Monetary Policy Regimes and Macroeconomic Outcomes: Hong Kong and Singapore

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Abstract

This paper studies the relationship between macroeconomic behaviour and the monetary policy regime in Hong Kong and Singapore, using data for 1984-2004. We estimate an econometric model, comprising a Phillips, an IS curve and an equation for changes in the nominal effective exchange rate (NEER), which, for the MAS, can be interpreted as a policy reaction function. The parameter estimates differ in two regards: the NEER responds to inflation in Singapore but not in Hong Kong, and the autoregressive parameter for the output gap in Singapore is smaller than in Hong Kong. Overall, inflation has been better controlled in Singapore, but real activity has been surprisingly similar.

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1. Introduction

The Hong Kong Monetary Authority (HKMA) and the Monetary Authority of Singapore (MAS) have been strikingly successful in delivering on their monetary policy objectives. Following the introduction of a currency board in October 1983, the Hong Kong dollar (HKD) has been rigidly linked to the USD at the rate of 7.8 HKD/USD. While admittedly there are other episodes in which central banks have managed to maintain a fixed exchange rate for more than 20 years, this performance is remarkable given the openness of the Hong Kong economy, the absence of any restrictions on capital flows and the fact that Asia experienced in this period several large economic shocks that were associated with episodes of intense speculative pressures on the HKD. Notably, these shocks included the Asian financial crisis, which led to broadly-based reconsideration of exchange rate policies elsewhere in Asia.

Similarly, following the shift in 1981 to a monetary policy framework centred on the management of the Singapore Dollar (SGD) against a basket of currencies, with the objective *"to promote price stability as a sound basis for sustainable economic growth"*, inflation in Singapore has averaged 1.7%.[1] Furthermore and in contrast to many, if not most, other economies, inflation in Singapore has been strongly mean-reverting, indicating that policy makers' efforts to guide inflation back to the desired rate after shocks have been successful. This record is impressive as the Singapore economy has experienced much the same shocks as Hong Kong and because of the fact that it is also extremely open.

However, even though monetary policy makers in both economies have enviable records in delivering on their objectives, macroeconomic outcomes have differed and have at times been adverse. Since the HKMA has sought to stabilise the exchange rate while the MAS has geared policy directly to inflation, it is no surprise that inflation has been more variable in Hong Kong. Turning to cyclical movements on the real side of the economy, however, the differences appear smaller. For instance, the volatility of real GDP growth

[1] See MAS (2001, p. 2). Inflation is here defined as the four-quarter rate of change of consumer prices.

is similar in the two economies.[2] Moreover, both economies have experienced adverse outcomes in periods of large contractionary external shocks. Thus, real GDP growth collapsed during the Asian financial crisis in 1997-98, following the US recession in 2001-2 and during the episode of Severe Acute Respiratory Syndrome (SARS) in 2003.

The observation that monetary policy strategies and nominal outcomes differ but that real developments, at least at business cycle frequencies, have been broadly similar raises a number of issues regarding the functioning of the Hong Kong and Singaporean economies and what the MAS's reaction function looks like. How sensitive are inflation and output to economic disturbances? How do changes in external demand and exchange rates impact on the economy? How has the MAS moved the exchange rate in response to the economy? Have the MAS's policy reactions tended to reduce the impact of shocks, sped up the economy's adjustment to them, or both?

This paper addresses these questions. It is structured as follows. Section 2 provides an overview of the structure of the Hong Kong and Singapore economies. We argue that while there are some differences, those are not necessarily likely to imply dissimilar responses of the economies to shocks. Next, we study macroeconomic outcomes since the early 1980s. We find that, not surprisingly, the difference in the monetary policy regimes has been associated with different behaviour of nominal variables. In particular, Hong Kong has had higher and more variable inflation than Singapore. By contrast, the behaviour of real variables appears to have been quite similar, although with the notable exception that unemployment in Singapore has responded less to contractionary shocks, and has been declining much more rapidly in the aftermath of them.

However, it is difficult to determine to what extent business cycles in the two economies differ using time series plots. In Section 3 we therefore go on to estimate a small econometric model for each economy. The model consists of a standard, backward-looking Phillips curve and an IS curve. We also estimate a function for changes in the nominal effective exchange rate (NEER), which many authors have used to describe and analyse the interest rate reactions of the MAS.

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[2] One difference is that Singapore has experienced somewhat higher trend growth of real GDP than Hong Kong. While that may well reflect other factors than monetary policy, we note that it is compatible with the notion that low and stable inflation promotes growth.

We first compare the parameter estimates for the two economies and argue that these are strikingly similar, with two exceptions. First, we find that the NEER appreciates strongly in response to inflation in Singapore but not in Hong Kong. This supports the notion that the equation for the change in the NEER can be interpreted as capturing the MAS's policy reactions. However, this interpretation is challenged by the surprising finding that in both Singapore and Hong Kong, the NEER appreciates in response to positive output gaps.[3] Second, and more technically, we find that the autoregressive parameter for the output gap is larger in Singapore than in Hong Kong.

The fact that the parameter estimates are so similar raises again the issue whether the responses of real economic activity to shocks have been so different in the two economies, and whether the observed differences in macroeconomic outcomes could have arisen because of differences in the shocks the two economies have been subject to. Since the dynamic behaviour of the economy depends on all equations, in Section 4 we perform simulations to explore how the models respond to economic disturbances. In brief, the main conclusion we draw from these simulations is that while the two economies respond is similar ways to shocks, the MAS's policy reactions have facilitated the adjustment of the Singaporean economy to disturbances and have prevented these from having persistent effects on the inflation rate.

Finally, Section 5 concludes.

2. The economies of Hong Kong and Singapore

2.1 Economic structure

As a first step, it is useful to review briefly the main features of the Hong Kong and Singapore economies. The data in Table 1 show that the economies are strikingly similar in important ways: they are extremely small, highly open to international trade and very advanced. However, there are differences that may be germane when discussing macroeconomic fluctuations in the two economies.

[3] For this reason, the equation for the change in the NEER is most likely a convolution of a reduced form and a reaction function.

--- Insert Table 1: Overview statistics ---

First, manufacturing is more important in Singapore than in Hong Kong. This largely reflects the fact that much of the manufacturing industry in Hong Kong has moved to the surrounding Pearl River delta as a consequence of the ever growing economic integration with Guangdong province. Since that integration has been associated with tighter links between economic cycles of the neighbouring economies, it is unlikely that this process has significantly dampened the sensitivity of the Hong Kong economy to manufacturing cycles. Furthermore, the sample used in the empirical analysis below starts in 1983 when light industry was still important for the Hong Kong economy. Thus, this difference in structure should not be overemphasised.

Second and as suggested by the gravity theory of international trade, both economies trade intensely with their immediate neighbour, Mainland China and Malaysia, respectively. Since changes in demand in one economy are transmitted through the international trading system quite rapidly, this distinction may also be less significant than it would first appear, in particular since both Hong Kong and Singapore trade intensely with a number of other economies, including the US and Japan. However, it suggests that the two economies could experience somewhat different economic disturbances.

Indeed, the close proximity of Hong Kong to Mainland China is important because it played a critical role when Hong Kong abandoned the floating exchange rate regime in 1983. The currency board was introduced against a backdrop of high and variable inflation in the 1970s and in response to the sharp depreciation of the HKD in the early 1980s. Thus, between June 1982 and June 1983, the currency fell from 5.9 per USD to 7.2 because of weak economic fundamentals.[4] The exchange rate continued to depreciate during the summer of 1983 largely due to concerns arising from Mainland China's announcement that it intended to regain sovereignty over Hong Kong in 1997. After falling by 10% in a single day's trading to 9.6 HKD/USD in late September, the currency board was introduced in the middle of October when the (at that time) two note-issuing

[4] See Jao (1990) or Gerlach (2005).

banks were required to back the note issue by depositing an equivalent amount in US dollars, using a conversion rate of 7.8 HKD/USD, with the Exchange Fund.[5]

2.2 Macroeconomic fluctuations

Next we provide a short overview of macroeconomic developments in the two economies using, where available, quarterly data for the period 1983:1 to 2005:3.[6] Table 2 and Figure 1 show that the CPI inflation rate in Hong Kong was on average higher than that of Singapore. Furthermore, the swings in inflation in Hong Kong were generally much larger than in Singapore. Most notably, while Singapore experienced three quarters of deflation around the time of the Asian financial crisis, Hong Kong underwent 23 quarters of deflation. Of course, the differences in the behaviour of inflation are a direct consequence of the choice of monetary policy framework. Thus, the greater stability of inflation in Singapore reflects the fact that the MAS lets the nominal exchange rate respond to movements of inflation away from the desired level, which ensures that shocks to inflation are temporary. By contrast, in Hong Kong policy is completely determined by the need to ensure stability of the nominal exchange rate against the US dollar, implying that there are no policy responses to inflation. As a consequence, movements in inflation are larger and more protracted in Hong Kong than in Singapore.

