y_t are both I(1) and $z_t \approx I(0)$. For then although x_t and y_t may each have infinite variance, the linear combination z_t is stationary. We mainly use tests based on the work of Fuller (1976) and Dickey and Fuller (1979, 1981) to test for unit roots and cointergration. First, we test for integration to find d.

$$\Delta x_t = \alpha_0 + \alpha_1 x_{t-1} + \varepsilon_t$$

If x_t is random walk, it implies $\alpha_1 = 0$ ($\alpha_0 = 0$); or, if x_t is random variable, it implies α_1 <0. We set the hypothesis as follows;

$H_0: x_t \approx I(1)$

$H_1: x_t \approx I(0)$

We run the regression by OLS:

$$\Delta x_t = \alpha_0 + \alpha_1 x_{t-1} + \sum_{i=4}^{2or4} \beta_i \Delta x_{t-i} + \varepsilon_t$$

So, we can find t – statistic for $\hat{\alpha}_1$ and compare with Augmented Dickey-Fuller (ADF) table. If the value of t – statistic for $\hat{\alpha}_1$ is statistically insignificant, we accept the null hypothesis [$x_t \approx I(1)$]. If from the other hand, the value of t – statistic for $\hat{\alpha}_1$ is significant, then, we reject the null hypothesis [x_t is I(0) and not I(1)].

Suppose we get all the results to accept the null hypothesis for the above equation, then, we can run the regression for the twice differenced variable as follows;

$$\Delta^2 x_t = \alpha_0 + \alpha_1 \Delta x_{t-1} + \sum_{i=4}^{2or4} \beta_i \Delta^2 x_{t-i} + \varepsilon_t$$

Similarly, we may compute the t – statistic and compare with ADF table. If the t – statistic value for $\hat{\alpha}_1$ is statistically insignificant, we conclude that $\Delta x_t \approx I(1)$ [or $x_t \approx I(2)$]. Alternatively, if the t – statistic for $\hat{\alpha}_1$ is significant, we propose that

$\Delta x_t \approx I(0)$ [or $x_t \approx I(1)$]. Also, the present paper concentrates on two tests: Sargan & Bhargava (1983) Durbin-Watson (DW) test and the Augmented Dickey Fuller (ADF) test of residuals from the cointergrating regression.The cointegrating regression for the present model has the following form:

$$x_t = INT + \alpha Y_t + \varepsilon_t$$

[Note that this equation is simply the stochastic version with an intercept term (INT)] Engle & Granger (1987) report tables of critical values generated by Monte Carlo simulation for the DW statistic from the cointegrating regression; these are 0.511, 0.386 and 0.322 for test sizes of one, five and ten per cent, and 100 observations. Augmented Dickey & Fuller (ADF) test is computed by first running the cointegrating regression and find the residuals $e = x - \hat{x}$ then, we run the following regression:

$$\Delta e_t = \phi_0 + \phi_1 e_{t-1} + \sum_{i=1}^{2or4} \phi_i \Delta e_{t-i} + U_t$$

The test statistic is computed as the ratio of ϕ_1 to its estimated standard error. The estimated residual series, U_t, is white noise. The t ratio is known as the ADF statistic. If it is necessary to add one or more lagged first differences into the auxiliary regression in order to induce an approximately white noise disturbance, then the 't – ratio' of the lagged level ('Augmented Dicky & Fuller statistic') has approximate critical values of -3.77, -3.17 and -2.84 for nominal test sizes of one, five and ten per cent and a sample size of 100 observations. Granger (1983), and Engle & Granger (1987) have proved a theorem showing that the existence of an error-correction form between two variables is necessary and sufficient for them to be cointegrated. The definition of causality proposed by Granger (1969) essentially states that X causes Y, if the past history of X can be utilized to more accurately predict Y than only the past history of Y. This view of causality give rise to a one-sided distributed lag approach. The test consists of estimating the following two equations:

$$Y_t = a_0 + \sum_{i=1}^{m1} \alpha_i Y_{t-i} + \sum_{i=1}^{n1} \beta_i x_{t-i} + e_{1t} \tag{1}$$

$$X_t = b_0 + \sum_{i=1}^{m2} \gamma_i x_{t-1} + \sum_{i=1}^{n2} \delta_i Y_{t-i} e_{2t} \tag{2}$$

In estimating these two equations, it is assumed that X and Y are stationary time series and that e_{1t} and e_{2t} are uncorrelated. Decisions regarding the lag length of the variables and the appropriate filter to achieve stationary must be made when employing this test procedure.

