Monetary policy regimes and macroeconomic outcomes: Hong Kong and Singapore

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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 in this period experienced several large economic shocks that were associated with 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%.[4] 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, which is also extremely open, has experienced much the same shocks as the Hong Kong economy.

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 objective of the HKMA has been to stabilise the nominal exchange rate against the USD while the MAS has focussed on controlling inflation, inflation has been more variable in Hong Kong. Cyclical movements on the real side of the economy, however, have been comparable. For instance, the volatility of real GDP growth is similar in the two economies.[5] 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 2001-02 and during the episode of severe acute respiratory syndrome (SARS) in 2003.

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

5 One difference is that Singapore has experienced somewhat higher trend growth of real GDP than Hong Kong. Wensheng Peng, in his discussion of the paper, pointed out that real GDP per capita has grown faster in Hong Kong than in Singapore. Of course, it is unclear whether the choice of monetary framework has any implication for the average real growth rate as long as inflation is low.

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 Singapore 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?

The purposes of this paper are to address these questions and to explore the potential role of the monetary regime in accounting for any differences in macroeconomic outcomes. We highlight from the outset that it is not possible on the basis of our analysis to infer whether one policy regime is preferable to the other, since this depends on policy makers' objectives, which, as noted above, differ,

The paper 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, these are not significant. Next, we study macroeconomic outcomes since the early 1980s. We find that the difference in the monetary policy regimes is reflected in the behaviour of nominal variables. In particular, Hong Kong has had higher and more variable inflation than Singapore. Conversely, the behaviour of real variables has been quite similar, with the exception that unemployment in Singapore has responded less to contractionary shocks, and has declined more rapidly in their aftermath.

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, an IS curve and an equation for changes in the nominal effective exchange rate (NEER).

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 is evidence of the MAS's policy reaction function. Second, we find that the autoregressive parameter for the output gap is larger in Singapore than in Hong Kong. As we argue below, it is possible that this also reflects the MAS's active monetary policy strategy. Thus, seeking to mitigate the inflationary consequences of shocks may have led to more protracted movements in real economic activity.

The fact that the parameter estimates are so similar raises again the issue of whether the responses of real economic activity to shocks have been 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, we conclude that while the two economies respond in similar ways to shocks, the MAS's policy reactions have facilitated the adjustment of the Singapore 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, we review briefly the main features of the Hong Kong and Singapore economies. The data in Table 1 show that the economies are 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.

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 doubtful 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.

Table 1

Overview statistics on Hong Kong and Singapore

	Hong Kong	**Singapore**
Population	6.9 million	4.0 million
Population per km^2	6,564	6,502
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.

Second and as suggested by the gravity theory of international trade, both economies trade intensively with their immediate neighbours, mainland China and Malaysia, respectively. Although changes in demand in one economy are rapidly transmitted through the international trading system to the regional economies, the fact that Hong Kong's and Singapore's trade patterns differ suggests that the two economies have experienced somewhat different economic disturbances. Indeed, the close proximity of Hong Kong to mainland China 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.[6] 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 the exchange rate fell 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 banks were required to back the note issue by depositing an equivalent amount in USD, using a conversion rate of 7.8 HKD/USD, with the Exchange Fund.[7] This reintroduced the currency board regime, which subsequently has been seen as essential to ensuring monetary and financial stability.[8]

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.[9] 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 likely to be related to the choice of monetary policy framework. Thus, the lower volatility 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, the policy framework in Hong Kong is completely geared to ensuring stability of the nominal exchange rate against the USD, implying that there are no monetary policy responses to inflation. As a consequence, movements in inflation are larger and more protracted in Hong Kong than in Singapore.

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6 See Jao (1990) or Gerlach (2005).

7 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. Note that, by contrast, if most shocks affecting the exchange rate come from real side developments, it will be desirable to let the exchange rate function as a shock absorber.

8 Singapore's monetary history is in many ways similar to that of Hong Kong. From the 1930s, Singapore's currency was pegged to sterling. The devaluation of sterling in 1972 led the monetary arrangements in Singapore to be changed to a peg to the USD, which in turn was abandoned in 1973 following the breakdown of the Bretton Woods system. With the exchange rate floating, monetary policy was aimed at limiting inflation, and was conducted using a range of intermediate targets and direct controls. In the early 1980s, the MAS adopted the current framework in which the inflation objective is pursued by managing the exchange rate. See MAS (2000) for a review of Singapore's monetary history.

9 The consumer price index, real GDP, the unemployment rate for Hong Kong and Singapore, as well as the Hong Kong short-term interest rate are from the BIS database. The long-term interest rate for both economies and the real and nominal effective exchange rates for Hong Kong are from the HKMA database. The Singapore nominal and real effective exchange rates 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.