--- Insert Table 2: Key macro variables ---

--- Insert Figure 1: Inflation rates ---

[5] To understand why a fixed exchange rate was attractive in the environment of policy uncertainty at that time, suppose that the economy is in equilibrium and that the exchange rate depreciates because of political developments. Since this will stimulate the economy and raise inflation pressures, fixing the exchange rate is desirable. A currency board system, in which the domestic money supply (the "aggregate balance" in the case of Hong Kong) is fully backed by foreign exchange, may be an appropriate system to deal with such confidence crises. Note that, by contrast, if most shocks affecting the exchange rate come from real side developments it will desirable to let the exchange rate function as a shock absorber.

[6] The GDP deflator, the consumer price index, real GDP, the unemployment rate for Hong Kong and Singapore, as well as the short-term Hong Kong interest rate are from the BIS database. The long-term interest rate for both economies and the real and NEERs for Hong Kong are from the HKMA database. The Singaporean nominal and REERs and short-term interest rate are from the IFS database, while US CPI inflation, the federal funds rate and US import demand are from the FRED database. All series are seasonally adjusted.

In Figure 2 we plot output gaps, constructed using the Hodrick-Prescott filter (with the smoothing parameter set equal to 1600), and unemployment rates for the two economies.

--- Figure 2: Output gaps and unemployment ---

The graph shows that the output gaps are moving closely together after 1997, no doubt because the two economies were exposed to common shocks in the form of the Asian financial crisis in 1997-98, the US slowdown in 2001 and SARS in 2003. Both also experienced large negative output gaps around 1985. Surprisingly, however, neither economy shows a large, persistent output gap after the Asian Financial Crisis, despite the collapse in property prices. One possible explanation for this may be that the effects on output were so protracted that the Hodrick-Prescott filter attributes them to a decline in the growth rate of potential.

The unemployment rates provide further information about business cycle fluctuations in the two economies. While unemployment was roughly the same in 1997, it rose more sharply, and was slower to decline toward the original level, in Hong Kong than in Singapore following the contractionary shocks of 1997, 2001 and 2003. Overall, these results are compatible with the notion that, on the whole, external shocks had less persistent effects on the Singaporean economy. In the econometric analysis below we provide a more formal analysis of the stabilising effects of monetary policy in Singapore.

In Figure 3 we plot short- and long-term interest rates in the two economies. Of course, because of the currency board, short-term rates in Hong Kong are largely determined by USD interest rates, except during periods of speculative pressures when rates rise to compensate for the perceived exchange rate risk. By contrast, the active monetary policy strategy used by the MAS and the resulting lower inflation rate have led short and long interest rates to stay below HKD rates. Interestingly, however, the HKD and SGD short-term interest rates are quite strongly correlated at business cycle horizons despite the difference in monetary policy strategy.

--- Insert Figure 3: Interest rates ---

Finally, we consider the behaviour of the effective exchange rates in Hong Kong and Singapore. Figure 4 displays in the upper plot the real effective exchange rate (REER), and the lower plot the NEER, both of which we have normalised to 100 in the second quarter of 1994, that is, in the middle of the sample.

The figure shows that the HKD appreciated (rose) more in real terms than the SGD before the Asian financial crisis, and that it depreciated (declined) more thereafter. For Singapore, the graph indicates that the MAS loosened monetary policy by letting the REER depreciate in 1985 when the economy was in recession. From the end of the 1980s until the Asian financial crisis, the REER for Singapore appreciated due to the Balassa-Samuelson effect (see e.g. Devereux, 2003). In 1998, monetary policy again was loosened, reflected by a renewed decline in the effective exchange rate.

--- Insert Figure 4: Effective exchange rates ---

The REER of Hong Kong also shows a trend appreciation until the onset of the Asian financial crisis. However, because of the peg against the US dollar, the NEER could not absorb all the burden of adjustment arising from the Balassa-Samuelson effect, as is shown in the lower plot of Figure 4. Instead, prices had to adjust. This explains at least in part why inflation in Hong Kong was on average higher than in Singapore when a real appreciation of the two currencies was warranted, and why Hong Kong experienced a long period of deflation following the Asian financial crisis.

2.2 Literature

The fact that Hong Kong and Singapore have opted for different monetary policy setups in spite of their striking similarities has given rise to a number of studies that compare the economic performance of the two economies. In an early paper, Moreno (1988) analyses differences in annual GDP growth and inflation in Hong Kong and Singapore before 1985. He finds a high correlation between the business cycles of the two economies, which he argues is due to the impact of global factors on markets in Hong Kong and Singapore. He also reports that inflation was lower in Singapore over the period 1971 to 1985, and attributes this to the strong SGD policy pursued by the MAS.

Rajan and Siregar (2002) and Gerlach-Kristen (forthcoming) consider the period since the introduction of the currency board in Hong Kong in 1983. Rajan and Siregar use

quarterly data spanning 1984 to 2000 and find that since the 1990s, Singapore saw higher growth and lower inflation rates than Hong Kong. They interpret this, and the fact that Singapore's economy was less affected by the Asian financial crisis than Hong Kong, as evidence that the MAS's policy has been very successful. Gerlach-Kristen estimates structural Vector Auto-Regressions (VARs) for the two economies on quarterly data from 1990 to 2002. To address the question how the Singaporean policy framework would have performed in Hong Kong, she simulates the model under the counterfactual assumption that changes in the NEER are determined using the policy reaction function of the MAS. The results suggest that this policy approach might have limited the deflation Hong Kong experienced after 1998, but could not have averted the recession caused by the Asian financial crisis.

Genberg (2005) estimates unrestricted VARs for a number of small Asian economies, including Hong Kong and Singapore. Using quarterly data between 1990 and 2002, he finds that inflation and output growth in these economies depend to a large extent on developments in the US. He furthermore reports that roughly a tenth of the movements in inflation in Hong Kong, and in output growth in Singapore, is due to Mainland China.

Devereux (2003) presents evidence that Hong Kong experienced higher volatility of GDP growth but less variation in the REER than Singapore between 1983 and 1998. He shows that a micro-founded model predicts exactly this pattern as a consequence of the different monetary policy strategies in the two economies. Tse and Yip (2002), finally, study the interest rate behaviour in Hong Kong and Singapore and argue that the Singaporean framework is preferable since it gave the MAS greater flexibility during the Asian financial crisis.

3. A model of business cycles in Hong Kong and Singapore

To better understand the nature of business cycles in Hong Kong and Singapore and, in particular, the effects of the monetary policy strategy of the MAS, we turn to the econometric work. Since many authors have estimated VARs, we conduct the analysis by estimating a simple, "semi-structural" model for inflation, π_t, the output gap, y_t, and the change in the NEER, Δe_t, in Hong Kong and Singapore. Such models have the advantage over VARs that it is possible to interpret the estimated equations. For instance, we can compare the degrees of mean reversion of the endogenous variables, or the short- and long-run effects of one variable on another. This is helpful since it gives us a "feel"

for the nature of the differences between the two economies. While the model is intended to be "semi-structural", allowing us to interpret the equations for inflation and the output gap as being independent of the policy rule in force, in fact and as discussed below, this aim is probably not achieved.

We first estimate a standard backward-looking Phillips curve for each economy of the form:[7]

$$\pi_t = a + a_\pi \pi_{t-1} + a_y y_t + a_q q_t + z_t . \qquad (1)$$

This specification implies that inflation depends on the current output gap and on the lagged inflation rate.[8] The latter variable is arguably best interpreted as capturing inflation expectations, leading to us to believe that a_π is probably not independent of the policy rule in force. Thus, one would expect that the mean reversion of inflation induced by the MAS's focus on price stability makes it rational for the public to expect future inflation to decline (rise) when current inflation is high (low), implying that a_π is less than unity. By contrast, the fact that shocks to inflation in Hong Kong have been much more persistent implies that current inflation is probably a good predictor of future inflation, so that a_π may well be close to unity.

To capture international influences, we incorporate the (logarithm of the) REER, q_t, in the analysis. Since a depreciation of the real exchange (that is a decline in q_t) shifts spending from foreign to domestic goods, we expect a_q to be negative. As is clear from graphs inspected earlier, both economies have experienced a gradual real appreciation as a consequence of rapid economic development. Thus, the real interest rate evolves over time in response to gradual structural changes and macroeconomic shocks. Since the

[7] This specification follows that of Gerlach, Lam and Peng (2005).

