PERSISTENCE OF OUTPUT FLUCTUATIONS UNDER ALTERNATIVE EXCHANGE RATE REGIMES

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Abstract

In a recent paper Giugale and Korobow (2000) present evidence to suggest the time that output takes to return to its trend following a negative shock is faster under a flexible exchange rate regime than under a fixed exchange rate. In this paper VAR models are used to provide empirical evidence on the speed of recovery of real output following an interest rate shock for a number of Asian economies. We find little evidence that the degree of persistence in output is systematically related to the type of exchange rate regime that particular countries have adopted. Across a number of specifications we find that real output for Hong Kong and Australia has the least persistence following a negative interest rate shock. These countries represent the two ends of the spectrum, the former has an exchange rate that is pegged to the U.S. dollar via a currency board and the latter has one of the more flexible exchange rates in the Asian region.

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1. Introduction

In a recent review of international macroeconomics Obstfeld and Rogoff (2000) point to a surprising absence of any strong empirical relationship between exchange rates and macroeconomic variables. They call this the "exchange rate disconnect" puzzle. One manifestation of the disconnection between exchange rates and macroeconomic fundamentals is the empirical finding that while nominal and real exchange rate volatility is much larger under floating exchange rates, there is little difference in the statistical characteristics of macroeconomic variables under fixed and floating exchange rates (Baxter and Stockman, 1989; Flood and Rose, 1995). This finding has a number of possible implications. Flood and Rose point to the difficulties that it creates for traditional models of the exchange rate that are based on macroeconomic fundamentals. A second issue where these findings have some relevance is whether the choice of exchange rate regime is important in helping to insulate an economy (particularly a small open economy) from the effects of external shocks.

A standard argument in favour of a floating exchange rate regime is its perceived effectiveness at insulating an economy from the impact of external shocks (Friedman, 1953). Marston (1985) provides a review of the predictions of various theoretical models about exchange rate insulation. He notes that in general the exchange rate regime with the best insulation properties depends on a number of factors including the nature of the shock and the degree of nominal rigidity in an economy. In light of these model specific predictions there is a small but growing empirical literature that uses formal econometric methods to examine the role of the exchange rate regime in insulating an economy from external shocks (Lastrapes and Koray, 1990; Hutchison and Walsh, 1992; Bayoumi and Eichengreen, 1994; Otto and Kung, 2000; Giugale and Korobow, 2000). These studies typically use small VAR models and appear to find some evidence that exchange rate regimes can matter for insulation purposes.

Hutchison and Walsh, for example, use a four-variable VAR model comprising oil prices, U.S. output, U.S. M1 and Japanese output to examine the insulation issue for Japan. In contrast to the results obtained from using simple unconditional variances and correlations, Hutchison and Walsh find that after accounting for changes in the magnitude of external shocks, the adoption of a floating exchange rate has been more effective at insulating Japanese output from external shocks than was the fixed rate. In a similar vein Otto and Kung examine the relative ability of fixed and floating exchange rates to insulate the Australian economy from external shocks. In a VAR model with U.S. prices and output and Australian prices and output they find that the move from a fixed to a floating exchange rate regime has done little to mitigate the relatively large effect of U.S. aggregate demand and supply shocks on Australian output. However there is evidence that the move to floating exchange rates in the 1980s has helped to insulate Australian prices from external shocks.

Rather than focusing on the relative magnitude of the response of output to various shocks under different exchange rate regimes, Giugale and Korobow (henceforth GK) examine the degree of persistence in output following an external shock. Is the temporary deviation of output from its long-run level following a negative shock more or less persistent under a floating exchange rate regime than under a fixed exchange rate? The authors present evidence from a number of countries suggesting that the decline in real output following a negative external shock is less persistent under a flexible exchange rate regime than under a fixed exchange rate.

While the GK study is quite suggestive, an interesting and open question is whether the authors have identified a robust empirical characteristic of floating and fixed exchange rate regimes. To answer this question further evidence is needed on what GK call exchange rate regime-dependent differential shock persistence. In this paper we re-examine and extend the GK study in a number of ways. While GK focus on Mexico and a number of emerging economies we analyse nine Asian economies.[1] Our motives for focusing on Asian countries include: the relative diversity of exchange rate regimes, from fixed (Hong Kong) through managed floating (Singapore) to relatively free floating (Australia), and the fact that the 1997 Asian crisis represented a large external financial shock for many economies in the region. One extension that we make is to consider a number of different specifications for the VAR model. Essentially we are interested in seeing if the results obtained from GK's model are robust to alternative VAR models.

The remainder of the paper has the following structure. Section 2 provides a review of the GK study and a discussion of the VAR models that are used in this paper. In section 3 we present our empirical results for the countries in our sample. Section 4 contains an analysis of our findings and section 5 concludes.

2. VAR Models

In their study GK use a VAR model comprised of a domestic short-term interest rate, broad money, inflation and industrial production.[2] Using monthly data they initially estimate this model for Mexico over the period 1995:01-2000:02. Since 1995 Mexico has adopted a floating exchange rate. The same VAR is also estimated for Mexico over the period 1987:04-1994:11 when it had a "crawling peg" system and for a number of other countries with non-floating exchange rate regimes.[3]

The authors then compare the relative persistence of real output (industrial production) to a negative external shock in these countries. GK argue that in small open economies like these the domestic interest rate is predominately a function of external shocks and the world interest rate. Therefore it is reasonable to treat an innovation to the domestic interest rate as an external shock. Identification of the interest rate shock is achieved by assuming a recursive ordering for the variables in the system given

1 Two countries appear in both studies: Hong Kong and Thailand.

2 The model is estimated with all variables in levels. The authors recognise the possibility of cointegration among the variables in their system, but argue that any possible efficiency gains from a vector error-correction model are likely to be modest, see Naka and Tufte (1997).

3 Brazil (1994:09-1998:12 - fixed); Thailand (1990:01-1997:06 - fixed); Latvia (1993:09-2000:02 - fixed); Estonia (1994:01-2000:02 - currency board); Hong Kong (1982:03-1998:04 - currency board) and Argentina (1994:06-2000:03 - currency board).

by: interest rate, money, inflation and industrial production. GK report the impulse response functions of industrial production to a one standard deviation shock to the nominal interest rate. They find two interesting results. For Mexico the negative impact of an interest rate shock under the floating regime is much less persistent than under the crawling peg — lasting about 6-9 months compared with 14-18 months. Similarly the cross-country comparisons indicate that all of the other countries with fixed exchange rate regimes display much longer adjustment periods for industrial production. The estimated response time for economies with fixed exchange rates is typically 3-4 times as long as for Mexico under the float.

On the basis of these findings GK draw the following conclusion. They conjecture that the degree of output persistence to an external shock depends on the degree of exchange rate flexibility, with recovery being faster under a more flexible exchange rate regime.

In our view the approach used by GK to examine the question of output persistence raises a number of issues. The authors only consider one country with a floating exchange rate, Mexico post-1995. The remaining countries are all examples of non-floating regimes. Thus one of our objectives is to consider a group of countries with a greater variety of exchange rate regimes. To this end we examine nine Asian economies (see Table 1). These economies cover a range of exchange rate regimes, from Hong Kong which fixes to the USD via a currency board, to Australia which has a floating rate with official intervention primarily limited to reducing the speed with which sudden large movements in the exchange rate occur. In addition there are a number of countries that have managed floats (Moreno, 1995; Caramaza and Aziz, 1998). If GK's findings for Mexico (under floating) are robust then we expect to see quite different degrees of persistence in the output response to an interest rate shock for these nine economies.

Table 1 provides a classification of the exchange rate regime for each country in our sample. This classification should not be taken too literally. At least two countries, Thailand and Malaysia, explicitly changed their exchange rate regime during the period under consideration. However the sample sub-periods are too short to be useful for estimation purposes. Some support for our classification is provided by the measures of exchange volatility reported in Table 1 that use pre-Asian crisis data. Volatility is measured as the standard deviation of the quarterly percentage change in the country's nominal exchange rate relative to the U.S. dollar. The three countries with the greatest volatility are Japan, the Philippines and Australia. Not surprisingly Hong Kong has the least variable exchange rate. The remaining countries, Singapore, Korea, Taiwan, Malaysia and Thailand, all have quite similar degrees of exchange rate volatility. The impact of the Asian crisis is most evident in the sharp jump in volatility for Korea, Malaysia and Thailand when data for the full sample are used for estimation.

Unlike GK we use a number of VAR models to provide empirical evidence on the issue of output persistence. We begin by considering a model — Model 1 — that is essentially the same as that used by GK. Model 1 is a four-variable VAR that is comprised of a domestic nominal interest rate (r),

money (m), inflation (π) and real output (y).[4] The major difference between this specification and that used by GK is that we use constant price GDP rather than industrial production to measure real output. In our view the advantage of using GDP rather than industrial production is its broader coverage of real output. For many countries, manufacturing production represents a declining share of their total production of goods and services. Identification of the VAR is achieved by imposing a recursive ordering of $\{r, m, \pi, y\}$. This is consistent with the domestic interest rate in small open economies being (largely) determined by external shocks and world interest rates. While the theoretical justification for a recursive structure for the other three variables is less obvious, we simply follow Giugale and Korobow's lead on this issue.[5]

One issue with the GK study is whether shocks to the *domestic* interest rate are a good proxy for external shocks. While this may be a reasonable assumption under fixed exchange rates, it is less clearly so for more flexible regimes. With a floating exchange rate domestic and world interest rates can differ even with perfect capital mobility, so there is a question as to whether we can view the innovation in domestic interest rates for countries with floating regimes as a good indicator of an external shock.[6] A simple test of the validity of using domestic rates is to replace them with a world or foreign interest rate series and see if similar results are obtained. In this study we use the U.S. Federal Funds rate as a proxy for foreign interest rates. Thus Model 2 comprises a foreign interest rate (r^*), money, inflation and real output. Once again we identify the shocks by assuming a recursive structural form, $\{r^*, m, \pi, y\}$.