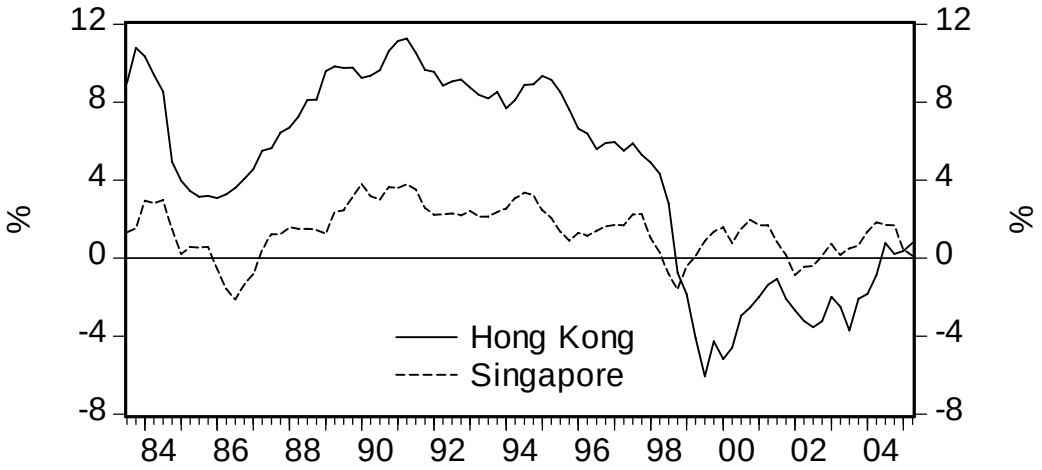
Table 2

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.

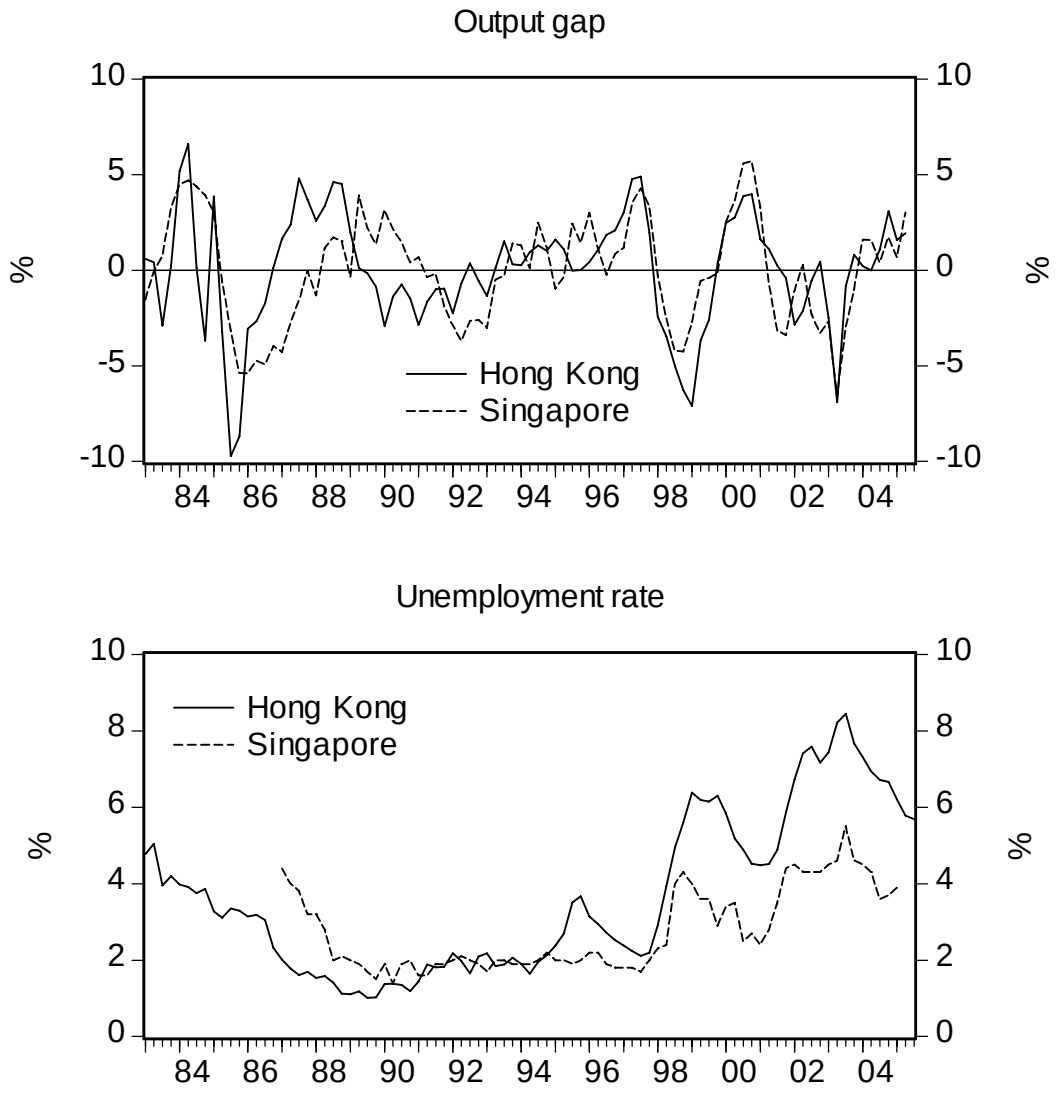
Figure 1



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 Singapore economy.[10]

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 outflows 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 strongly correlated at business cycle horizons, which suggests that the difference in monetary policy strategy may not be so important in determining the short-run responses of the real economy to shocks.