[8] Inflation is here measured as the change in the CPI over four quarters. We also estimated the model using the quarterly change in inflation, but found that the regressors were then much less significant. We view this as merely reflecting the fact that quarterly changes in prices are much more volatile than annual changes.

focus of the econometric work is to analyse the effect of the latter, we use the detrended logarithm of the REER, $q_t \equiv e_t + p_t - p_t^{World} - q_t^*$, where q_t^* denotes the equilibrium real exchange rate, p_t the logarithm of the domestic price level and p_t^{World} that abroad, in the econometric analysis below.[9] This leaves us with one composite exogenous variable, $p_t^{World} + q_t^*$, which we use to capture foreign price disturbances in the analysis below.

In order to account for potential simultaneity that arises from the fact that the current price level appears both on the left-hand side of equation (1) and, implicitly, in the definition of the real exchange rate, we instrument y_t and q_t with their own once-lagged values and current US inflation and the federal funds rate.

The second equation of the model is a standard backward-looking IS curve of the form:

$$y_t = b + b_y y_{t-1} + b_q q_t + b_r r_t + b_{imp} imp_t + u_t . \qquad (2)$$

The current output gap thus depends on its lagged value and on the (detrended) real exchange rate, which enters because of competitiveness effects. We also let the real interest rate enter among the regressors. However, given the far-reaching changes in the real and financial sectors the two economies have seen in the more than twenty years of data that we use, it seems implausible that the equilibrium real interest rate has remained constant. To account for this, we use the detrended real interest, r_t, in the IS curve. [10] Finally, to capture changes in the global demand for goods, we incorporate the growth rate of US imports of goods, services and income, imp_t, which Gerlach, Lam and Peng (2005) find played an important role in driving the output gap in ten Asian economies between 1990 and 2003. In the estimation below we instrument the current regressors

[9] We obtained this variable by applying the Hodrick-Prescott filter, with a smoothing parameter of 1600, to the logarithm of the REER.

[10] The detrended real interest rate is calculated by means of the Hodrick-Prescott filter, with a smoothing parameter of 1600, from the difference between the current nominal three-month interest rate and inflation.

with their own once-lagged values, current US inflation and the current federal funds rate to deal with any simultaneity problems.

--- Insert Table 3 ---

3.1 Estimates of the inflation and output gap equations

As a preliminary, we estimated the model with OLS and with 2SLS. Not surprisingly, the parameter estimates were quite different, as our concern about simultaneity suggested should be the case. Since system estimates are more efficient than single-equation estimates, we also estimated the equations with 3SLS. However, that adds the assumption that all equations are correctly specified, which may or may not be the case. In the end, the results obtained with 3SLS estimates were broadly similar to those obtained with 2SLS, and we therefore focus on the latter here.

Table 3 shows the estimation output. Considering first the Phillips curves, we find that the parameter on lagged inflation, a_π, is 0.88 in Singapore and 0.97 for Hong Kong. This difference, which most likely arises from the fact that the MAS manages the effective exchange rate in response to economic developments, implies that shocks to inflation are less persistent in Singapore than in Hong Kong, as the simple time series plots considered above suggested. The estimates also show that a rise in the output gap raises inflation in both economies and that an appreciation of the REER (which is defined such that an appreciation is an increase) reduces inflation.

Given our interest in comparing the two economies, we also test the hypothesis that the short- and long-run effects of the regressors are the same.[11] The p-values for Wald tests of this hypothesis are provided in Table 3, and show that while the parameters on the lagged dependent variable are significantly different, we can in fact not reject the hypotheses that the short- and long-run effects of the output gap and the real exchange rate are the same. While this may merely reflect the fact that the parameters are not

[11] For an equation $y_t = \alpha y_{t-1} + \beta x_t + \varepsilon_t$, we have that the short-run impact of x_t is given by β, and the long-run impact by $\beta/(1-\alpha)$.

precisely estimated, it nevertheless suggests that the economic structure of Hong Kong and Singapore may not be very different.

Next we turn to the estimates of the output gap equations, and note that the lagged dependent variable is significantly smaller in Hong Kong than in Singapore (b_y = 0.68 vs. 0.86), implying that shocks to output are more persistent in Singapore than in Hong Kong.

The estimates of b_q indicate that a rise in the REER reduces activity somewhat more in Hong Kong than in Singapore, although we do not reject the hypothesis that the short-run effects are similar. In the long run, however, the impact of the real exchange is significantly larger in Singapore than in Hong Kong. The same is true for the growth rate of US import demand: in the long run an increase in imp_t raises output in Hong Kong more than in Singapore, whereas in the short run the two economies respond virtually identically. Finally, we note that a rise in the real interest rate depresses activity by about the same amount in Hong Kong and Singapore in the short run (b_r is border-line insignificant), but that the long-run effect is significantly larger in Singapore.[12]

The estimates of the parameters in the equations for the output gap are thus generally quite similar, except for that on the lagged output gap, which is larger in Singapore than in Hong Kong. These findings suggest that the short-run effects of movements in the real exchange rate, real interest rate and US real import demand are similar, the long-run effects are much larger in Singapore. However, the full effect of a shock depends also on the persistence of inflation since movements in prices impact on real interest and real exchange rates and thus play a role in restoring macroeconomic equilibrium. For this reason we perform an impulse response analysis below.

Despite the fact that the differences in the persistence of the shocks may not carry over to the full model, it is of interest to contemplate why the parameter on the lagged output gap is larger in Singapore than in Hong Kong. There are at least two possible explanations. First, it may be that Hong Kong has been more exposed than Singapore to large but

[12] Khor et al. (2004) state that the interest-rate channel of the monetary transmission mechanism is much weaker than the exchange-rate channel in the case of Singapore.

temporary shocks to aggregate demand, perhaps because of its closer proximity to China. Second, it may be that the MAS's policy of stabilising inflation has led it to slow down shifts in aggregate demand, leaving them to have more protracted effects on the output gap. Further work will be needed to distinguish between these two hypotheses.

The parameter estimates suggest that there are differences in the Phillips and IS curves, but these do not necessarily appear to be very large. We therefore next turn to the equations for the change in the NEER, which might differ considerably between the two economies in light of their contrasting policy strategies.

3.2 Monetary policy reactions in Singapore

While Hong Kong's currency board regime does not permit any discretionary policy in response to changes in inflation and activity, the MAS lets the nominal exchange rate move to mitigate the effects of economic disturbances.[13] While many observers have studied the conduct of monetary policy in various economies by estimating empirical reaction functions in which the central bank is seen as changing an overnight or short-term interest rate in response to the deviation of inflation from some explicit target (or implicit objective) and to the output gap and with reference to the lagged interest rate, this specification is thus not relevant in the case of the MAS.[14]

However, several observers have modified these reaction functions for Singapore, by viewing the change in the effective exchange rate as capturing monetary policy. Since the MAS has not disclosed the exact currency composition of the exchange rate basket it uses as an instrument, the literature typically uses the NEER as a proxy (e.g., Parrado, 2004).[15] We follow this approach and fit:

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[13] However, there may be indirect and automatic responses by the currency board mechanism in Hong Kong to the extent that movements in inflation and the output gap lead to strong capital flows.

[14] These empirical reaction functions are sometimes interpreted as empirical generalisations of the Taylor rule, see Taylor (1993). Corbo (2002) and Mohanty and Klau (2005) estimate monetary reaction function for a number of emerging market economies.

[15] See also McCauley (2001) and Khor et al. (2004) for discussions of the MAS's reaction function.

$$\Delta e_t = c + c_e \Delta e_{t-1} + c_\pi \pi_t + c_y y_t + v_t, \qquad \textbf{(3)}$$

where e_t is the logarithm of the NEER. Thus, the reaction function states that the rate of appreciation depends on its own past value, on inflation and the output gap. Assuming that the average value of the output gap and the parameter on the lagged change in the NEER are zero, we can compute the implied inflation objective as $\pi_t^T = -c/c_\pi$.

In the lowest panel of Table 3 we report estimates of equation (3) for Singapore. For comparison purposes, we also present estimates for Hong Kong. Given that monetary policy in Hong Kong is passive, we would expect the parameters to be insignificant.

Turning first to the results for Singapore, we note that both c_π and c_y are highly significant, but that the lagged change in Δe_t is not. Thus, there is no evidence of policy smoothing. Instead, the Singapore dollar appreciated immediately in nominal effective terms in response to inflation above target and the state of the business cycle as captured by the output gap.[16] Interestingly, the implied estimate of the inflation objective is about 1.2%. These results are very similar to those obtained elsewhere in the literature.