To examine the robustness of our empirical results we consider two other specifications for the VAR model. Model 3 replaces the money supply with the domestic interest rate to yield $\{r^*, r, \pi, y\}$. The motivation for this specification is the widespread view in central banks that monetary aggregates play a largely passive role in monetary policy and economic activity (Walsh, 1998). In addition, for many countries financial innovation and deregulation have made money supply figures increasingly volatile and difficult to interpret. Finally, Model 4 is a five-variable VAR — $\{r^*, r, m, \pi, y\}$ — that encompasses all of the preceding models. Both of these models allow us to examine the link between foreign and domestic interest rates.

Like GK we estimate the VAR models in levels (logarithms of real output and the money stock are used). Given our relatively short sample periods of about 20 years we approximate any trends in the data by including a linear time trend in the model.[7] The relatively small number of observations also limits the lag-length of the VAR models. All of the results reported in this paper are based on VAR models with two lags. In practice, results obtained from models with up to four lags are generally similar to those reported.

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4 Like GK we specific the VAR models in the levels of all of the variables. A linear time trend is included in the model to capture any deterministic trends. While it is likely that some of the variables in the model, in particular money and output, contain stochastic trends, the VAR in levels will still provide consistent parameter estimates and valid impulse response functions.

5 In practice, varying the order of the latter three variables does not alter our findings in a significant manner.

6 Compare the behaviour of Australian and N.Z. short-term interest rates around the time of the Asian crisis. Australian interest rates were relatively constant, while its exchange rate depreciated, whereas N.Z. rates rose quite steeply. In this episode the domestic interest rate for Australia was not a particularly good indicator of the external shock associated with the Asian crisis.

7 In the case of Australia we use a dummy variable on the trend that allows a break in 1991:1 (Perron, 1989).

3. Output Persistence in Asian Economies

In this section we briefly describe the data used in the study and report the results obtained from estimating the different VAR models. To keep things manageable we do not report detailed results for all nine countries, rather we use Hong Kong as a reference country. Hong Kong is the only country in our sample with a fixed exchange rate and based on the findings of GK should have one of the most persistent real output responses. In sub-section 3.2 we present relatively detailed results for Hong Kong for each of Models 1 to 4. Specifically, we report the response of each variable in the VAR to financial shock, where this is proxied either by a shock to the domestic interest rate (r) or to the foreign interest rate (r^*). This provides some indication, at least for Hong Kong, on whether the VAR models and the identification scheme produce intuitively plausible impulse response functions. In sub-section 3.3 we compare the impulse response functions for each country in the sample for the different VAR models. Finally in sub-section 3.4 we examine the effect of including the real exchange rate in the model.

3.1 Data

The main variables used in the study for each country are the following: a short-run nominal domestic interest rate, the U.S. Federal Funds rate, the money stock, inflation, GDP in constant prices and the real bilateral exchange rate against the U.S. dollar. The data used in this study are all taken from the CEIC and the International Financial Statistics databases. Definitions of the variables for each country are provided in the Data Appendix. In general we have tried to use similar measures of variables for all countries. However this is not always possible due to the unavailability of some series for particular countries, e.g. we use M1 as our measure of the money stock for all countries except Hong Kong, Taiwan and Thailand where M2 is used. All series are quarterly and we have used data back to the beginning of the 1980s where possible.[8] For some countries data are only provided on a seasonally unadjusted basis and when this is the case seasonal dummy variables are included in the VAR models.

3.2 Results for Hong Kong

In this sub-section we present selected impulse response functions obtained from estimating the different VAR models for Hong Kong. Since the VAR models all include a time trend, the responses of the variables to a given shock should be interpreted as being changes around trend. We begin by reporting results from Model 1 — our baseline four-variable VAR comprised of the domestic interest rate, nominal money, inflation and real output.

While we are primarily interested in the response of real output to an interest rate shock, Figure 1 reports the impulse response functions of all four variables to a one standard deviation shock to r (1.17 per cent). The signs of the impulse responses for money, inflation and real output are broadly consistent with what would be anticipated when the rise in the interest rate reflects a negative external shock. There is an immediate fall in money holdings, which then slowly return to their trend level. In the case of

8 For Thailand and Malaysia only annual data for constant price GDP are available for much of the 1980s. In this case we used simple linear interpolation to convert the annual observations into quarterly observations.

inflation the initial effect of the interest rate shock is a small (but very short-lived) rise in the inflation rate following the shock to interest rates, however inflation subsequently falls below trend for about 10 quarters. The initial rise in inflation is an example of what has become known in the empirical VAR literature as the price puzzle (Leeper, Sims and Zha, 1996). The puzzle is that in certain VAR specifications the price level tends to rise (rather than fall) in response to a rise in interest rates.[9] The standard interpretation of the price puzzle is that the VAR model is mis-specified in some manner. Conventional economic theory suggests that a rise in the nominal interest rate that is exogenously induced, either by policymakers or by some external shock, should reduce inflation (along with reducing output). However it is possible in our VAR that the rise in nominal interest rates is occurring in anticipation of a future rise in inflation, either because policymakers or financial markets are forward-looking. One resolution of the price puzzle that has been found for VAR models that use U.S. data is to include commodity prices as an additional variable in the VAR. The economic reasoning is that commodity prices act as a predictor of future inflation.

Since the initial rise in inflation is much smaller than the shock to nominal interest rates, the real interest rate rises. This rise in real rates is associated with a fall in real output below trend and eventually a fall in the rate of inflation. Like inflation, real output takes about three quarters to fall below trend after the rise in interest rates. Output achieves its maximum decline of about 0.5 per cent after six quarters and has returned to trend by 13 quarters or about three years. This recovery speed is faster than that found by GK for Hong Kong. They find that real output (measured by industrial production) takes at least 48 months (more than four years) to return to trend after an interest rate shock. Finally, one other notable characteristic of the impulse response functions is that they display some dampened cyclical behaviour.

As we have already noted, one potential problem with GK's VAR model is whether the domestic interest rate is necessarily a good proxy for external shocks. A simple test of the validity of using domestic rates is to replace them by a foreign (world) interest rate series and see if similar results are obtained. To this end we replace the domestic interest rate for Hong Kong in the VAR with the U.S. Federal Funds rate (r^*). This is our Model 2. Figure 2 presents the impulse response functions given a one standard deviation shock to r^* (0.41 per cent). It is apparent that the qualitative pattern of responses is very similar to those based on the domestic interest rate. The major differences are that with a foreign interest rate shock it takes slightly longer for output to achieve its maximum decline (about eight quarters rather than six) and the output decline is more persistent, with output taking 18 as opposed to 13 quarters to return to trend. This degree of output persistence is closer to what GK found for Hong Kong.

The results in Figures 1 and 2 suggest that for Hong Kong the domestic interest rate is largely driven by external influences. However, some further evidence on this issue can be obtained by allowing the VAR to include both foreign and domestic interest rates. Figure 3 shows the impulse responses from a four-variable VAR comprised of $\{r^*, r, p, y\}$ given a one standard deviation shock to r^* (0.36 per cent). Notice that the shock to the Federal Funds rate produces a very similar response in the Hong Kong

9 Since Giugale and Korobow do not report the response of inflation to an interest rate shock we cannot say whether or not their empirical model exhibits an anomalous price response.

interest rate. This provides support for the view that external factors are a key influence on domestic interest rates in Hong Kong. The responses of inflation and real output are similar to Figures 1 and 2. While real output still shows an initial rise, it is relatively short-lived. What is interesting about this VAR is that it suggests greater persistence of output to the external shock, with output taking more than 10 years to return to trend.

Figure 4 presents the impulse responses for the five-variable VAR comprised of $\{r^*, r, m, \pi, y\}$. We consider the responses to a one standard deviation shock to r^* (0.34 per cent). Again the strong response of the Hong Kong interest rate to a foreign interest rate is evident. In contrast to the other VAR models, inflation and output show an initial and relatively persistent rise in response to the foreign interest rate shock. While both variables eventually fall below trend in response to the rise in r^*, this does not occur until at least one year after the initial shock. While there can certainly be lags in response to interest rate shocks, the initial rise in output and inflation combined with its persistence is somewhat puzzling and suggests that the five-variable VAR is not an entirely appropriate specification for Hong Kong.

Figures 1 to 4 report point estimates of the impulse response functions; however it is important to get some indication of the degree of uncertainty surrounding these estimates. We compute standard error bounds for these impulse response functions using a Monte Carlo procedure with 1000 draws (Doan, 1996). The response of output to the interest rate shock in each of the four models along with one standard deviation error bounds are reported in Figure 5. Notice that for all of the models except Model 4 the fall in real output in response to the interest rate shock is significantly different from zero.

