Effects of U.S. Inflation on Hong Kong and Singapore

Yin-Wong Cheung
University of California, Santa Cruz
Hong Kong Institute for Moneary Research

and

Jude Yuen
Economics Department
University of California, Santa Cruz, CA 95064

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Abstract

Standard economic models predict that the choice of an exchange rate regime has important implications for the interdependency of national monetary policies, which is sometimes measured by the degree of inflation transmission across borders. In this paper, we examine how inflation rates in two small open economies, namely Hong Kong and Singapore, interact with that in the U.S. It is found that the price levels in these three economies are cointegrated. Thus, a vector error correction model is used to study the inflation dynamics. It is found that Hong Kong and Singapore inflation rates, but not the U.S. one, respond to the error correction term. Compared with Singapore, the Hong Kong inflation rate is more responsive to U.S. price shocks. The different responses to U.S. price shocks are consistent with the difference in exchange rate regimes adopted by the two economies.

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1. Introduction

The choice of an exchange rate regime has vital implications for a country's ability to conduct monetary policy. One of the advantages of the flexible rate regime, as advocated by its early proponents, is its insulation property. For instance, Friedman (1953) contends that the flexible rate regime puts an end to the inflation transmission mechanism prevailing under the fixed rate system. Exchange rate flexibility enables a country to pursue its own monetary/inflation policy and insulates it from external inflation shocks.

The empirical linkage between exchange rate choice and inflation dynamics seems ambiguous. Ghosh *et al*. (1997) find that both the level and variability of inflation are substantially lower under fixed exchange rates than under flexible exchange rates. Their results are contradictory to the conclusion of Quirk (1994), who asserts that there is not much relationship between exchange rate regime and inflation behaviour. In general, it is quite uncontroversial to state that the insulation property of the flexible rate regime is imperfect (Corden, 1985; Mussa, 1979; Salant, 1977).

It is known that a flexible rate regime does not inhibit transmission of real shocks. Even for nominal shocks, they can propagate across national boundaries through various channels (Devereux and Engel, 1998; Dornbusch, 1983; Marston, 1985). Darby *et al*. (1983) present an extensive study on international inflation propagation and transmission mechanisms. It is observed that exchange rate flexibility does offer a country an extra degree of freedom to contain inflation. In examining the data from the U.S., U.K., France, and Germany, Lastrapes and Koray (1990) report that flexible exchange rates have not completely insulated economies from external shocks. More interestingly, they found countries have different degrees of insulation and interdependence across exchange rate regimes. Winer (1986), on the other hand, claims that the flexible rate regime helps insulate Canada from nominal shocks originating in the U.S. Using the cointegration technique, Crowder (1996) finds inflation rates from the G7 countries converge during and after the Bretton Woods period. During the Bretton Woods period, U.S. inflation is found to be the main driving force of the common stochastic trend. However, there are multiple determining factors of the common stochastic trend during the flexible rate period.

While most theoretical models on inflation transmission are constructed under the small open economy assumption (Mundell, 1963; Parkin, 1979), the extant empirical studies mainly use price data from the G7 or other industrialised countries. Even though the U.S. is large relative to other industrialised countries, it is not clear if these industrialised nations meet the implicit assumption of price-takers. Another issue is that these countries, due to the presence of various implicit and explicit trade barriers, may not be characterised as "open" economies. Thus, investigating inflation dynamics under different exchange rate regimes in small open economies should add to our understanding of international inflation transmission.

To study the implications of an exchange rate choice on inflation dynamics, this paper examines the responses of Hong Kong and Singapore inflation rates to the U.S. ones. Hong Kong and Singapore are two very similar economies in the Far East region. Both economies are small and rely heavily on international trade. It is widely perceived that authorities in these two economies take a *laissez-faire* approach so that the economies enjoy a high degree of economic freedom with minimal government intervention. One major difference between these two city-economies is their exchange rate policies. Since 1983, Hong Kong has established a currency board system and virtually fixed its currency value to the U.S. dollar. On the other hand, Singapore switched to a managed float system after 1973 and officially abandoned capital controls in 1978. Thus, we believe Hong Kong and Singapore provide a good setting to study the effects of exchange rate choice on inflation transmission.

In the next section, we present some background information about Hong Kong and Singapore. Results of the preliminary data analysis are given in Section 3. Section 4 reports the results of applying several advanced time series techniques to identify the interactions between the price indices. Specifically, the use of an error correction model to study inflation transmission is justified by the Johansen test results. The generalised impulse response and forecast error variance decomposition are analysed to gain further information on the effects of U.S. inflation on these two Far East economies. In general it is found that, compared with inflation in Singapore, inflation in Hong Kong is more responsive to U.S. price shocks. The recently developed common feature and codependence tests are also used to detect the common cyclical movements between the national inflation rates. Some concluding remarks are offered in Section 5.

2. Hong Kong and Singapore: Background Information

Although there are no two identical economies in the world, Hong Kong and Singapore are arguably the two most similar ones. The two economies share a number of common characteristics. Hong Kong and Singapore are two of the most populous cities in the world and their populations are mainly ethnic Chinese. Geographically, both Hong Kong and Singapore are small cities located on the major world trading routes. In addition to their superior physical locations, both cities offer excellent transportation and port services, which make them premier *entrepôts* and trading centers. Politically, both cities were formerly British colonies. Singapore became independent in the 1960s. Hong Kong was returned to Chinese sovereignty in 1997 and has retained a high degree of economic autonomy. The British legal and civil servant structures still have considerable influences on these two economies.

