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# External Shocks, Transmission Mechanisms and Deflation in Asia

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## Abstract

This paper examines the inflation experience of seven small economies in East Asia: Hong Kong, Malaysia, Korea, Philippines, Singapore, Taiwan, and Thailand. It documents common elements in the inflation processes across countries that are not only due to the reaction of the countries to the crisis in 1997-98. Using a particular recursive form of a vector autoregression model the paper finds empirical support for the view that developments in the world economy, as measured by inflation, growth, and interest rate developments in the United States, have very strong influences on each of the countries. The importance of the United States is explained by the historical tendency of the countries in the region to limit fluctuations of their exchange rates vis-à-vis the dollar. Observed differences in the degree of dependence on the US can indeed be ascribed to differences in exchange rate/monetary policy responses to external shocks. The empirical results also show that Mainland China has been a less important source of external shocks than is commonly thought.

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## 1. Introduction

The recent concern with deflation in industrialized countries has prompted a number of studies assessing the causes and consequences of deflation, proposing appropriate policy responses, as well as drawing lessons from historical experiences.<sup>1</sup> The concern has also motivated particular interest in understanding the sources and dynamics of the deflations in Japan and Hong Kong, as well as the experiences with low inflation in East Asia more generally.<sup>2</sup>

In the case of East Asia the main issues have centered on the role of the crisis in 1997-98, the transmission of deflationary impulses from Mainland China, and the consequences of different monetary policy choices in the post-crisis period. This paper is a contribution to the analysis of these questions. Section 2 sets the stage by recalling the main features of the inflation experiences in the region and presenting some preliminary evidence on the importance of external influences. Section 3 reviews some recent cross-country evidence from the literature, which suggests that the inflation process in the region can be understood in terms of an inflation equation driven by a relatively conventional open economy Phillips curve relationship combined with an aggregate demand relationship in which external demand has an important effect. A small analytical framework based on these relationships is used in Section 4 to investigate the role of interdependence among the countries, the possible reasons why countries may react differently to the same external shock, and the consequences of divergent policy responses.

Section 5 reports the results from an empirical analysis based on estimated vector autoregression models which attempt to isolate the role of world-wide shocks as opposed to shocks originating in China for the smaller countries in the region, and discusses differences in the responses of individual countries to external events.

Section 6 summarizes and concludes.

## 2. The Evolution of Inflation in East Asian Countries: An Overview

Like in many other parts of the world inflation has been on a declining trend in East Asia since the early 1990s. Chart 1 presents CPI inflation rates for eight individual countries in the region and for three country groups.<sup>3</sup> The United States is included as a reference. The trend towards lower inflation is illustrated most forcefully by the average inflation rate of all eight countries in the group shown in the lower left hand corner of the chart. In the first half of the 1990s the inflation rate was 6.4% on average,

<sup>1</sup> See for example Kumar, et al. (2003) and Borio and Filardo (2004) and the references therein.

<sup>2</sup> E.g. Ahearne et al. (2002) for Japan, Shellekens (2003) for Hong Kong, and Fung, Ma, and McCauley (2003) and Gerlach, Lam, and Peng (2003) for Asia more generally.

<sup>3</sup> The eight countries are Mainland China, Hong Kong SAR, Korea, Malaysia, Philippines, Singapore, Taiwan, and Thailand. Apart from not including Japan and Indonesia these countries were also studied in Disyatat (2003) and Gerlach, Lam, and Peng (2003). I have excluded Japan and Indonesia from the analysis since Japan is the object of a separate paper in the conference, and since Indonesia was somewhat of an outlier in the 1997-98 period with a peak year-on-year inflation rate of 59.2% (in 1998:4) whereas the next largest was 9.9% in the Philippines in 1998:3

it fell to 2.6% in the second half of the decade, and declined further to 0.8% in the last three years of the sample.<sup>4</sup>

Two other groups are shown in the last row of the chart, a 'crisis' group consisting of countries that were most directly affected by the 1997-98 crisis, namely Korea, Malaysia, Philippines, and Thailand, and a 'no crisis' group consisting of Hong Kong, Singapore, and Taiwan.<sup>5</sup> The declining trend is present in both, although the inflation rates in the 'crisis' countries spiked up significantly in 1998 in response to the currency depreciations at the time (see Chart 2), before falling in a similarly spectacular manner as the recessions took hold. In contrast, the 'no crisis' group experienced a more regular decrease in inflation during this period, consistent with their more stable exchange rates with respect to the US dollar and appreciating rates with respect to the 'crisis' countries.

The crisis episode is an example where country-specific factors had important impacts on the macroeconomic evolution in individual countries. Because of this and because it was so traumatic, it has figured importantly in explanations of the post-crisis deflation in the countries involved. But by focusing on this episode alone, one runs the risk of not seeing the woods for the trees, however.

This paper aims to provide a more unified explanation of the inflationary forces operating in the region, and to do so it will attempt to isolate both common and country-specific factors that have operated throughout the period. A working hypothesis is that the countries in our sample were influenced to a significant degree by external macroeconomic forces, because of their tendency to gear monetary policy towards stabilizing dollar exchange rates.

A first piece of evidence consistent with this hypothesis is that, both prior and subsequent to the crisis, the cyclical patterns of inflation rates have been quite similar across the countries in the group. This is clearest in the 1999-2003 period which is characterized by a generalized slowdown in 1999, a recovery in 2000 and 2001, followed by another slowdown in 2002 and again a tentative turnaround in 2003. These common movements suggest that the cyclical pattern of inflation in the region may have a single underlying cause. Common reactions to the 1997-98 crisis have been mentioned in this context, as has been the evolution of inflation in China, which, as the chart shows, has followed a similar pattern as the smaller countries in the region. Although these explanations are plausible, they do not take into account the fact that the inflation rate in the United States also followed a very similar pattern during the same time period. This could of course be a pure coincidence, but it could also be an indication that external factors have important impacts on the countries in the region.<sup>6</sup> Statistical evidence based on principal component analysis brings it out quite clearly that there is a common element in the individual inflation rates even before the crisis. This analysis also shows that this element is related to the evolution of inflation in the United States.

<sup>4</sup> The spike in the average in 1994 owes much to the high inflation rate in Mainland China during this year. Considering only the seven other countries does not change the essence of the overall picture, however. For this group the averages were 5.5% in 1991-95, 2.8% in 1996-2000, and 0.9% in 2001-03.

<sup>5</sup> The terms 'crisis' and 'no crisis' to identify countries should not be taken to mean that only the former suffered in a real sense from the crisis. Judged by the slow-down in real economic activity all countries in the group, with the possible exception of Mainland China, experienced significant difficulties.

<sup>6</sup> The United States is of course not the only relevant external source of macroeconomic shocks for the countries in question. The US inflation rate should therefore be thought of as a proxy for more general external factors.

Table 1 contains the results obtained for two periods, one spanning the entire sample from 1991 to 2003, and the other covering the pre-crisis period until the end of 1997. In both cases the first principal component explains a substantial portion of the behavior of inflation rates across countries. In the longer sample all countries load approximately equally on the first component, suggesting that this can be interpreted as the common element of inflation. The second principal component for the full sample appears to pick up the common response of the 'crisis' countries to the 1997-98 crisis.

The first principal component in the pre-crisis period appears to capture the common elements in all countries except Mainland China and Thailand. The reason why the inflation process in Mainland China is not captured is immediately evident in Chart 1, which shows that the build-up of inflation until 1995 in this country is quite unique. The reason for Thailand's low loading on the first principal component is less obvious, but it may be a sign that the macroeconomic evolution in general in this country was out of step with the rest of the group leading up to the currency crisis in the summer of 1997.

The evidence in Table 1 suggests the presence of an important common factor in the inflation rates of the countries in our sample, but it does not give any hint as to what the driving forces behind this common factor might be. Table 2 contains preliminary results indicating that external forces, as proxied by the US inflation rate, are important. The table reports results from fitting a regression of the first principal component computed from the full sample on the US inflation rate. Whether one looks at the entire period from 1991 to 2003 or the pre-crisis period or the post-crisis period the conclusion from these regressions is the same; the inflation rate in the United States is strongly related to the common element in the inflation rates in the East Asian countries.

Finding a strong common element in the inflation rates among the countries in our sample, and suggesting that this common element is related to the inflation rate in the United States, does not mean that all countries react in the same way to external forces, and that country specific shocks are unimportant. Investigating further the mechanism whereby external shocks are translated into domestic inflation, and identifying important domestic sources of inflation is therefore important if we want to have a fuller understanding of the inflation process in each country. A review of recent comparative studies provides useful clues.

### 3. Empirical Evidence from Recent Comparative Studies

Several comparative studies of inflation in East Asia have been carried out in the last year. The most extensive is Gerlach, Lam, and Peng (2003) which reports results from a panel-structure regression analysis of inflation and output movements in ten countries in the region.<sup>7</sup> Disyatat (2003) studies the same set of countries using more informal empirical techniques, and Kumar et al. (2003) investigates the particular role of Mainland China in the price formation process of neighboring countries. What follows is a summary of the major conclusions and open questions left by these studies.

Gerlach, Lam, and Peng adopt a framework based on a relatively conventional open economy Phillips curve for inflation and an IS-type relationship for the output gap. Domestic inflation is a function of the

<sup>7</sup> The group of countries is the same as those described briefly in the previous section plus Indonesia and Japan.

domestic output gap, foreign inflation, the change in the effective exchange rate, and the deviation of the real exchange rate from its equilibrium level. The output gap depends on foreign demand and the real interest rate.

The results of the estimation show that foreign factors measured by inflation in trading partners and import demand from the United States are important sources of inflation and output dynamics for all countries in the sample. Interest rate and exchange rate effects are also significant, indicating that domestic monetary policy could potentially have an impact. Of course, in some of the countries, the interest rate will also be heavily influenced by developments in international financial markets, so it cannot be viewed as a purely domestic factor.<sup>8</sup>

As already noted, Gerlach, Lam, and Peng estimate their model in a panel set-up which means that slope coefficients are assumed to be equal across countries. Although this assumption cannot be rejected for many of the variables, the authors report evidence showing that the responses to changes in the nominal effective exchange rate vary across countries. This implies that responses to external shocks may be different across countries as suggested by the discussion in the previous section.