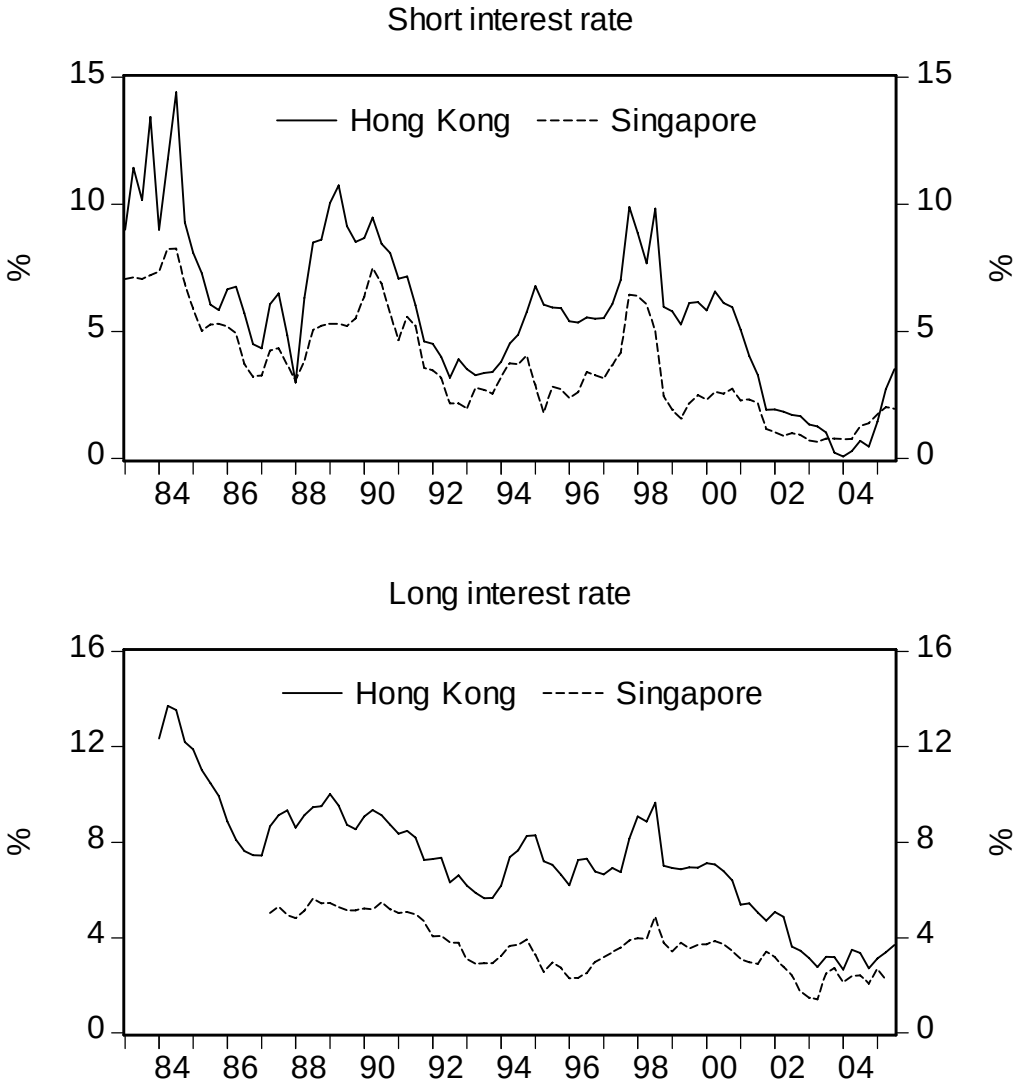
Finally, we consider the behaviour of the effective exchange rates in Hong Kong and Singapore. Figure 4 displays in the upper plot the real effective exchange rate (REER), and the lower plot the NEER, both of which we have normalised to 100 in the second quarter of 1994, that is, in the middle of the 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 eg Devereux, 2003). In 1998, monetary policy was again relaxed, reflected by a renewed decline in the effective exchange rate.

[10] It should be noted that the Singapore authorities have made active use of labour market measures, including cuts in employers' contributions to the Central Provident Fund, to maintain competitiveness in the face of adverse shocks.

Figure 3

Interest rates

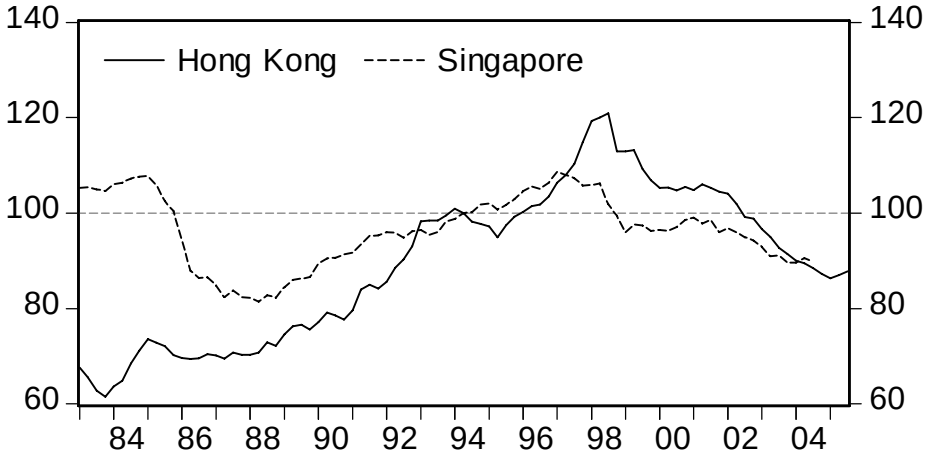


The REER of Hong Kong also shows a trend appreciation until the onset of the Asian financial crisis. However, because of the peg against the USD, the NEER could not absorb the entire burden of adjustment arising from the Balassa-Samuelson effect, as is shown in the lower plot of Figure 4. Instead, prices 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 deflation following the Asian financial crisis.