In order to summarise the results for the different VAR models, Figure 6 presents the response of output to the various interest rate shocks. Notice that all models indicate that a positive shock to the foreign interest rate will temporarily reduce real output in Hong Kong below trend. A half per cent rise in the Federal Funds rate will reduce real output below trend by approximately about half a per cent after about 1-2 years following the shock. The effect of the shock appears to be reasonably persistent, with our VAR models indicating that it takes a minimum of three years for output to return to trend. One interesting finding is the interest rate shocks do not seem to produce a permanent effect on the level of Hong Kong output. This provides some support for the use of a deterministic time trend in the VAR models.

3.3 Other Asian Economies

Each of the four VAR models was estimated for the other Asian economies in our sample. Interestingly, of all the four models, Model 1 produces the most consistent results across all of the countries. In particular a positive interest rate shock is always associated with a fall in real output below trend. Figure 7 shows the response of real output to a one standard deviation (domestic) interest rate shock for all nine economies. Note that because we have not standardised the size of the shock across countries the magnitudes of the output responses are not directly comparable. However, the persistence of the various responses can be compared. It is apparent from Figure 7 that two countries, Hong Kong and the Philippines have the most rapid recovery times for real output following a negative financial shock —

about 13 quarters. The recovery times of the other seven countries tend to fall into two clusters. The most persistent output effects occur in Thailand, Japan, Korea and Taiwan. Real output in these four countries is very slow to recover from an interest rate shock. Thailand, in particular, displays a very large and persistent response, which (as we show below) is influenced by the period of the Asian crisis. Singapore, Malaysia and Australia have output responses that lie between the two extremes. Recovery times for the first two countries are very similar and are approximately double that of Hong Kong and the Philippines, while Australia has the third quickest recovery time of about 15-16 quarters.

The main implication of Figure 7 is that for our group of countries there does not seem to be any systematic relationship between output persistence and the exchange rate regime. For example, while Australia and Hong Kong both show low persistence relative to other Asian economies the countries have very different exchange rate regimes. Australia has a relatively freely floating exchange rate while Hong Kong has a highly credible fixed exchange rate regime.

One question about the above results is the extent to which they are influenced by the impact of the Asian crisis. During this period some of the countries in our sample experienced a large depreciation of their currency, in particular Malaysia, Thailand and the Philippines. One result of the crisis was that Malaysia moved from a managed float to a fixed exchange rate regime in September 1998. In Figure 8 we compare the impulse responses for output obtained from full sample data with those obtained using data prior to the Asian crisis, i.e. up to 1997:2. Some interesting results emerge. For Hong Kong, Taiwan, the Philippines and Australia, very similar estimates of output persistence are obtained from the two sample periods. For the remaining five countries there seem to be some important differences. In the case of Malaysia, Singapore and Korea, the response of output to the interest rate shock is no longer negative if we only use data prior to the Asian crisis. This suggests that for these economies the observations from the crisis period are very influential in obtaining a negative response in real output to an interest rate shock. In the case of Thailand, using only pre-crisis data implies a small negative output response compared with the large and very persistent response obtained from the full sample of data. Finally, for Japan, the output response becomes much more persistent when post-crisis data is used in the estimation. While the different sample periods do produce some differences in the impulse response functions for some countries, Hong Kong, the Philippines and Australia display the least persistence in output regardless of the sample that is used for estimation.

We now consider whether the above findings about relative persistence obtained with Model 1 are robust to the use of the other VAR specifications. Figure 9 shows the responses where the domestic interest rate is replaced with the U.S. Federal Funds rate. While this change to model specification has little impact for Hong Kong, this is not the case for a number of other countries in the sample. When a shock to the Federal Funds rate is used to proxy a financial shock, the output response for both the Philippines and Japan is positive rather than negative. Therefore we do not include these countries in Figure 9. Notice that although Singapore displays a large initial positive output response, it does eventually become negative after 12 quarters. For the other countries, negative output responses are obtained. Hong Kong and Australia have the least persistent output responses and Thailand and Korea have the most persistent responses to a Federal Funds shock.

Figure 10 presents the responses of output to a Federal Funds shock for Model 3. In this case we have excluded Singapore and the Philippines since they have positive output responses. Hong Kong, Australia and Malaysia show the least persistence for this model. Figure 11 contains the results for Model 4. All countries except the Philippines are included. For the Philippines there is only a brief decline in real output and that is followed by a substantial rise. The results for the other countries are similar to those for Model 2; Hong Kong and Australia show the least persistence and Thailand and Korea the most persistence.

3.4 The Real Exchange Rate

In this section we consider the effect on our results of including a measure of the real exchange rate (*q*) in the VAR model. Even though some countries may choose not to allow their nominal exchange rate to adjust in response to a financial shock, adjustment may occur through the real exchange rate. Thus in Model 5 we replace the money stock with the real exchange rate to give — $\{r^*, r, q, \pi, y\}$. Again there is some question about how to order the last four variables in the system. For countries with more flexible nominal exchange rates the real exchange rate will probably respond to a change in the foreign interest rate before inflation and real output (and possibly before the domestic interest rate). Alternatively where the nominal exchange rate is less flexible, changes in the real exchange rate may be driven by changes in the domestic price level. Our somewhat arbitrary choice is to place the real exchange rate after the interest rate variables but before domestic inflation and real output.

The real exchange rate for each country is measured as the real bilateral exchange rate against the U.S. dollar. Figure 12 shows the response of real output on a one standard deviation shock to the Federal Funds rate for all countries except the Philippines (which again exhibits a positive output response). In fact the results are quite similar to those obtained from Model 3 in that Hong Kong, Australia and Malaysia display the least persistence in real output. Thus inclusion of the real exchange rate does not alter our basic finding.

4. Discussion

Are there any robust patterns across all five VARs? In general Hong Kong and Australia consistently display the least persistence in real output following a financial shock. Korea, Thailand and Taiwan generally display the most persistent output responses. We also find that recovery speeds tend to be more rapid when we use a shock to domestic interest rates rather than the Federal Funds rate to proxy an external financial shock. In our view it is likely that for countries with flexible exchange rates the domestic interest rate shock is capturing a combination of external and domestic financial shocks.

The results from the nine Asian countries that we have examined do not support the view that output persistence is systematically lower under a floating exchange rate. We find that two countries with exchange rate regimes at the ends of the spectrum typically have the least persistence in real output. One question that arises is what factors might explain our finding of relatively low persistence for Hong Kong and Australia. As Marston (1985) notes, the fundamental cause of persistence to an aggregate

demand shock is likely to be the degree of wage and price flexibility in an economy. If the degree of nominal rigidity in an economy is low then the need to have a flexible exchange rate to aid adjustment to demand shocks (at least) is reduced. In the case of Hong Kong, a high degree of wage and price flexibility may substitute for changes in the nominal exchange rate. In the case of Australia, over the last two decades successive governments have implemented policies aimed at deregulating the Australian economy and increasing competition. To the extent that these have been successful we would expect to see an improved ability of the Australian economy to withstand and recover from negative shocks. One area where the Australian economy appears to be somewhat less flexible than Hong Kong is the labour market. However, it may be that this is one area where Australia's floating exchange rate can compensate for not having as great a flexibility as Hong Kong.

Following the Asian crisis there has been a debate about the need for countries to choose either a very "hard" fixed exchange rate or a relatively free floating rate (Frankel, Schmukler and Serven, 2000; Grenville 2000). It has been argued that intermediate exchange rate regimes such as flexible pegs are no longer viable.[10] Interestingly our results provide some support for this position. The two countries with the less persistent output responses are those with exchange rate regimes closest to the ends of the spectrum. It is also the case that these are two of the countries in the region that were least affected by the Asian crisis.

5. Conclusion

In this paper we examine the claim that the degree of output persistence following a financial shock can be linked to a country's exchange rate regime. In particular, we test the proposition that output persistence is lower under a more flexible exchange rate regime. Using a sample of nine Asian countries we did not find any systematic relationship between output persistence following a financial shock and the degree of flexibility of the exchange rate regime adopted by the various countries. If anything, our results indicate that it is more important to choose either a fixed rate or a floating rate rather than some intermediate regime.

The question as to what factors explain differences in output persistence (following various types of shocks) is an interesting one. In this paper we have used some standard VAR models to compare output persistence following a financial shock. Some checks for the robustness of our results have been undertaken by using a number of alternative VAR models. However, because of our interest in comparing results for a number of countries we have kept the VAR models relatively simple. Further work could be done to try and customise the VAR models for each economy along the lines of Brischetto and Voss (1999) for the Australian economy. In particular, alternative identification schemes could be used to test the robustness of the findings in this study. It might also be interesting to consider measures of financial shocks other than short-term interest rates such as other asset prices. Finally, while we have focused on the persistence of real output in this paper, other macroeconomic variables could usefully be considered.

10 Calvo and Reinhart (2000) present empirical evidence that suggests the decline in intermediate exchange rate regimes is more apparent than real.

References

Baxter, M. and A. Stockman (1989), "Business Cycles and the Exchange Rate Regime," *Journal of Monetary Economics*, 23: 337-400.

Bayoumi, T. and B. Eichengreen (1994), "Macroeconomic adjustment under Bretton Woods and Post-Bretton-Woods Float: An Impulse-Response Analysis," *The Economic Journal*, 104: 813-27.

Brischetto, A. and G. Voss (1999), "A Structural Vector Autoregression Model of Monetary Policy in Australia," RDP 1999-11, Reserve Bank of Australia, Sydney.

Caramaza, F. and J. Aziz (1998), "Fixed or Flexible? Getting the Exchange Rate Right in the 1990s," Economic Issues, No.13, International Monetary Fund.

Calvo, G. and C. Reinhart (2000), "Fear of Floating," NBER Working Paper No.7993.