In a practical sense, Hong Kong and Singapore have no natural resources. Both cities depend on imports for food and raw materials supply. Trading is an important economic activity for the two cities. For both economies, their values of trade, as measured by the sum of imports and exports, are substantially larger than their GDPs. In fact for the sample period considered, the annual average ratio of value of trade to GDP is 2.19 for Hong Kong and 2.85 for Singapore (IMF statistics). In terms of economic policy, Hong Kong and Singapore are renowned for their *laissez-faire* approach and high degree of economic freedom (O'Driscall *et al*., 2000).[1] Hong Kong imposes no capital controls, and money can move freely in and out of the territory. In 1978, Singapore removed most capital control regulations.

1 Some may argue that Hong Kong adopts a more *laissez-faire* policy than Singapore. The Hong Kong SAR government is seen to provide mainly infrastructure for business and industries. On the other hand, the Singapore government is more ready to direct economic development through tax incentives and policy measures. See Chiu *et al.* (1997) and Monetary Authority of Singapore (1989) for more information.

One major difference between Hong Kong and Singapore is their exchange rate policies. Since October 1983, Hong Kong has adopted the linked exchange rate system, which effectively is a currency board arrangement and represents an extreme form of fixed exchange rate arrangement. Officially, the exchange value of Hong Kong currency is fixed at the rate of HK$7.8 per US$1. By law, only the notes and coins in circulation are fully backed by the U.S. dollar reserves held by the Exchange Fund. The U.S. dollar reserves have always been larger than the money base since the beginning of the linked exchange rate system. On the other hand, Singapore has adopted the managed float system since 1973. The Singapore dollar is allowed to move within an undisclosed band, which is determined by an unspecified trade-weighted measure. See Latter (1993), Lau *et al*. (1994), and Koh (1994) for a more detailed discussion of exchange rate arrangements in Hong Kong and Singapore.

In summary, Hong Kong and Singapore are quite close to the small, open economy concept typically assumed in economic modeling. Their similarities in geographical attribute, experience as a British colony, and economic policy make Hong Kong and Singapore an ideal pair of economies to compare and contrast the effect of exchange rate arrangement on inflation transmission.

3. Preliminary Analysis

The data used in this exercise are monthly observations of Hong Kong, Singapore and U.S. consumer price indices (CPIs). The sample period is from January 1984 to June 1997. Following the usual practice, the data were de-seasonalized and expressed in logarithms. As discussed in the previous section, the two Far East economies are considered to be small open economies with similar economic characteristics but different exchange rate arrangements. The U.S. is chosen as the "large" economy in the empirical analysis given its dominant role in the global economic stage. It is noted that both Hong Kong and Singapore have close economic ties with the U.S. The value of trade with the U.S. to GDP ratios are 0.35 and 0.51, respectively, for Hong Kong and Singapore.

First, the augmented Dickey-Fuller (ADF) test is used to determine the order of integration of the CPI series. The ADF test is based on the regression equation,

$$\Delta Y_{it} = c_i + \tau_i t + \delta_i Y_{it-1} + \sum_{j=1}^{p} \alpha_{ij} \Delta Y_{it-j} + \varepsilon_{it} \qquad (1)$$

where Y_{it} is the economy *i*'s CPI (in logs) at time t for i = Hong Kong, Singapore, and U.S. Under the unit-root null hypothesis, $\delta_i = 0$. The lag parameter (*p*) is chosen so that the resulting residuals have zero serial-correlation. The ADF test results given in Table 1, indicate that the three CPI series are I(1) series. The ADF test (with the trend term) does not reject the unit root null for the CPI data themselves. However, the test (with only the intercept term) shows that the three inflation rate series (i.e., first differences of log CPIs) are stationary. Thus, in the following analysis, we assume the CPI data are I(1).

During the sample period, the average annual inflation rate in Hong Kong is 7.32%, and it has a standard deviation of 2.48%. For Singapore, the average and standard deviation of the annual inflation rate are 1.18% and 1.30%, respectively. Both the level and the variability of inflation in Hong Kong are higher than those in Singapore. The result is in contrast to the one in Ghosh *et al*. (1997), which finds inflation is higher and more variable under a flexible rate regime. As the data in the same sample period are compared, the differences in level and variability of inflation are not likely to be induced by different external shocks. In fact, the differences are likely to be the result of the monetary policy of Singapore to promote sustained and non-inflationary growth for the Singapore economy. In the next section, we conduct a detailed analysis of the inflation transmission between the U.S. and each of the two small economies.

4. Inflation Transmission

Since the CPI series are I(1), we have to determine whether a standard vector autoregressive (VAR) or a vector error correction (VEC) model should be used to study the interaction between the inflation rates. The choice depends crucially on the presence or absence of long-term comovements between the individual CPI series. To this end, we employ the Johansen procedure to test for cointegration. Besides the choice between a VAR and a VEC model, information on the long-term comovement also helps specify the appropriate model to construct impulse responses, decompose forecast error variance, and study common cyclical movement.