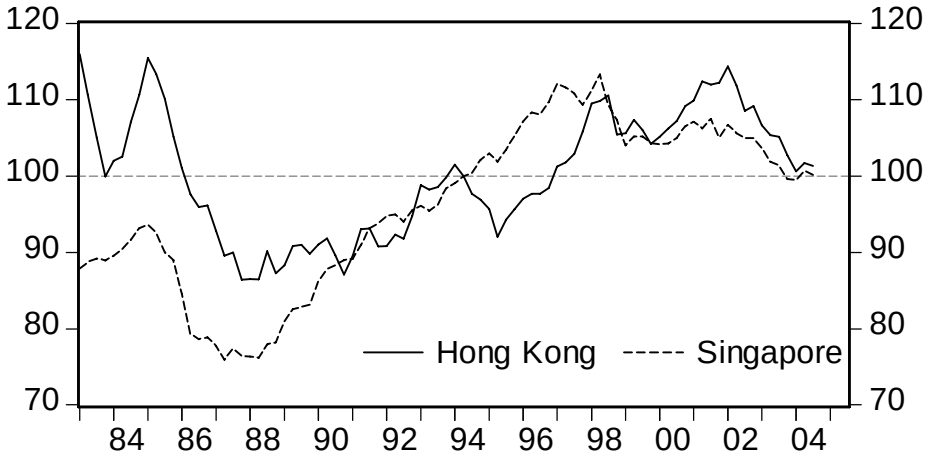
Figure 4

Effective exchange rates

Real effective exchange rate



Nominal effective exchange rate



2.3. Literature

The fact that Hong Kong and Singapore have opted for different monetary policy setups in spite of the similarities between their economies 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 (2006) consider the period since the introduction of the currency board in Hong Kong in 1983. Rajan and Siregar use quarterly data spanning the period 1984 to 2000 and find that, since the 1990s, Singapore has seen 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's, as

evidence that the MAS's policy has been successful. Gerlach-Kristen estimates structural vector autoregressions (VARs) for the two economies on quarterly data from 1990 to 2002. To address the question of how the Singapore 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 Singapore framework gave the MAS 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 is clear from the discussion below, we do not believe that this aim is achieved. Despite this, the model is useful since it serves to structure the discussion.

We first estimate a standard backward-looking Phillips curve for each economy of the form:[11]

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

This specification implies that inflation depends on the current output gap and on the lagged inflation rate.[12] The latter variable is arguably best interpreted as capturing inflation expectations, leading us to believe that 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

[11] This specification follows that of Gerlach et al (2005).

[12] 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.

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 import price shocks, 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) raises the prices of imported 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 and far-reaching economic development in the period under study. Thus, the real exchange rate evolves over time in response to gradual structural changes and macroeconomic shocks. Since the 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, the logarithm of the domestic price level and p_t^{World} that abroad, in the econometric analysis below.[13] 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, in estimating the model 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 20 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.[14] 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 et al. (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 with their own once-lagged values, current US inflation and the current federal funds rate to deal with any simultaneity problems.

It should be noted that the specification of the IS curve used above disregards the role played by movements in property prices in economic fluctuations in Hong Kong and Singapore. However, this omission, which is made in the interest of limiting the complexity of the model, can be seen as implicitly treating changes in property prices as determined by the same factors as, and as impacting without lag on, the output gap. Under this interpretation, property prices still play a role in the model by influencing the sensitivity of the output gap to interest rates, exchange rates and external demand.

[13] We constructed the equilibrium real exchange rate by applying the Hodrick-Prescott filter, with a smoothing parameter of 1600, to the logarithm of the REER.

[14] 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.

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)
$\pi_1 = a + a_\pi \pi_{t-1} + a_y y_t + a_q q_t + z_1$				
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 10% / 5% / 1% level.

3.1. Estimates of the inflation and output gap equations

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 results. Considering first the estimates of 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 is likely to be due to the fact that the MAS manages the effective exchange rate in response to economic developments, implying 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.[15] 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 cannot in fact 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 precisely estimated, it nevertheless suggests that the economic structures of Hong Kong and Singapore are similar.

Turning to the estimates of the output gap equations, we 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. One possible explanation for this finding is that seeking to stabilise inflation leads to more protracted output movements.

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 borderline insignificant), but that the long-run effect is significantly larger in Singapore.[16]

The parameter estimates of 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, while 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 temporary shocks to aggregate demand, perhaps because of its closer proximity to mainland 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. Of course, under this interpretation the equation estimates are in fact not structural.

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.

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

[16] Interestingly, 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.

3.2. Monetary policy reactions in Singapore

As is well known, whereas 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.[17] 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 or influencing a 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 not relevant in the case of the MAS.[18]

However, several authors have modified these reaction functions for Singapore by using the change in the effective exchange rate as a measure of the stance of 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 (eg Parrado, 2004).[19] We follow this approach and fit:

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

where e_t is the logarithm of the NEER. This reaction function states that the rate of appreciation depends on its own past value, on inflation and on 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 $\pi_t^T = -c/c_\pi$.