Crosby, M. (2000), "Exchange Rate Volatility and Macroeconomic Performance in Hong Kong," Working Paper No. 3/2000, HKIMR.

Doan, T (1996), RATS User's Manual Version 4, Estima, Evanston.

Flood, R and A. Rose (1995), "Fixing Exchange Rates: A Virtual Quest for Fundamentals," *Journal of Monetary Economics*, 36: 3-38.

Frankel, J., S. Schmukler and L. Serven (2000), "Verifiability and the Vanishing Intermediate Exchange Rate Regime," NBER Working Paper No. 7901.

Friedman, M. (1953), "The Case for Flexible Exchange Rates," in Essays in Positive Economics, University of Chicago Press, Chicago, pp. 157-203.

Giugale, M. and A. Korobow (2000), "Shock Persistence and the Choice of Foreign Exchange Regime: An Empirical Note from Mexico," Policy Research Working Paper No. 2371, World Bank.

Grenville, S. (2000), "Exchange Rate Regimes for Emerging Markets," Reserve Bank of Australia Bulletin, November, pp. 53-63.

Hutchison, M. and C. Walsh (1992), "Empirical Evidence on the Insulation Properties of Fixed and Flexible Exchange Rates: The Japanese Experience," *Journal of International Economics*, 32: 241-63.

Lastrapes, W. and F. Koray (1990), "International Transmission of Aggregate Shocks Under Fixed and Flexible Exchange Rate Regimes: United Kingdom, France and Germany, 1959 to 1985," *Journal of International Money and Finance*, 9: 402-23.

Leeper, E., C. Sims and T. Zha (1996), "What Does Monetary Policy Do?" *Brookings Papers on Economic Activity*, 2: 1-78.

Maston, R. (1985), "Stabilization Policies in Open Economies," in Handbook of International Economics, Vol. 2, R.W. Jones and P.B. Kenen (eds.), Amsterdam: North Holland.

Moreno, R. (1995), "Macroeconomic Behavior During Periods of Speculative Pressure or Realignment: Evidence from Pacific Basin Economies," *Economic Review*, Federal Reserve Bank of San Francisco, 3: 3-16.

Naka, A. and D. Tufte (1997), "Examining Impulse Response Functions in Cointegrated Systems," *Applied Economics*, 29: 1593-603.

Obstfeld, M. and K. Rogoff (2000), "The Six Major Puzzles in International Macroeconomics: Is There a Common Cause," NBER Working Paper No. 7777.

Otto, G. and J. Kung (2000), "Insulation Properties of Australia's Floating Exchange Rate Regime," mimeo, University of New South Wales.

Perron, P. (1989), "The Great Crash, the Oil Price Shock and the Unit Root Hypothesis," *Econometrica*, 57: 1361-401.

Walsh, C. (1998), Monetary Theory and Policy, MIT Press, Cambridge.

Table 1: Country, Sample Period and Exchange Rate Regime

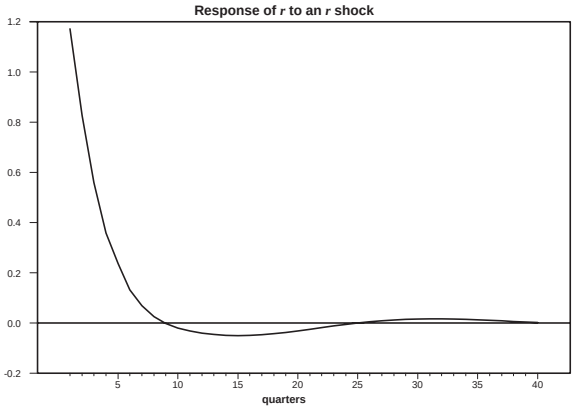
Country	Period	Regime	Volatility	
			Full Sample	Pre-Crisis
Hong Kong	1984:1-2000:2	Currency Board	0.209	0.226
Singapore	1980:2-2000:2	Managed Float	2.710	2.195
Korea	1980:4-2000:2	Managed Float	6.711	2.110
Philippines	1980:2-2000:2	Floating	6.709	5.276
Taiwan	1982:4-2000:2	Managed Float	2.581	2.149
Australia	1984:1-2000:2	Floating	4.905	4.969
Japan	1980:2-2000:2	Floating	6.584	6.503
Malaysia	1982:1-2000:2	Managed Float[1]	4.928	2.273
Thailand	1980:2-2000:2	Managed Float[2]	6.819	2.652

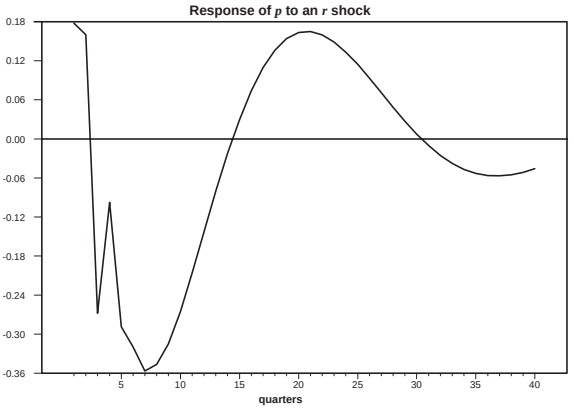
Notes to Table: Volatility is measured as the standard deviation of the quarterly percentage change in the country's nominal exchange rate relative to the U.S. dollar. Pre-crisis data includes observations up to and including 1997:2.

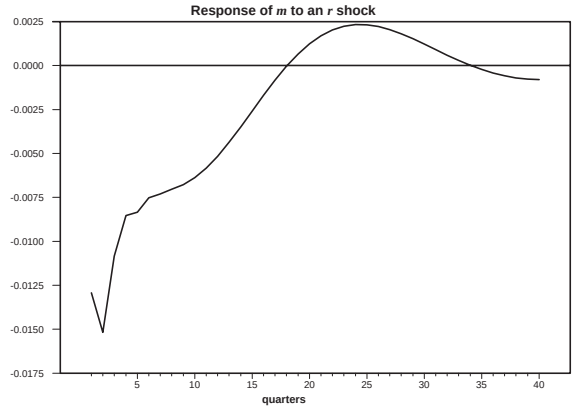
[1] Malaysia has fixed its currency to the U.S. dollar since 1998:3.

[2] Thailand had a fixed exchange rate against the U.S. dollar during the period 1981:4 to 1984:3.

Figure 1: Impulse Response Functions for Hong Kong — Model 1 {*r*, *m*, *π*, *y*}







