A TRIVARIATE STOCHASTIC MODEL FOR EXAMINING THE CAUSE OF INFLATION IN A SMALL OPEN ECONOMY: HONG KONG

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I. INTRODUCTION

IT HAS been argued that under a floating exchange system, the domestic price level is not affected by world inflation. This insulating property of floating exchange rate was demonstrated theoretically by a relatively simple model of Turnovsky and Kaspura [31]. However, Johnson [18] pointed out that the floating exchange rate is not a panacea. Indeed, a more sophisticated model developed by Turnovsky and Kingston [32] indicated that the floating exchange rate might import inflation if foreign nominal interest rate did not fully reflect the foreign inflation rate.[1] Other conditions which would handicap the functioning of the floating exchange rate include (1) inelastic import demand, (2) capital flow generated by external inflation [27], and (3) downward price rigidity [12]. For a small and open economy like Hong Kong, the first two factors seem to play an important role. The third factor, i.e., downward price rigidity, is connected more often with the economy's institutional aspects such as the power of the labor union.

The effect of imported inflation for big and less open economies like the United States was studied by Cagan [4] who estimated roughly that the increase in world price raised U.S. manufacturing prices by about 15 per cent. Quantification of the effect of imported inflation for smaller and more open economies like the Philippines and Papua New Guinea was done by Otani [25] and Lam [20]. They both concluded that external inflation had strong influence on domestic inflation.[2]

Hong Kong is not completely barren in the examination of imported inflation. Using a single equation regression model, Jao [17] found that import prices had a significant impact on domestic inflation while the influence of money supply was not important in most cases.[3] However Chou [5] found that money supply rather than import prices had strong impact on domestic inflation. Both the Jao

[1] Wanniski [33], Witteveen [34], and Crockett and Goldstein [6] even believed that the floating exchange rate had a global inflationary bias.

[2] Although Sheehey [29] criticized Otani for overestimating the relative importance of imported inflation in the Philippines, the notion that imported prices had significant impact on domestic inflation was still not refuted.

[3] Jao also included the real growth rate in gross domestic product (GDP) as an explanatory variable for domestic inflation but the effect was not significant.

and Chou studies employed annual data, their regression results may thus reflect only the long run equilibrium situation and may not be able to track the causal relationships during the short run. Besides, detection of causal direction were not a feature of the aforementioned studies. It will be clear from the following presentation that we want to fill this gap by employing a formal causal test on monthly data.

Furthermore, the influence of domestic money supply on inflation is yet to be more carefully investigated. Earlier works on the effect of money supply on inflation were done by Friedman and Schwartz [11], Friedman [10], and Cagan [3]. These studies assigned important role to the money supply in determining domestic inflation. In this sense, the money supply is exogenous. This may be true for countries which can actively manipulate their money supply through the central bank or other monetary authorities. However, this is not the case for Hong Kong as there is no central bank. The most proximate counterpart to a central bank is the Exchange Fund established in 1935 with the objective of stabilizing the value of the Hong Kong dollar. But the function of the Exchange Fund as a central bank with respect to the process of money supply is far fetched. Commercial banks in Hong Kong are not required to hold reserve with the Exchange Fund. They only need to hold a certain minimum amount of liquid assets which is equal to 25 per cent of their deposite in their asset portfolio. The so-called liquid assets include cash, gold, silver, short-term deposits with other banks and deposits taking companies, short-term deposits overseas, short-term treasury bills, and certificate of deposits issued outside Hong Kong, etc. As the Exchange Fund has no way to control the volume of liquid assets and the problem is further aggravated by the fact that banks in Hong Kong can practically borrow unlimited amount of foreign assets from overseas countries, it is extremely doubtful if the money supply in Hong Kong is exogenous, particularly after Hong Kong adopted the floating exchange rate system in late 1973. Indeed Lee and Jao [21] found that the portfolio behavioral parameter has become more important factors influencing the supply of money.

Formal causality studies or money supply and inflation based on the Granger [13] causation criteria were not performed until the early 1970s. Good examples include Sargent and Wallace study [28] of six industrial countries, Frenkel work [9] on the German hyperinflation, Feige and Pearce work [7] and Mehra study [23] of the United States. Although these studies do not provide a consistent conclusion about the causal relationship between money supply and prices, it does not necessarily mean that such relationship did not exist. This is because these money-price causality studies have been done in a bivariate framework without taking imported inflation into account. The adoption of such a bivariate framework is understandable because most of the money-price studies mentioned above are done for larger and less open economies where imported inflation may not be a serious problem.