For Hong Kong, we note that the parameter on the lagged dependent variable is positive and highly significant, indicating that changes of the NEER have been serially correlated. Furthermore, the estimate of c_π is insignificant and close to zero as could be expected, suggesting that the NEER has not moved in response to changes in the rate of inflation. By contrast, c_y is highly significant and roughly as large as in the case of Singapore. This finding, which is somewhat surprising, and which plainly does <u>not</u> capture monetary policy reactions by the HKMA, indicates that weakness in the Hong Kong economy has tended to coincide with a depreciation of the NEER. Figure 5 plots Δe_t and y_t and shows that the NEER of the HKD depreciated during the recessions of 1985 - 86 and 1998 - 99. Since the NEERs of the HKD and of the USD are strongly correlated, it appears that the positive contemporaneous correlation between Δe_t and y_t reflects the fact that strength

[16] See MAS (2001) for a general discussion of Singaporean exchange rate policy. MAS (2003) contains a technical exposition of the MAS's exchange rate management.

in the global economy, and therefore in Hong Kong, has coincided with episodes of a strong USD.

--- Insert Figure 5 here ---

Whatever the explanation for why the output gap is so significant in the NEER equation for Hong Kong, it implies that the significance of the output gap in the equation for Singapore is not necessarily due solely, or even largely, to policy reactions. Furthermore, it suggests that the main distinction between Hong Kong and Singapore is that the MAS has responded strongly to inflation whereas the HKMA, of course, has not. This finding would seem compatible with the observation that real economic activity, at least at business cycle frequencies, has evolved in similar ways in the two economies.

3.3 The residuals

Assuming that equations (1) to (3) capture the dynamics of inflation, the output gap and the rate of appreciation of the NEER, we can examine the residuals of these equations to compare the shocks affecting π_t, y_t and e_t. Since the residuals by construction have a zero mean, we concentrate on their standard deviation. For the inflation equation, the residuals have a standard deviation of 0.008 for Hong Kong and 0.005 for Singapore. A formal F-test rejects the hypothesis that the variance is the same (p-value of 0.000). This indicates that Hong Kong has experienced larger shocks to inflation. While the sudden drop from inflation to deflation after the Asian financial crisis may account for this finding, it is likely that the MAS's commitment to maintaining low and stable inflation has anchored inflation expectations, which may have made inflation less sensitive to shocks.

Interestingly, the output gap shock has a standard deviation of 0.015 for both Hong Kong and Singapore, and the hypothesis that they are the same can consequently not be rejected (p-value of 0.998). Thus, the shocks affecting the output gaps in these two economies

seem to be drawn from the same distribution.[17] This supports the earlier hypothesis that the main impact of the MAS's policy strategy has been to dampen shocks to inflation.

Finally, we consider the shocks to the rate of appreciation of the NEER. Not surprisingly given the MAS objective of stabilising the NEER, these do seem to arise from different distributions for Hong Kong and Singapore in that the standard deviation is 0.022 in Hong Kong and 0.013 for Singapore. A test for the equality of the variances of these residuals rejects (p-value of 0.000).

4. Simulations

To shed light on the question whether differences in economic performance are due to the choice of policy regime, we proceed by simulating the paths of (changes in) the NEER, the rate of inflation and the output gap to a set of economic disturbances.[18] The first three of these are a one percent increase in (i) the residual in the inflation equation, (ii) the residual in the output gap equation and (iii) the residual in the NEER equation. Of course, it is difficult to give meaning to shocks to endogenous variables, and one is tempted to treat them as reduced form and seek to identify them by looking at their contemporaneous correlations. However, the three shocks are essentially uncorrelated (the highest correlation, -0.15, is between the residuals for the inflation and exchange rate equation in Hong Kong). The remaining two shocks we consider are unit increases in world prices and US import demand.

4.1 Inflation shocks

Figure 6 shows the impulse responses to a unit shock in the residual of the inflation equation. The responses of the Hong Kong economy are in the upper three plots, and those of the Singapore economy in the lower plots. We show 80% confidence bands that have been obtained using Monte Carlo methods.[19]

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[17] It is worth noting that in spite of this finding, the correlation between innovations to the output gaps in Hong Kong and Singapore is low (0.25). This suggests that we have not left out a global factor that affects economic activity in both economies.

[18] In the simulations below, we take into account that inflation enters the real interest rate and that the price level enters the REER.

[19] To calculate the confidence bands, we draw a vector from a multivariate normal distribution with the same mean and covariance matrix as the parameters estimated from the data and calculate a new impulse

--- Insert Figure 6 here ---

The responses of inflation are shown in the second column of the figure: inflation rises by one percentage point and falls to zero after about three quarters in both economies, drops to roughly -0.4% after about seven quarters and then approaches zero in an oscillating manner. The main differences between the responses in the two economies are in the first column: while the nominal effective exchange does not change in Hong Kong, it rises by almost 0.4% in Singapore as policy is tightened to mitigate the effect of the shock. Subsequently, the NEER depreciates in both economies in response to higher inflation in the domestic economy.

Since the increase in inflation causes a real appreciation the currency, which in turn reduces the domestic aggregate demand, the output gap turns negative after the shock. Of course, with monetary policy in Singapore trying to offset the inflation shock by appreciating the NEER, it is not surprising that the output gap declines to about -1.4% while in Hong Kong it only falls by about 1%.

4.2 Output gap shocks

Figure 7 plots the reactions to a unit shock to the output gap. While the responses of the NEER in the first column are very similar, the simulations show that the shocks have a less lasting impact on the output gap in Hong Kong than in Singapore, as suggested by the parameter estimates discussed above. However, the impact of the output gap shock on inflation is smaller in Singapore, perhaps because inflation expectations are firmly anchored by a history of low and stable inflation and the resulting credibility of monetary policy.

--- Insert Figure 7 here ---

response function. The confidence band is obtained by repeating the procedure 10,000 times and retaining the 10^{th} and 90^{th} percentile.

4.3 NEER shocks

Figure 8 shows the impulse responses to a unit increase in the rate of appreciation, which causes a fall in inflation and the output gap. While the autocorrelation of the rate of appreciation found for Hong Kong leads to a gradual return of Δe_t to zero, monetary policy in Singapore responds actively by a depreciation in period 1. As a consequence, the reactions of inflation and the output gap to the initial shock are considerably smaller in Singapore than in Hong Kong.

--- Insert Figure 8 here ---

4.4 World price/equilibrium exchange rate shocks

Next we turn to the impact of the REER. Since that rate is defined as

$q_t = e_t + p_t - p_t^{World} - q_t^*$, we consider in Figure 9 the effect of a unit increase in foreign prices, which corresponds to a unit depreciation of the equilibrium REER.

--- Insert Figure 9 here ---

This disturbance causes an increase in inflation and in the output gap in both economies. Since the increase in inflation leads to an appreciation of the exchange rate, aggregate demand and inflation start to decline. Overall, the movements in the output gap are larger and faster in Hong Kong than in Singapore. By contrast, the movements in inflation are smaller in Hong Kong, while the movements in the NEER are quite similar in the two economies.

4.5 US import demand shocks

Finally, we consider the impact of a unit shock to the growth rate of US import demand. Figure 10 indicates that in both economies economic activity reacts with a significant, and inflation with a borderline significant, increase to this shock. As a consequence, the rate of appreciation rises, thereby causing inflation and the output gap to decline below their equilibrium levels. Again we find that the movements in the NEER are longer lasting in Singapore than in Hong Kong. In particular, the rate of change of the NEER in

Singapore falls below zero from the fourth to the twelfth quarter, while we observe depreciation of the HKD only between the fourth and the ninth quarter.

--- Insert Figure 10 here ---

4.6 Discussion

One striking aspect of the simulation results above is that the impulse responses generally look similar for the two countries. In particular, the impact effect on inflation, the output gap and the NEER are very similar, as are the dynamic responses. One reason for the similarity of the impulse responses may be that the policy reactions of the MAS have been less strong than commonly believed.[20]

While overall the impulse responses show no large differences, there are three notable exceptions. The first of these is the marked and immediate response of the NEER in Singapore to inflation shocks, which is due to the MAS's efforts to maintain inflation control. The second difference is that the output gap appears to be more rapidly mean reverting in Hong Kong than in Singapore. This finding is compatible with the notion that Hong Kong may have been exposed to more temporary shocks. The last difference is that the responses of, and the confidence bands for, inflation to the different disturbances are typically smaller in Singapore than in Hong Kong, again no doubt due to the authorities' successful efforts to stabilise inflation.

5. Conclusions

The overriding conclusion from the analysis above is that while the two economies have experienced surprisingly similar movements of the output gap, Singapore has achieved a superior inflation outcome (and has grown faster). Thus, inflation has been lower, less volatile and less persistent. This is most likely due to the fact that the MAS has for a considerable time focussed policy on stabilising inflation, although potentially other factors could have played a role.