4.1 Cointegration Test

As the focus is on inflation transmission between large and small economies under different exchange rate regimes, we apply the Johansen procedure separately to two pairs of CPIs; namely the HK/U.S. pair (which contains Hong Kong and U.S. CPIs) and the SP/U.S. pair (which contains Singapore and U.S. CPIs). The Johansen test for cointegration is based on the sample canonical correlations between ΔY_t and Y_{t-p-1} (Johansen and Juselius, 1990), where *p* is a lag parameter, $Y_t = (Y_{it})'$ is a 2x1 vector containing U.S. and Hong Kong (or U.S. and Singapore) CPI series. To implement the test, two least squares regressions

$$\Delta Y_t = C_1 + \sum_{i=1}^{p} \gamma_{1i} \Delta Y_{t-i} + \varepsilon_{1t} \tag{2}$$

and

$$Y_{t-p-1} = C_2 + \sum_{i=1}^{p} \gamma_{2i} \Delta Y_{t-i} + \varepsilon_{2t} \tag{3}$$

are performed, where C_i is a constant vector and the lag parameter, *p*, is chosen to eliminate serial correlation in the residuals. The sample canonical correlations between ΔY_t and Y_{t-p-1}, adjusting for all intervening lags, are given by the eigenvalues, $\lambda_1 > \lambda_2$, of $\Omega_{21}\Omega_{11}^{-1}\Omega_{12}$ with respect to Ω_{22} where $\Omega_{ij} = T^{-1}\sum_t \hat{\varepsilon}_{it}\hat{\varepsilon}'_{jt}$, i, j = 1,2. The trace and the maximum eigenvalue statistics are, respectively, given by

$$t_r = -T \sum_{j=r+1}^{2} \ln(1-\lambda_j), \tag{4}$$

and

$$t_{r|r+1} = -T \ln(1-\lambda_{r+1}), \qquad 0 \le r \le 1. \tag{5}$$

The former statistic tests the hypothesis that there are at most r cointegrating vectors and the latter one tests the hypothesis of r against the alternative hypothesis of $r+1$ cointegrating vectors. The eigenvectors v_1 and v_2 are sample estimates of the cointegration vectors.

The cointegration test results are reported in Table 2. Both the trace and the maximum eigenvalue statistics show that there is one cointegration relationship in each of the two pairs of national CPI series.

The null hypothesis of no cointegration relation is rejected at the 5% level of significance in both cases. And the null hypothesis of at least one cointegration relation is not rejected. Thus, the CPI series in each country pair are linked together in the long run. Individually, they tend to drift around without an anchor as indicated by their I(1) properties. However, the CPI series are cointegrated and they have synchronized long-term movements.

The estimated cointegrating vector of the HK/U.S. system is (1, -2.37) with the coefficient of the Hong Kong series normalized to one. Both elements of the cointegrating vector are statistically different from zero.[2] For the SP/U.S. country pair, the normalized cointegrating vector is (1, -0.74) and, again, the elements are statistically significant.[3] According to the cointegrating vectors, a unit change in the U.S. CPI induces a more (less) than proportional change in the Hong Kong (Singapore) CPI series in the long run. Thus, the fixed exchange rate arrangement adopted by Hong Kong seems to be associated with a stronger response to foreign inflation.

4.2 VEC Model

The cointegration result suggests that a VEC, instead of a VAR, model is the appropriate specification to study the interactions within each pair of inflation series. The VEC model is given as

$$\Delta Y_t = \mu + \sum_{i=1}^{p} \Gamma_i \Delta Y_{t-i} + \alpha Z_{t-p-1} + \varepsilon_t \, , \qquad (6)$$

where $Z_{t\text{-}p\text{-}1}$ is the error correction term given by $\beta' Y_{t\text{-}p\text{-}1}$ and β is the cointegrating vector. μ is a vector of constants. The responses of inflation to short-term price movements are captured by the Γ_i coefficient matrices. The α coefficient vector reveals the speed of adjustment to the error correction term, which measures the deviation from the long-run relationship between the CPI series.

The VEC estimates of the HK/U.S. system are presented in the upper panel of Table 3. The error correction term has different effects on Hong Kong and U.S. inflation rates. While inflation in Hong Kong responds to deviations from the long-run relationship, inflation in the U.S. does not adjust to such deviations. In the short run, Hong Kong inflation is affected by both its own and the U.S. lagged inflation rates. Specifically, the U.S. inflation has a delayed positive impact on Hong Kong inflation. On the other hand, the U.S. inflation is only affected by its own lagged values. Thus, inflation in the U.S. causes inflation in Hong Kong but not *vice versa*. The findings are consistent with the conventional wisdom that inflation transmission under a fixed exchange rate system is mainly unidirectional and runs from large to small economies.

Even though Singapore does not maintain a fixed exchange rate relationship with the U.S., its inflation is significantly influenced by both $Z_{t\text{-}p\text{-}1}$ and lagged U.S. inflation (lower panel of Table 3). The U.S. inflation is only affected by its own lagged values. Again, unidirectional inflation transmission from the

2 The $\chi^2(1)$ statistics for testing each element is zero are 27.28 and 30.68, which are significant at the 5% level.

3 The $\chi^2(1)$ statistics for testing each element is zero are 12.34 and 19.77, which are significant at the 5% level.

large to the small economy is observed. Comparing the coefficient estimates, the error correction term and the lagged U.S. inflation seem to have a stronger effect on Hong Kong inflation, though the lagged U.S. inflation has a more immediate impact on Singapore inflation. Thus, exchange rate flexibility does not completely insulate Singapore from external shocks, but it may dampen their effects.