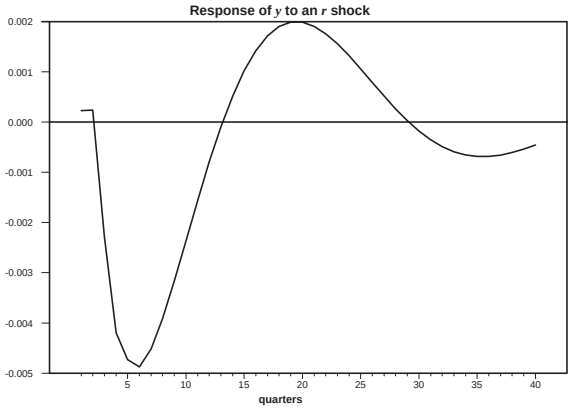


Figure 2. Impulse Response Functions for Hong Kong — Model 2 {r^*, m, π, y}

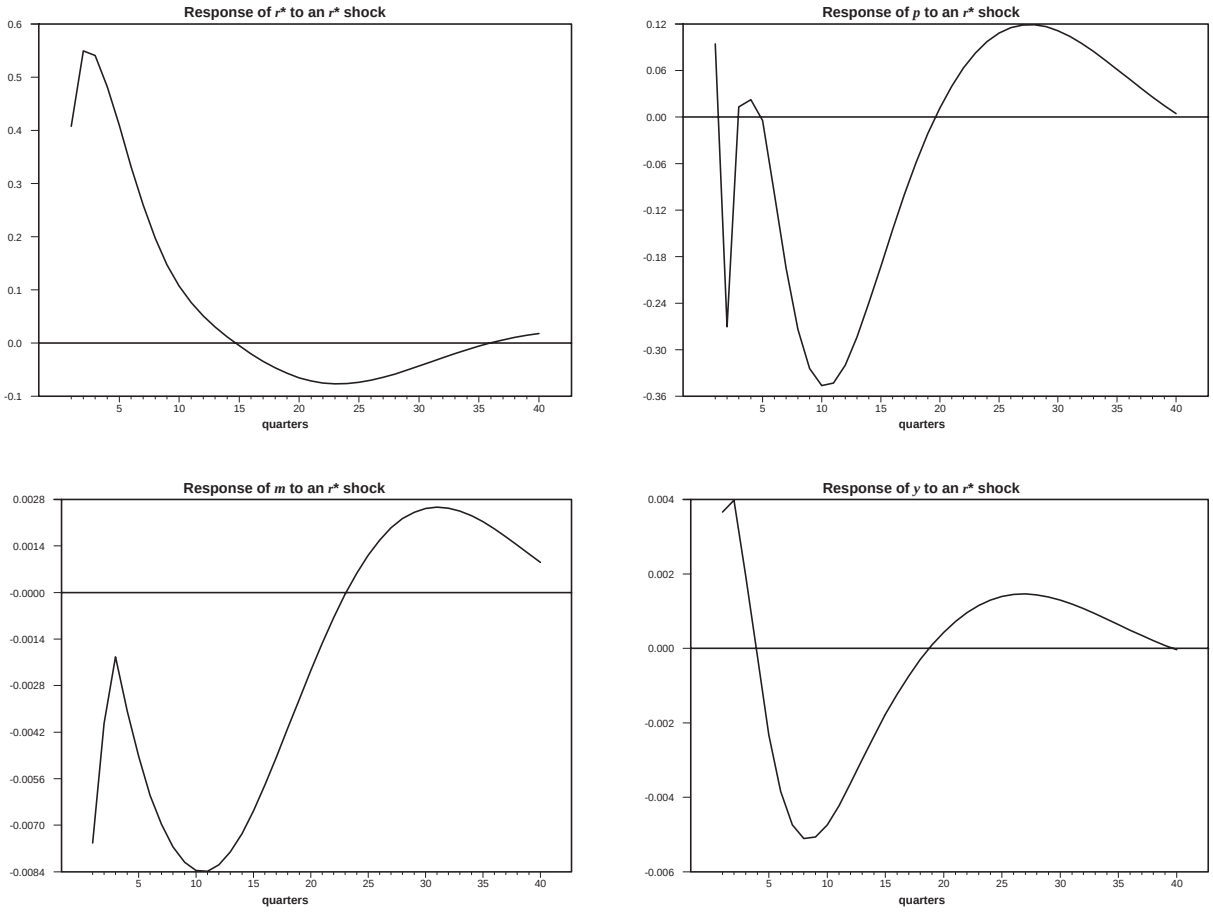


Figure 3: Impulse Response Functions for Hong Kong — Model 3 {r^*, r, π, y}

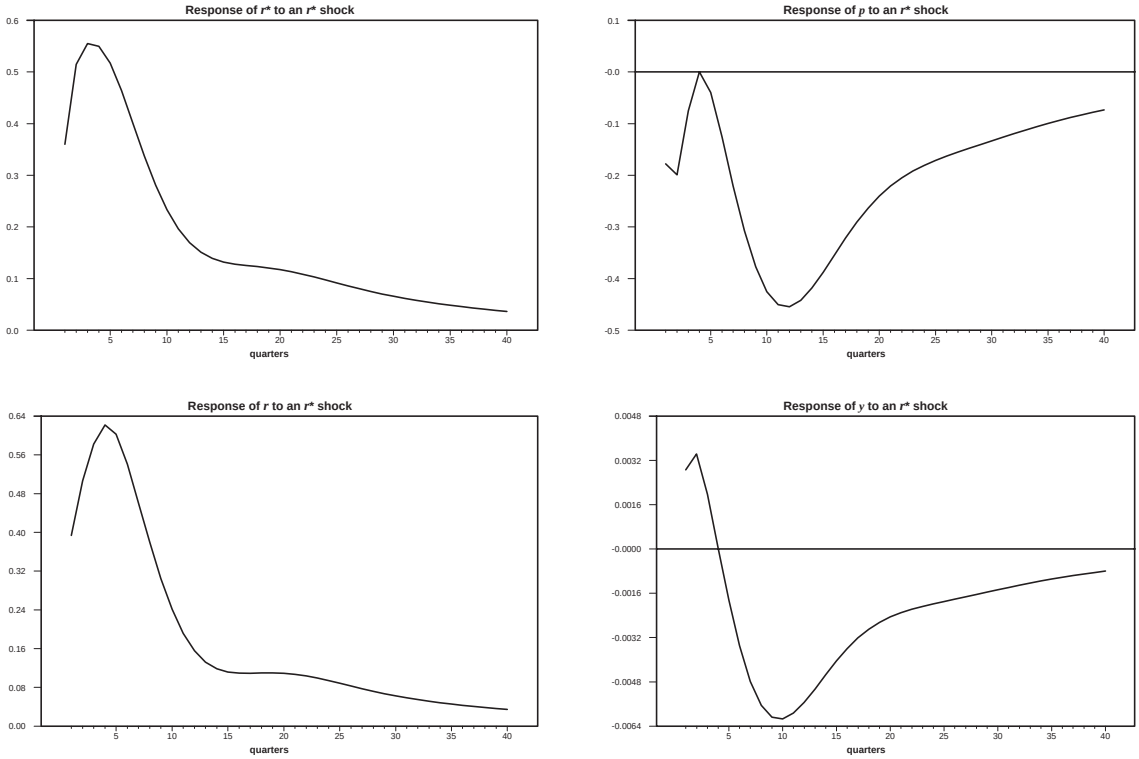


Figure 4: Impulse Response Functions for Hong Kong — Model 4 *{r*, r, m, π, y}*

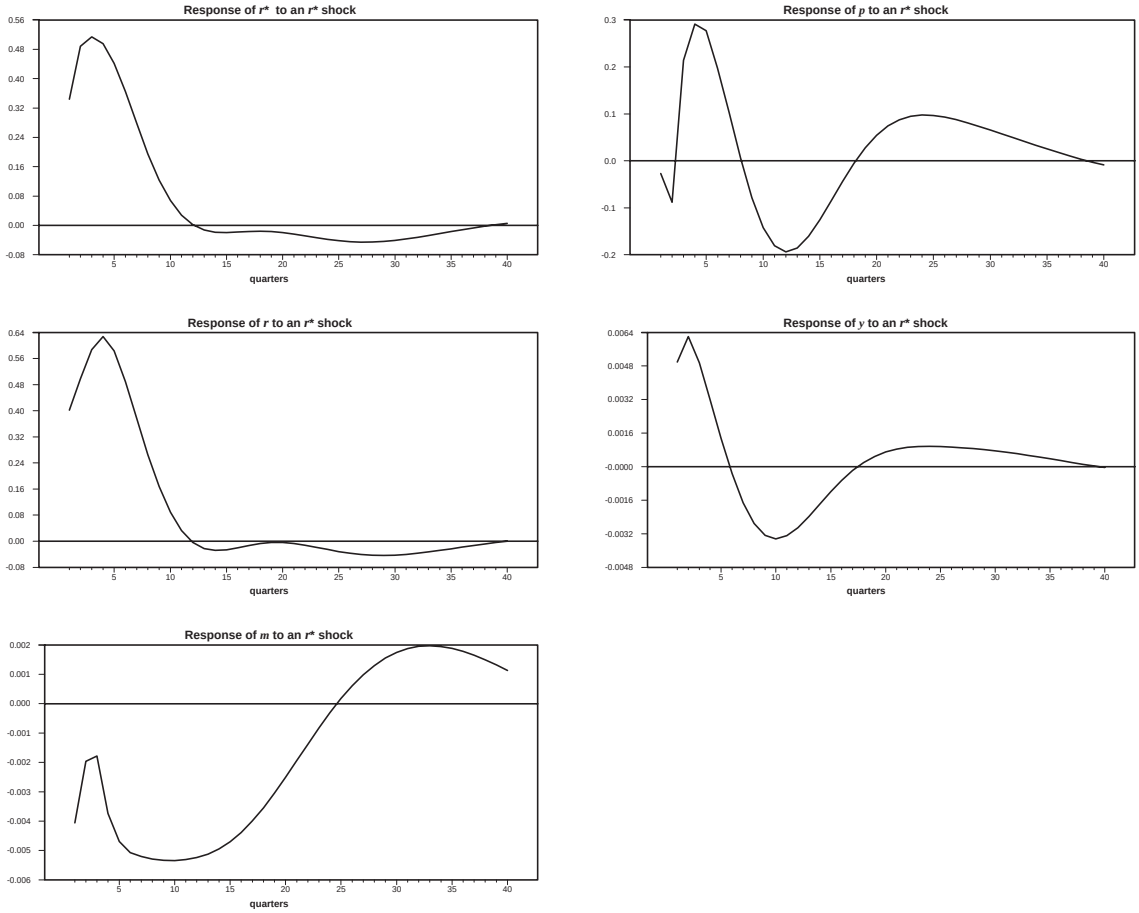


Figure 5: Impulse Responses for HK Output — one standard error bounds