Although the study by Disyatat (2003) is mainly descriptive, it raises a number of issues dealing with the transmission mechanism of deflationary impulses. Like Gerlach et al. the author argues that output gaps have been important explanations of inflation rates in the region and argues that these have been principally of domestic origin until the latest slowdown in 2000-2001.<sup>9</sup> Exchange rate developments are also emphasized and it is suggested that the countries which have pursued a fixed US dollar exchange rate regime were particularly affected by the strength of the dollar during the late nineties and early 2000. More generally the author argues that it is important to recognize differences in monetary policy in order to fully understand the differences in inflation performance across countries.

Kumar et al. consider the particular role of China in the deflation process in the neighboring countries. They point to a sharp increase in inter-regional trade as a possible conduit of stronger inflation links between the countries, and report results from estimates of a vector autoregressive model showing that prices in Taiwan and Hong Kong are particularly sensitive to inflation developments in the Mainland. Singapore is influenced as well but to a smaller extent, whereas Malaysia and Thailand do not seem to be affected at all.

All three papers suggest that asset price developments combined with balance sheet effects and credit crunches had an important role to play in the inflation process in the region immediately following the 1997-98 crisis. While this seems a priori reasonable, the empirical evidence of these effects is limited. To be sure, asset prices did decline in many of the economies in the region during the crisis, and credit contracted. These factors may therefore have played a certain role in the transmission of shocks. To what extent they constituted independent shocks themselves or were endogenous to the deflation process is more controversial, however.

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<sup>8</sup> The clearest example of this is Hong Kong where interest rates are very highly correlated with corresponding rates in the United States because of the currency board arrangement.

<sup>9</sup> The study covers the period 1995 to 2002.

The evidence in these studies points to several elements that must be considered in an analytic framework used to describe the price formation process in the countries in the region. Fluctuation in demand as measured by output gap or unemployment is an important element of the transmission. External sources of demand shifts are significant in addition to competitiveness effects transmitted through real exchange rate movements. Exchange rate changes and foreign price movements also appear to have an impact on inflation over and above the effects that impinge on demand. A possible channel may be changes in the cost of imported intermediate goods.<sup>10</sup> Finally it is important to keep in mind that the chosen monetary policy strategy may play an important role in insulating some countries from external deflationary impulses, while it strengthens the effects of these impulses in other countries. In the next section I will use an analytical framework that incorporates some of these factors to explore how structural and policy differences between countries may lead to different reactions to common external shocks. A version of the same framework will be used in the following section to measure the importance of external relative to internal shocks for the dynamics of inflation and output in our group of countries.

#### 4. External Shocks, Transmission, and Interdependence in a Simple Analytical Framework

The empirical results suggest that the countries in the region can be described by a relatively standard macroeconomic model of the aggregate demand – aggregate supply variety provided external demand and international competitiveness considerations are taken into account. In this section a model of this type will be used to illustrate the consequence of interdependence among countries, of differences in key structural parameters, and differences in monetary/exchange-rate policies for inflation and output fluctuations. As will become apparent, the model will be simplified drastically to focus on these issues.

Consider two countries that are competitors on the market of a third country and that import intermediate goods both from the third country and from each other. Each country will be described by a price adjustment equation, a wage equation, a relationship reflecting Okun's law, and an aggregate demand equation.<sup>11</sup> I will refer to the two countries of interest by superscripts A and B and the third country by a \*.

$$\pi_t^A = \alpha_1^A \pi_{t-1}^A + \alpha_2^A E_t \pi_{t+1}^A + \alpha_3^A \hat{w}_t^A + \alpha_4^A (\pi_t^B + \hat{e}_t^{A/B}) + \alpha_5^A (\pi_t^* + \hat{e}_t^{A/*}) + \varepsilon_t^{\pi,A} \quad (1)$$

$$\hat{w}_t^A = \beta_1^A \hat{w}_{t-1}^A + \beta_2^A E_t \pi_{t+1}^A - \beta_3^A u_t^A + \varepsilon_t^{\hat{w},A} \quad (2)$$

$$u_t^A = -\gamma_1^A y_t^A + \varepsilon_t^{u,A} \quad (3)$$

$$y_t^A = \delta_1^A y_t^* - \delta_2^A (\pi_t^A - \hat{e}_t^{A/*} - \pi_t^*) - \delta_3^A (\pi_t^A - \hat{e}_t^{A/B} - \pi_t^B) - \delta_4^A (i_t^A - E_t \pi_{t+1}^A) + \delta_5^A E_t y_{t+1}^A + \varepsilon_t^{y,A} \quad (4)$$

<sup>10</sup> This channel is emphasized in the study by Genberg and Pauwels (2004) on Hong Kong.

<sup>11</sup> Genberg and Pauwels (2004) estimate models with this structure for Hong Kong. See also Gerlach-Kristen (2004) for a related empirical analysis.



Equation (1) is a relatively standard mark-up equation for country A in which inflation,  $\pi_t^A$ , depends on past and expected future inflation and on changes in input costs in the form of wage increases,  $\hat{w}_t^A$ , and changes in imported intermediate goods from country B,  $\pi_t^B + \hat{e}_t^{A/B}$ , and country \*,  $\pi_t^* + \hat{e}_t^{A/*}$ , where  $\hat{e}_t^{A/B}$  and  $\hat{e}_t^{A/*}$  stand for the rate of change in the nominal exchange rate between countries A and B and countries A and \* respectively. Equation (2) relates wage increases to expected inflation and unemployment, and equation (3) relates unemployment to the state of demand for goods. Finally the demand for country A's goods depends on demand in the rest of the world (\*), on two competitiveness terms (one reflecting the price of country A's goods relative to the goods of \* and one reflecting the relative price of the goods of countries A and B on the market of \*), on the real interest rate and on expected future demand. A similar set of equations describes country B.

Equations (1) – (3) can be combined to yield an equation that is quite similar to that used in the empirical study of Gerlach et al. as well as in the other less detailed empirical investigations mentioned in the previous section. This will allow me to discuss informally the results obtained in terms of the analytical structure I am proposing.

To make the model complete one would need to specify laws of motion for the variables in \* as well as the determinants of the exchange rates and nominal interest rates. As my objective is the more limited one of studying the consequences of interdependence and some aspects of price and wage flexibility, I will not go this route but I will instead strip down the model to the maximum. I eliminate all dynamics as well as expectations terms, and I consider monetary policy only in so far as it affects the exchange rates. With these simplifications, equations (1) – (4) can be reduced to the following static Phillips curve and AD equation respectively.<sup>12,13</sup>

$$\pi_t^A = \alpha_3^A \beta_3^A \gamma_1^A y_t^A + \alpha_4^A \pi_t^B + \alpha_4^A \hat{e}_t^{A/B} + \alpha_5^A \pi_t^* + \alpha_5^A \hat{e}_t^{A/*} + \varepsilon_t^{P,A} \quad (5)$$

$$y_t^A = \delta_1^A y_t^* - (\delta_2^A + \delta_3^A) \pi_t^A + \delta_3^A \pi_t^B + \delta_2^A \hat{e}_t^{A/*} + \delta_3^A \hat{e}_t^{A/B} + \delta_2^A \pi_t^* + \varepsilon_t^{y,A} \quad (6)$$

Familiar properties of these equations are immediately visible. The slope of the reduced-form Phillips curve depends on the flexibility of wage and price adjustments in the economy represented by the parameters  $\alpha_3$ ,  $\beta_3$ , and  $\gamma_3$ . Its open-economy nature reflects the interdependence due to trade in imported intermediate goods. The slope of the aggregate demand equation reflects competitiveness effects and its location depends on external demand, inflation in country B and in the rest of the world as well as on exchange rate policy. The analogous set of equations for country B are

<sup>12</sup> Eliminating dynamics implies that I investigate only impact effects, and eliminating expectations amount to assuming they are static. These are admittedly strong assumptions, but I conjecture that they are not crucial for the limited purpose I use the model.

<sup>13</sup> The disturbance term in equation (5) is a linear combination of the error terms in equations (1) - (3).

$$\pi_t^B = \alpha_3^B \beta_3^B \gamma_1^B y_t^B + \alpha_4^B \pi_t^A - (\alpha_4^B + \alpha_5^B) \hat{e}_t^{A/B} + \alpha_5^B \pi_t^* + \alpha_5^B \hat{e}_t^{A/*} + \varepsilon_t^{P,B} \quad (7)$$

$$y_t^B = \delta_1^B y_t^* - (\delta_2^B + \delta_3^B) \pi_t^B + \delta_3^B \pi_t^A + \delta_2^B \hat{e}_t^{A/*} - (\delta_2^B + \delta_3^B) \hat{e}_t^{A/B} + \delta_2^B \pi_t^* + \varepsilon_t^{y,B} \quad (8)$$

where use has been made of the fact that  $\hat{e}_t^{B/*} = \hat{e}_t^{B/A} + \hat{e}_t^{A/*}$ .

Inserting (6) into (5) and (8) into (7) yields a pair of equations in  $\pi^A$  and  $\pi^B$  which can be depicted as the AA and BB lines in Figure 1. In the case of complete symmetry between the countries AA will necessarily be flatter than BB. External deflationary shocks in the form of reductions in either  $y^*$  or  $\pi^*$  will shift the lines towards the origin, whereas depreciations of the currencies with respect to  $*$  will shift both lines away from the origin. A depreciation of currency B relative to currency A will shift BB away from and AA towards the origin. The slope of the lines (with respect to their 'own' axis) depends positively on what I will refer to as the flexibility parameters  $\Phi \equiv \alpha_3 \beta_3 \gamma_3$ , positively on parameters  $\alpha_4$  and  $\alpha_5$ , measuring the importance of imported intermediate goods in the inflation equation, and on the competition parameter with respect to the neighbor country ( $\delta_3$ ), and negatively on the competition parameter with respect to  $*$  ( $\delta_2$ ).

Although the dynamics of the inflation-output nexus has been stripped away, I believe that the model can provide some insights into the role of external effects, interdependence, and national economic policy for inflation and output developments. To this end I use it to examine the effects of deflationary shocks under different assumptions about structure and monetary policy.<sup>14</sup>

#### a. A Deflationary External Shock under Symmetry

Consider first the effect of an external deflationary shock represented, for example, by a reduction in  $y^*$  or  $\pi^*$ . In the context of the set of countries under consideration we can interpret the  $*$  country as representing either China as the large local influence or the USA/Europe as the more distant influence capturing developments in the world economy as a whole. The impact of the deflationary shock is illustrated by the dashed lines in Figure 1. Assuming that both A and B maintain their exchange rate fixed, their inflation rates will fall to those represented by point  $E_1$ . The explanation is straightforward. The reduction in external demand leads to slack in the labor market, which reduces wage claims which in turn bring about a decline in price inflation as a result of the mark-up mechanism. In addition, the fall in prices in country B leads to further deflationary pressures on country A, in part because of the competitive effect in the goods market of country  $*$  and in part because of the reduction in the cost of intermediate inputs. The greater the direct interdependence between the economies, in the sense of trade in intermediate inputs, the larger the reduction in inflation and output as illustrated by point  $E_2$  in the figure. Similarly, greater flexibility of price and wage adjustments, as measured by the parameters  $\alpha_3$ , and  $\beta_3$ , will lead to larger reductions in inflation.