4.3 Impulse Response and Forecast Error Variance Decomposition Analyses

In this subsection we employ the generalised impulse response and forecast error variance decomposition techniques (Pesaran and Shin, 1998) to examine the effects of a U.S. price shock on Hong Kong and Singapore CPIs. Unlike the traditional approach based on Cholesky decomposition and orthogonalised shocks, the Pesaran-Shin approach yields unique impulse response functions and forecast error variance decomposition that are invariant to the ordering of variables. Only in the limiting case of a diagonal error variance matrix do the traditional and the generalised approaches coincide.
Suppose Y_t has a VAR representation:

$$Y_t = C + \sum_i^p \Phi_i Y_{t-i} + \varepsilon_t \tag{7}$$

where C is a vector of constant and ε_t is a vector of innovation with $E(\varepsilon_t) = 0$ and $E(\varepsilon_t \varepsilon_t') = \Sigma = (\sigma_{ij})$. The generalised impulse response of Y_{t+n} with respect to a unit shock to the *j*-th variable at time *t* is given by

$$\frac{B_n \Sigma e_j}{\sigma_{jj}}, \qquad n = 0, 1, 2, \dots \tag{8}$$

where $B_n = \Phi_1 B_{n-1} + \Phi_2 B_{n-2} + \dots\dots + \Phi_p B_{n-p}$, n = 1, 2,......, $B_o = I$, and $B_n = 0$ for $n < 0$. e_j is a selection vector with unity as its *j*-th element and zeros elsewhere. The portion of variable *i*'s *n*-th periods ahead forecast error variance, which is contributed by innovations in the *j*-th variable can be computed as

$$\frac{\sigma_{ij}^{-1} \sum_{l=0}^{n} (e_i' B_l \Sigma e_j)^2}{\sum_{l=0}^{n} e_i' B_l \Sigma B_l' e_i} \qquad i, j = 1,2. \tag{9}$$

It is shown that (8) and (9) are valid for a system of cointegrated variables. See Pesaran and Shin (1998) for a more detailed discussion.

The generalised impulse response functions of Hong Kong CPI with respect to the price shocks in Hong Kong and U.S. are depicted in Figure 1. The U.S. price shock has a sizable and sustained impact on Hong Kong CPI. Its effect steadily increases over time and stays at a relatively high level. The pattern is in contrast to the effect of a Hong Kong price shock, which appears to decline over time. It is evident that the price in Hong Kong has a stronger response to price shocks emanating from the U.S. than those from the domestic economy.

Similarly, Figure 2 shows that price shocks from the U.S. exert a more powerful influence on Singapore CPI than shocks from Singapore itself. The impulse responses are increasing with respect to the U.S.

shock and decreasing to the Singapore shock. The overall response profiles in Figures 1 and 2 are quite similar. Both indicate a stronger foreign price influence over a domestic one. However, in terms of the relative magnitude, the U.S. effect is much smaller in the case of Singapore.

The results of the generalised forecast error variance decomposition are graphed in Figures 3 and 4. While the impulse responses trace the effect of a shock over time, the forecast error variance decomposition analysis assesses the relative contributions of domestic and foreign price shocks to the price uncertainties in Hong Kong and Singapore. For both Far East economies, the proportion of domestic price uncertainty explained by the U.S. shock is increasing with the forecasting horizon. At the three and a half years horizon, the U.S. shock accounts for about one half of the Hong Kong CPI uncertainty. However, the contribution of the U.S. price shock grows to more than 80% as the horizon increases. For Singapore, it takes a longer forecasting horizon (six years plus) for the U.S. shock to contribute to one half of its price uncertainty. Apparently, the proportion of Singapore price uncertainty attributable to U.S. price shocks levels off at the 70% mark.

Similar to the cointegration and VEC model results, both the generalised impulse response and forecast error variance decomposition analyses confirm the U.S. influences on Hong Kong and Singapore. Despite the fact that the two Far East open economies have different exchange rate arrangements, the price dynamics in both economies are affected by external price shocks. Exchange rate flexibility does not fully insulate Singapore from external forces. However, the U.S. price shock seems to have a stronger impact on Hong Kong, rather than on Singapore, CPI data.

4.4 Common Cyclical Movement

In this subsection we explore whether the inflation series within each of the HK/U.S. and the SP/U.S. pairs share some common cyclical movement. The cointegration analysis reported in the previous subsection describes the comovement of the nonstationary components but not the short-term variation. Engle and Kozicki (1993) propose the common feature test to detect the presence of common stochastic elements in a system. Suppose the elements of ΔY_t share common temporal dynamics. Then, in the process of forming an appropriate linear combination of ΔY_{it}'s (the elements of ΔY_t), we can eliminate the effect of the common component. Thus, the presence of a common cycle, which is routinely measured by serial correlation, implies the existence of a linear combination of ΔY_{it}'s that is not correlated with the past information set. Vahid and Engle (1993) devise a procedure to test for common serial correlation cycles in the presence of cointegration.