However, for an economy like Hong Kong where external disturbances are crucial to domestic economic activities, leaving out import prices in the causality study may cause serious specification error. Hence, this paper examines the

causal relationship between money, domestic prices, and import prices within a trivariate framework. Specifically, we try to test the following propositions:
Proposition I : Money supply causes domestic inflation.
Proposition II : Money supply does not accommodate inflationary demand.
Proposition III: Import prices cause domestic inflation.

For this purpose, we employ the recently developed trivariate stochastic causality model as the analytical tool. It is found that we could confirm proposition III but not the other two propositions. Hence, it can be said that domestic inflation in Hong Kong was caused by foreign inflation and the role of money supply was nothing more than accommodating the domestic inflationary pressure.

A word about the data used in this study is in order. We use three measures of domestic consumer prices, namely, consumer price index A (*CPA*), consumer price index B (*CPB*), and Hang Seng consumer price index (*HCP*) corresponding to consumer price indexes for three different income classes.[4] Meanwhile, two measures of money supply, namely, *M1* and *M2* are used.[5] The import unit value index is used to measure import price. The period covered is November 1974 to December 1979. All the data are supplied by the Census and Statistics Department of the Hong Kong Government.

II. CAUSAL ORDERING

The notion that either the money supply or import prices influence domestic inflation implies that the movement in domestic prices is led by the movement in either the money supply or import prices. This lead-led relationship is consistent with the cause-effect criteria according to Granger [13]. A brief review of the Granger's definition of causality is presented here.

For two stationary stochastic processes or white noise, X and Y, $\overline{X}$ and $\overline{Y}$ are the sets of past values of X and Y, respectively, and $\sigma^2(X|K)$ is the minimum predictive error of X given a set of information K. The causality relationship can be defined as:

(1) Y causes X or there exists a unidirectional relationship running from Y to X if X can be predicted better by using both the past values of X and Y than by using the past values of X alone. This is equivalent to $\sigma^2(X|\overline{X})>\sigma^2(X|\overline{X},\overline{Y})$. The idea that Y causes X can be defined similarly.

(2) Y causes X and X also causes Y or there exists a bidirectional relationship between X and Y if $\sigma^2(X|\overline{X},\overline{Y})<\sigma^2(X|\overline{X})$ and $\sigma^2(Y|\overline{X},\overline{Y})<\sigma^2(Y|\overline{Y})$.

Based on this concept, many operational tests have been formulated,[6] notably the two sided lag regression of Sims [30], the Box-Jenkins approach of Pierce and Haugh [26], and the direct Granger approach or the distributed lag approach

[4] *CPA, CPB,* and *HCP* correspond to consumer price indexes for family spending HK$400–1,499, HK$1,500–2,999, and HK$3,300–9,999, respectively.

[5] *M1* equals legal tender notes and coins in the hands of non-bank public plus demand deposits of the non-bank public with commercial banks. *M2* equals *M1* plus time and saving deposits of the non-bank public with commercial banks.

[6] For a review of the recent development in causality studies, see Feige and Pearce [7].

of Hsiao [15] [16]. Following Hsiao, the causality relationship between X and Y can be tested operationally by using linear predictors:

$$X_t = \alpha + \sum_{j=1}^{k} \beta_j X_{t-j} + \sum_{j=1}^{m} \gamma_j Y_{t-j} + e_{1t}, \tag{1}$$

$$Y_t = \theta + \sum_{j=1}^{p} \delta_j X_{t-j} + \sum_{j=1}^{q} \phi_j Y_{t-j} + e_{2t}, \tag{2}$$

where e_{1t} and e_{2t} are white noises. If X_t can be predicted better by using X_{t-j}'s and Y_{t-j}'s than by using X_{t-j}'s alone in equation (1), then Y is said to cause X. Similarly, if Y_t in equation (2) can be predicted better by including X_{t-j}'s, X is said to cause Y.

All the methods mentioned above, though different in statistical techniques, share one common shortcoming in that they only allow the investigation of causal patterns for a bivariate case.[7] However, a variable may be influenced by more than one other variable. Therefore, the bivariate stochastic model such as those presented in equations (1) and (2) may have serious specification error. With regards to this problem, Granger did provide a definition for a trivariate case.

Let Z be the third stationary stochastic process and $\bar{Z}$ be the set of past values of Z. Granger defined causal pattern conditional on the presence of Z as follows:

(1) Y causes X in the presence of Z if X can be predicted better by $\bar{X}$ and $\bar{Y}$ than by $\bar{X}$ alone conditional on the presence of $\bar{Z}$ in both cases. Symbolically, Y causes X in the presence of Z if $\sigma^2(X|\bar{X},\bar{Y},\bar{Z}) < \sigma^2(X|\bar{X},\bar{Z})$. The reverse causation of X to Y can be defined similarly.