The bottom panel of Table 3 reports estimates of equation (3) for Singapore. For comparison purposes, we also present estimates for Hong Kong. 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 has appreciated immediately in nominal effective terms in response to inflation above the MAS's objective and the state of the business cycle as captured by the output gap.[20] 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, the parameter on the lagged dependent variable is positive and highly significant, indicating that changes in 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 *not* 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 correlation between the NEERs of the HKD and of the USD is positive and quite large ($\rho = 0.46$), it appears that the positive contemporaneous correlation between and reflects the fact that strength in the

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[17] 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.

[18] 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 functions for a number of emerging market economies.

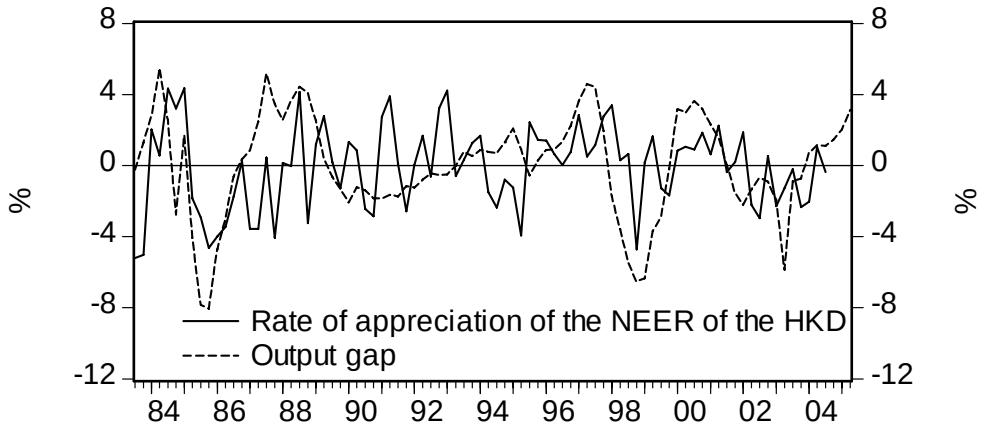
[19] See also McCauley (2001) and Khor et al (2004) for discussions of the MAS's reaction function.

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

global economy, and therefore in the Hong Kong economy, has coincided with episodes of a strong USD.[21]

Figure 5

NEER of the HKD and output gap



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 cannot consequently 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.[22] 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 that the MAS stabilises the NEER in order to control inflation, these do seem to arise from different distributions in that the standard deviation is 0.022 in Hong Kong and 0.013 for Singapore. A test rejects the null hypothesis that the variances of these residuals are equal (p-value of 0.000).

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[21] This hypothesis is supported by a closer analysis which shows that the US and HK NEERs tend to appreciate about four quarters after a rise in the US output gap. Furthermore, Hong Kong typically experiences an increase in the output gap following a rise in the US output gap (the peak correlation, which occurs with a lag of one quarter, is 0.32).

[22] 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 ($\rho = 0.25$).

4. Simulations

To shed light on the question of 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.[23] The first three of these are a 1% 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.[24]

The responses of inflation are shown in the second column of the figure: inflation rises by 1 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 NEER does not change in Hong Kong, it appreciates by almost 0.5% in Singapore as policy is tightened to mitigate the effect of the shock. Subsequently, the NEER depreciates in both economies in response to higher domestic inflation.

Since the increase in inflation causes a real appreciation in the currency, which in turn reduces 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.

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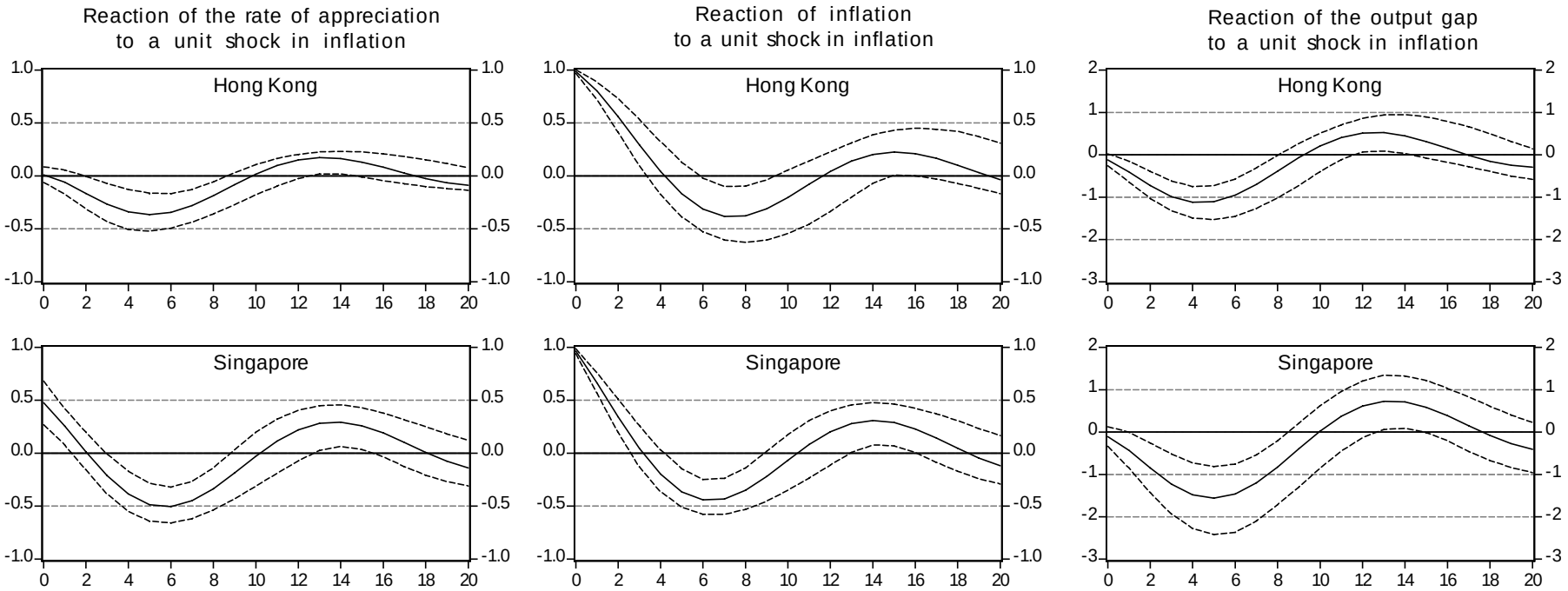
[23] The simulations below take into account that inflation enters the real interest rate and that the price level enters the REER.