While the solution for the inflation rates is simple enough to be illustrated in a figure, the reactions of the output levels are more complicated, because they depend not only on whether the deflationary shock

<sup>14</sup> Readers familiar with the literature on interdependence in the Mundell-Fleming model will recognize the similarity of many of the results obtained here for inflation with corresponding results for output obtained in that literature.

originates in a decline in external inflation or demand, but also in a relatively complex manner on the interaction of the parameters in the aggregate demand and aggregates supply relationships in the economy. This being said, it is possible to draw some conclusions that help us understand reasons why countries may react differently to the same external shock. Consider, for example, a decline in external demand. As already noted this will lead to a decline in inflation in both our countries, and the decline will be larger in the country which has a more flexible wage and price adjustment structure as measured by the parameters  $\alpha_3$  and  $\beta_3$ . Output will also decline, but now the implications of flexibility are likely to be the reverse; the more flexible country will normally experience a smaller decline. The qualification 'normally' in this statement stems from the possible non-linearity in the response of aggregate demand to the reduction in inflation when it is already very low. Suppose, for example, that the external shock actually creates deflation (i.e. negative inflation), and suppose further that as a result of the deflation aggregate demand actually falls.<sup>15</sup> In this case it is possible that a country that has a more flexible price and wage adjustment process will suffer a greater decline in output in response to the external shock. The reason is simply that the non-linear demand response in this economy can be more significant in view of the more substantial reduction in inflation.

#### **b. The Consequence of Asymmetry between A and B.**

Suppose the economy of A relies more on imported inputs from B than country B relies on imported inputs from A. In this case AA will be steeper than in the case of symmetry. As a consequence more of the price adjustment will take place in A and, given the incomplete wage adjustment, the reduction in output will also likely to be larger. This is illustrated by the equilibrium point  $E_3$  in Figure 2. Note that inflation will also fall more in B as a result of competition between their products in \* and the spillover effect due to trade in intermediate goods.

#### **c. An Active Monetary Policy in B.**

Let us return to the case of symmetry, but assume now that the authorities in country B conduct an active monetary policy which in the context of the model will be interpreted as a policy of managing the exchange rate to counteract the effects of the external deflationary impulse. In Figure 3 the benchmark equilibrium with fixed exchange rates is at point  $E_1$ . Continue to assume that the exchange rate of currency A relative to \* is fixed but suppose the authorities in B depreciate the domestic currency by enough to counteract the impact effect of the fall in external demand, i.e. suppose BB is brought back to its initial position. In this case the equilibrium will move to  $E_4$  which entails a reduction of the deflationary impact in B but a magnified effect in A. The magnification is due in part to the expenditure-switching effect in \* of the depreciation of currency B and in part to the reduction in the cost of imported intermediate goods from country B. If the central bank in B engineers a depreciation large enough to maintain  $\pi^B$  constant in spite of the fall in external demand, the deflationary pressure in A will be even larger as illustrated by point  $E_5$ .

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<sup>15</sup> The justification usually given for this is that price deflation may lead to sharp declines in asset prices which through wealth or balance sheet effects lead to a decrease in aggregate demand.

#### d. A Country-specific Shock.

Finally, suppose country A experiences a fall in inflation due to a decline in production costs which does not occur in country B. Due not only to the change in competitiveness of country B but also to the spillover effect of lower intermediate goods inflation, the inflation rate in B will decline but not as much as in A.

In Sections 2 and 3 we reviewed evidence pointing to a significant role for external shocks for the evolution of inflation in East-Asian countries. In this section we have shown that small open economies may react differently to similar external shocks depending on the domestic policy responses and structural features such as the degree of wage/price flexibility and trade patterns. In the remainder of the paper we use empirical methods to investigate the relative importance of external and internal factors.

## 5. Some Evidence on the Nature, Importance, and Consequences of External Shocks

### a. The Methodology.

The empirical methodology is motivated by the empirical models reviewed in Section 3 and the analytical model used in the previous section. The structure of these models is illustrated schematically in Chart 3. Inflation and output movements in any of the smaller countries in the region are influenced by three sets of factors. First there is what might be called ‘world’ factors, i.e. demand, price, and interest rate developments in world markets generally. These have a direct influence on output and inflation through trade and price transmission channels. They also have indirect influences through their impact on domestic interest rates, the exchange rate, asset prices etc. as well as on macroeconomic developments in Mainland China which in turn exerts significant influence on the smaller economies (cf. the evidence in Kumar et al. 2003).

Economic development in Mainland China can be a second source of macroeconomic shocks for the smaller economies in the region.<sup>16</sup> As already noted, this economy is influenced by, but is assumed not to influence, the rest of the world.

Finally there are domestic factors that influence and are influenced by inflation and output developments. These variables are also determined in part by external developments, both in Mainland China and in the rest of the world, but because of the small size of the economies we are modeling, they are unlikely to have any impact in return.

To investigate the importance of differences in structure and economic policy one should ideally estimate structural models for each of the economies and simulate them jointly in the spirit of the work in, for example, Bryant, Hooper, and Mann (1993). This is beyond the scope of the present undertaking.

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<sup>16</sup> In a more complete structure one should also give a special role to Japan in the context of the countries under study. Here Japan is implicitly included in ‘world market influences’.

The approach followed here is instead to conduct the analysis in a vector autoregression (VAR) framework which explicitly takes into account the recursive nature of the interactions illustrated in Chart 3. The reduced form nature of VAR models will of course limit the questions to which the analysis can provide answers, but it is hoped that the results will nevertheless provide novel and useful insights.

Consider each of the following seven small economies separately: Hong Kong, Korea, Malaysia, Philippines, Singapore, Taiwan, and Thailand. Fluctuations in inflation and growth in each country are assumed to be determined by external shocks coming from China and the rest of the world in addition to domestic shocks of various kinds. Fluctuations in the Chinese economy are assumed to depend on developments in the rest of the world but not significantly on those in the small neighbors. Finally, macroeconomic fluctuations in the rest of the world are determined independently of both the Chinese and the small economies we are interested in. The recursive nature of the interactions in the model permits drawing certain structural inferences from the estimated VAR. To be specific, let  $y^i$ ,  $y^C$ , and  $y^U$ , represent relevant macroeconomic variables in country  $i$ , China, and the US (representing the rest of the world) respectively. Interactions among them can be described by the following general structural model.

$$\begin{pmatrix} A_0^{ii} & A_0^{iC} & A_0^{iU} \\ 0 & A_0^{CC} & A_0^{CU} \\ 0 & 0 & A_0^{UU} \end{pmatrix} \begin{pmatrix} y_t^i \\ y_t^C \\ y_t^U \end{pmatrix} = \begin{pmatrix} A^{ii}(L) & A^{iC}(L) & A^{iU}(L) \\ 0 & A^{CC}(L) & A^{CU}(L) \\ 0 & 0 & A^{UU}(L) \end{pmatrix} \begin{pmatrix} y_{t-1}^i \\ y_{t-1}^C \\ y_{t-1}^U \end{pmatrix} + \begin{pmatrix} u_t^i \\ u_t^C \\ u_t^U \end{pmatrix} \quad (9)$$

$A_0$  and  $A(L)$  represent structural coefficients and the error vector contains structural shocks to the equations in each of the regions. The triangular form of the matrices that pre-multiply the vectors of endogenous variables reflects the assumed recursive nature of the interactions between them. This also ensures that the VAR representation of the system is triangular as in (10). Furthermore, the VAR residuals will be such that the elements of  $\varepsilon^U$  will be linear combinations of the elements of  $u^U$  only, that  $\varepsilon^C$  will be linear combinations of  $u^U$  and  $u^C$ , but not of  $u^i$ , and that  $\varepsilon^i$  will be linear combinations of all structural shocks.<sup>17</sup>

$$\begin{pmatrix} y_t^i \\ y_t^C \\ y_t^U \end{pmatrix} = \begin{pmatrix} D^{ii}(L) & D^{iC}(L) & D^{iU}(L) \\ 0 & D^{CC}(L) & D^{CU}(L) \\ 0 & 0 & D^{UU}(L) \end{pmatrix} \begin{pmatrix} y_{t-1}^i \\ y_{t-1}^C \\ y_{t-1}^U \end{pmatrix} + \begin{pmatrix} \varepsilon_t^i \\ \varepsilon_t^C \\ \varepsilon_t^U \end{pmatrix} \quad (10)$$

In the principal empirical implementation  $y^i$  contains two elements, CPI inflation and growth of real GDP,  $y^C$  consists only of the rate of CPI inflation in China, and  $y^U$  contains three variables, the US Federal Funds rate, the CPI inflation rate in the US, and the growth of real GDP in the US.<sup>18</sup> I will make no attempt to identify separately the structural shocks that correspond to each of these variables. The

<sup>17</sup> A number of authors have recursive structures of this type to identify partially estimated VAR systems for small open economies. A partial list includes Genberg, Salemi, and Swoboda (1987), Cushman and Zha (1997), Hoffmeister and Roldos (1997), and Genberg (2003).

<sup>18</sup> Checks for robustness of the results were carried out with two alternative model specifications: one in which  $y_t^i$ ,  $y_t^C$  and  $y_t^U$  each contained two variables, the rate of CPI inflation and the growth rate of real GDP, and another in which Mainland China was eliminated and where  $y_t^i$  and  $y_t^U$  each contained the rate of CPI inflation, the growth rate of real GDP, and a short-term interest rate.

results I report below only rely on identifying the US shocks as a group, the Chinese shock, and the shocks to the country being analyzed as a group.<sup>19</sup> To achieve this identification I can rely on the standard Cholesky factorization of the covariance matrix of the VAR residuals.