(2) There exists a bidirectional relationship between X and Y conditional on the presence of Z if $\sigma^2(X|\bar{X},\bar{Y},\bar{Z}) < \sigma^2(X|\bar{X},\bar{Z})$ and $\sigma^2(Y|\bar{X},\bar{Y},\bar{Z}) < \sigma^2(Y|\bar{Y},\bar{Z})$.

Using linear predictors again, equations (1) and (2) can be expanded to:

$$X_t = \alpha + \sum_{j=1}^{k} \beta_j X_{t-j} + \sum_{j=1}^{m} \gamma_j Y_{t-j} + \sum_{j=1}^{n} \phi_j Z_{t-j} + e_{1t}, \tag{3}$$

$$Y_t = \theta + \sum_{j=1}^{p} \delta_j X_{t-j} + \sum_{j=1}^{q} \phi_j Y_{t-j} + \sum_{j=1}^{r} \eta_j Z_{t-j} + e_{2t}. \tag{4}$$

Hence, conditional on the presence of Z, Y causes X if X_t can be predicted better by including Y_{t-j}'s in equation (3) and X causes Y if Y_t can be predicted better by including X_{t-j}'s in equation (4).

The specifications in equations (3) and (4) provide a convenient framework to test three propositions. The three variables that concern us here are domestic consumer prices (*CP*), import prices (*IP*), and money supply (*MS*). Let $\overline{CP}$, $\overline{IP}$, and $\overline{MS}$ be the sets of past values of *CP*, *IP*, and *MS*, respectively. The propositions in the last section can be tested as follows:

(1) The test of proposition I is consistent with predicting *CP* by $\overline{CP}$, $\overline{IP}$, and $\overline{MS}$. If $\sigma^2(CP|\overline{CP},\overline{MS},\overline{IP}) < \sigma^2(CP|\overline{CP},\overline{IP})$, *MS* causes *CP* conditional on the presence of *IP*.

[7] As noted by Feige and Pearce [7], the Haugh-Pierce approach serves only to test independence rather than causal pattern between two variables.

(2) Proposition II can be tested by predicting MS by $\overline{MS}$, $\overline{CP}$, and $\overline{IP}$. If $\sigma^2(MS|\overline{MS},\overline{CP},\overline{IP}) > \sigma^2(MS|\overline{MS},\overline{IP})$, money supply does not accommodate the need of inflationary demand conditional on the presence of IP.
(3) Similarly, by predicting CP by $\overline{CP}$, $\overline{IP}$, and $\overline{MS}$, proposition III can be confirmed if $\sigma^2(CP|\overline{CP},\overline{IP},\overline{MS}) < \sigma^2(CP|\overline{CP},\overline{MS})$ conditional on the presence of MS.

III. ESTIMATION OF LINEAR FILTER

One of the most crucial assumptions of the analysis suggested above is that all the variables are white noises or stationary stochastic processes. This assumption is surely too demanding for economic time series which are usually nonstationary. However, stationary can usually be achieved by differenting the series.

Sims [28] suggested differencing the raw data by a linear filter of the form $(1-0.75B)^2$ where B is the lag operator. Sims claimed that this filter would work for most economic time series. However, Mehra [22] believed that $(1-0.75B)^2$ may not produce white noise for all variables under consideration. Mehra [22] [23] and Mehra and Spencer [24] suggested a more general filter $(1-pB)^2$ and found the value of p such that the Sim's two sided lag regressions using the filtered data can produce random residuals.[8] An extension of this method, noted by Kawai [19], is to use a filter of the form: $(1-\pi_1B)(1-\pi_2B)\ldots(1-\pi_kB)$ and find the combination of π's (the values of which lie between 0.1 and 0.9) which produces random residuals and best predictive power. Another method to stationalize a variable is to include a time trend in the Sim's two sided lag regression, e.g., Mehra's study [22]. All the approaches mentioned above except the time trend method are basically a trial and error search method which may be very time consuming. This paper will follow the method suggested by Kawai [19].