The Vahid-Engle procedure amounts to finding the sample canonical correlations between ΔY_t and W = ($\Delta Y'_{t-1}$, $\Delta Y'_{t-2}$,..., $\Delta Y'_{t-p}$, Z_{t-1}), where the error correction term Z_{t-1} is included to control for the cointegration effect on the test for common features. The test statistic for the null that the number of co-feature vectors is at least *s* is

$$C(p,s) = -(T-p-1)\sum_{j=1}^{s}\log(1-\lambda_j) \quad (10)$$

where λ_j is the *j*-th smallest squared canonical correlation coefficient between ΔY_t and W, T is the sample size, and p is the lag parameter. Under the null hypothesis, $C(p,s)$ has an asymptotic χ^2 distribution with degrees of freedom with $s^2 + snp + sr - sn$ degrees of freedom with n number of variables in the system, r is the number of cointegrating vector included in W, and p is the lag parameter.

The common feature test results are reported in Table 4. The lag parameters identified for the VEC models are used to compute the statistics. For the HK/U.S. system, the statistics for both $s = 1$ and $s = 2$ are significant at the 5% level, indicating that the Hong Kong and U.S. inflation rates do not have common cyclical movements. On the other hand, there is evidence that Singapore and U.S. inflation rates share a common cycle. That is, prices in Singapore and U.S. have both common and synchronised long-term and short-term components. For Hong Kong and U.S. prices, they only share a common long-term component.

The common feature test results seem puzzling. The value of the Hong Kong dollar, and not the Singapore dollar, is pegged to the U.S. dollar. However, it is Singapore and the U.S. that share a common inflation cycle. The estimation results in Table 3 offer a hint. As Hong Kong inflation reacts to U.S. inflation with a lag, the two economies may not respond to the same shocks simultaneously. Thus the concept of common features, which implicitly assumes individual series simultaneously respond to common shocks, may not be relevant for the HK/U.S. system.

To allow for the possibility that individual series have different initial responses before they move in synchronisation some periods later, Vahid and Engle (1997) develop the codependence test. While a common feature requires the variables of a system to have colinear impulse responses, codependence allows different initial responses but requires the variables to share a common response pattern after the initial stage. To test the null hypothesis that there exists at least *s* codependence vectors after the *k*-th period, we use the statistic (Vahid and Engle, 1997)

$$C(k,p,s) = -(T-p-k)\sum_{j=1}^{s} \log(1-\hat{\lambda}_j(k)/d_j(k)) \qquad (11)$$

where $\hat{\lambda}_j(k)$ is the *j*-th smallest squared canonical correlation coefficient between ΔY_t and $W(k) \equiv (\Delta Y'_{t-k-1},...,\Delta Y'_{t-k-p-1},Z_{t-1})$, and $d_j(k)$ is given by

$$d_j(k) = 1, \qquad \text{for } k = 0,$$

and

$$d_j(k) = 1 + 2\sum_{v=1}^{k} \hat{\rho}_v(\hat{\alpha}\Delta Y_t)\hat{\rho}_v(\hat{\gamma}W(k)), \qquad \text{for } k>0,$$

with $\hat{\rho}_v(q_t)$ is the sample *v*-th lag autocorrelation of q_t, and $\hat{\alpha}$ and $\hat{\gamma}$ are the canonical variates corresponding to $\hat{\lambda}_j(k)$. The statistic has an asymptotic χ^2 distribution with $s^2 + snp + sr - sn$ degrees of freedom under the null hypothesis.

Since a common feature is a special case of codependence, the presence of the former implies the latter. Thus, the codependence test is only applied to the HK/U.S. system and the result is reported in Table 5. With $k = 1$, there is strong evidence of one codependence vector. That is, aside from the reaction in the first month, there is a common cycle among the Hong Kong and U.S. inflation rates. In other words, the two economies share common and non-synchronized inflation cycles.

5. Concluding Remarks

In this paper we use several statistical techniques to investigate the interactions of price and inflation rates in Hong Kong, Singapore, and the U.S.. The U.S. is taken as the large world economy and the other two are interpreted as small open economies operating under different exchange rate regimes. The cointegration analysis shows that the CPIs in the three economies are moving together in the long run. However, as indicated by the results from the VEC model, inflation in a small economy is caused by the large economy. Further, it is the inflation in a small country (and not the large one) that adjusts to deviations from the cointegration relationship between the CPIs.

The generalised impulse response and forecast error variance decomposition analyses offer some similar inferences on the dominating role of U.S. price shocks on these two Far East economies. For instance, the U.S. price shock exhibits amplified long-term effects on both Hong Kong and Singapore CPIs. It also accounts for a substantial amount (70% or higher) of price uncertainty in the other two economies. It is also found that Hong Kong (Singapore) and the U.S. have non-synchronized (synchronized) inflation cycles.

In general, U.S. inflation affects inflation in both Hong Kong and Singapore even though U.S. inflation exerts a stronger influence on Hong Kong than Singapore. The result on Hong Kong is consistent with the standard prediction that, under a fixed exchange rate arrangement, inflation in a small open economy is subject to significant influences of the large economy. The Singapore result is a bit intriguing. Apparently, the difference in exchange rate policy pursued by the two small open economies has no significant implication for the qualitative result on inflation transmission. Exchange rate flexibility does not completely insulate Singapore from the U.S. price shock.