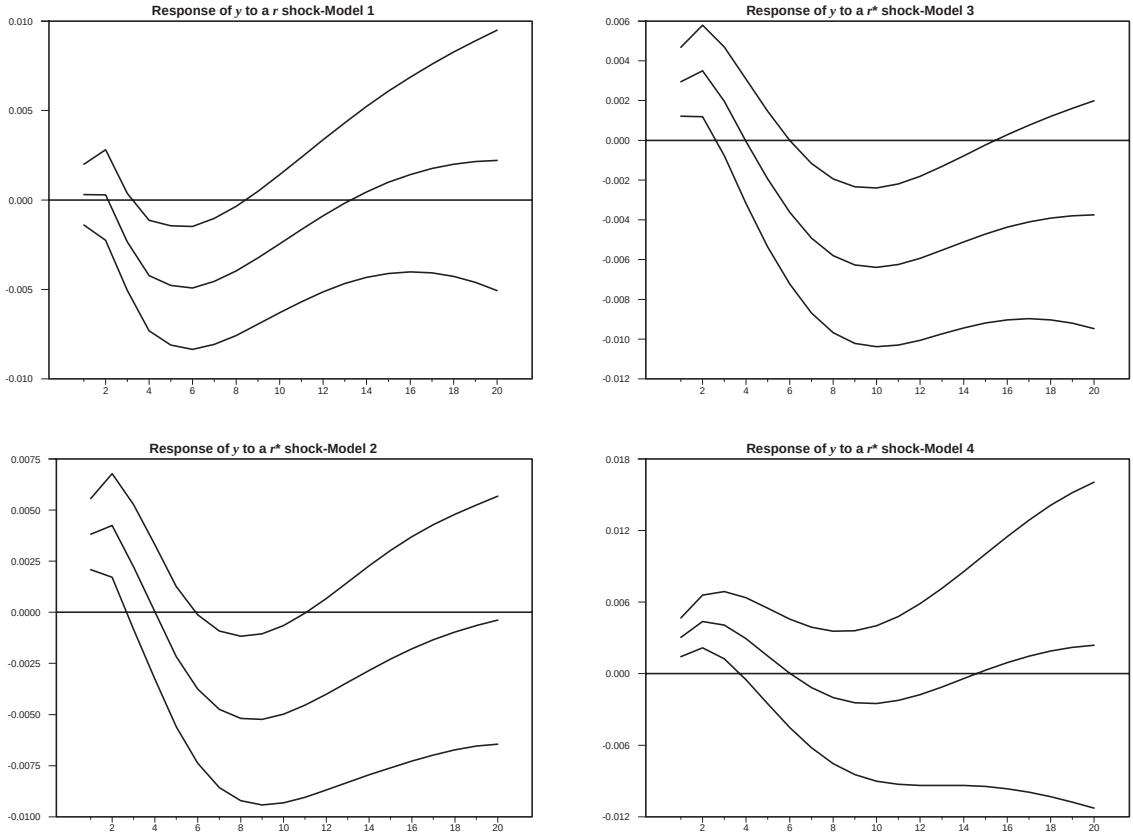


Figure 6: Impulse Responses for Hong Kong Output — Model 1 to 4

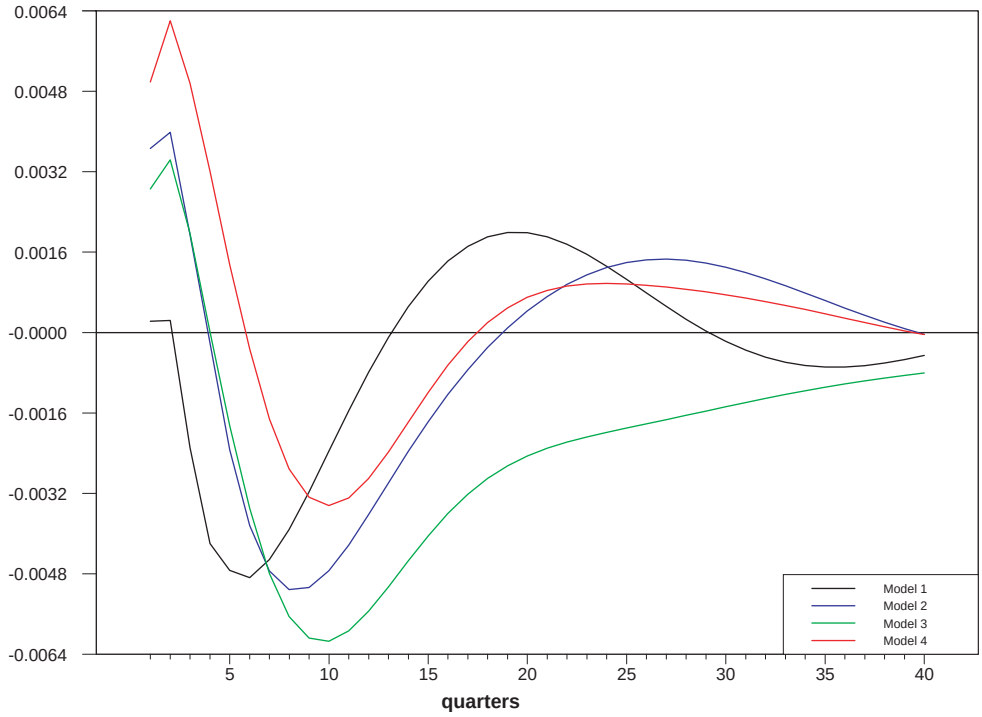


Figure 7: Comparison of Impulse Responses of Output to a Domestic Interest Rate Shock for Asian Countries — Model 1

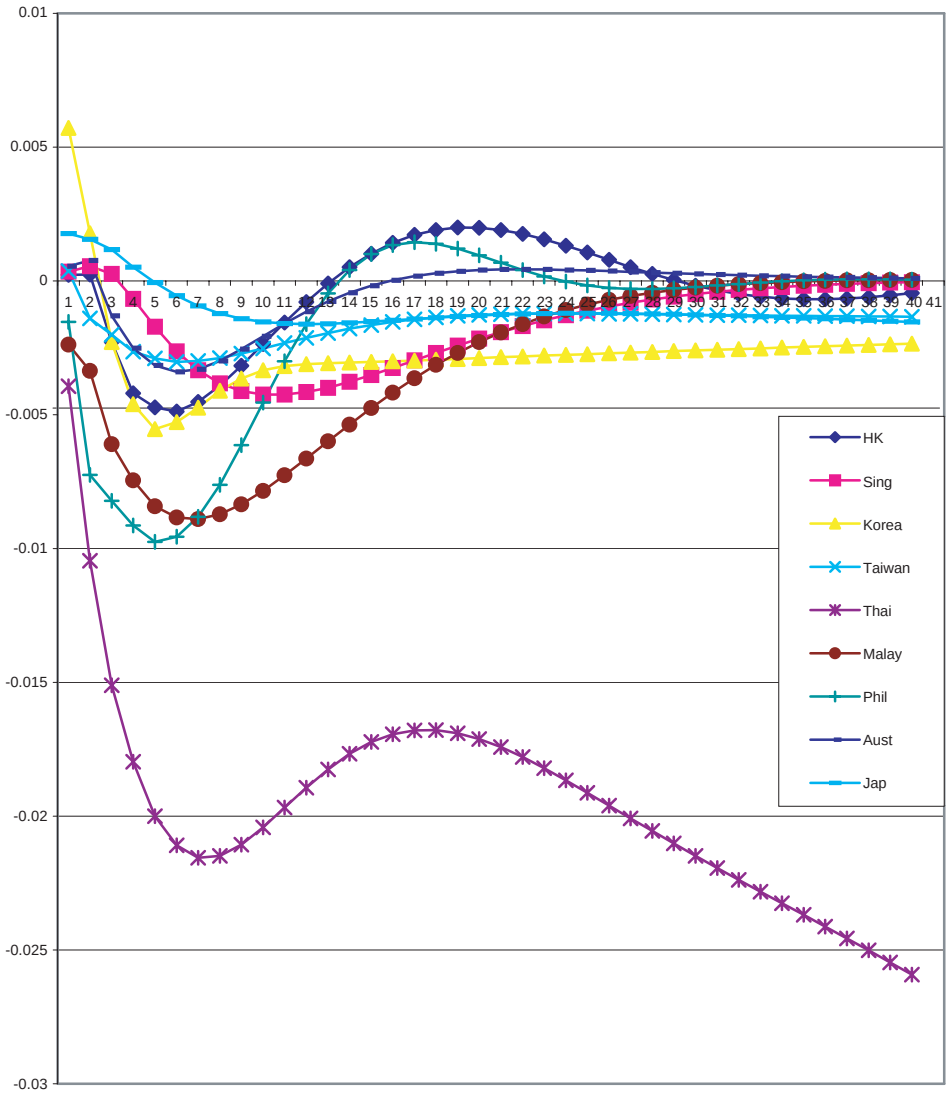


Figure 8: Comparison of Impulse Responses of Output to a Domestic Interest Rate Shock for Asian Countries — Model 1 (Full Sample and Pre-97:2 Data)