Consider a linear filter of the form:

$$\pi(B)=(1-\pi_1B-\pi_2B^2)(1-B)^d,$$

where d is a positive integer to be estimated. If $\pi(B)$ is a "good" filter for any given variable A, the filtered series would be a white noise v_t, i.e.,

$$(1-\pi_1B-\pi_2B^2)(1-B)^dA_t=v_t. \qquad (5)$$

Rearranging equation (5),

$$(1-B)^dA_t=\pi_1(1-B)^dA_{t-1}+\pi_2(1-B)^dA_{t-2}+v_t. \qquad (6)$$

Therefore, running a regression as specified in equation (6), the π's can be estimated for any given value of d. By varying the value of d, a set of estimated for the π's can be obtained. The values of π_1 and π_2 and their corresponding d value will be chosen if they can produce random residuals.

Applying equation (6) to the case of CPA, CPB, HCP, $M1$, $M2$, and IP and transforming the variables to natural logarithm form, a set of six equations to be estimated are obtained:

[8] This procedure is equivalent to the Hildreth-Lu search procedure [14].

TABLE I

CONSTRAINED ESTIMATION OF FILTER COEFFICIENTS

d	π_1	π_2	Variable	Residual Autoregressive F-statistics[a]	
1	0.320270***	0.345394***	*CPA*	1.64	
	(7.19)	(7.67)	*CPB*	1.07	
			HCP	1.47	
			M1	0.98	[16,26]
			M2	1.72	
			IP	1.15	
2	−0.705035***	−0.309642***	*CPA*	3.60***	
	(−14.23)	(−6.23)	*CPB*	2.11**	
			HCP	1.49	
			M1	1.70	[16,25]
			M2	1.15	
			IP	1.21	
3	−1.03912***	−0.49279***	*CPA*	7.19***	
	(−22.55)	(−10.61)	*CPB*	4.82***	
			HCP	4.27***	
			M1	4.21***	[16,24]
			M2	2.78***	
			IP	2.05**	
4	−1.241337***	−0.596466***	*CPA*	11.81***	
	(−29.20)	(−13.91)	*CPB*	9.06***	
			HCP	10.22***	
			M1	7.89***	[16,23]
			M2	7.39***	
			IP	6.27***	

Notes: 1. The figures in parentheses are t-statistics.
2. The figures in swuared brackets are degree of freedom of the F-statistics.
3. Based on the equation (6).

*** Significant at the 1 per cent level.

** Significant at the 5 per cent level.

[a] Residual autoregressive F-statistics are the F values obtained from regressing the current value of the residual against sixteen lagged values of the residual.

$$(1-B)^d \ln CPA_t = \pi_{11}(1-B)^d \ln CPA_{t-1} + \pi_{12}(1-B)^d \ln CPA_{t-2} + v_{1t}, \quad (7.1)$$

$$(1-B)^d \ln CPB_t = \pi_{21}(1-B)^d \ln CPB_{t-1} + \pi_{22}(1-B)^d \ln CPB_{t-2} + v_{2t}, \quad (7.2)$$

$$(1-B)^d \ln HCP_t = \pi_{31}(1-B)^d \ln HCP_{t-1} + \pi_{32}(1-B)^d \ln HCP_{t-2} + v_{3t}, \quad (7.3)$$

$$(1-B)^d \ln M1_t = \pi_{41}(1-B)^d \ln M1_{t-1} + \pi_{42}(1-B)^d \ln M1_{t-2} + v_{4t}, \quad (7.4)$$

$$(1-B)^d \ln M2_t = \pi_{51}(1-B)^d \ln M2_{t-1} + \pi_{52}(1-B)^d \ln M2_{t-2} + v_{5t}, \quad (7.5)$$

$$(1-B)^d \ln IP_t = \pi_{61}(1-B)^d \ln IP_{t-1} + \pi_{62}(1-B)^d \ln IP_{t-2} + v_{6t}. \quad (7.6)$$

Since in the later analysis, all the price and money variables will enter the same regression equation in various combinations, it is necessary to filter the series with the same filter, i.e., the d value and the π's should be equal for all series. Hence, a "seemingly unrelated" regression procedure is adopted to estimate equations (7.1)–(7.6) with the following two restrictions:

$$\pi_{11}=\pi_{21}=\pi_{31}=\pi_{41}=\pi_{51}=\pi_{61},$$

$$\pi_{12}=\pi_{22}=\pi_{32}=\pi_{42}=\pi_{52}=\pi_{62}.$$

Table I presents the regression results for equation (7) with d varies from 1 to 4. It is obvious from the autoregressive F-ratios that the regression with $d=1$ will produce random residuals. Therefore, the following filter is chosen to filter the six series:

$$\pi(B)=(1-0.32027B-0.345394B^2)(1-B).$$

IV. CAUSALITY TEST PROCEDURE

The causality test will be done with the bivariate case first and then with the trivariate case. Before proceeding, let us redefine the variables:

PA, PB, HP = Filtered ln*CPA*, ln*CPB*, and ln*HCP*, respectively.