[24] 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 response function. The confidence band is obtained by repeating the procedure 10,000 times and retaining the 10th and 90th percentile.

Figure 6

Shock to inflation



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.

4.4. World price/equilibrium exchange rate shocks

Next we turn to the impact of the REER, which 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.

This disturbance increases inflation and 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 12th quarter, while we observe depreciation of the HKD only between the fourth and the ninth quarter.

Figure 7

Shock to the output gap

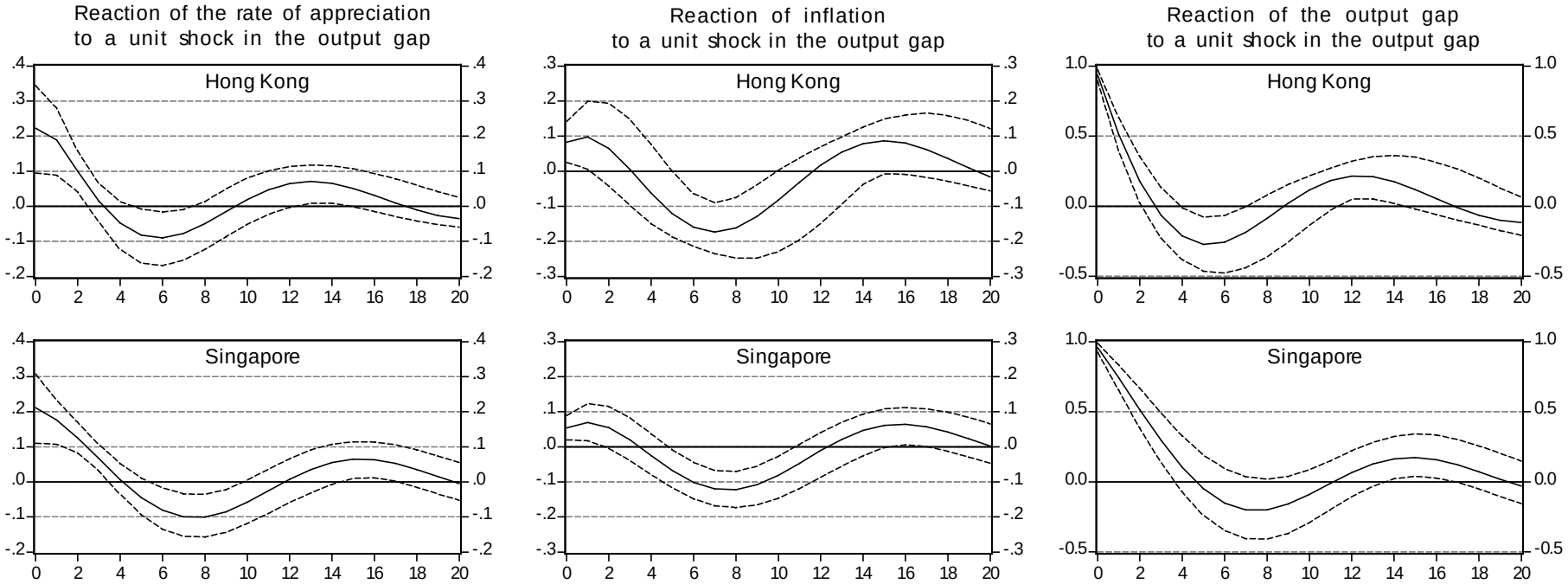


Figure 8

Shock to the rate of appreciation

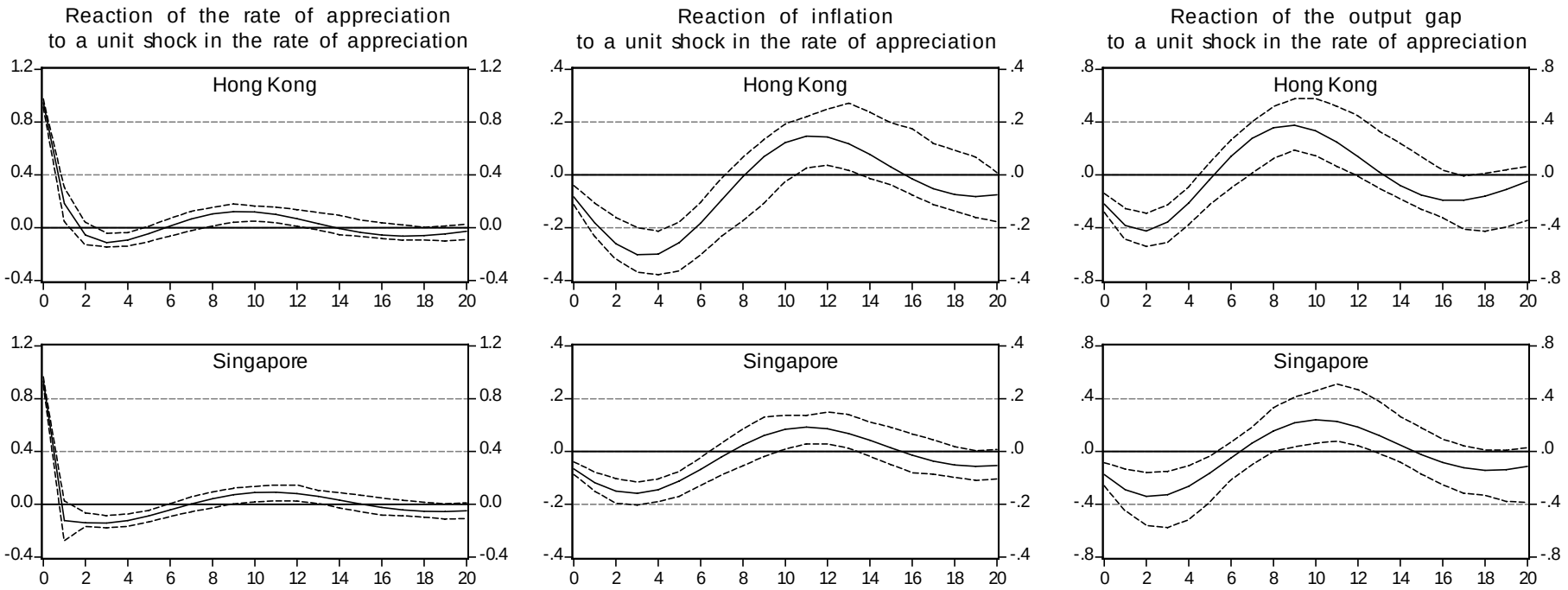


Figure 9

Shock to world prices

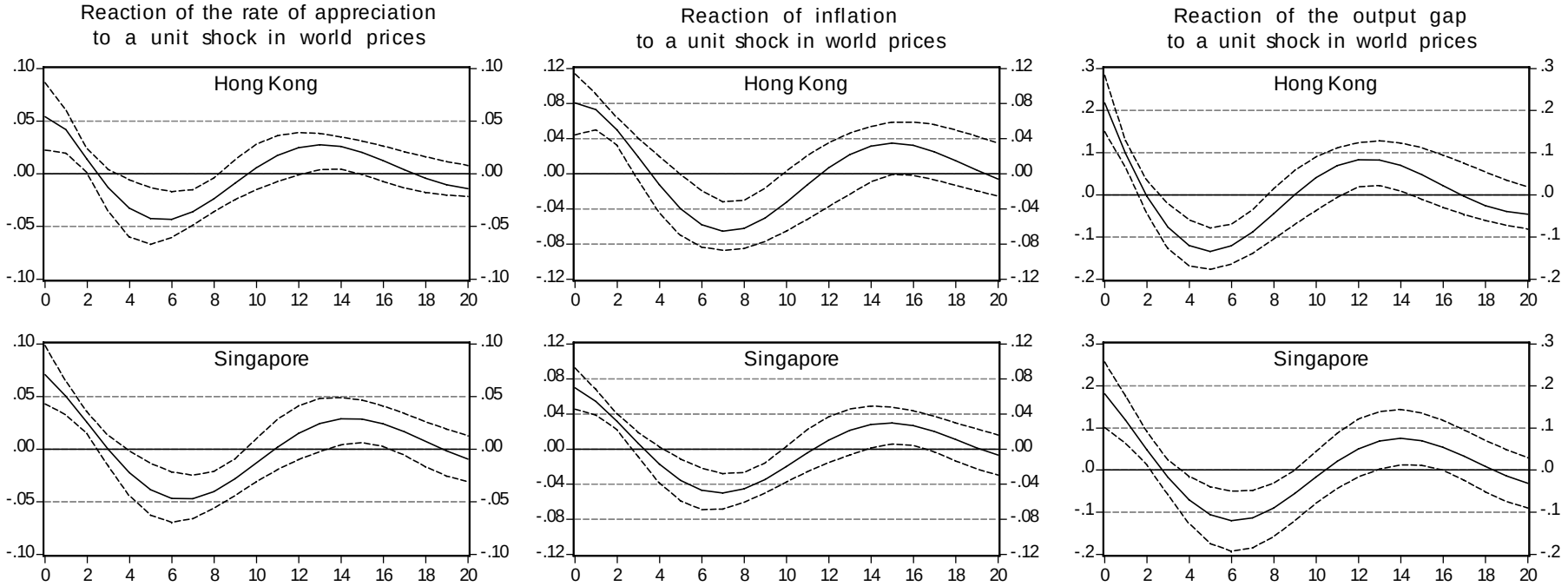
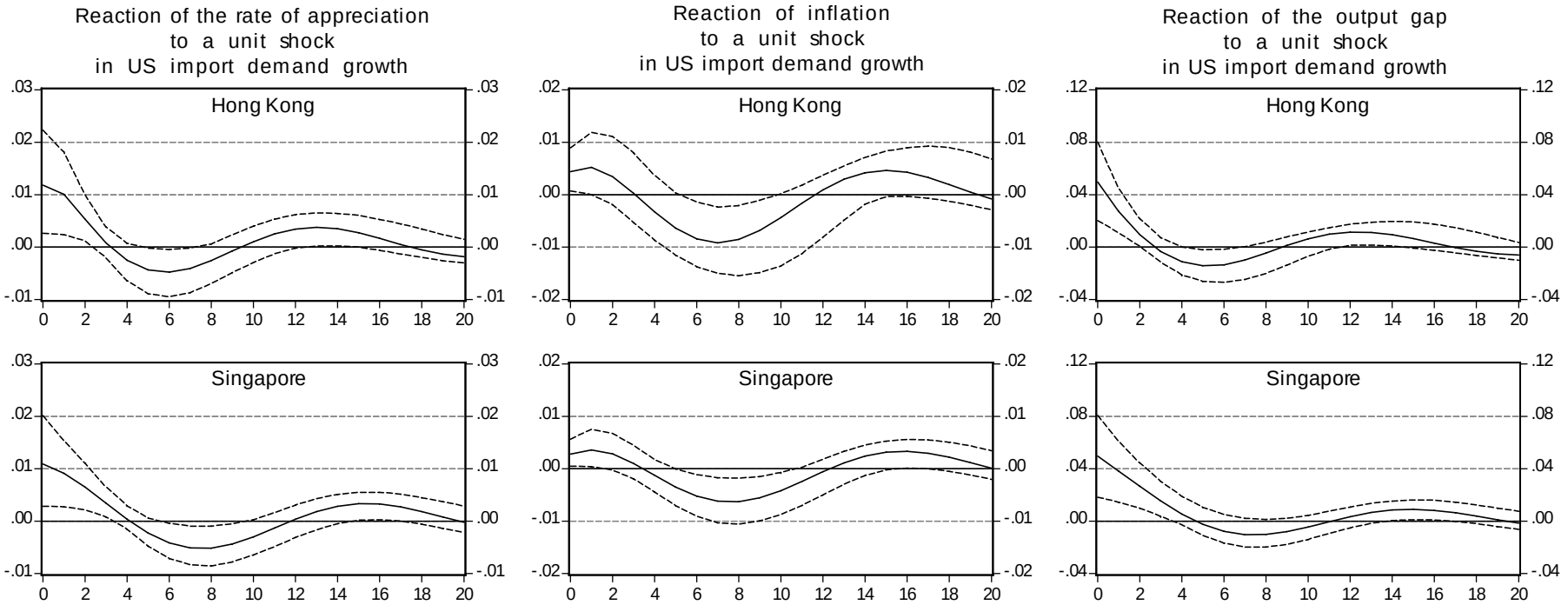


Figure 10

Shock to the growth rate of US import demand



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.[25]

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 a larger number of temporary shocks or that the MAS's efforts to stabilise inflation have led to more protracted responses of output. The last difference is that the responses of inflation to the different disturbances, and the related confidence bands, are typically smaller in Singapore than in Hong Kong, again no doubt due to the authorities' successful efforts to stabilise inflation.