Unidirectional causality from X to Y is said to exit if the estimated coefficients on the lagged values of X in Equation (1) are significantly different from zero as a group, while the set of δ_i is statistically zero.

Unidirectional causality from Y to X is said to exit if, as a group, δ_i is statistically different from zero and the β_i is not.

Bidirectional causality is indicated when the sets of β_i and δ_i are both statistically non-zero.

No causality is indicated when the sets of β_i and δ_i are both statistically zero.

All data were taken from Datastream and Hong Kong Monthly Digest of Statistics. Due to avoid the influence of June Fourth Incident[1] in 1989, the analysis covers the period from the first quarter 1981 to fourth quarter 1988. Quarterly data were used as this was thought more appropriate. The definition of money supply are:

Money Supply definition 1. (Total): Notes and coins with public, plus customers' demand deposits with and licensed banks.

[1]The Tiananmen Square protests of 1989, commonly known as the June Fourth Incident or '89 Democracy Movement in Chinese, were student-led popular demonstrations in Beijing which took place in the spring of 1989 and received broad support from city residents, exposing deep splits within China's political leadership.

Money supply definition 2. (Total): M1 plus customers' savings and time deposits with licensed banks, plus negotiable certificates of deposit issued by licensed banks and held outside the monetary sector.

Money supply definition 3. (Total): M2 plus customers' deposit with licensed and registered deposit-taking companies plus negotiable certificates of deposits issued by deposit-taking companies held outside the monetary sector.

HK$M1, HK$M2 and HK$M3 are the Hong Kong dollar components of these definitions. Gross domestic product (GDP) is an aggregate measure of the value of goods and services produced by residents within the domestic boundary of a country or a territory, net of their import contents before provision for depreciation (or capital consumption).

The two consumer price index series were derived from the household expenditure survey conducted in 1984-1985. They are defined in terms of the percentage distribution of households by expenditure as follows;

	Approximate percent of households covered	Monthly expenditure range in 1984/85
INDEX		
CPI(A)	50	HK$2,000-HK$6,499
CPI(B)	30	HK$6,500-HK$9,999

The effective exchange rate indexes (EERI) measures movements in weighted-average of nominal exchange rates of HK Dollar against the currencies of 15 principal trading partners. Since quarterly data on GDP are not available from the first quarter 1981 to fourth quarter 1988, we have derive them indirectly. We use the total domestic export data to estimate the quarterly GDP. One plausible method is that GDP as annual data (GDP_A) is regressed on total domestic export as annual data (DX_A). We find the intercept term (INT_A) and the slope (S_A), then the whole equation is divided by four to give the estimate of GDP as quarterly data (GDP_Q) as follows.

$$GDP_A = INT_A + S_A DX_A$$

$$\frac{GDP_A}{4} = \frac{INT_A}{4} + S_A \frac{DX_A}{4}$$

$$GDP_Q = INT_Q + S_A DX_Q$$

4. Results

Cointegration techniques for examining long-run equilibrium relationships are used as the basis of our study. Quarterly data were obtained on M1, M2, M3, GDP, CPIA, CPIB and effective exchange rate indexes (EX) for the period first quarter 1981 to fourth quarter 1988 for the Hong Kong. First, we tested for a unit root in the above macroeconomic variables series, the results of which are reported in Table 1.