Before we proceed, two types of complications have to be dealt with: the implications of expectations variables in the structural equations, and the effects of leaving out (in the empirical implementation) some relevant variables.<sup>20</sup> It turns out that neither of these will change the basic structure of the VAR representation at least as far as our use of it is concerned. If expectations of future values of the elements  $(y_t^i, y_t^C, y_t^U)$  belong in the structural model, then we can eliminate them by invoking an expectations generating mechanism where the expectations of future values are replaced by projections of current and past information. This means that expectations of future will be functions of current and past values of  $y_t^i$ ,  $y_t^C$  and  $y_t^U$ , that expectations of future values of  $y_t^C$  will be functions of  $y_t^C$  and  $y_t^U$ , and that expectations of future values of  $y_t^U$  will be functions of current and past values of  $y_t^U$ . Hence, the triangular structure of the VAR representation in equation (10) will remain the same.

A similar argument can be made with respect to omitted variables. Suppose a domestic variable that is important for the propagation mechanism of the shocks is left out of the empirical model. In this case it is effectively included in the structural error term. In a larger model including the additional variable would still have the triangular form of both (9) and (10). Eliminating the additional variable from the system by direct substitution would lead to a model in which the first element of the ‘structural’ error in (9) would now contain the structural errors in both of the lower blocks of the system. The structural errors in these lower blocks would remain the same, however. A consequence of this would be that our method of identification of the elements of  $(y_t^i, y_t^C, y_t^U)$  will lead to an overestimate of the importance of domestic shocks in the system.

If some element of  $y_t^U$  has been left out of the model, a similar argument implies that the structural errors in the  $y_t^U$  equations will be a linear function of the true errors in these equations and the error in the left-out equation. But the triangular structure of VAR would be preserved, including the property that VAR errors of the higher-ordered variables will be a linear combination of both their own and lower-ordered shocks whereas the VAR errors corresponding to the lowest-ordered variables,  $y_t^U$ , will be functions only of their own shocks.

## **b. The data.**

Quarterly data on all variables were generously provided by Stefan Gerlach, and they are thus a subset of those used in Gerlach, Lam, and Peng (2003). The consumer price and real GDP series were seasonally adjusted in Eviews using the X-12 option. Quarterly growth rates were calculated as 1st differences of the natural logarithm of the corresponding levels. The sample period is 1990:1 to 2002:4.

<sup>19</sup> Even though there is only one Chinese shock in the model, I will not be able to identify it as a structural shock because it presumably represents a linear combination of supply and demand shocks in China.

<sup>20</sup> The arguments in this and the following two paragraphs are adapted from Genberg (2003).

Estimation and calculations of variance decompositions and historical decompositions were carried out in RATS 6.0.

### **c. The Results.**

Two sets of results will be presented and analyzed. First I will ask what proportions of the forecast error variances of inflation and growth in country *i* can be ascribed to shocks in the US, in China, and in the local economy. This will reveal whether there are differences among the countries in the degree of dependence on external shocks and to gauge the relative importance of China and the USA as the source of these shocks. Second, the actual inflation will be decomposed into components that are due to US shocks, Mainland China shocks, and local shocks in an attempt to isolate the importance of domestic policy differences.

#### ***i. Decomposition of forecast error variances.***

By definition forecast errors are the consequences of shocks occurring between the time of the forecast and the realization of the outcome. The variance of the forecast errors can thus be attributed to the variance of the underlying shocks, and provided the shocks are uncorrelated with each other, it is possible to decompose the total variance into the contribution of each of the shocks. As explained above, the restrictions imposed on the VAR permits a decomposition according to the country of origin of the shocks but not to the market origin. Table 4 presents the results obtained for forecast horizons of 8 and 16 quarters for the inflation rates and the real growth rates.<sup>21</sup>

Several aspects of the results are noteworthy. First, foreign shocks are generally very important for these countries. For the two countries with arguably the most stable exchange rate vis-à-vis the US dollar, Hong Kong and Malaysia, over seventy percent of the forecast error variance (FEV) of inflation at a horizon of sixteen quarters is explained by external shocks. For the other countries, the proportion accounted for by external shocks is close to or exceeds one half. This means that even if conventional models of inflation – i.e. models in which the output gap, the real interest rate, and the real exchange rate are the proximate determinants – are applicable to the economies in our sample, it is important to realize that the driving variables in these models are themselves heavily influenced by external forces.

In view of the small size of the economies, their substantial openness to trade, and their proclivity to conduct monetary policy with a view towards stabilizing the nominal exchange rate, it is not surprising that external sources of shocks should be so important. It is perhaps more surprising that only a relatively small part of the external effects can be associated with shocks originating in China. Shocks to the US variables generally account for the largest part of the external effects, even if in Hong Kong, Malaysia, and Taiwan the proportion of the FEV accounted for by Mainland China is significant.<sup>22</sup> It should be kept

<sup>21</sup> The results in Table 4 refer to VAR systems with four lags of each variable in each equation. Very similar results are obtained with systems estimated with three lags. For example, the correlation coefficient between the 16 quarter horizon FEVs for the 3 lag systems and those for the 4-lag systems are .95 for inflation and .85 for real growth.

<sup>22</sup> Our results for Hong Kong and Taiwan are consistent with those reported in Kumar, et al. (2004) who found that prices in these two economies were strongly influenced by price developments in Mainland China. Contrary to our findings, their results also showed significant influences of the Mainland on Singapore and no effect on Malaysia. A possible reason for the discrepancy is that their results were based on bivariate VARs including only prices, whereas ours also control for the influence of US variables.

in mind that these results are based on relationships estimated for the entire period from 1990 to 2003. It is likely that China has become more important over time in the region as trade and financial linkages have grown. To capture such effects one would have to rely on econometric techniques that allow for time-varying coefficients, a potentially fruitful area of future research.

It bears emphasizing that even if Mainland China is not an important source of shocks, it is quite possible that it constitutes an important mechanism of transmission of shocks coming from elsewhere. In fact, given the fixed exchange rate between the RMB and the USD for much of the sample, one would expect the Chinese economy to be influenced importantly by developments in the United States, and in view of China's strong trade links to the other countries in the region, the shocks originating elsewhere would affect them as well. If this result holds up to further scrutiny, it implies that it would be misleading to look at relationships between China and the other countries in the region without controlling for the influence of the United States.

The third striking result in Table 4 is the differences between Hong Kong, Malaysia, and Singapore on the one hand and Korea, Philippines, Taiwan, and Thailand on the other with respect to the importance of external influences for the forecast error variance of CPI inflation. At the 16 quarter horizon the share accounted for by external shocks is about 70% for the former group of countries whereas it is 'only' around 50% for the latter. My interpretation of this difference is that it reflects a greater independence of monetary/exchange-rate policy in Korea, Philippines, Taiwan, and Thailand than in the other countries.<sup>23</sup>

Finally it is interesting to note that there is much less difference between the countries with respect to the decomposition of the forecast error variance of the real growth rates. If my interpretation is correct, this means that monetary independence can provide some control of domestic price developments but that this is less the case for output fluctuations.

## ***ii. Historical decomposition of inflation and output movements.***

Since the assumption of a recursive structure of the relationships between the United States, China, and each of the countries permits us to identify the origin of the shocks to the inflation and real growth equations, it is possible to calculate how much of the forecast errors in those variables is due to shocks from each region. I will conduct such a decomposition to illustrate the sources of the evolution of inflation and real growth in the six countries since the mid 1990s, and to discuss similarities and differences among the countries in their response to the same external economic environment.

The results of the decomposition are displayed in Chart 4 for the year-on-year CPI inflation rates and in Chart 5 for year-on-year real growth rates. The thick solid line represents the actual realizations of the corresponding variable, and the line with long dashes (— — —) depicts the forecast as of the fourth quarter of 1994. In other words this is the path that one would have expected the variables to follow on

<sup>23</sup> When VAR systems were estimated in which a domestic short-term interest was included instead of the inflation rate in Mainland China (i.e. where both  $y_t^i$  and  $y_t^U$  contained the rate of CPI inflation, the growth rate of real GDP, and a short-term interest rate, and  $y_t^C$  was eliminated), there was a tendency for the external component of the FEVs for the domestic inflation rate and the interest rate to be correlated across countries. I.e. in countries where domestic shocks accounted for a relatively larger portion of interest rate movements, the inflation rate was also less dependent on external shocks.



the basis of the estimated VARs and on the assumption that no shocks would occur. The line based on short dashes (- -) represents the forecast combined with the effects of the shocks associated with the USA, and the thin solid line the forecast plus the effects on all external shocks (associated with both the US and China). By construction the difference between the thick and the thin solid lines shows the effects of the purely domestic shocks.

Focusing first on the influence of external shocks on inflation rates, it is possible to distinguish between three groups of economies. In Hong Kong and Singapore, innovations in inflation are closely associated with shocks in the US and (for Hong Kong) the Mainland, even though domestic shocks had some positive impact immediately before the 1997-98 crisis and negative impact immediately after. In Korea, Philippines, and Thailand domestic shocks account for a more significant part of the forecast errors – especially around the crisis years – and the external shocks are predominantly from the USA.<sup>24</sup> Finally for Malaysia and Taiwan, the role of Mainland China is particularly strong. For the three countries where Mainland China has had the strongest influence, the impact has been to reduce inflation during the first part of the period (until about the end of 2000). Thereafter its effect is more muted and not unidirectional.

Turning to decomposition of real GDP growth rates it is again noteworthy that external shocks, and in this case these are mainly of US origin, explain substantial portions of the innovations except during the period 1997-99 where ‘domestic’ factors played an important role. ‘Domestic’ is placed in quotation marks because on closer inspection it turns out that these shocks are quite closely correlated across countries, as if in fact they had a common source. Tables 5a and 5b report the correlation coefficients for the period as a whole as well as for 1997-1999. Significant correlation coefficients are in bold (99% level) typescript and italics (95% level). They suggest that with the exception of Taiwan the ‘domestic’ shocks may be the result of some left-out common, and hence external, factor. The boom and bust in capital flows associated with the crisis is the obvious candidate.

The information in the historical decompositions makes it possible to compare the responses in each of the six countries to the same external shock. Chart 6 shows the joint contribution of the three US shocks to inflation in each of the countries and Chart 7 does the same for real growth. Recall that the VAR is specified in such a way that the US variables depend only on each other and not on the other countries. This implies that the shocks to the US variables will be exactly the same for each of the countries. The charts therefore measure the impact of the same external shocks on each of the countries, and the charts can therefore be used to gauge the structural similarities and differences between the countries.<sup>25</sup>

While the responses of Hong Kong, Korea, Malaysia, Singapore, and Thailand are broadly speaking quite similar to each other, there are some differences in both amplitude and phase. The reactions of Philippines and Taiwan are more idiosyncratic. We can therefore conclude that differences in inflation performance in the former set of countries must be due primarily to the nature of domestic policy

<sup>24</sup> It bears recalling that the USA is used as a proxy for world market conditions in general. For the interest rate this is arguably quite reasonable, whereas for external inflation and growth it may be a source of mis-specification.