These findings suggest that the different policy frameworks adopted in the two economies have had little impact on the behaviour of the real economy. However, there are at least two reasons for believing that we may underestimate the impact of the MAS's active monetary policy strategy on the real economy. First, little is known about the exact definition of the NEER basket (particularly in the early part of the sample) used by the MAS to steer policy. The difference between our and the correct measure of the NEER introduces a bias in the estimates of unknown magnitude. Second and probably more importantly, the estimates assume that the MAS's policy regime was operational through the entire estimation period. If instead policy was passive under "normal" economic conditions and only turned active in response to occasional large shocks, the estimates may be biased. Assessing the latter hypothesis would require more data about the MAS's conduct of monetary policy than are currently available.

5. Conclusions

The main conclusions from the analysis above are twofold. First, inflation in Singapore has been lower and less volatile, and inflation shocks have been less persistent than in Hong Kong. Of course, this finding reflects the fact that the MAS has adopted an active monetary policy strategy in an effort to stabilise inflation while the HKMA has linked the nominal exchange rate of the HKD to the USD to ensure monetary and financial stability in the face of large external shocks.

Second, despite the different monetary policy frameworks, real economic behaviour has been similar in the two economies. One potential explanation for that finding is that the impact of monetary policy on real economic behaviour has been dwarfed by the effects of the large external shocks Hong Kong and Singapore have experienced in the sample period.

We end by reiterating that the purpose of the analysis has been to assess macroeconomic responses in Hong Kong and Singapore to economic shocks and to explore the potential role of choice of monetary policy strategy in conditioning these reactions. It should be re-emphasised that it is not possible to infer on the basis of these findings whether one policy

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

was more successful than the other. Such a judgement would depend on the objectives of policy makers in the two economies. Given the focus on nominal exchange rate fixity in Hong Kong and on inflation control in Singapore, these preferences appear to have been different.

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