Table 1. *Test for a unit root in M1, M2 M3, GDP, CPIA, CPIB and EX series*

	$\hat{T}_\mu$		$\hat{T}_\mu$
$\Delta(LM1)$	1.5147	$\Delta^2(LM1)$	-4.2591
$\Delta(LM2)$	-2.2058	$\Delta^2(LM2)$	-3.1581
$\Delta(LM3)$	-1.9659	$\Delta^2(LM3)$	-3.3597
$\Delta(LGDP)$	-0.9689	$\Delta^2(LGDP)$	-6.4374
$\Delta(LCPIA)$	-0.6387	$\Delta^2(LCPIA)$	-2.2867

$\Delta(LCPIB)$	-0.6658	$\Delta^2(LCPIB)$	-2.2169
$\Delta(LEX)$	-2.1046	$\Delta^2(LEX)$	-3.5625

Where:
LM1 is the money supply definition 1 (Total) in logarithms;
LM2 is the money supply definition 2 (Total) in logarithms;
LM3 is the money supply definition 3 (Total) in logarithms;
LGDP is the gross domestic product in logarithms;
LCPIA is consumer price index (A) in logarithms;
LCPIB is consumer price index (B) in logarithms;
LEX is the effective exchange rate indexes in logarithms.

Critical values for the $\hat{T}_{\mu}$ statistic are -2.93 and -2.60 for 5% and 10% level of significance respectively (critical values are taken from Fuller, 1976). In all seven cases we are unable to reject the null hypothesis of a unit root in the framework of equation $\left[\Delta x_t = \alpha_0 + \alpha_1 x_{t-1} + \sum_{i=1}^{2or4} \beta_i \Delta x_{t-i} + \varepsilon_t\right]$. Moreover when the data series are twice differenced the hypothesis is accepted that LM1, LM2, LM3, LGDP, LEX may be intergrated of the order I(1) with rejection region $\{\theta : \theta < -2.93\}$; LCPIA and LCPIB may be integrated of order I(2) with rejection region $\{\theta : \theta < -2.93\}$. We ran the cointegrating regressions for each of the possible combinations, normalizing alternately on the LM1, LM2, LM3, LGDP and LEX. These regressions are reported in Table 2.

Table 2. *Cointegrating regressions (1981-1988)*

(1)	M1-GDP	LM1=-12.1554+2.1204 LGDP	DW=1.2154
		LGDP=6.6037+0.3869 LM1	DW=1.3319
(2)	M1-EX	LM1=27.9125-3.6631 LEX	DW=0.1859
		LEX=6.1524-0.1348 LM1	DW=0.2802
(3)	M2-GDP	LM2=-20.9363+3.1256 LGDP	DW=0.9488
		LGDP=7.3037+0.272 LM2	DW=1.0967
(4)	M2-EX	LM2=40.9633-6.0007 LEX	DW=0.2423
		LEX=6.0426-0.1046 LM2	DW=0.3679
(5)	M3-GDP	LM3=-15.8753-2.6727 LGDP	DW=1.1085
		LGDP=6.5321+0.328 LM3	DW=1.2585
(6)	M3-EX	LM3=36.3688-4.9858 LEX	DW=0.2143
		LEX=6.2935-0.1226 LM3	DW=0.3422

Approximate critical value for **DW** statistic at 5% level is 0.386, with rejection region $\{DW | DW > 0.386\}$; the result are largely invariant to choice of normalizing variable. Only for the M1-EX, M2-EX and M3-EX regressions do the Durbin-Watson statistic fall below the 5% critical level for the test of I(1) residuals. For all other regressions (M1-GDP, M2-GDP, M3-GDP) the Durbin-Watson statistic is large enough to reject the null of I(1) residuals at 5% test size. This impression is confirmed by examining the Dickey-Fuller test statistics for a unit root in the residuals from the cointegrating regression, which are reported in Table 3.

Table 3. Augmented Dickey-Fuller test statistic for residuals from cointegrating regressions

Normalised on	LM1	LM2	LM3	LGDP	LEX
(1)M1-GDP	-2.3741			-3.3502	
(2)M1-EX	-1.4423				-2.8429
(3)M2-GDP		-6.5804		-6.9287	
(4)M2-EX		-2.3317			-2.8652