<sup>25</sup> The responses plotted in the charts are similar to standard impulse response functions. The difference is that instead of showing the response to a unit shock of a particular variable, the charts depict the responses to the estimates of the actual shocks that occurred in the United States.

responses and shocks, whereas for the latter two countries it appears that structural differences may also play a role.

#### **d. Extensions.**

The VAR analysis has uncovered interesting similarities and differences across the countries in the sample, and I have suggested that these may be related to differences in monetary/exchange rate policies they have adopted. It is not possible to test this suggestion formally within the system of equations that I have estimated, however. One way to do so would be to estimate policy reaction functions together with equations for inflation and output growth, and to simulate the counterfactual situation where all countries are assumed to react in the same way to the external shocks. This approach would require a higher-dimension VAR as well as the imposition of additional restrictions to identify the structural policy reaction equation.

Extending the dimension of the VAR system quickly leads to problems of degrees of freedom. To deal with this it may be interesting to adopt a Bayesian procedure as implemented by Sims and Zha (1998) which involves combining prior assumptions about the structure of the interactions with information in the data. If the same prior is used for all countries, this approach could be useful in highlighting differences between them that really stand out in the data.

Another approach to dealing with the problem of degrees of freedom would be to estimate a panel VAR system in which differences among countries are introduced by having separate monetary policy reaction functions for each one. The panel structure may also allow the estimation to be carried out on a shorter sample which would make coefficient instability due to structural changes less of an issue.

Finally it would be interesting to explore to what extent periods of deflation (i.e. negative inflation rates) generate different dynamic behavior of the endogenous variables due to the type of non-linearities suggested in section 4a. To do so would however require different estimation methods, for example a threshold VAR approach.

## **6. Summary and Conclusions**

Several countries in East Asia have experienced persistent deflation in the recent past, most notably Japan and Hong Kong, but also Mainland China. Other countries in the region have had low rates of inflation but only relatively brief periods of actually falling general price levels. Leaving Japan aside as a somewhat special case, this paper has investigated (i) some aspects of the determinants of inflation rates in the region, (ii) whether China has had a particularly important role to play, and (iii) why the inflation experiences have differed between countries.

If common shocks – for example the crisis in 1997-98, deflationary impulses from Mainland China, or developments in the world economy in general – have been the main reasons for the inflation experiences in the region, why did some countries react differently than others? The paper has suggested answers with the help of a small analytical model. Potentially important factors include differences in price and

wage adjustment processes combined with non-linearities in the reaction of aggregate demand, differences in trade structure which condition the competitive effects of price and exchange rate changes, and, most importantly in my view, differences in monetary policy response.

Empirical analysis of these issues has been carried using vector autoregression models for seven small economies: Hong Kong, Malaysia, Korea, Philippines, Singapore, Taiwan, and Thailand. The models have a semi-structural interpretation due to the recursive structure of interactions between the United States, China and the small economies in the region. While some of the results are expected, for example that external shocks are very important for inflation and GDP growth in these small countries, others are less in line with conventional views. Shocks originating in China do not appear to be as important as might be gleaned from the literature. Instead developments in the world economy in general, represented in the empirical analysis by the United States, are by far more important sources of external shocks. This does not rule out China as an important conduit of such shocks to the other countries. In fact, this is what one would expect given the fixed exchange rate policy of China.

The results also point to interesting differences in the responses of individual countries to the same external shocks. It is argued that some of these differences can be ascribed to differences in monetary/exchange rate policies, but the evidence is more circumstantial than based on estimated policy reactions. It is suggested that extensions of the empirical framework may be able to uncover direct evidence for differences among countries.

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**Table 1. Principal component analysis of y-o-y inflation rates**

Sample period	1991:1 - 2003:2		1991:1 - 1997:4	
	1st principal component	2nd principal component	1st principal component	2nd principal component
Cumulative proportion of variance explained	64%	79%	47%	69%
	Factor loadings		Factor loadings	
Mainland China	.28	.60	.00	-.57
Hong Kong	.42	.13	.46	-.13
Singapore	.32	.41	.38	.00
Taiwan	.38	.22	.33	-.38
Korea	.38	-.27	.45	.23
Malaysia	.35	-.34	.37	-.13
Philippines	.34	-.34	.42	.34
Thailand	.34	-.31	-.02	.56

**Table 2. Determinants of the common factor in inflation rates**

Dependent variable: The first principal component as defined in Table 1, col. 2.

Sample period	1991:1 - 2003:2	1991:1 - 1997:4	1999:1 - 2003:2
US Inflation	0.71 (0.26) [0.008]	1.31 (0.28) [0.0001]	1.88 (.38) [.0003]
Post crisis dummy	-2.93 (0.66) [0.0001]		
Constant	-0.87 (-1.13) [0.26]	-2.30 (0.66) [0.002]	-4.88 (.62) [.0000]
Adjusted R <sup>2</sup>	.94	.91	.92

Note: Standard errors are reported in parentheses and p-values in square brackets. The equations are estimated taking into account the third order moving average structure of the data inherent in the use of overlapping y-o-y inflation rates. Standard errors are estimated with White's method to correct for heteroscedasticity.

Table 3. Countries and variables used in the VAR analysis

Symbol	Country	Variables included
$y^i$	$i=\{$ Hong Kong, Korea, Malaysia, Philippines, Singapore, Taiwan, Thailand $\}$	<ul style="list-style-type: none"> <li>- CPI inflation</li> <li>- Real GDP growth</li> <li>- Money market interest rate</li> </ul>
$y^C$	China	<ul style="list-style-type: none"> <li>- CPI inflation</li> <li>- Real GDP growth</li> </ul>
$y^U$	United States	<ul style="list-style-type: none"> <li>- CPI inflation</li> <li>- Real GDP growth</li> <li>- Federal Funds Rate</li> </ul>

Table 4. Decomposition of the Forecast Error Variance\*

		INFLATION		REAL GROWTH		
		of which due to Mainland China		of which due to Mainland China		
4 LAGS	8 Quarters	Singapore	67.57	3.14	50.07	13.44
		Malaysia	66.95	15.19	65.89	3.74
		Hong Kong	54.17	8.19	54.52	4.56
		Taiwan	42.85	24.28	54.3	11.98
		Korea	42.34	6.82	46.55	1.63
		Philippines	41.93	8.5	35.78	7.4
		Thailand	32.13	3.24	56.22	10.13
	16 Quarters	Hong Kong	77.64	10.39	56.46	4.87
		Malaysia	70.98	19.96	67.49	4.09
		Singapore	69.97	2.91	51.34	12.84
		Taiwan	50.85	23.73	60.16	12.56
		Philippines	50.08	8.27	39.14	6.99
		Korea	47.05	6.29	49.47	1.77
		Thailand	45.74	7.26	58.61	9.99

Notes: \* Baseline model with three US variables (CPI inflation, real GDP growth, federal funds rate), one Mainland China variable (CPI inflation), and two local variables (CPI inflation and real GDP growth). The equations contained 4 lags of each of the variables as well as a constant term.

**Table 5a. Correlation between the contributions of 'domestic' shocks to growth of real GDP,  
1996:1 - 2002:4**

	Taiwan	Thailand	Singapore	Malaysia	Korea	Hong Kong	Philippines
Taiwan	1.00						
Thailand	0.12	1.00					
Singapore	<b>0.62</b>	<b>0.55</b>	1.00				
Malaysia	0.07	<b>0.54</b>	<i>0.47</i>	1.00			
Korea	0.15	<b>0.68</b>	<i>0.47</i>	<b>0.80</b>	1.00		
Hong Kong	<i>0.38</i>	<i>0.41</i>	<b>0.68</b>	<b>0.71</b>	<b>0.59</b>	1.00	
Philippines	0.18	<b>0.69</b>	<b>0.53</b>	<b>0.72</b>	<b>0.79</b>	<b>0.78</b>	1.00

**Table 5b. Correlation between the contributions of 'domestic' shocks to growth of real GDP,  
1997:1 - 1999:4**

	Taiwan	Thailand	Singapore	Malaysia	Korea	Hong Kong	Philippines
Taiwan	1.00						
Thailand	<i>0.42</i>	1.00					
Singapore	0.36	<b>0.90</b>	1.00				
Malaysia	0.36	<b>0.79</b>	<b>0.78</b>	1.00			
Korea	<i>0.45</i>	<b>0.92</b>	<b>0.89</b>	<b>0.91</b>	1.00		
Hong Kong	0.07	<b>0.59</b>	<b>0.72</b>	<b>0.89</b>	<b>0.76</b>	1.00	
Philippines	0.36	<b>0.78</b>	<b>0.84</b>	<b>0.94</b>	<b>0.90</b>	<b>0.93</b>	1.00