MI, MII = Filtered ln*M1* and ln*M2*, respectively.

I = Filtered ln*IP*.

A. *The Bivariate Case*

Within the bivariate framework, the three propositions can be tested by the following equations:

$$P_t=\alpha+\sum_{j=1}^{k}\beta_jP_{t-j}+\sum_{j=1}^{m}\gamma_jM_{t-j}+e_{1t}, \tag{8}$$

$$M_t=\theta+\sum_{j=1}^{p}\delta_jP_{t-j}+\sum_{j=1}^{q}\phi_jM_{t-j}+e_{2t}, \tag{9}$$

$$P_t=\lambda+\sum_{j=1}^{s}\mu_jP_{t-j}+\sum_{j=1}^{u}\rho_jI_{t-j}+e_{3t}, \tag{10}$$

where $P=PA$, PB, or HP, $M=MI$ or MII, e_{1t}, e_{2t}, and e_{3t} are white noises. Propositions I and III are true if P_t can be predicted better by including the M_{t-j}'s and I_{t-j}'s in equations (8) and (10), respectively. Proposition II is true if the P_{t-j}'s does not decrease the predictive error of M_t in equation (9).

For the determination of the lags k, m, p, q, s, and u, we adopt the Akaike [1] [2] minimum final prediction error (FPE) criterion which has been applied in several empirical works, e.g., the studies of Hsiao [15] [16] and Kawai [19]. Akaike defined FPE as the mean square error of the prediction. If $\hat{P}_t$ is the predicted value of P_t in equation (8), $FPE=E(P_t-\hat{P}_t)^2$. Alternatively, FPE can be defined operationally in terms of the sum of squared error (SSE) of the regression equation:

$$FPE=\frac{N+k+m+1}{N-k-m-1}\cdot\frac{SSE}{N},$$

where N is the number of observations. The equation with the optimal number of lags is the one with the minimum *FPE*. However, the number of regressions needed will be enormous. If $k=0,\ldots,20$, and $m=1,\ldots,20$, the number of regressions equals 420! A more efficient approach suggested by Hsiao [15] [16] is followed which involves two steps:

(1) Regress P_t on a constant term and its own past values for $k=0,\ldots,20$, and choose the number of lags k which gives the min $FPE(P)$ which is given by

$$\min FPE(P)=\frac{N+\hat{k}+1}{N-\hat{k}-1}\cdot\frac{SSE}{N}.$$

(2) For a given $\hat{k}$, equation (8) is run again with the M_{t-j}'s included and with $m=1,\ldots,20$. Again, the equation with lags $(\hat{k}, \hat{m})$ is chosen which gives the minimum $FPE(P, M)$:

$$\min FPE(P, M)=\frac{N+\hat{k}+\hat{m}+1}{N-\hat{k}-\hat{m}-1}\cdot\frac{SSE}{N}.$$

After performing steps (1) and (2), a single equation is chosen for equation (8) which gives the optimum number of lags $\hat{k}$ and $\hat{m}$. Kawai [18] then defined two forms of causality:

Weak form : M *weakly* causes p if min $FPE(P, M)<$min $FPE(P)$.

Strong form: M *strongly* causes P if all the coefficients for M_{t-j}'s are jointly and significantly different from 0, i.e., $\gamma_j's\neq 0$.

Obviously, if one variable strongly causes the other, it must also weakly cause the other but the reverse may not be true. A similar procedure can be applied to equations (9) and (10) in order to test propositions II and III.

B. *The Trivariate Case*

For the trivariate case, the three equations (8), (9), and (10) are modified as:[9]

$$P_t=\alpha+\sum_{j=1}^{k}\beta_jP_{t-j}+\sum_{j=1}^{m}\gamma_jM_{t-j}+\sum_{j=1}^{n}\phi_jI_{t-j}+e_{1t}, \tag{11}$$

$$M_t=\theta+\sum_{j=1}^{p}\delta_jP_{t-j}+\sum_{j=1}^{q}\phi_jM_{t-j}+\sum_{j=1}^{r}\eta_jI_{t-j}+e_{2t}, \tag{12}$$

$$P_t=\lambda+\sum_{j=1}^{s}\mu_jP_{t-j}+\sum_{j=1}^{t}\nu_jM_{t-j}+\sum_{j=1}^{u}\rho_jI_{t-j}+e_{3t}. \tag{13}$$

Using equation (11) as an example for illustration, the three-steps procedure suggested by Kawai [19] for finding the optimum lags $(\hat{k}, \hat{m}, \hat{n})$ is briefly summarized as:

(1) Regress P_t separately on P_{t-j}'s and I_{t-j}'s for $k=0,\ldots,20$ and $n=0,\ldots,20$ and then choose the six best equations in each case according to the minimum *FPE* criterion.