(5)M3-GDP	-4.8429	-6.3616	
(6)M3-EX	-2.1172		-2.9077

Approximate critical value for Augmented Dickey-Fuller (ADF) statistic at the 5% level is -3.17, with rejection region $\{ADF | ADF < -3.17\}$. With the exception of the M1-EX, M2-EX and M3-EX combinations, the null hypothesis of a unit root in the residuals is rejected for all variables combinations (M1-GDP, M2-GDP, M3-GDP) at or below the 5% significance level. We can in some cases reject the null hypothesis of I(1) residuals using Augmented Dickey-Fuller statistics or the Durbin-Watson statistic; i.e. we find cointegration between M1-GDP, M2-GDP and M3-GDP. If cointegration exists then causality tests may be performed with regard to the levels of the variables concerned (X causes Y or vice versa). If cointegration does not exist, one way may still difference the data and perform causality tests on the differenced (i.e. stationary) series (ΔY causes ΔX; ΔX causes ΔY). We examine M1-GDP, M2-GDP, M3-GDP, M1-EX, M2-EX, M3-EX, GDP-M1, GDP-M2, GDP-M3, EX-M1, EX-M2 and EX-M3 to find an error-correction forms which are reported in Appendix 1. Period of estimation is 1981 quarter 2 – 1988 quarter 4. Figures in parentheses are heteroscedastic-consistent standard errors $[White(1980]$, figures in brackets are critical values. DW is Durbin-Watson statistic. LM is a Lagrange multiplier test statistic for up to fourth order serial correlation (Breush & Pagan, 1980); Q is the Ljung-Box statistic; ARCH is a test statistic for autoregressive conditional heteroscedasticity (Engle, 1982); WH is White's (1980) test statistic for general heteroscedasticity and functional misspecification; N is a test statistic for normally of the residuals based on the coefficient of skewness and excess kurtosis; CHOW is Chow's (1960) test statistics for post sample predictive failure, obtained by estimating up to 1987 quarter 4 and forecasting twelve months out of sample. Q, ARCH and N are central chi-square under the appropriate null, all other statistic (except R^2 and DW) are central F. The estimated error-correction forms for (1) to (12) are quite impressive. Error correction forms re-estimated up to 1987 quarter 4, forecast well for twelve months out of sample. For models (7) to (12), the Q statistic are too large to accept the hypothesis of no autocorrelation and we can reject the models, since the probability that the residuals are not white notice is at least 95 percent; thus we need not accept the hypothesis that the residuals are nonwhite, and for (1) to (6) models would be acceptable. To determine the "best" specification, we might want to specify and estimate some models to see whether a low chi-square statistic can be obtained. For models (1) to (12), since the value of the CHOW statistic are smaller than the critical value of the F distribution at the 5 percent level, we accept the null hypothesis. It is plausible to assume equal coefficients (no structure change). Except model (4), for models (1) to (12), since the value of the White's F statistic is smaller than the critical value of the F distribution at the 5 percent level, there is no evidence of heteroscedasticity; but, if we consider the LM version of the statistic for normality test, for model (1) to (4), the value of the $\chi^2 N(2)$ statistic are greater than the critical value of the χ^2 distribution at 95 percent level, there is evidence of heteroscedasticity for them.

For models (1) to (12), an ARCH test, since the value of the chi-square statistic are smaller than critical value of the χ^2 distribution at 95 percent level, there is no evidence of heteroscedasticity; but, if we consider the Lagrange Multiplier (LM) test statistic for up to fourth order serial correlation, in models (1), (7), (8) and (9), since the value of the F version statistic are greater than the value of the F distribution at the 5 percent level, there is evidence of autocorrelation. The **R**-squares are quite small for each model. It means that they are not quite representative. However, these results concur with my cointegration analysis for models (1) to (6). Long-run relationships go through for M1-GDP, M2-GDP, M3-GDP, M1-EX, M2-EX and M3-EX. We report next the results of 'Granger' causality testing between the above variables. There is strong evidence of no causality relationship between them.