However, the evidence is not necessarily contradictory to the insulation argument. For instance, it is known that flexible rates do not protect the economy from external real shocks. Besides the nature of the shock, the inflation transmission mechanism is also determined by policies pursued by the authorities. For instance, it is the policy of the Monetary Authority of Singapore to manage the Singapore dollar exchange rate to maintain export competitiveness and to curb imported inflation. As the evidence suggests that inflation in Singapore, compared to that in Hong Kong, is less responsive to the U.S. price movement, exchange rate flexibility appears to absorb some of the impact of foreign price shocks.

Overall, the empirical results indicate that, under both fixed and flexible exchange rate arrangements, a large economy has intense influences on a small open economy. The evidence also points to the possibility that exchange rate flexibility may allow a small open economy to alleviate the impact of foreign price shocks.

Our exercise mainly focuses on price data. Even though Hong Kong and Singapore are similar in many aspects, they still have differences in economic and institutional factors. These differences can induce inflation transmission mechanisms not captured by the design of the current study. For instance, Marston (1985) points out that inflation can propagate across borders through various paths including the price, output, and interest rate channels. A useful future research exercise would be to conduct a more detailed analysis on the roles of macroeconomic variables such as output growth, money growth, and openness on the inflation determination and transmission mechanism.

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Table 1. Augmented Dickey-Fuller Test Results

	Levels		First Differences	
	# of lags	test statistics	# of lags	test statistics
HK CPI	5	-2.51	4	-2.91**
SG CPI	6	-2.63	5	-3.04**
U.S. CPI	7	-1.00	6	-2.71*

Note: Significance at the 5% (10%) level is indicated by ** (*). See the text for a description of the tests.

Table 2. Cointegration Test Results

	HK/U.S.		SP/U.S.	
H(0)	M. statistic	Trace statistic	M. statistic	Trace statistic
r=1	4.09	4.09	6.72	6.72
r=0	40.30*	44.39*	37.09*	43.82*

Note: Significance at the 5% level is indicated by *. The maximum eigenvalue statistics are given under "M. statistic". The trace statistics are given under "Trace statistic". For the HK/U.S. system, the lag parameter is 2 and the cointegrating vector is (1, -2.37) with the HK coefficient normalized to 1. For the SP/U.S. system, the lag parameter is 1 and the cointegrating vector is (0, -0.74) with the SP coefficient normalized to 1.

Table 3. Estimates of the VEC Models

a. HK/U.S.

	c	Z_{t-3}	$\Delta HKCPI_{t-1}$	$\Delta USCPI_{t-1}$	$\Delta HKCPI_{t-2}$	$\Delta USCPI_{t-2}$
$\Delta HKCPI$	-0.3371**	-0.0545**	-0.2917**	-0.0054	-0.1405*	0.4672**
	(-6.5522)	(-6.6277)	(-3.6222)	(-0.0279)	(-1.7294)	(2.3960)
$\bar{R}^2$ =0.253	Q(1) = 0.001 (0.970)		Q(5) = 1.809 (0.875)		Q(10) = 4.741 (0.908)	
$\Delta USCPI$	-0.3267	-0.0007	0.0132	0.4949**	0.0026	-0.0169
	(-0.1513)	(-0.2126)	(0.3913)	(6.0535)	(0.0773)	(-0.2068)
$\bar{R}^2$ =0.217	Q(1) = 0.008 (0.977)		Q(5) = 2.851 (0.723)		Q(10) = 15.775 (0.106)	

b. SP/U.S.

	c	Z_{t-2}	$\Delta SPCPI_{t-1}$	$\Delta USCPI_{t-1}$
$\Delta SPCPI$	0.0489**	-0.0400**	-0.3018**	0.4321**
	(6.3900)	(-6.3386)	(-4.2285)	(3.5589)
$\bar{R}^2$ =0.242	Q(1) = 0.664 (0.415)	Q(5) = 3.729 (0.589)	Q(10) = 6.473 (0.774)	
$\Delta USCPI$	-0.0047	-0.0027	-0.0562	0.5276**
	(-0.9990)	(-0.7052)	(-1.2852)	(7.2891)
$\bar{R}^2$ =0.245	Q(1) = 0.007 (0.933)	Q(5) = 2.637 (0.756)	Q(10) = 15.080 (0.129)	

Note: Significance at the 5% (10%) level is indicated by ** (*). *t*-statistics are given in parentheses below the parameter estimates. $\bar{R}^2$ is the adjusted R-square. Q(*p*) is the Q-statistic calculated from the first *p* autocorrelations with the associated *p*-value given in the parentheses next to it.

Table 4. Common Feature Test Results

Null Hypothesis	Squared Canonical Correlation	Statistic $C(p, s)$	Degress of Freedom
a. HK/U.S.			
s=1	0.1074	17.7215*	4
s=2	0.8527	316.5295*	10
b. SP/U.S.			
s=1	0.0189	1.3135	2
s=2	0.8019	253.9499*	6