(2) Regress P_t on both P_{t-j}'s and I_{t-j}'s for the thirty-six different combinations

9 Although equations (11) and (13) look similar, it must be aware that (11) is used to test whether M causes P conditional on the presence of I while (13) is used to test whether I causes P conditional on the presence of M.

of best lags for P_{t-j} and I_{t-j} obtained in step (1). Hence, there are thirty-six regression equations to be run. The best lags $(\hat{k}, \hat{n})$ is chosen for the equation with minimum $FPE(P, I)$ which is given by:

$$\min FPE(P, I) = \frac{N+\hat{k}+\hat{n}+1}{N-\hat{k}-\hat{n}-1} \cdot \frac{SSE}{N}.$$

(3) Given the optimum lags $\hat{k}$ and $\hat{n}$, the M_{t-j}'s are now included with $m=1,\ldots,20$. Again, the best lag $\hat{m}$ is chosen for the regression with minimum $FPE(P, M, I)$ which is given by:

$$\min FPE(P, M, I) = \frac{N+\hat{k}+\hat{m}+\hat{n}+1}{N-\hat{k}-\hat{m}-\hat{n}-1} \cdot \frac{SSE}{N}.$$

This three-steps procedure is used to test proposition I, i.e., to test if M causes P conditional on the presence of the third variable I. Both forms of causality can then be defined as:

(1) M weakly causes P conditional on the presence of I if min $FPE(P, M, I) <$ min $FPE(P, I)$.

(2) M strongly causes P conditional on the presence of I if all the coefficients of M_{t-j}'s are jointly and significantly different from 0, i.e., γ_j's$\neq 0$.

Propositions II and III can be tested similarly using equations (12) and (13), respectively.

V. EMPIRICAL RESULTS

The bivariate results will be presented first followed by the trivariate results.

A. *The Bivariate Case*

Proposition I: There is no empirical evidence to support this proposition. Table II indicates that the inclusion of *MI* or *MII* does not improve the predictive accuracy of *PA, PB,* and *HP*. For all combinations of prices and money supply, min $FPE(P) <$ min$FPE(P, M)$, and the F-statistics for all γ_j's are not significantly different from 0. Thus both the weak and strong forms of causality are not fulfilled and we can conclude that, for the bivariate case, money supply does not cause domestic inflation.

Proposition II: The empirical evidence reported in Table III indicates that for all combinations of prices and money supply, the inclusion of the domestic price variable does improve the predictive accuracy of money supply, i.e., min $FPE(M, P) <$ min $FPE(M)$. The F-statistics are highly significant indicating that all the δ_j's are jointly and significantly different from 0 at least at the 5 per cent level. Therefore, prices both weakly and strongly cause the movement in money supply or we can say that money supply accommodates inflationary demand and proposition II is not supported by the evidence.

Proposition III: Table IV shows that for all measures of prices, min $FPE(P) >$ min $FPE(P, I)$, and the ρ_j's are all jointly and significantly different from 0 at least at the 1 per cent level. Therefore, we can conclude that proposition III is

TABLE II

THE EFFECT OF MONEY SUPPLY ON DOMESTIC PRICE WITHOUT IMPORT PRICE

P	*M*	Optimum Lags		min *FPE*(*P*) (10^{-4})	min *FPE*(*P*, *M*) (10^{-4})	*F*-statistics[a]
		$\hat{k}$	$\hat{m}$			
PA		5	1	2.1349	2.1981	$F(1,51)=0.3000$
PB	*MI*	4	1	1.2556	1.2888	$F(1,53)=0.4337$
HP		3	1	0.5162	0.5234	$F(1,55)=0.0517$
PA		5	2	2.1349	2.1946	$F(2,50)=1.0848$
PB	*MII*	4	2	1.2556	1.2667	$F(2,52)=1.5996$
HP		3	1	0.5162	0.5217	$F(1,55)=0.2307$

Note: Based on the equation (8).

[a] The *F*-statistics are used to test the null hypothesis that all the coefficients of the M_{t-j}'s are jointly equal to 0.