[20] Since the MAS's policy objectives for the NEER have not been released, it is difficult to explore this hypothesis further.

One novel finding is that the changes in the NEER are positively correlated with the output gap in both economies, indicating that the hypothesis that this correlation in the case of Singapore is evidence of the stabilising conduct of policy is debatable. What is clearer, however, is that the strong correlation between changes in the NEER and inflation in Singapore is due to policy, and has led to better inflation outcomes.

References

Corbo, Vittorio (2002), "Monetary Policy in Latin America in the 1990s," in Norman Loayza and Klaus Schmidt-Hebbel, eds., Monetary Policy: Rules and Transmission Mechanisms, Central Bank of Chile, Santiago.

Crosby, Mark (2004), "Exchange Rate Volatility and Macroeconomic Performance in Hong Kong," Review of Development Economics, 8(4), 606-623.

Devereux, Michael B. (2003), "A Tale of Two Currencies: The Asian Crisis and the Exchange Rate Regimes of Hong Kong and Singapore," Review of International Economics, 11, 38-54.

Economist (2003), Pocket World in Figures, Profile Books, London.

Genberg, Hans (2005), "External Shocks, Transmission Mechanisms and Deflation in Asia," HKIMR working paper 6/05.

Gerlach, Stefan (2005), "Monetary Operations by Hong Kong's Currency Board," Journal of Asian Economics, 15, 1119-1135.

Gerlach, Stefan, Raphael Lam and Wensheng Peng (2005), "Disinflation and deflation in Asia: A Panel-Data Study," unpublished working paper.

Gerlach-Kristen, Petra (forthcoming), "Internal and External Shocks in Hong Kong: Empirical Evidence and Policy Options," Economic Modelling.

Jao, Y. C. (1990), "From Sterling Exchange Standard to Dollar Exchange Standard: The Evolution of Hong Kong's Contemporary Monetary System, 1967-1989," in Y. C. Jao and Frank H. H. King, Money in Hong Kong: Historical Perspective and Contemporary Analysis, Centre for Asian Studies Occasional Papers and Monographs No. 91, University of Hong Kong.

Khor, Hoe Ee, Edward Robinson and Jason Lee (2004), "Managed Floating and Intermediate Exchange Rate Systems: The Singaporean Experience," MAS Staff Paper No. 37, available at www.mas.gov.sg.

McCauley, Robert N. (2001), "Setting Monetary Policy in East Asia: Goals, Developments and Institutions," in D. Gruen and J Simon, eds., Future Directions for Monetary Policies in East Asia, Reserve Bank of Australia. Available at www.rba.gov.au.

Mohanty, Madhusudan and Marc Klau (2005), "Monetary Policy Rules in Emerging Market Economies: Issues and Evidence," in Rolf J. Langhammer and Lúcio Vinhas de Souza, eds., Monetary Policy and Macroeconomic Stabilization in Latin America, Springer, Heidelberg.

Monetary Authority of Singapore (2001), Singapore's Exchange Rate Policy, available at www.mas.gov.sg.

Monetary Authority of Singapore (2003), Monetary Policy Operations in Singapore, available at www.mas.gov.sg.

Moreno, Ramon (1988), "Exchange Rates and Monetary Policy in Singapore and Hong Kong," in H. S. Cheng, ed., Monetary Policy in Pacific Basin Countries, Kluwer Academic Publishers, Boston.

Parrado, Eric (2004), "Singapore's Unique Monetary Policy: How Does It Work," IMF Working Paper 04/10, available at www.imf.org.

Rajan, Ramkishen S. and Reza Siregar (2002), "Choice of Exchange Rate Regime: Currency Board (Hong Kong) or Monitoring Band (Singapore)?" Australian Economic Papers, 41, 538-556.

Taylor, John B. (1993), "Discretion versus Policy Rules in Practice," Carnegie-Rochester Conference Series on Public Policy, 39, 195-214.

Tse, Y.K. and Paul S.L. Yip (2002), "Exchange-Rate Systems and Interest-Rate Behaviour: The Experience of Hong Kong and Singapore," working paper.

Table 1: Overview statistics on Hong Kong and Singapore

	Hong Kong	Singapore
Population	6.9 million	4.0 million
Population per km2	6564	6502
GDP per head	USD 23930	USD 22960
Industry	14.1% of GDP	34.2% of GDP
Services	85.8% of GDP	65.8% of GDP
Visible exports	124.3% of GDP*	150.5% of GDP*
Visible imports	129.4% of GDP#	138.1% of GDP*
Services inflows	58.2% of GDP	45.8% of GDP
Services outflows	46.7% of GDP	33.0% of GDP
Main export destinations (including re-exports)	1. China (34.5%) 2. US (23.2%) 3. Japan (5.5%)	1. Malaysia (18.2%) 2. US (17.3%) 3. Hong Kong (7.9%)
Main origins of imports	1. China (43.1%) 2. Japan (12.0%) 3. Taiwan (7.5%)	1. Japan (17.2%) 2. Malaysia (17.0%) 3. US (14.8%)

Note: Data from Economist (2003). * denotes fob, # cif

Table 2: Mean and standard deviations of key macroeconomic variables

	Hong Kong			Singapore		
	Data	Mean	Std dev	Data	Mean	Std dev
CPI inflation	83:1-05:3	4.50	4.99	83:1-05:3	1.37	1.31
Output gap	83:1-05:2	0	3.03	83:1-05:2	0	2.79
Unemployment rate	83:1-05:3	3.65	2.07	87:1-05:1	2.78	1.07
Output growth	83:1-05:2	5.06	4.52	83:1-05:2	6.21	4.61
Short-term interest rate	83:1-05:3	5.75	3.01	83:1-05:3	3.68	2.01
Long-term interest rate	84:1-05:3	7.26	2.45	87:2-05:2	3.65	1.10
Real effective exchange rate*	84:1-05:3	132.34	23.48	83:1-04:3	91.59	7.18
Nominal effective exchange rate*	83:1-04:3	86.46	6.97	83:1-04:3	109.37	12.08

Note: * Normalised such that 1983:1 = 100.

Table 3: Estimation output for equations (1) and (3)

	Hong Kong	Singapore	Wald test for short-run equality (p-values)	Wald test for long-run equality (p-values)
$\pi_t = a + a_\pi \pi_{t-1} + a_y y_t + a_q q_t + z_t$				
a	0.000 (0.001)	0.002* (0.001)	0.222	0.844
a_π	0.970*** (0.019)	0.883*** (0.059)	0.000	
a_y	0.113** (0.045)	0.073** (0.030)	0.377	0.231
a_q	-0.069* (0.038)	-0.062*** (0.022)	0.845	0.360
$\overline{R}^2$	0.971	0.830		
$y_t = b + b_y y_{t-1} + b_q q_t + b_r r_t + b_{imp} imp_t + u_t$				
b	-0.006* (0.003)	-0.004 (0.003)	0.598	0.193
b_y	0.685*** (0.066)	0.862*** (0.077)	0.007	
b_q	-0.246*** (0.065)	-0.189*** (0.072)	0.383	0.021
b_r	-0.112 (0.093)	-0.184 (0.167)	0.998	0.001
b_{imp}	0.053** (0.025)	0.053** (0.026)	0.989	0.006
$\overline{R}^2$	0.697	0.699		
$\Delta e_t = c + c_e \Delta e_{t-1} + c_\pi \pi_t + c_y y_t + v_t$				
c	-0.002 (0.003)	-0.006** (0.003)	0.261	0.563
c_e	0.294*** (0.100)	-0.007 (0.115)	0.993	
c_π	0.040 (0.049)	0.517*** (0.171)	0.000	0.000
c_y	0.234** (0.107)	0.191*** (0.087)	0.688	0.354
$\overline{R}^2$	0.137	0.335		

Note: Two-stage least squares estimates. Sample period 1983Q3 to 2004Q3. Standard errors in parentheses. * / ** / *** denotes significance at the ten / five / one percent level.