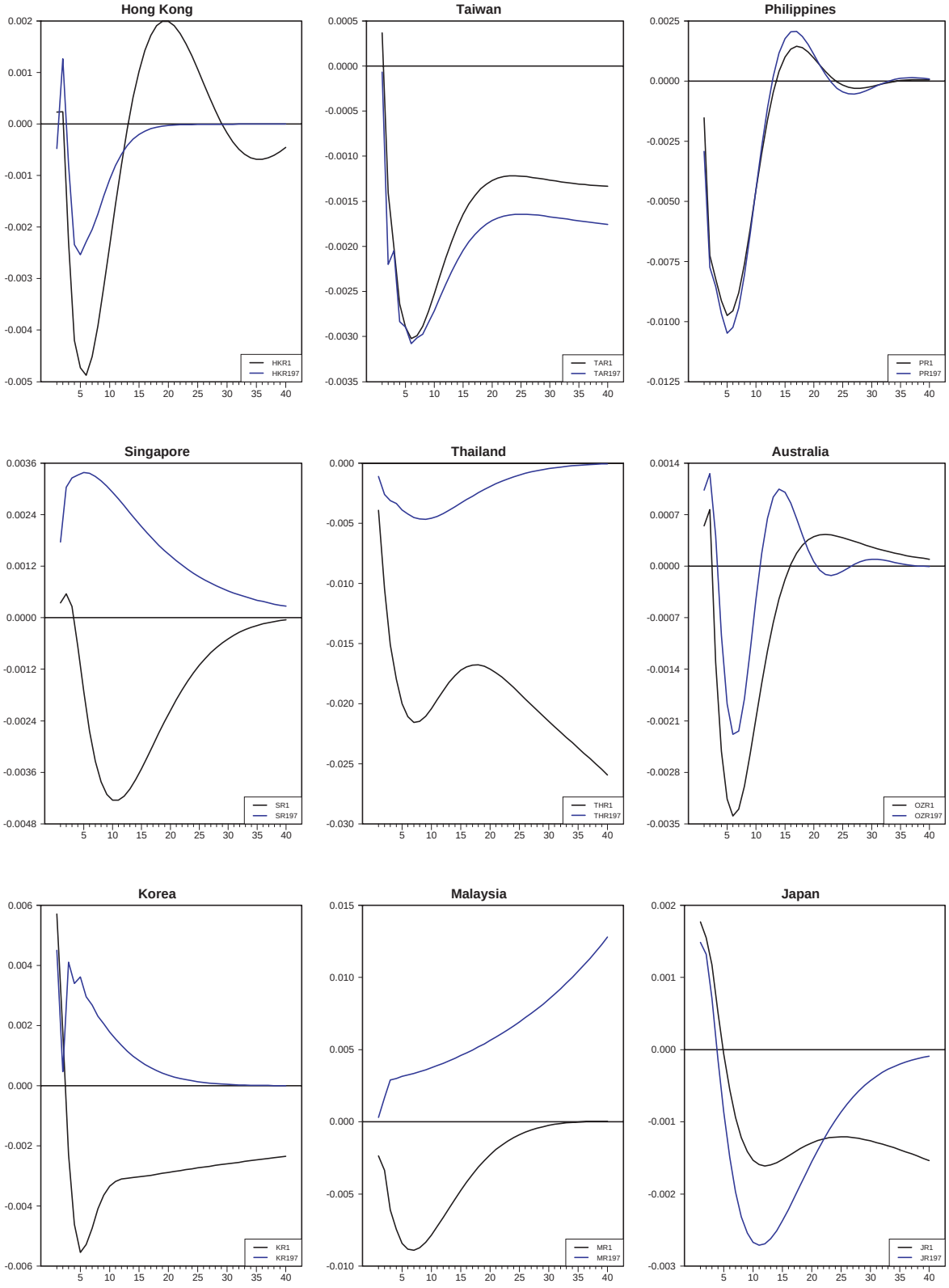


Figure 9: Comparison of Impulse Responses of Output to a Domestic Interest Rate Shock for Asian Countries — Model 2

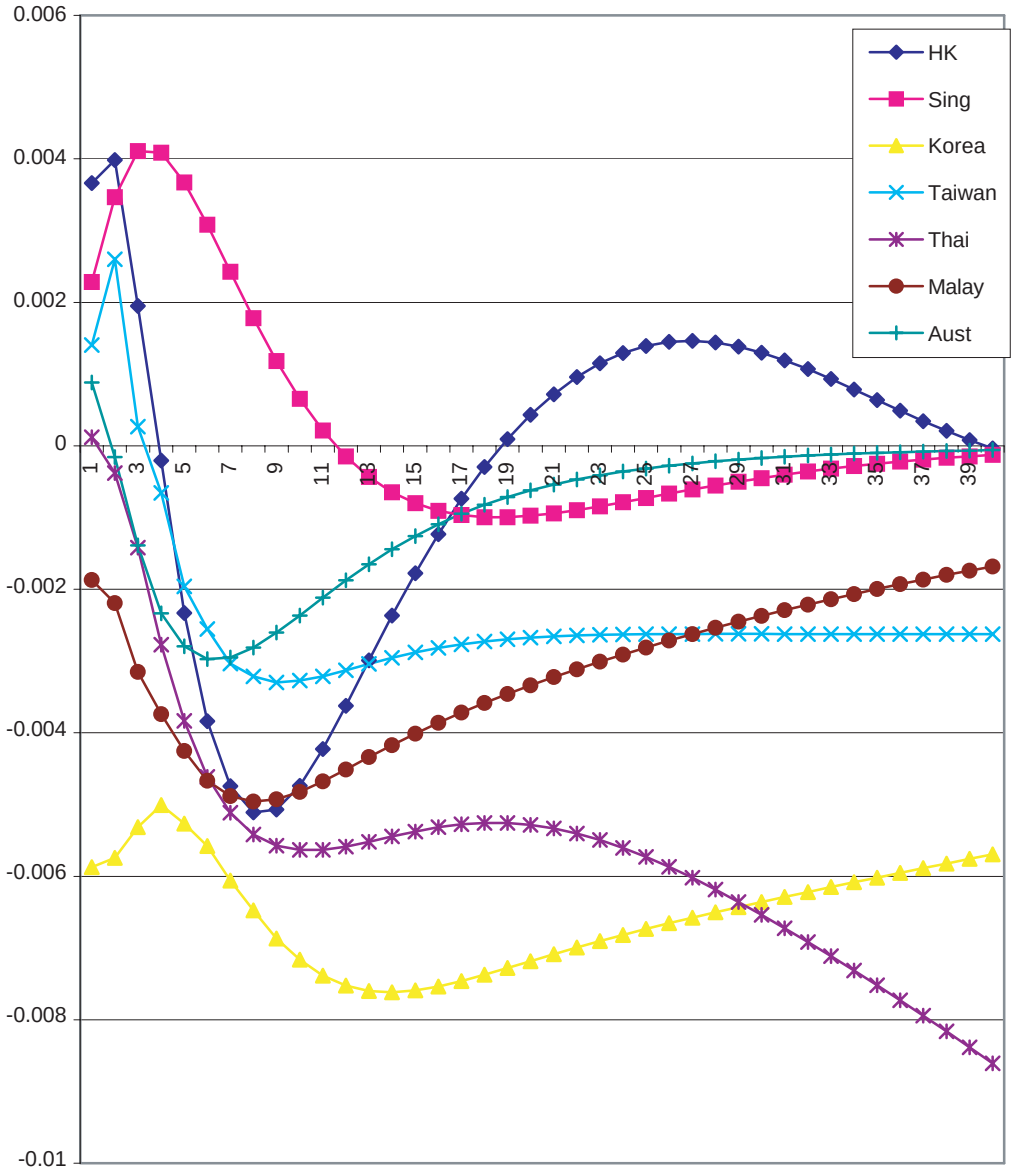


Figure 10: Comparison of Impulse Responses of Output to a Domestic Interest Rate Shock for Asian Countries — Model 3

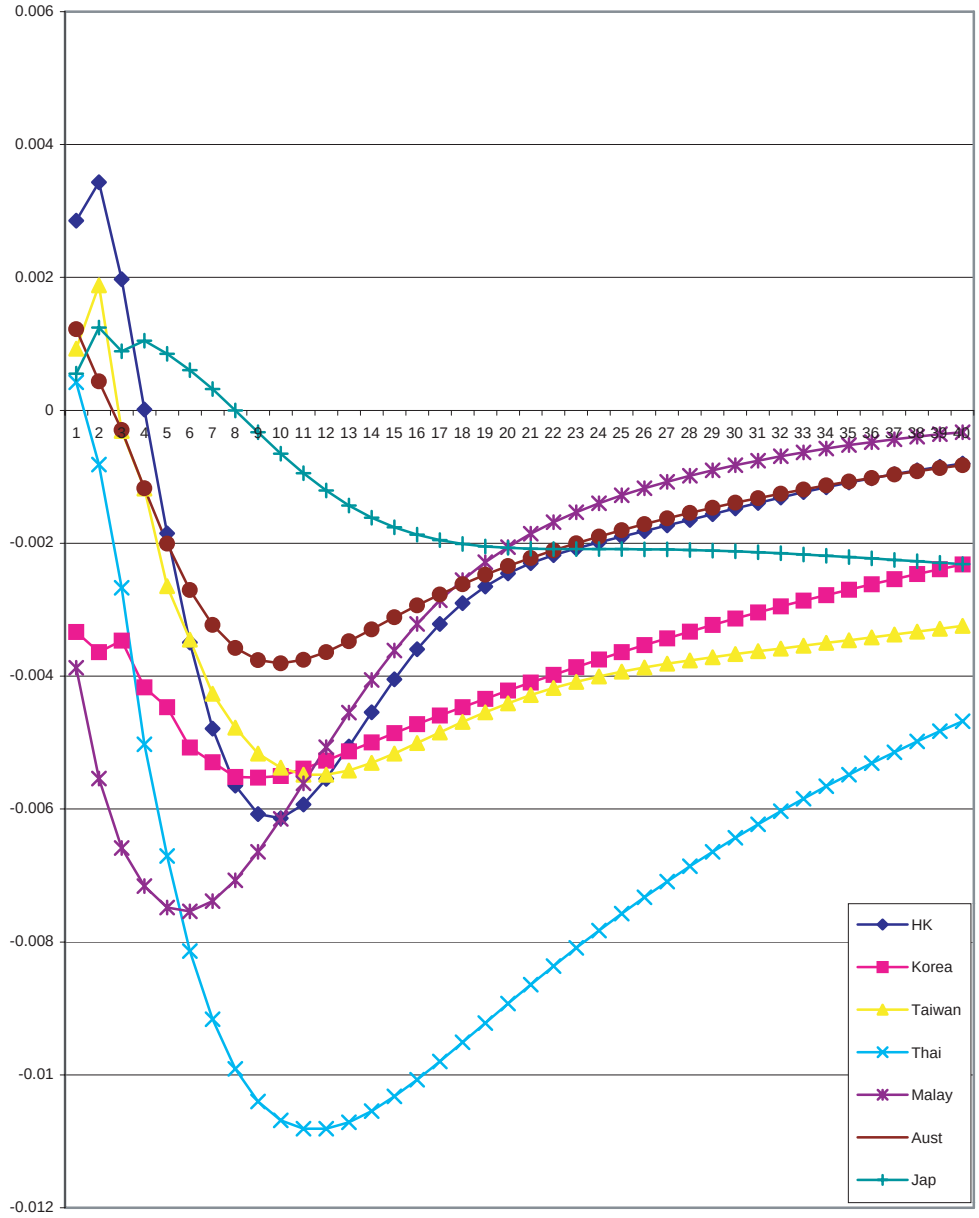


Figure 11: Comparison of Impulse Responses of Output to a Domestic Interest Rate Shock for Asian Countries — Model 4