Chart 1. Year-on-year inflation rates

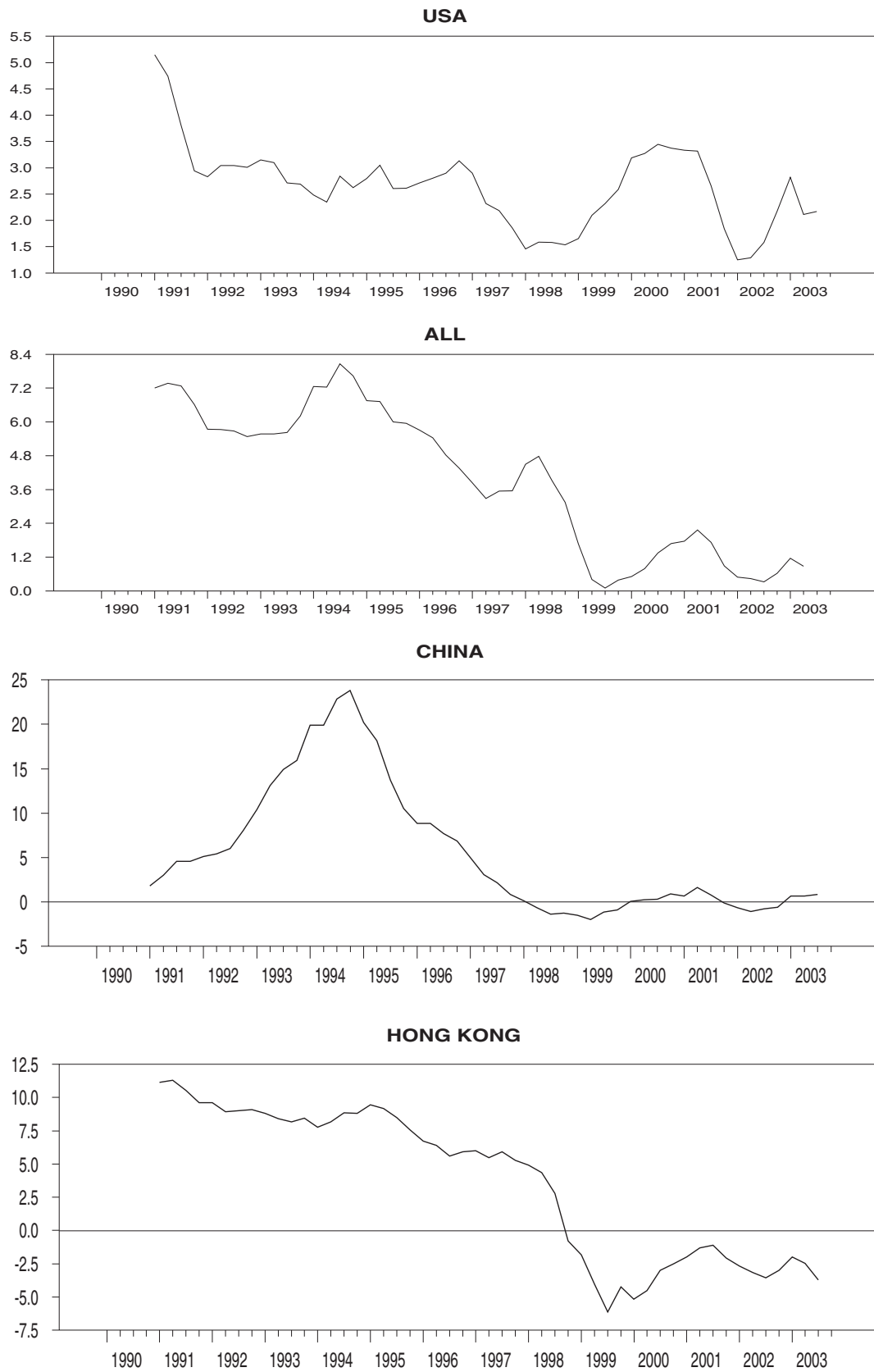


Chart 1. Year-on-year inflation rates (continued)

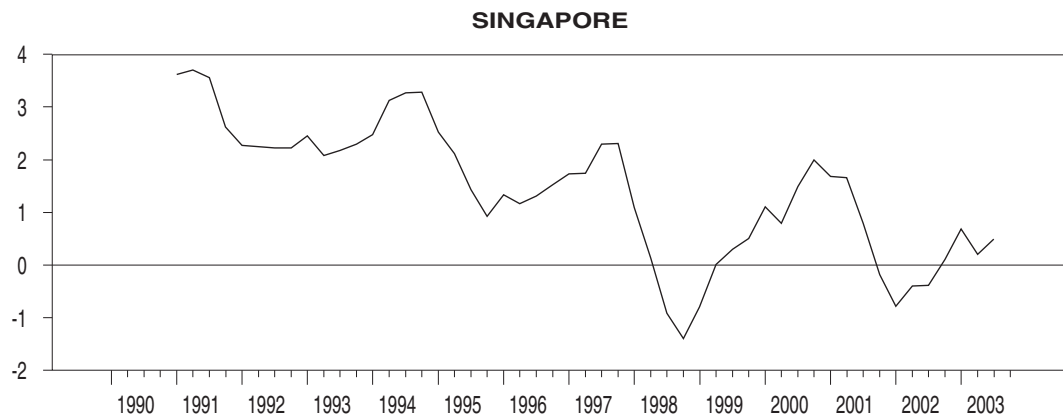
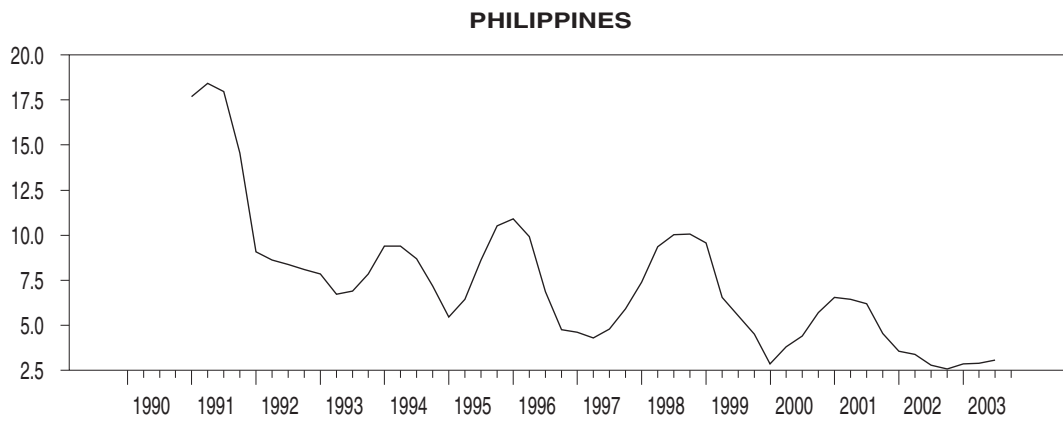
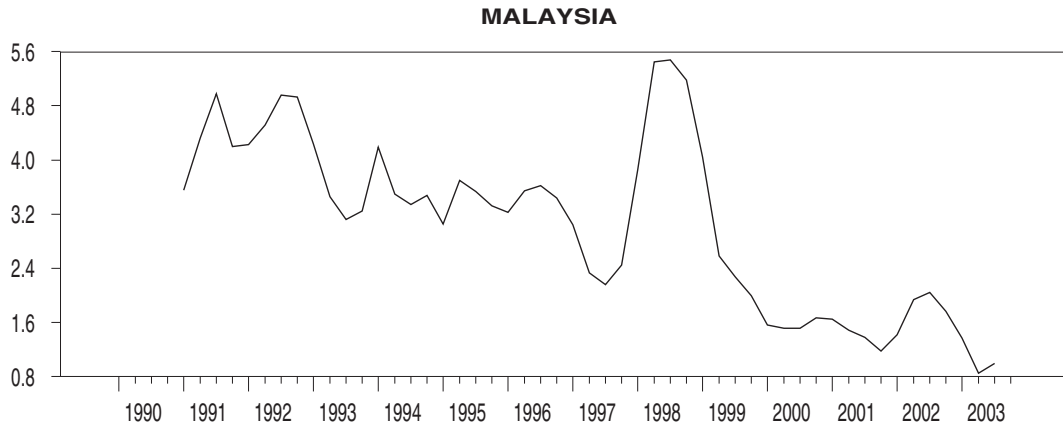


Chart 1. Year-on-year inflation rates (continued)