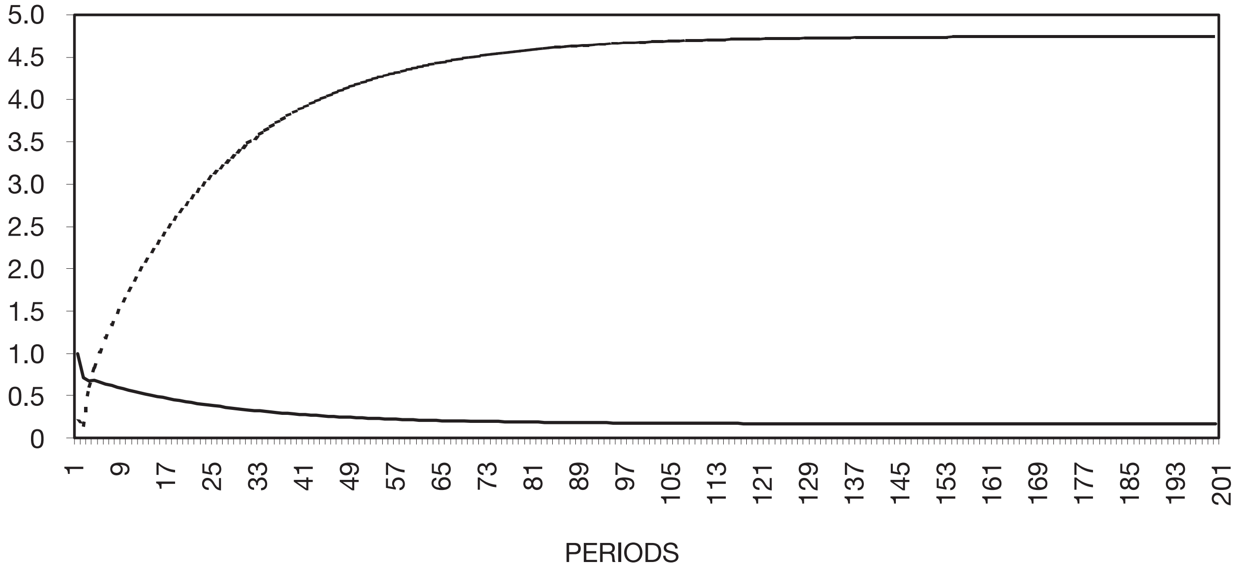
Note: * indicates significance at the 5% level. s gives the number of common features. Under the null hypothesis, the statistic $C(p, s)$ has an asymptotic χ^2 distribution with $s^2 + snp + sr - sn$ degrees of freedom, where in this exercise n=2 and r=1. For the HK/U.S. case, p=2 and for the SP/U.S. case, p=1.

Table 5. Codependence Test Results; HK/U.S.

Null Hypothesis	Squared Canonical Correlation	Statistic $C(k, p, s)$	Degress of Freedom
s=1	0.0393	4.8894	4
s=2	0.8491	115.5480*	10

Note: * indicates significance at the 5% level. s gives the number of codependence vectors. Under the null hypothesis, the statistic $C(k, p, s)$ has an asymptotic χ^2 distribution with $s^2 + snp + sr - sn$ degrees of freedom, where in this exercise n=2, p=2, and r=1.

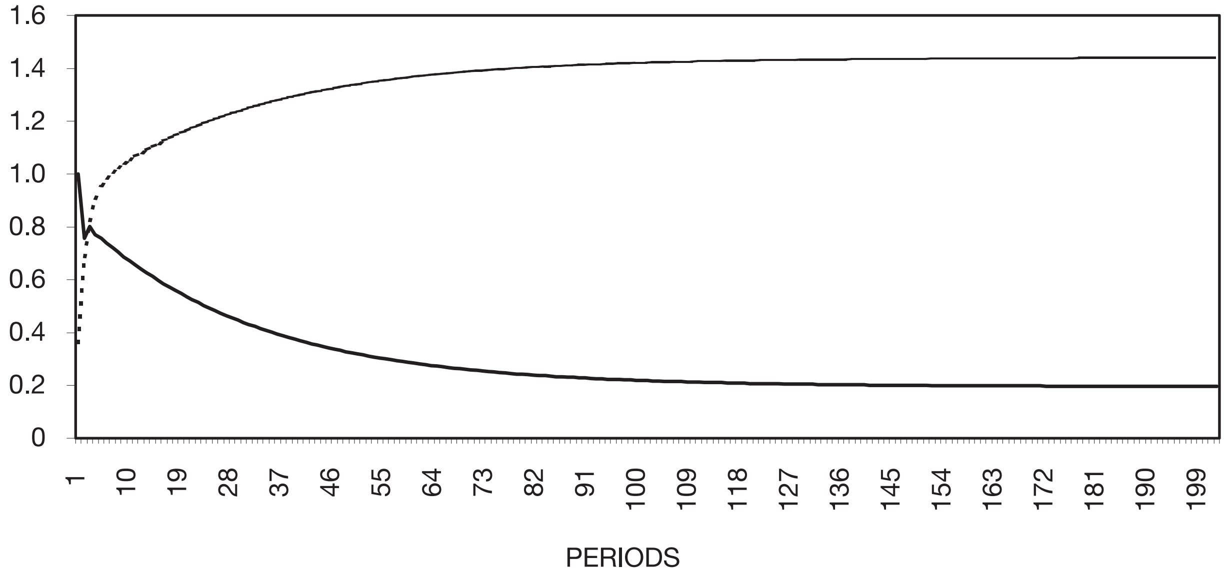
Figure 1. Generalised Impulse Response Functions: HK CPI



—— : the generalised impulse response of Hong Kong CPI to a one-standard-deviation Hong Kong price shock.

------ : the generalised impulse response of Hong Kong CPI to a one-standard-deviation U.S. price shock.