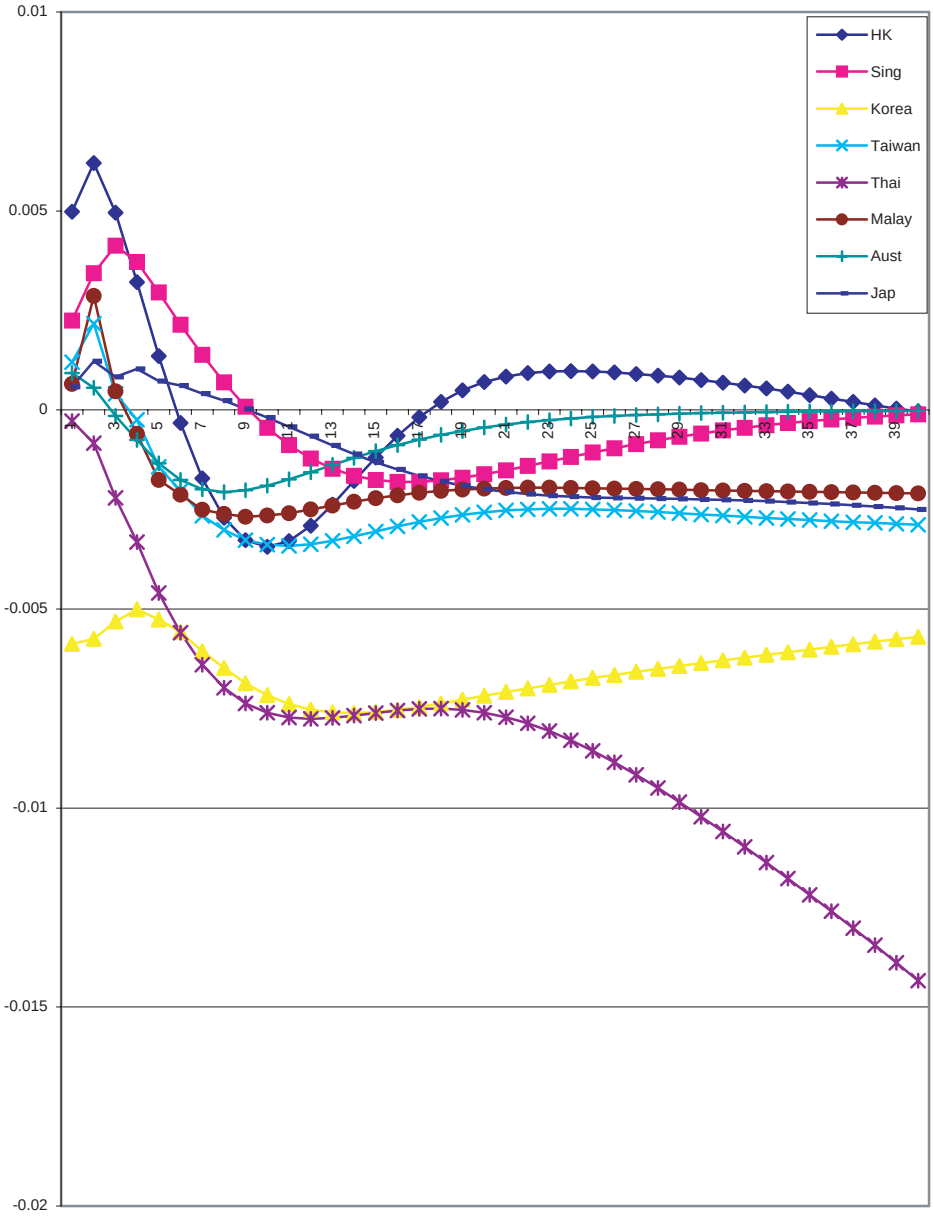
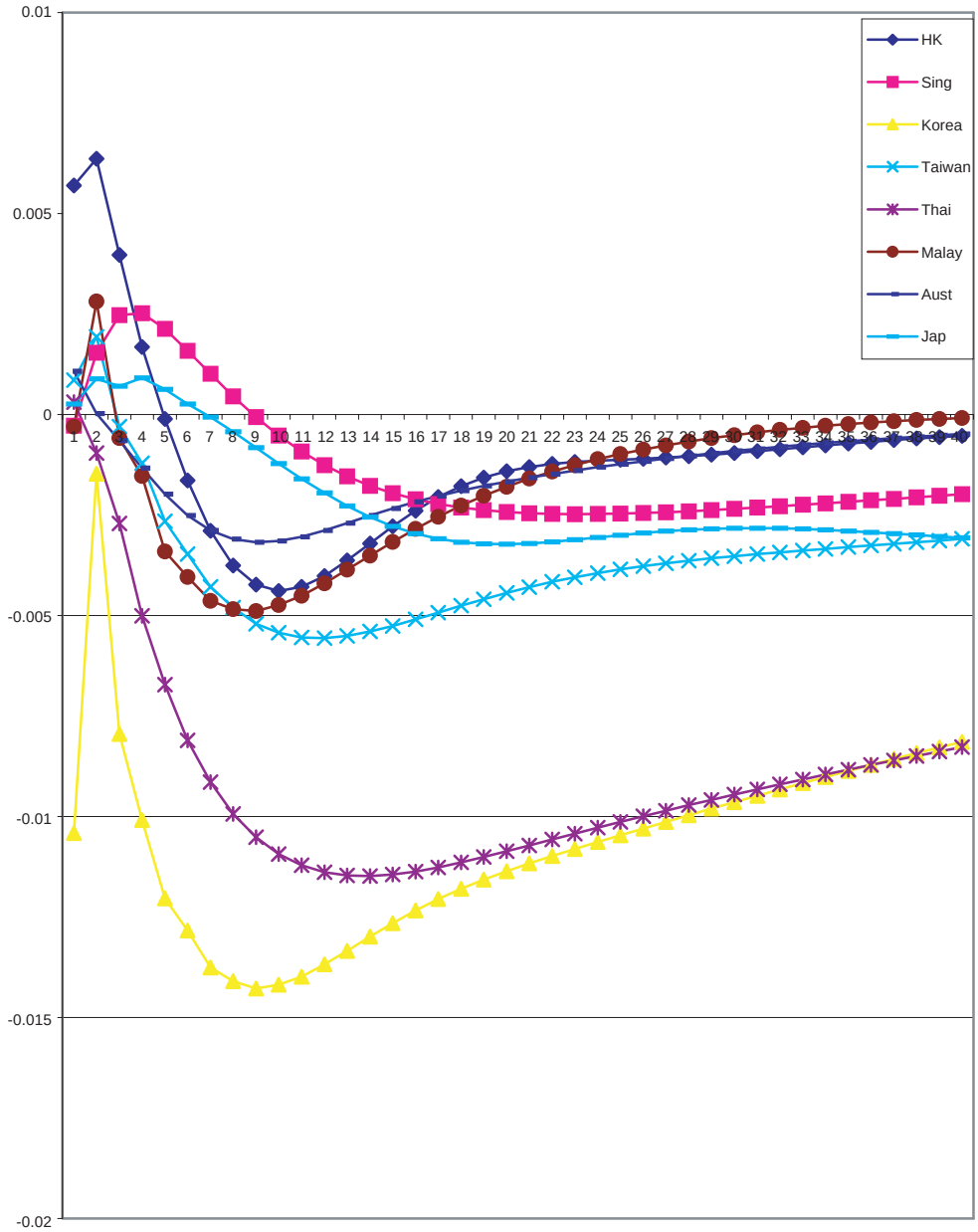


Figure 12: Comparison of Impulse Responses of Output to a Domestic Interest Rate Shock for Asian Countries — Model 5



Data Appendix

1. Inflation

   Inflation is measured for all countries in the sample by the quarterly percentage change in the consumer price index (CPI).

2. Real Output

   Real output is measured as GDP in constant prices for each country's own currency.

3. Domestic Interest Rate

   The domestic nominal interest rates used for each country are as follows: Hong Kong - HIBOR; Singapore - prime lending rate; Korea - money market rate (IFS code 54260B..ZF); Taiwan - commercial paper rate, secondary market 31-90 days; Thailand - money market rate (IFS code 57860B..ZF); Malaysia - money market rate (IFS code 58460B..ZF); Philippines - T-bill rate, 91 days; Australia - money market rate (IFS code 1936B..ZF); Japan - call market rate (IFS code - 15860B..ZF).

4. Foreign Interest Rate

   United States Federal Funds rate.

5. Money Stock

   The nominal money stock measures used for each country are as follows: Hong Kong - M2 (excluding foreign currency deposits); Singapore - M1; Korea - M1; Taiwan - M2; Thailand - M2; Malaysia - M1; Philippines - M1; Australia - M1; Japan - M1.

6. Real Exchange Rate

   This is a country's real bilateral exchange rate against the U.S. dollar. Real exchange rates are computed using CPIs.