Table 4. *Granger's technique*

Hypothesis	F-stat.	d.f.
GDP $\rightarrow$ M1	1.366	4, 19
M1 $\rightarrow$ GDP	0.833	4, 19
GDP $\rightarrow$ M2	0.5677	4, 19
M2 $\rightarrow$ GDP	1.482	4, 19
GDP $\rightarrow$ M3	0.446	4, 19
M3 $\rightarrow$ GDP	1.135	4, 19
$\Delta EX \rightarrow \Delta M1$	0.464	4, 18
$\Delta M1 \rightarrow \Delta EX$	0.357	4, 18
$\Delta EX \rightarrow \Delta M2$	1.186	4, 18
$\Delta M2 \rightarrow \Delta EX$	2.35	4, 18
$\Delta EX \rightarrow \Delta M3$	1.059	4, 18
$\Delta M3 \rightarrow \Delta EX$	1.347	4, 18

As seen in Table 4. Critical value for the F(4, 19) and F(4, 18) are 2.9 and 2.93 for 5 percent level of significance respectively. This suggests neither variable in each of these pairs causes the other in Granger sense. Taken with the cointegration results this may suggest other factors 'cause' both variables.

5. Conclusion

In our analysis there is no evidence of a causality relationship between money supply, income, prices and exchange rates in Hong Kong. All data covered the period from first quarter 1981 to third quarter 1983 in the floating exchange rate system and the period from fourth quarter 1983 to fourth quarter 1988 in the linked exchange rate system. The period covers a structural break[2] in the fourth quarter of 1983. When the linked exchange rate system was adopted. This may be a source of criticism on our finding. However, if we just consider under the linked exchange rate system, we can only obtain twenty-one observations, the validity of our tests may be jeopardized. Hence, we have to extend our data coverage. GDP is annually published before 1989. Since we should take GDP as quarterly data, we use the total domestic export data to estimate the quarterly GDP. However, in Hong Kong, GDP is sometimes propelled by exports, sometimes by domestic demand. Typically, in an upswing, growth is first propelled by exports, and then by domestic demand. It is not perfect cyclical considerations. This can be considered as a serious data limitation and may invalidate our results. The Granger approach relies on heuristic justification, i.e. 'post hoc ergo propter hoc'. Thus, they give the wrong result if an event occurs before the event which causes it. This is equivalent

[2]The Sino-British Joint Declaration, formally known as the Joint Declaration of the Government of the United Kingdom of Great Britain and Northern Ireland and the Government of the People's Republic of China on the Question of Hong Kong, was signed by Prime Ministers Zhao Ziyang of the People's Republic of China (PRC) and Margaret Thatcher of the United Kingdom (UK) on behalf of their respective governments on 19 December 1984 in Beijing.

to the ‘Christmas card’ and ‘Travel agent’ example – people go to travel agents and book their holidays; subsequently they take their holidays. This does not mean that the act of booking actually causes the holiday. For instance, if it is announced that wage increases over the next pay round will be very high so that the market expects large future price increases, the exchange rate may depreciate immediately. These tests would suggest that exchange rate change caused the subsequent price changes. Instantaneous causality (i.e. where on variable has an effect on other variable within the same period) may not be discovered by the tests. Moreover, when this test is extended to form ‘triangular’ causality, they may give misleading results. It A causes B and B causes C within the same period, it is possible that the effect on A on C may appear within the next period. Thus it will appear that the only causality between the variables is from A to C. The test cannot distinguish the actions of the authorities from those of other market participants: for instance, if it is found that exchange rate movements, unexplained by past price movements, lead to price movements, the implication for policy will be different, depending on whether the exchange rate movements are caused by the authorities or by private speculators. ‘Causality’ may be a misleading term in these tests since both variables may in fact respond to another variable. In Hong Kong the money supply cannot be treated as an exogenous variable with respect to change in aggregate economic activity. The linked exchange rate system provides sufficient current capital to the economy. It will not be excessive or inadequate because money is determined by the balance of payments. But, firstly, because of the depreciation of US dollars, the depreciation of HK dollars leads to ‘imported inflation’ which will raise the price of raw materials and production costs, and will finally lower the competitiveness of Hong Kong export goods. However, ‘imported inflation’ was, in fact, lower than expected in the period of 1985 to 1987. It is because Japan has cut down its export prices so as to maintain the market share in Hong Kong. There are so many speculators who want to get profit from the revaluation of the official rate. So, there was so much ‘hot money’ which flows into Hong Kong’s money market so as to press the government to revalue. For this reason the government considered the introduction of a negative interest rate policy for capital inflows. And also if HK dollars was pressed to revalue, the public holding assets valued in terms of US dollars will suffer great loss immediately and cause the public to lose confidence in the government which may trigger some kind of political impact. Furthermore, speculators would disturb the monetary system again and again in order to gain profits from the time after time revaluation. Interest rates do not reflect the actual need of Hong Kong economy but only the tool of maintaining the official rate. It fluctuated rapidly and frequently. And also, Hong Kong economy will directly be affected by US economy, Hong Kong will suffer economic recession whenever the US economy is contracted. The linked exchange rate system is still practical and feasible, because it can stabilize the confidence of public and the automatic adjusting mechanism of this system is satisfactory to a certain extent, because it can control the money sully according to the balance of payment.