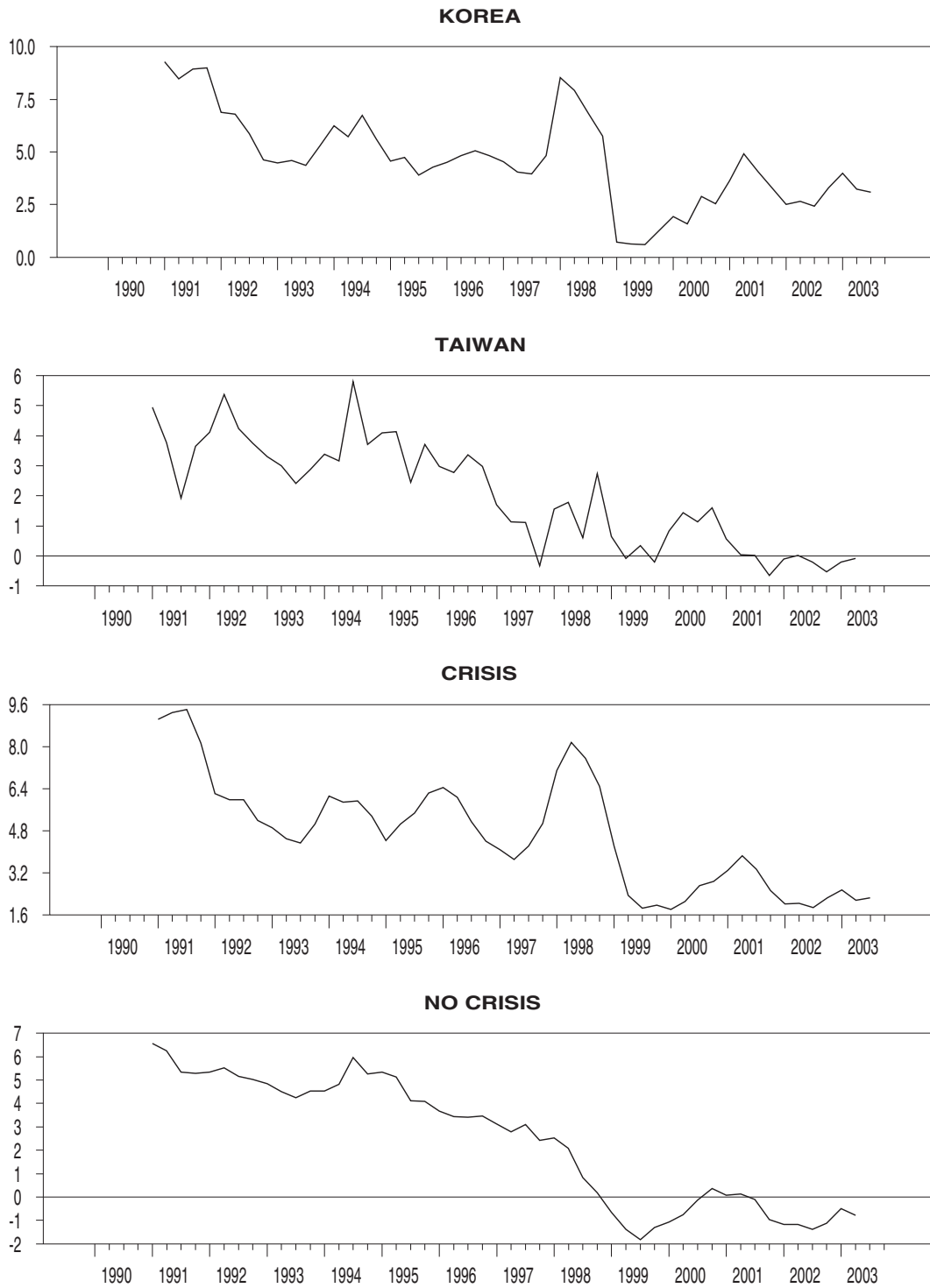


Chart 2. Nominal US dollar exchange rates. Index with 2003:1 = 100

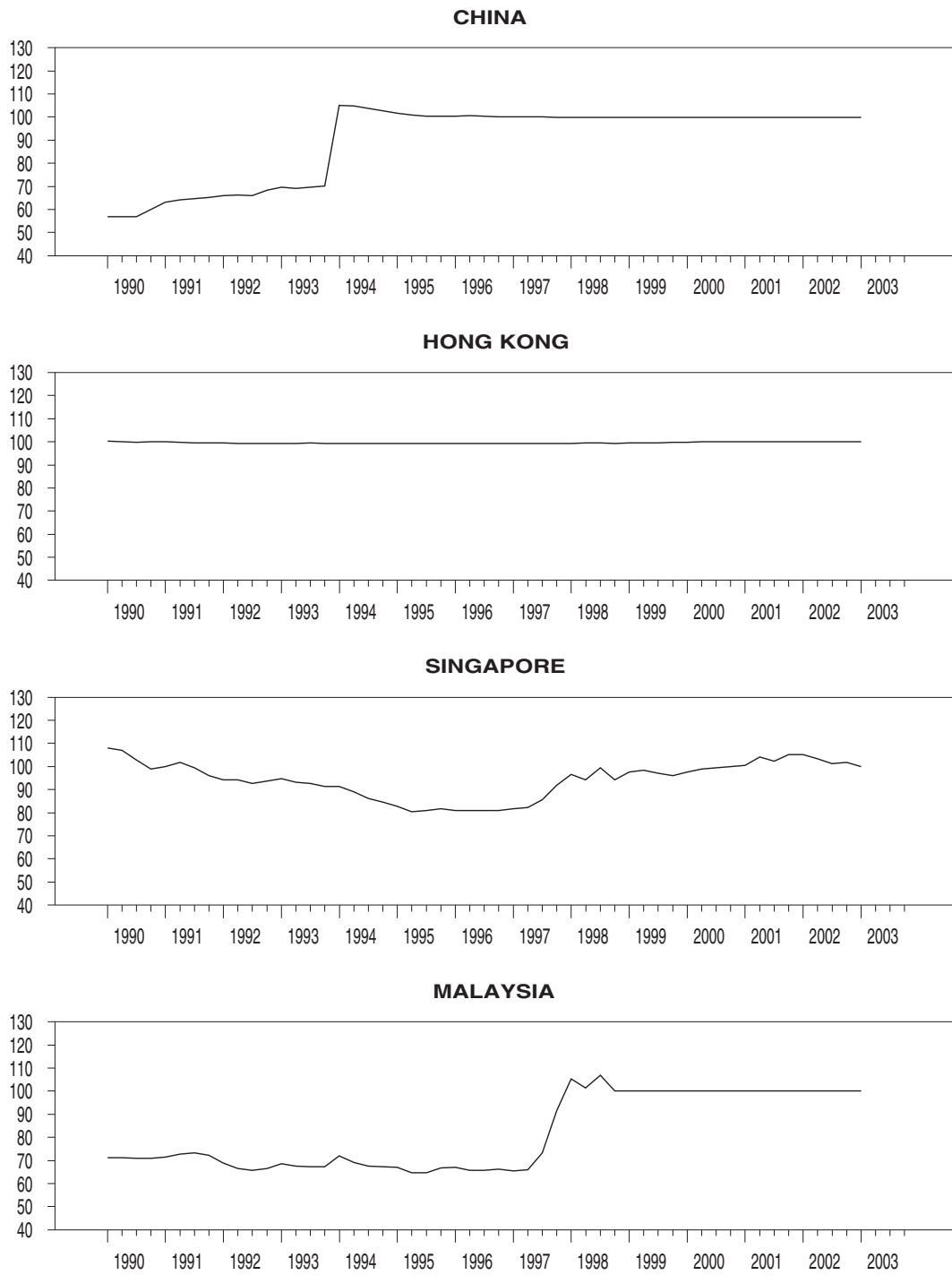
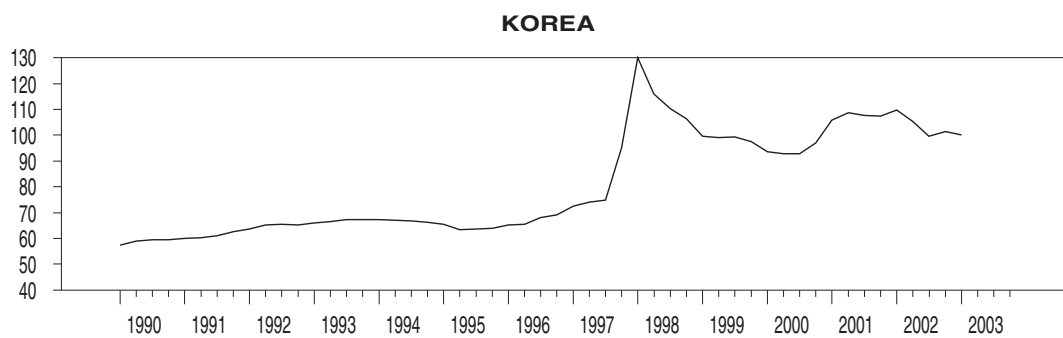
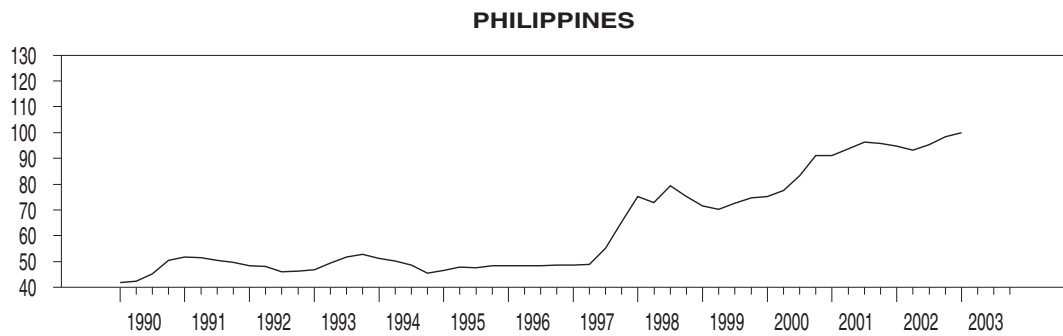
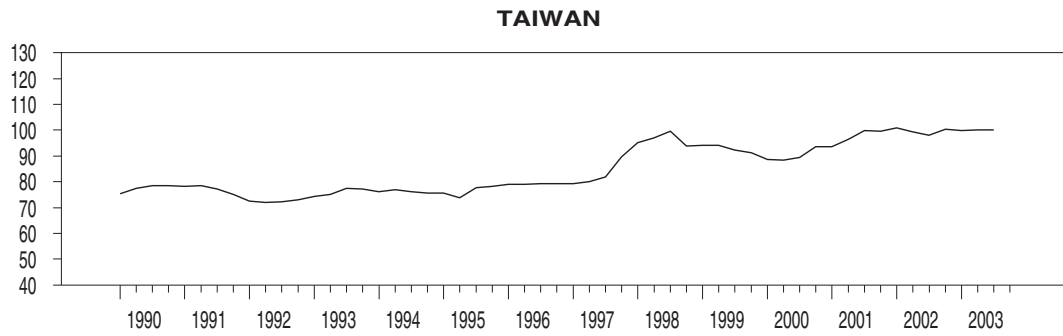
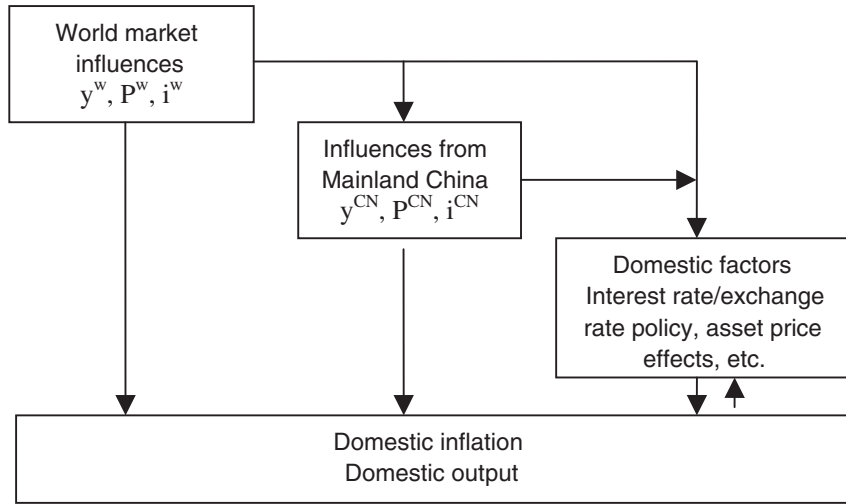


Chart 2. Nominal US dollar exchange rates. Index with 2003:1 = 100 (continued)