Figure 1: CPI inflation rates

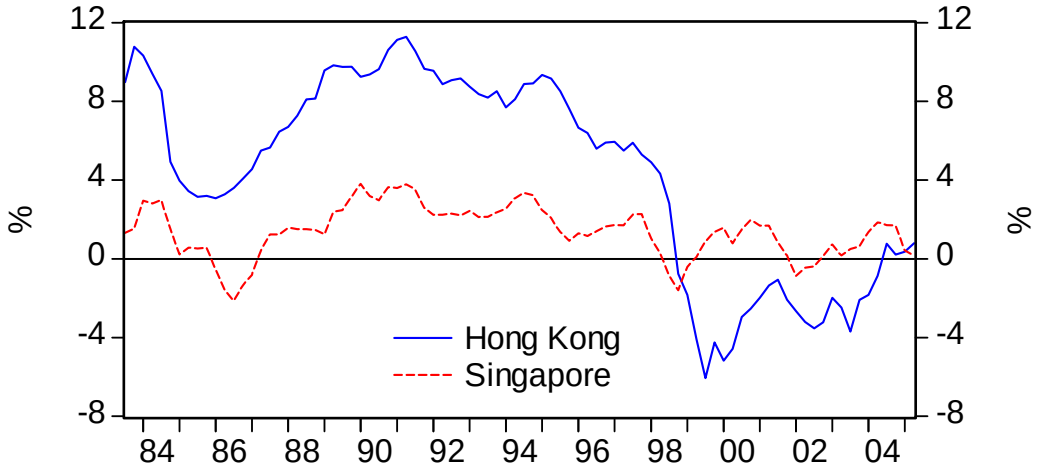

Figure 2: Output gaps and unemployment

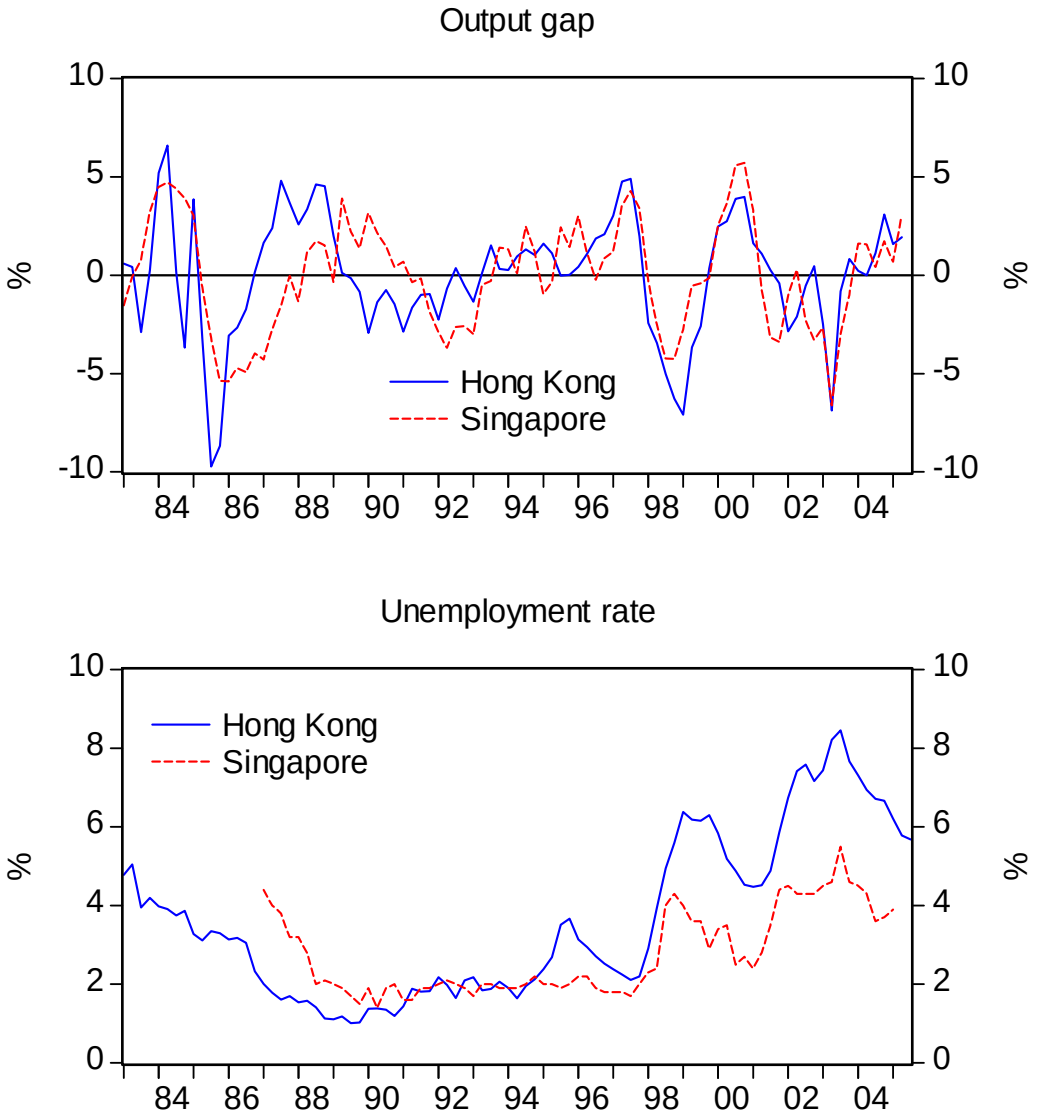

Figure 3: Interest rates

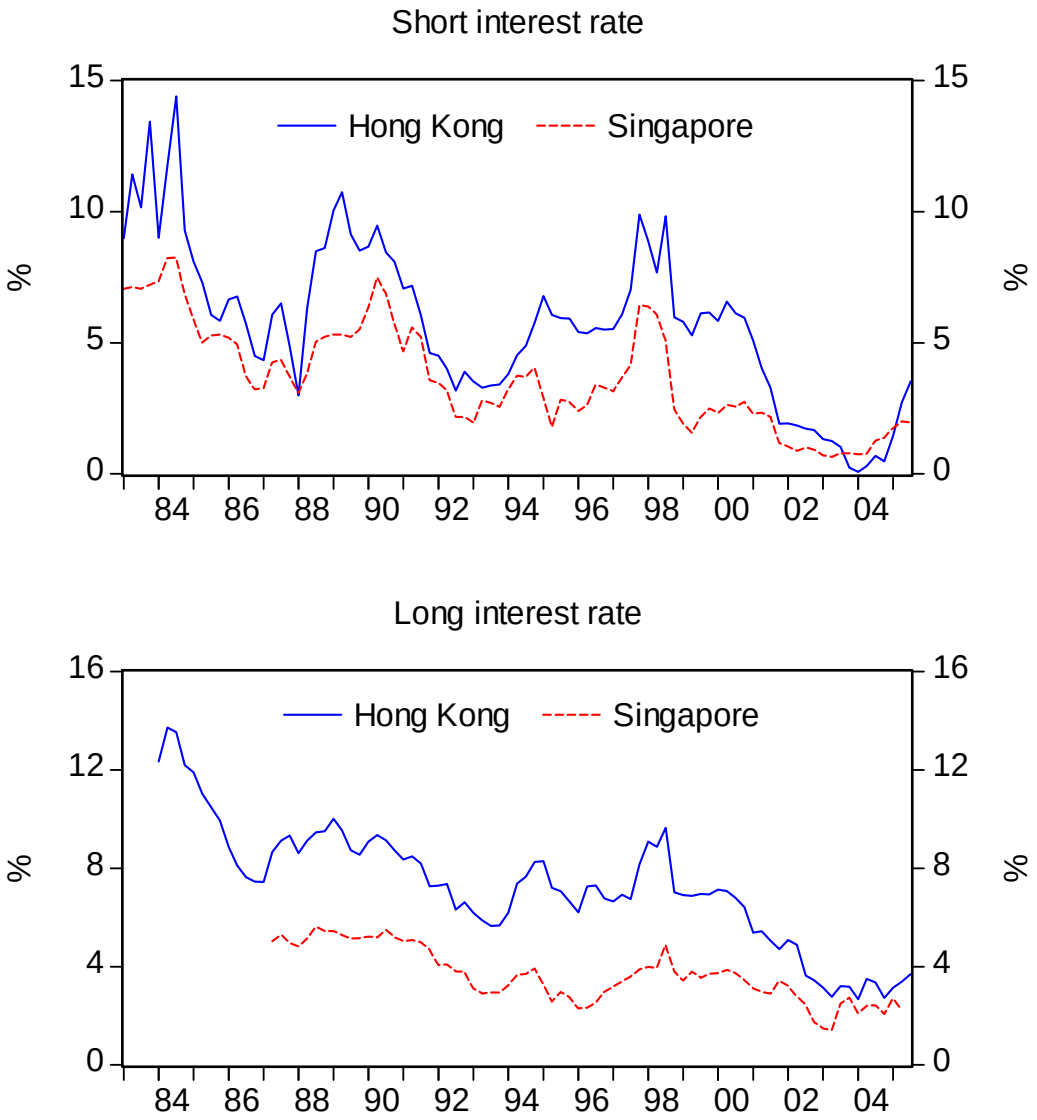

Figure 4: Effective exchange rates