It is hoped that the present work can stimulate and arouse future research to use causality test. In this paper, we suggest to use an advanced technique to confirm the assumption of the endogeneity of money supply in Hong Kong. It is highly recommended to use a vector autoregressive (VAR) test. This view can be put to rigorous empirical test. One relevant test would be that of causality between the money supply and factors which might have caused it or have been caused by it. Bivariate causality tests based on Granger’s (1969) conception have been very popular with econometricians and various versions have been developed. However, they suffer from the fact that only two variables could be considered despite

Granger's original multivariate formulation. The vector autoregression (VAR) technique popularized by Sim (1980; 1982) overcomes this drawback. Therefore, we recommend to adopt VAR test in determining the direction of causality between the money supply and other relevant variables in Hong Kong.

Appendix.

Estimated error correction forms

(1) M1-GDP

$$\Delta LM1_t = 0.0515 - 0.4248\Delta LGDP_t + 0.0123(LM1-LGDP)_{t-1}$$

(0.0179) (0.2145) (0.0584)

$R^2 = 0.1256$ DW=2.948 LM(4,24)=4.0557

$[2.78]$

N(2)=64.6271 WH(1,29)=1.2776 Q(10)=13.3706

$[5.99]$ $[4.17]$ $[18.31]$

ARCH(12)=11.5602 CHOW(3,25)=0.1916

$[21.03]$ $[2.99]$

(2) M1-EX

$$\Delta LM1_t = -0.0352 - 0.3003\Delta LEX_t + 0.0126(LM1-LEX)_{t-1}$$

(0.2) (0.5254) (0.0339)

$R^2 = 0.0154$ DW=2.7635 LM(2,24)=2.5631

$[2.78]$

N(2)=24.5252 WH(1,29)=0.000124 Q(10)=10.3977

$[5.99]$ $[4.17]$ $[18.31]$

ARCH(12)=12.4071 CHOW(3,25)=0.384

$[21.03]$ $[2.99]$

(3) M2-GDP

$$\Delta LM2_t = 0.1062 - 0.0983\Delta GDP_t - 0.0197(LM2-LGDP)_{t-1}$$

(0.0321) (0.1046) (0.0168)

$R^2 = 0.0854$ DW=1.0025 LM(4,24)=2.6914

$[2.78]$

N(2)= 28.4925 WH(1,29)=1.1702 Q(10)=18.2935

$[5.99]$ $[4.17]$ $[18.31]$

ARCH(12)=18.6475 CHOW(3,25)=0.0262

$[21.03]$ $[2.99]$

(4) M2-EX

$$\Delta LM2_t = 0.1986 + 0.0741\Delta LEX_t - 0.0166(LM2-LEX)_{t-1}$$

(0.0891) (0.2487) (0.0112)

$R^2 = 0.074$ DW=0.9869 LM(4,24)=2.5877

$[2.78]$

N(2)=11.2233 WH(1,29)=12.3122 Q(10)=17.4107

$[5.99]$ $[4.17]$ $[18.31]$

ARCH(12)=18.0208 CHOW(3,25)=0.1994

$[21.03]$ $[2.99]$

(5) M3-GDP

$$\Delta LM3_t = 0.0928 - 0.0167\Delta GDP_t - 0.0167(LM3-LGDP)_{t-1}$$

(0.0236) (0.0548) (0.0113)