TABLE III

THE EFFECT OF DOMESTIC PRICE ON MONEY SUPPLY WITHOUT IMPORT PRICE

M	*P*	Optimum Lags		min *FPE*(*M*) (10^{-4})	min *FPE*(*M*, *P*) (10^{-4})	*F*-statistics[a]
		$\hat{p}$	$\hat{q}$			
	PA	7	18	12.2788	9.5281[b]	$F(29,19)=2.2895$**
MI	*PB*	7	2	12.2788	10.1800[b]	$F(2,46)=6.8520$***
	HP	7	2	12.2788	10.7250[b]	$F(2,46)=5.3352$***
	PA	2	2	1.4594	1.3418[b]	$F(2,56)=4.5295$**
MII	*PB*	2	2	1.4595	1.2893[b]	$F(2,56)=5.8538$***
	HP	2	2	1.4594	1.3429[b]	$F(2,56)=4.5032$**

Note: Based on the equation (9).

*** Significant at the 5 per cent level.

** Significant at the 1 per cent level.

[a] The *F*-statistics are used to test the null hypothesis that all the coefficients of the P_{t-j}'s are jointly equal to 0.

[b] min $FPE(M, P) <$ min $FPE(M)$.

TABLE IV

THE EFFECT OF IMPORT PRICE ON DOMESTIC PRICE WITHOUT MONEY SUPPLY

P	*I*	Optimum Lags		min *FPE*(*P*) (10^{-4})	min *FPE*(*P*, *I*) (10^{-4})	*F*-statistics[a]
		$\hat{s}$	$\hat{u}$			
PA		5	3	2.1349	1.5699[b]	$F(3,49)=8.3444$***
PB	*I*	4	3	1.2556	1.0559[b]	$F(3,51)=5.4090$***
HP		4	6	0.5162	0.4431[b]	$F(6,47)=3.5713$***

Note: Based on the equation (10).

*** Significant at the 1 per cent level.

[a] The *F*-statistics are used to test the null hypothesis that all the coefficients of the I_{t-j}'s are jointly equal to 0.

[b] min $FPE(P, I) <$ min $FPE(P)$.

TABLE V

THE EFFECT OF MONEY SUPPLY ON DOMESTIC PRICE CONDITIONAL ON THE PRESENCE OF IMPORT PRICE

P	M	Optimum Lags of			min $FPE(P, I)$ (10^{-4})	min $FPE(P, I, M)$ (10^{-4})	F-statistics[a]
		$P(\hat{k})$	$I(\hat{n})$	$M(\hat{m})$			
PA		14	20	3[c]	1.2189	1.2118[b]	$F(3,4)=0.8949$
PB	MI	6	6	1	0.7985	0.8652	$F(1,42)=0.0639$
HP		8	3	5	0.3369	0.3492	$F(5,37)=1.2815$
PA		14	20	1[d]	1.2189	1.4029	$F(1,6)=0.0341$
PB	MII	6	6	1	0.7985	0.8663	$F(1,42)=0.0045$
HP		8	3	1	0.3369	0.3495	$F(1,41)=0.0622$

Note: Based on equation (11).

[a] The F-statistics are used to test the null hypothesis that all the coefficients of the M_{t-j}'s are jointly equal to 0.

[b] min $FPE(P, I, M) <$ min $FPE(P, I)$.

[c] The largest m allowed was 5 because the long lags in P and I had exhausted the degree of freedom. The second best combination of lags with $\hat{k}=6$, and $\hat{n}=20$ were experimented to allow a longer lags for m. The results were the same.

[d] Again, the largest m allowed was 5. When the analysis was done with the second best lags, i.e., $\hat{k}=6$, and $\hat{n}=20$, MII was found to weakly cause PA but the differential in FPE was very small.

TABLE VI

THE EFFECT OF DOMESTIC PRICE ON MONEY SUPPLY CONDITIONAL ON THE PRESENCE OF IMPORT PRICE

M	P	Optimum Lags of			min $FPE(M, I)$ (10^{-4})	min $FPE(M, I, P)$ (10^{-4})	F-statistics[a]
		$M(\hat{q})$	$I(\hat{r})$	$P(\hat{p})$			
	PA	7	3	14	11.0469	9.4142[b]	$F(21,23)=1.9465$*
MI	PB	7	3	2	11.0469	9.8538[b]	$F(2,42)=4.3729$**
	HP	7	3	2	11.0469	10.4564[b]	$F(2,42)=2.9107$**
	PA	2	0	18	1.4543	1.3129[b]	$F(34,23)=1.8550$*
MII	PB	2	0	2	1.4543	1.2850[b]	$F(2,55)=5.7426$***
	HP	2	0	19	1.4543	0.9960[b]	$F(36,21)=4.5040$***

Note: Based on equation (12).