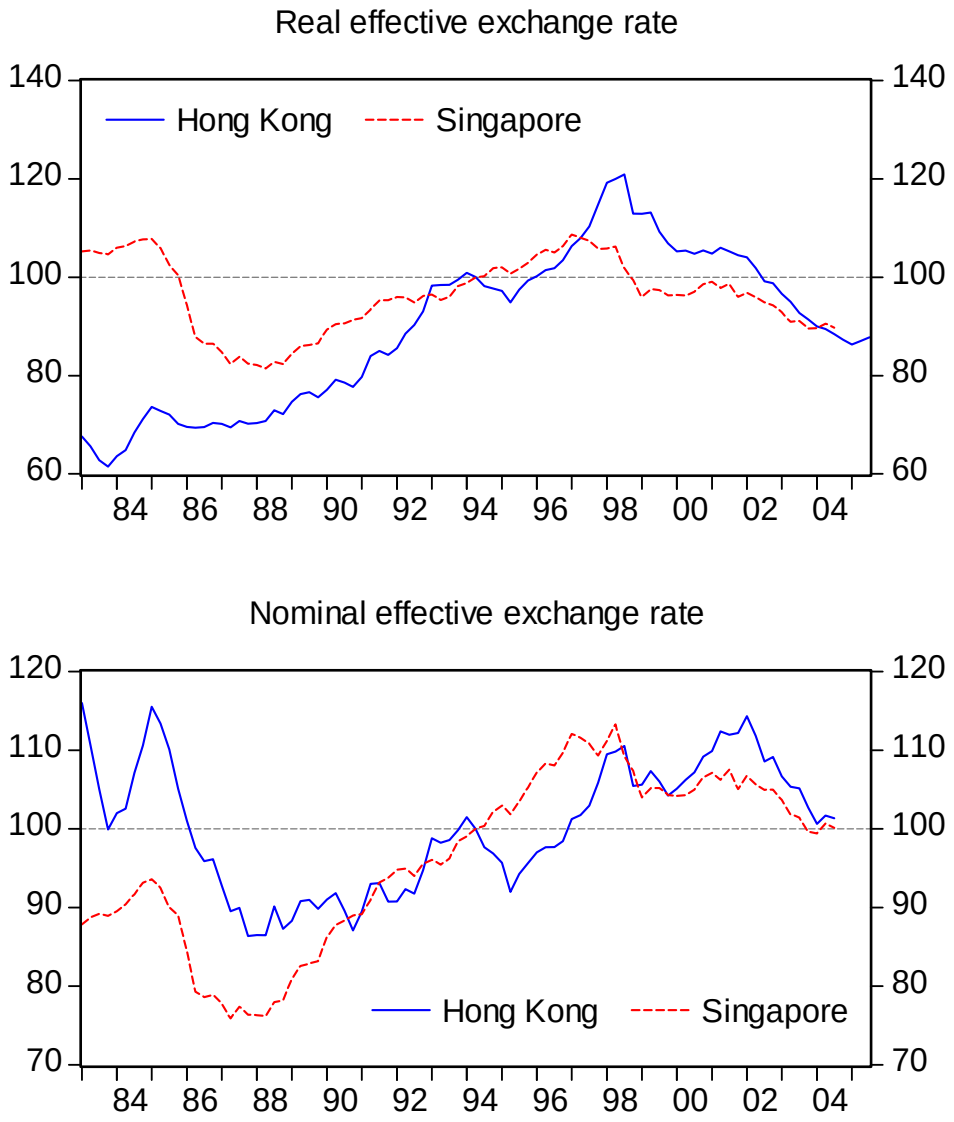

Figure 5: NEER of the HKD and output gap

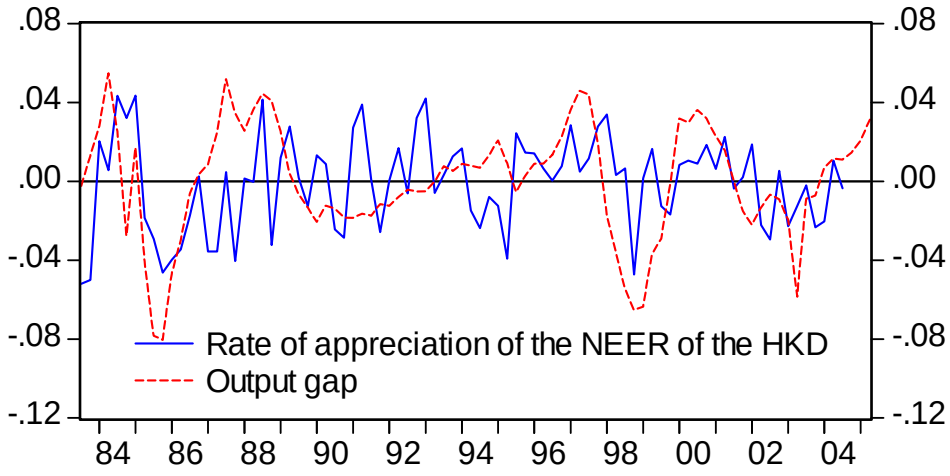

Figure 6: Shock to inflation

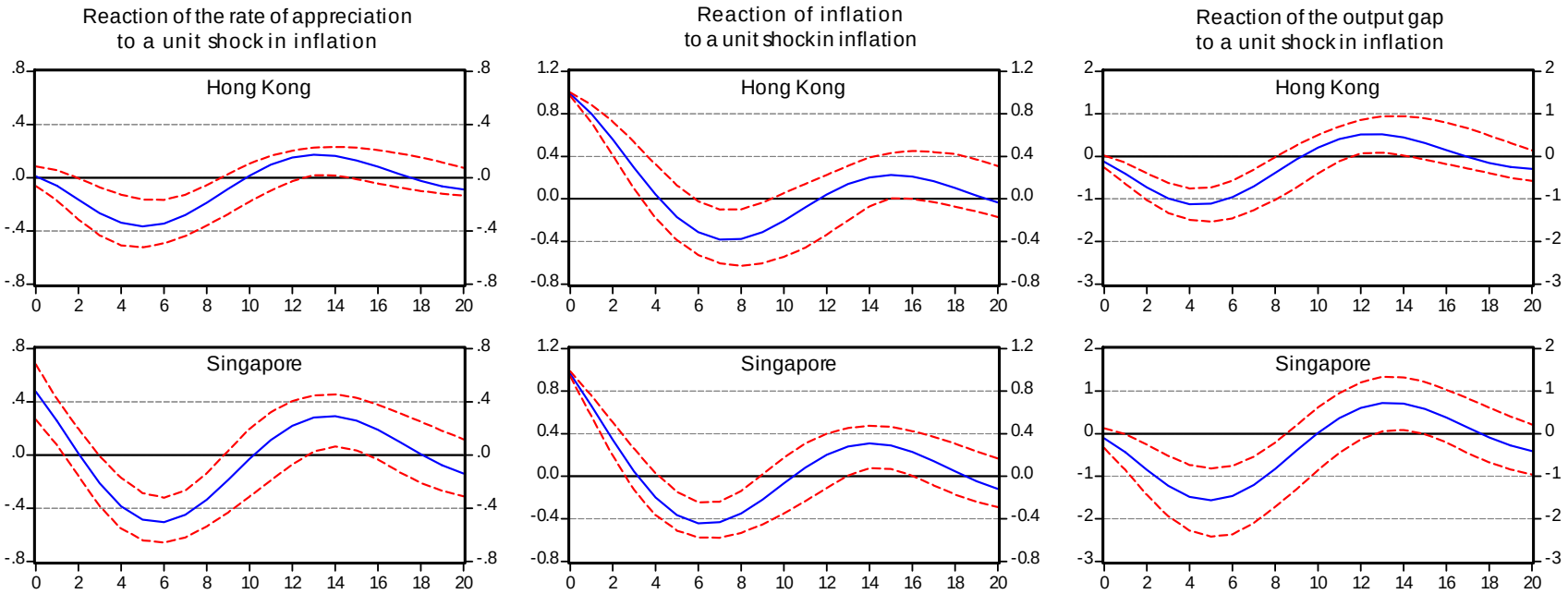

Figure 7: Shock to the output gap