$R^2 = 0.0813$ DW=1.637 LM(4,24)=0.8951

$[2.78]$

N(2)=1.7875 WH(1,29)=2.8958 Q(10)=10.8333

$[5.99]$ $[4.17]$ $[18.31]$

ARCH(12)=15.2786 CHOW(3,25)=0.1524

$[21.03]$ $[2.99]$

(6) M3-EX
$\Delta LM3_t = 0.1431 - 0.001788 \Delta LEX_t - 0.0106(LM3 - LEX)_{t-1}$ (0.0558) (0.1298) (0.0068768) $R^2 = 0.0783$ DW=1.6335 LM(4,24)=0.8755 [2.78] N(2)=1.4655 WH(1,29)=3.9336 Q(10)=10.1015 [5.99] [4.17] [18.31] ARCH(12)=15.0926 CHOW(3,25)=0.6945 [21.03] [2.99]
(7) GDP-M1
$\Delta LGDP_t = 0.0415 - 0.2893 \Delta LM1_t - 0.0653(LGDP - LM1)_{t-1}$ (0.0149) (0.146) (0.0466) $R^2 = 0.1815$ DW=2.3639 LM(4,24)=9.0454 [2.78] N(2)=0.6078 WH(1,29)=0.2662 Q(10)=42.4173 [5.99] [4.17] [18.31] ARCH(12)=15.5253 CHOW(3,25)=1.8773 [21.03] [2.99]
(8) GDP-M2
$\Delta LGDP_t = 0.0135 - 0.3112 \Delta LM2_t - 0.0151(LGDP - LM2)_{t-1}$ (0.0673) (0.3311) (0.0304) $R^2 = 0.0487$ DW=2.1075 LM(4,24)=19.0017 [2.78] N(2)=2.7929 WH(1,29)=0.038 Q(10)=70.5774 [5.99] [4.17] [18.31] ARCH(12)=16.5572 CHOW(3,25)=1.8398 [21.03] [2.99]
(9) GDP-M3
$\Delta LGDP_t = 0.0855 - 0.2003 \Delta LM3_t - 0.02(LGDP - LM3)_{t-1}$ (0.0881) (0.6541) (0.0342) $R^2 = 0.0209$ DW=2.0803 LM(4,24)=16.8168 [2.78] N(2)=3.1524 WH(1,29)=1.4128 Q(10)=71.5513 [5.99] [4.17] [18.31] ARCH(12)=17.0743 CHOW(3,25)=1.9752 [21.03] [2.99]
(10) EX-M1
$\Delta LEX_t = -0.0346 - 0.0384 \Delta LM1_t - 0.0048198(LEX - LM1)_{t-1}$ (0.0713) (0.0672) (0.0121) $R^2 = 0.0161$ DW=1.2365 LM(4,24)=1.192 [2.99] N(2)=0.1324 WH(1,29)=0.7047 Q(10)=21.7623 [5.99] [4.17] [18.31] ARCH(12)=16.2709 CHOW(3,25)=0.0272 [21.03] [2.99]

(11) GDP-M2

$$\Delta LEX_t = -0.0307 + 0.0426\,\Delta LM2_t - 0.0025365\left(LEX - LM2\right)_{t-1}$$

(0.0731) (0.1432) (0.008845)

$R^2 = 0.0047984$ DW=1.2158 LM(4,24)=1.2038

$[2.78]$

N(2)=0.2025 WH(1,29)=0.7696 Q(10)=22.3458

$[5.99]\,[4.17]\,[18.31]$

ARCH(12)=13.9485 CHOW(3,25)=0.37

$[21.03]\,[2.99]$

(12) EX-M3

$$\Delta LEX_t = -0.0237 + 0.0067243\,\Delta LM3_t - 0.0046128\left(LEX - LM3\right)_{t-1}$$

(0.0393) (0.2753) (0.0092964)

$R^2 = 0.0092543$ DW=1.2333 LM(4,24)=1.1774

$[2.78]$

N(2)=0.2612 WH(1,29)=1.5922 Q(10)=22.5568

$[5.99]\,[4.17]\,[18.31]$

ARCH(12)=14.2073 CHOW(3,25)=0.3889

$[21.03]\,[2.99]$

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