*** Significant at the 1 per cent level.

** Significant at the 5 per cent level.

* Significant at the 10 per cent level.

[a] The F-statistics are used to test the null hypothesis that all the coefficients of the P_{t-j}'s are jointly equal to 0.

[b] min $FPE(M, I, P) <$ min $FPE(M, I)$.

true and import prices weakly and strongly cause domestic inflation.

B. *The Trivariate Case*

Proposition I: In the presence of I, the results in Table V do not support the notion that money supply causes domestic inflation. Even the weak form causality is not fulfilled because in most cases min $FPE(P, I) <$ min $FPE(P, M, I)$.

TABLE VII

THE EFFECT OF IMPORT PRICE ON DOMESTIC PRICE CONDITIONAL ON THE PRESENCE OF MONEY SUPPLY

M	P	I	Optimum Lags of $P(\hat{s})$	Optimum Lags of $M(\hat{t})$	Optimum Lags of $I(\hat{u})$	min $FPE(P,M)$ (10^{-4})	min $FPE(P,M,I)$ (10^{-4})	F-statistics[a]
	PA		5	0	3	2.1191	1.5698[b]	$F(3,48)=7.9949$***
MI	PB	I	4	0	3	1.2440	1.0546[b]	$F(3,50)=5.1259$***
	HP		3	0	2	0.5063	0.4330[b]	$F(2,53)=5.5446$***
	PA		5	1	3	2.1370	1.6045[b]	$F(3,47)=7.5275$***
MII	PB	I	4	0	3	1.2228	1.0426[b]	$F(3,50)=5.0016$***
	HP		3	0	2	0.5040	0.4297[b]	$F(2,53)=5.6424$***

Note: Based on equation (13).
*** Significant at the 1 per cent level.
[a] The F-statistics are used to test the null hypothesis that all the coefficients of the I_{t-j}'s are jointly equal to 0.
[b] min $FPE(P, M, I) <$ min (P, M).

Only in one case does money supply weakly cause prices, i.e., *MI* weakly causes *PA*. However, this causal effect seems to be minimal as the two min *FPE*'s do not differ too much and the *F*-statistics further confirm that the causality from *MI* to *PA* is not significant enough to fulfill the strong form causality criterion.

Proposition II: Table VI indicates that the effect of domestic prices on money supply in the presence of import prices does not seem to differ too much from that without the conditional presence of import prices. In all cases, min $FPE(M, I) >$ min $FPE(M, P, I)$ indicating the fulfillment of the weak form causality running from domestic prices to money supply. However, the evidence from the strong form causality is not too consistent. While the *F*-statistics for examining the causality from both *PB* and *HP* to *MI* and *MII* are significant at least at the 5 per cent level, the strong form causality running from *PA* to *MI* and *MII* is only "weakly" fulfilled because the *F*-ratios are only significant at the 10 per cent level.

Proposition III: The causal effect of import prices on domestic prices in the presence of money supply (Table VII) is consistent with that in the absence of money supply. Either in the presence of *MI* or *MII*, *I* has been found to cause *PA*, *PB*, and *HP* both weakly and strongly because min $FPE(P, M) >$ min $FPE(P, M, I)$ and all the *F*-statistics for testing all the ρ_j's $=0$ are highly significant at least at the 1 per cent level.

VI. CONCLUDING REMARKS

It has been found that regardless of whether the analysis is done with or without the conditional presence of money supply, import prices contribute to domestic inflation in Hong Kong. This further confirms that inflation in a small open economy is highly sensitive to external influence.

The causal effect of money supply on domestic inflation seems to be extremely weak or practically nonexistent. The strong form causality was never fulfilled in any case and the weak form causality was "weakly" fulfilled in only one case. However, there is strong and consistent evidence showing that money supply is led by domestic price movement. In other words, money supply accommodates domestic inflation. It is not surprising that this accommodation phenomenon can happen because there is no institution that controls the money supply effectively in Hong Kong. However, the existence of a monetary authority does not guarantee the adoption of non-accommodation policy. The United States serves as a good example. Cagan [4] found that most of the increase in prices in the United States during 1973–74 was eventually accommodated. After studying the case of Germany, Austria, Hungary, Soviet Union, Greece, and Poland, Sargent and Wallace also concluded that "...the monetary authorities seemed to make money creation respond directly and systematically to inflation" [28, p. 350]. In order to mitigate the effect of imported inflation, a non-accommodation policy is important. However, the adoption of such a policy may involve tremendous institutional and governmental policy changes such as developing a central bank and imposing foreign exchange control. The consideration of such changes are surely outside the scope of this study and should be left as a topic for subsequent researches.

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