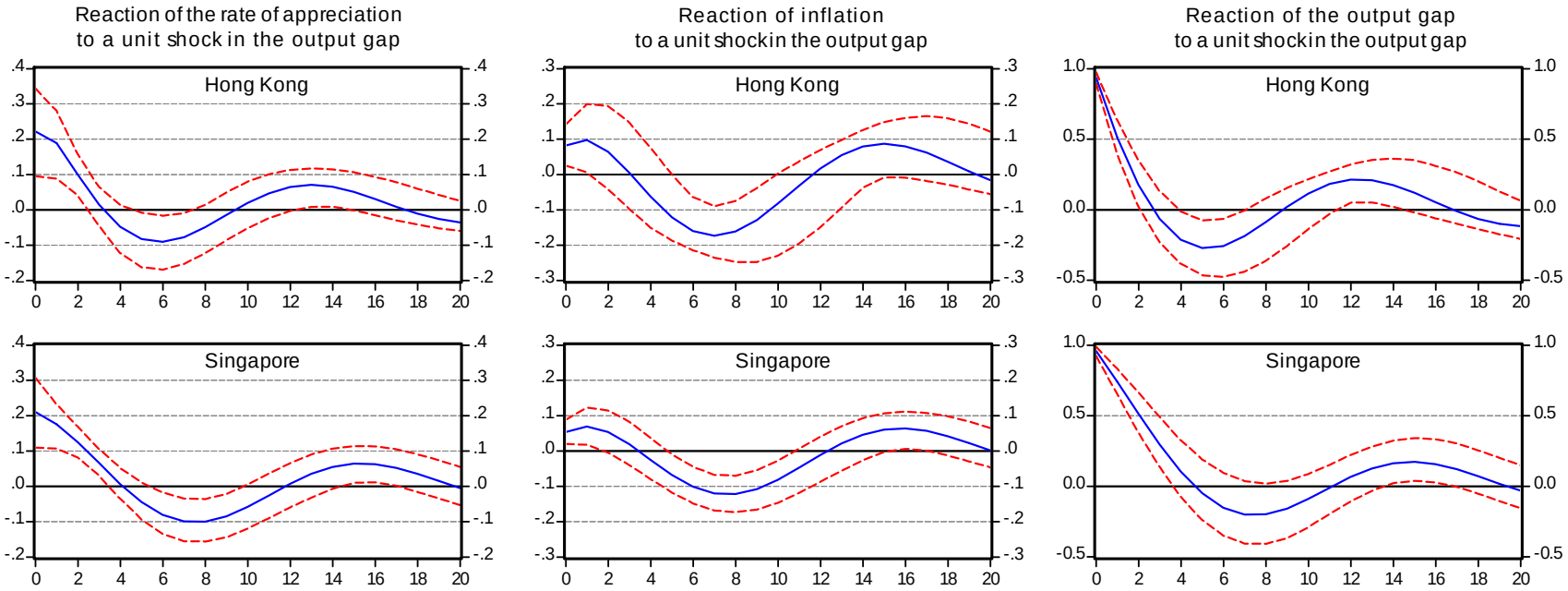

Figure 8: Shock to the rate of appreciation

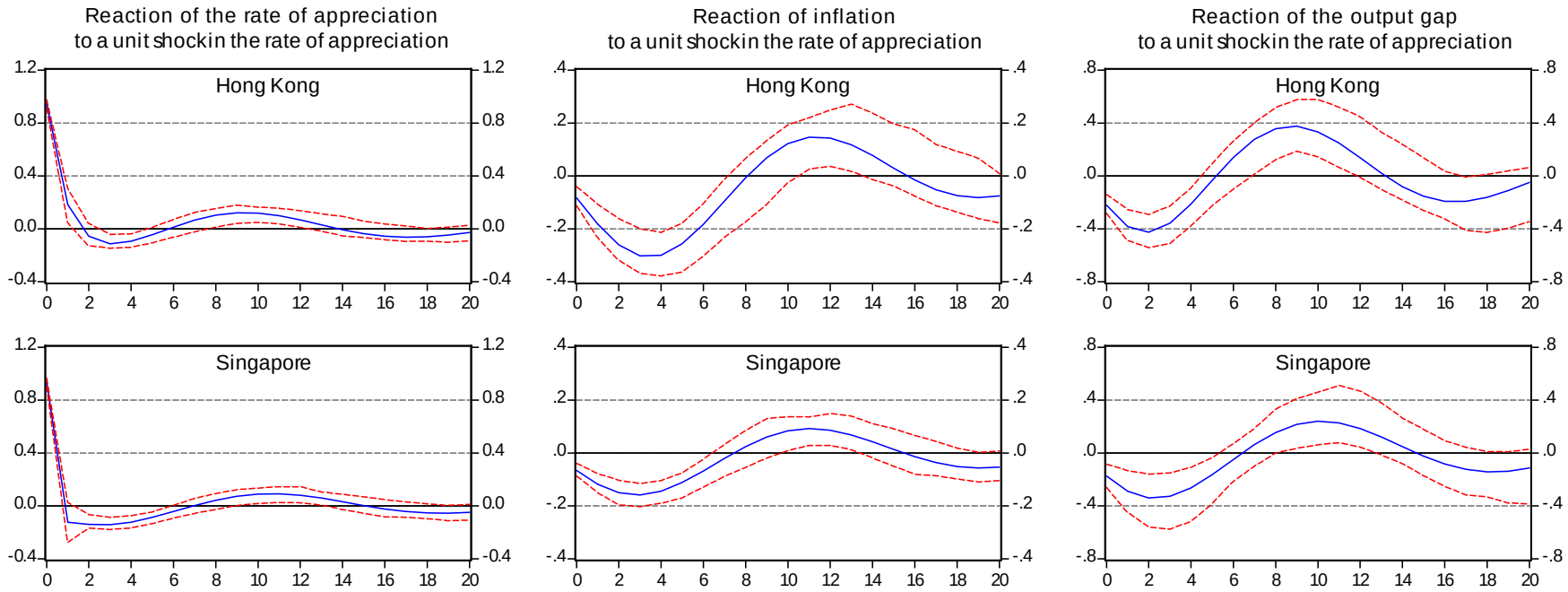

Figure 9: Shock to world prices

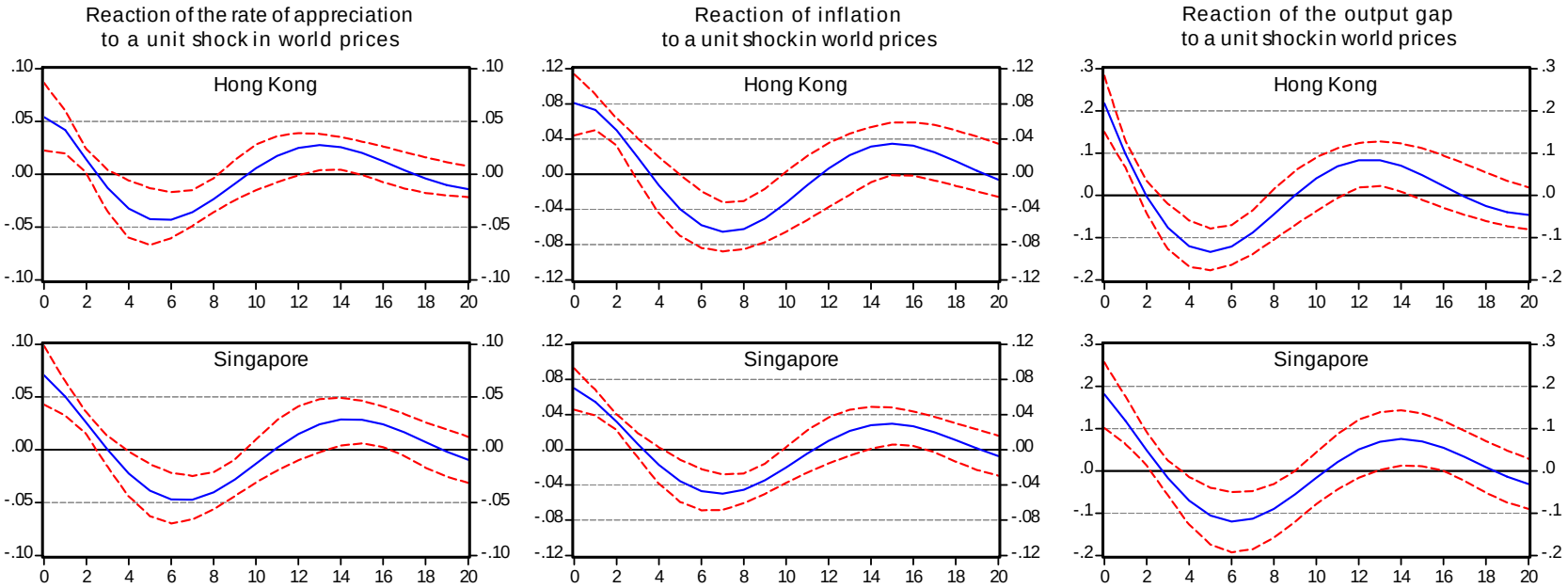

Figure 10: Shock to the growth rate of US import demand