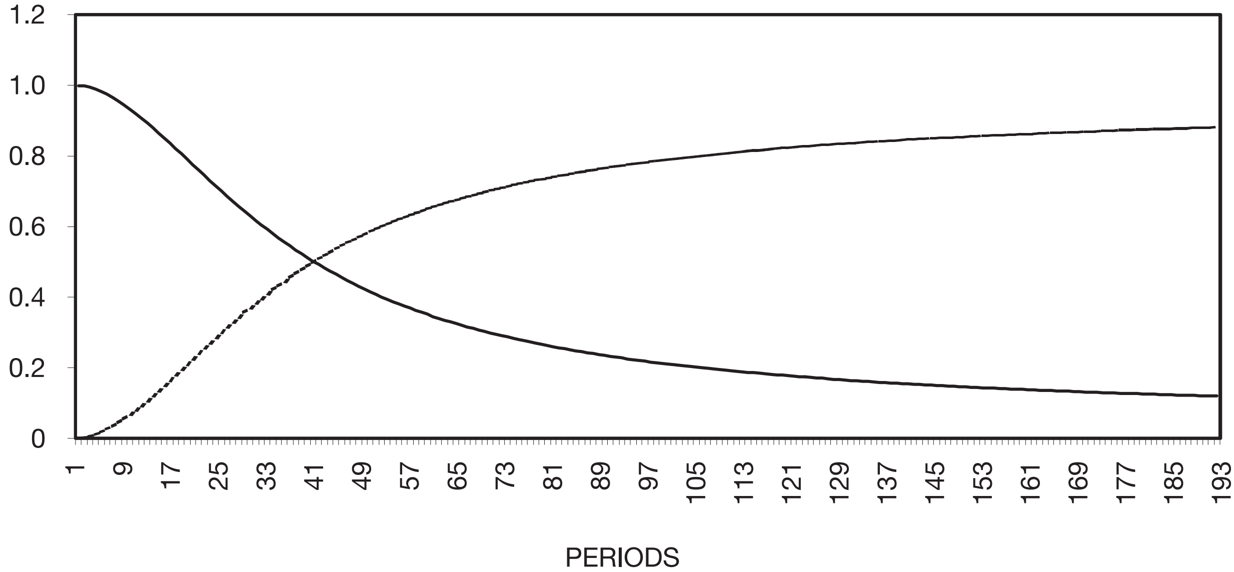
Figure 2. Generalised Impulse Response Functions: SP CPI



—— : the generalised impulsed response of Singapore CPI to a one-standard-deviation Singapore price shock.

------ : the generalised impulse response of Singapore CPI to a one-standard-deviation U.S. price shock.

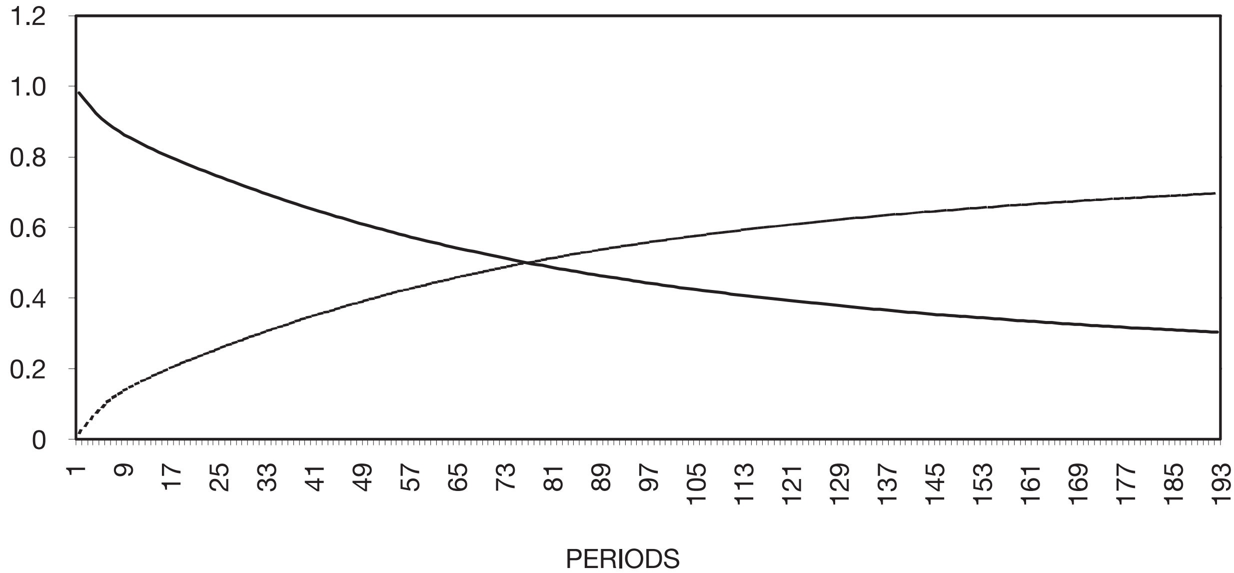
Figure 3. Generalised Forecast Error Variance Decomposition: HK CPI



——— : the portion of Hong Kong CPI forecast error variance explained by Hong Kong price shocks.

------ : the portion of Hong Kong CPI forecast error variance explained by U.S. price shocks.

Figure 4. Generalised Forecast Error Variance Decomposition: SP CPI



——— : the portion of Singapore CPI forecast error variance explained by Singapore price shocks.

------ : the portion of Singapore CPI forecast error variance explained by U.S. price shocks.