**Chart 3. Schematic illustration of the structure of macroeconomic influences on small East-Asian economies**



**Chart 4: Historical decomposition of year-on-year inflation rates**

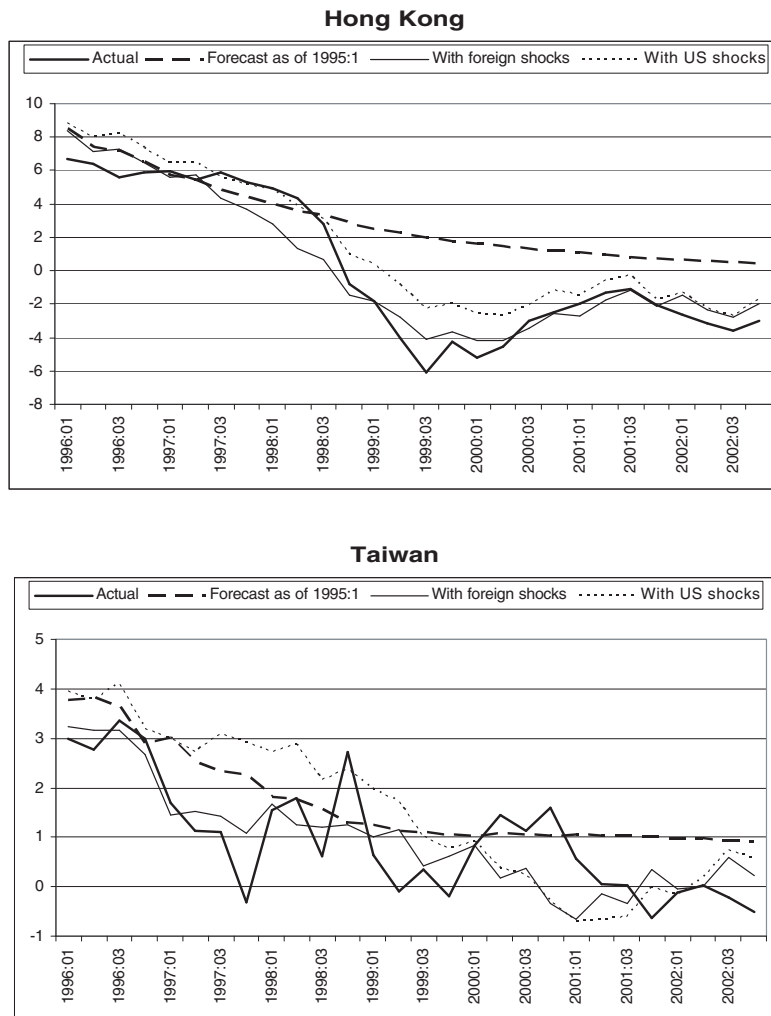


Chart 4. Historical decomposition of year-on-year inflation rates (continued)

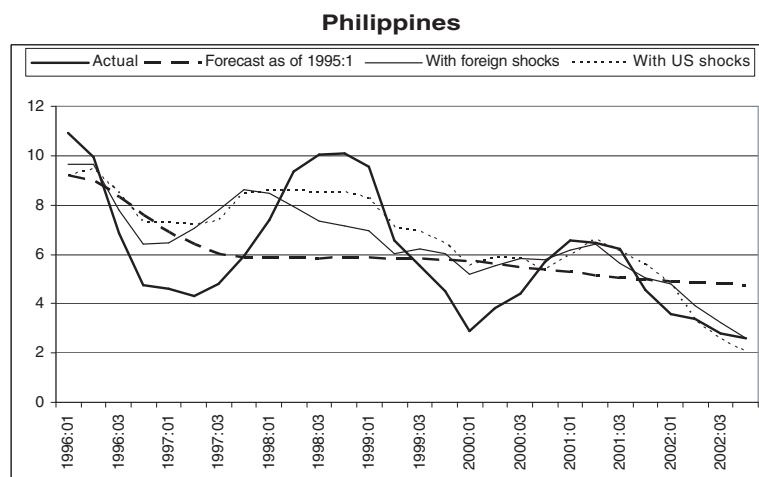
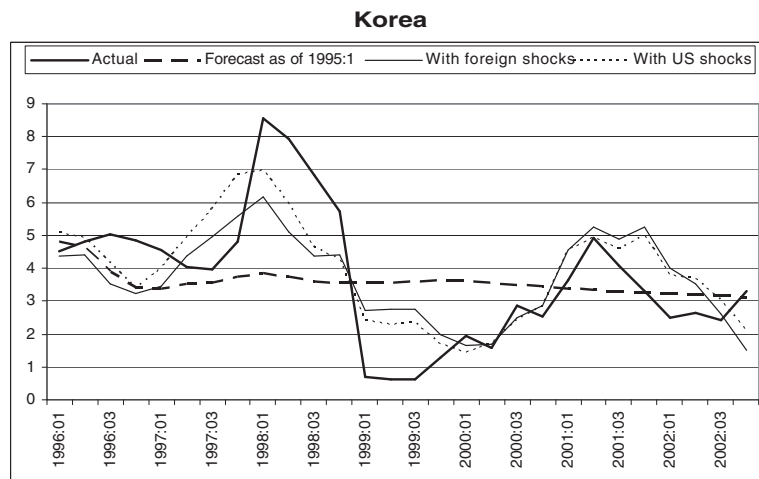
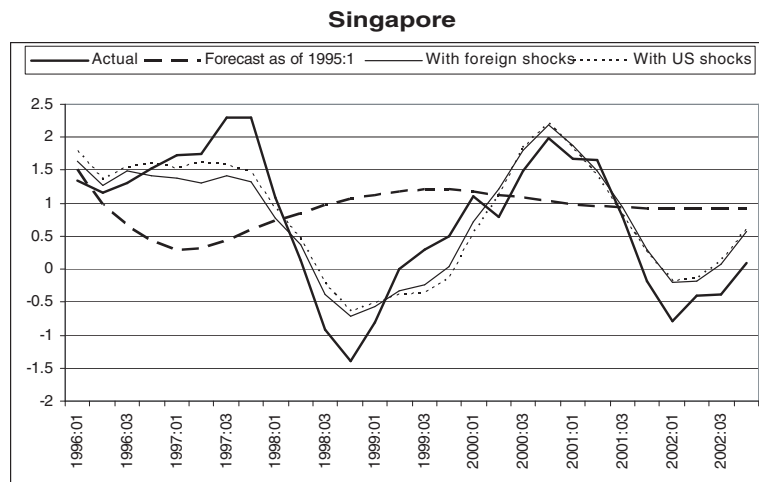


Chart 4. Historical decomposition of year-on-year inflation rates (continued)

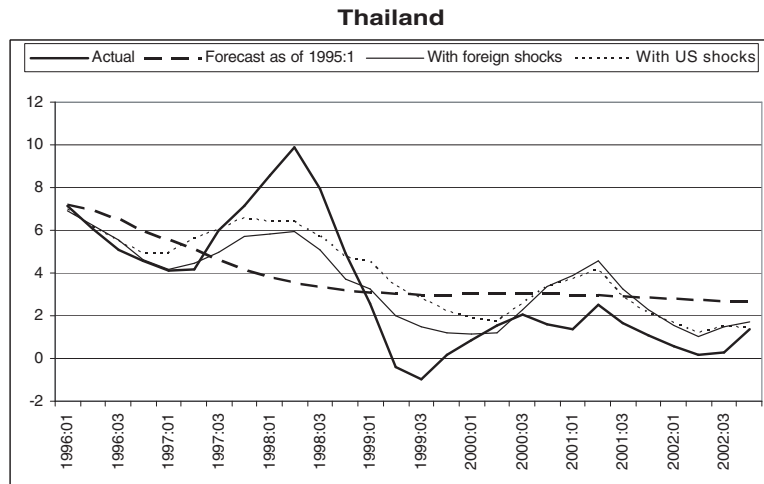
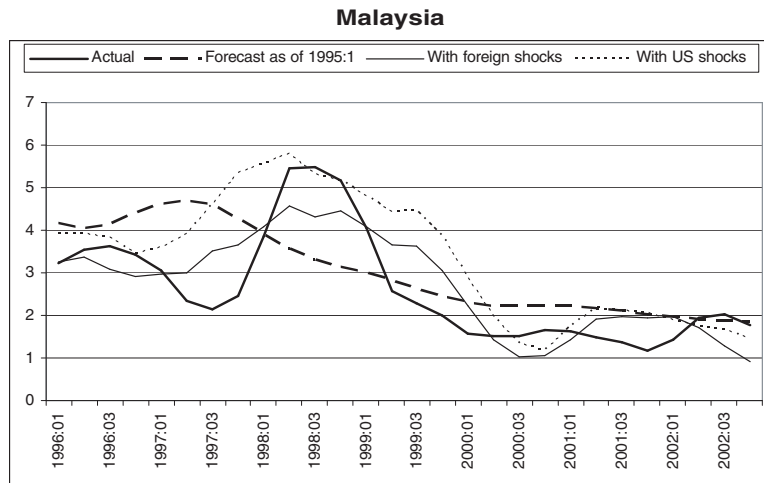




Chart 5. Historical decomposition of year-on-year growth rates of real GDP

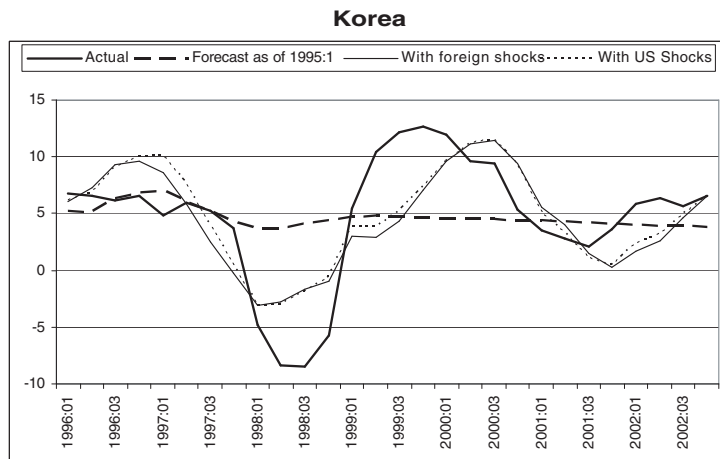
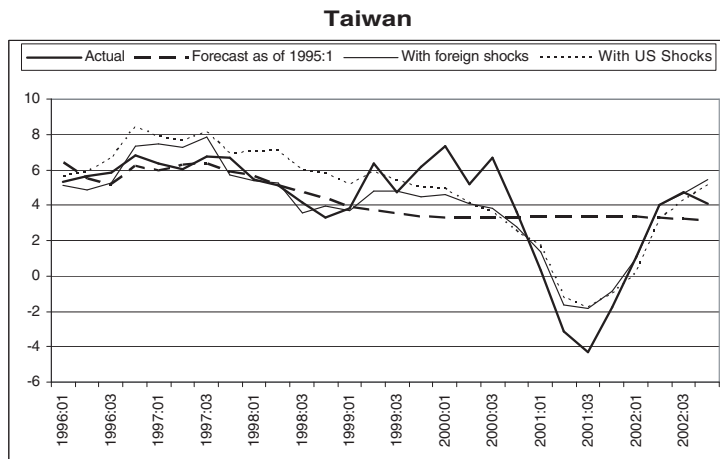
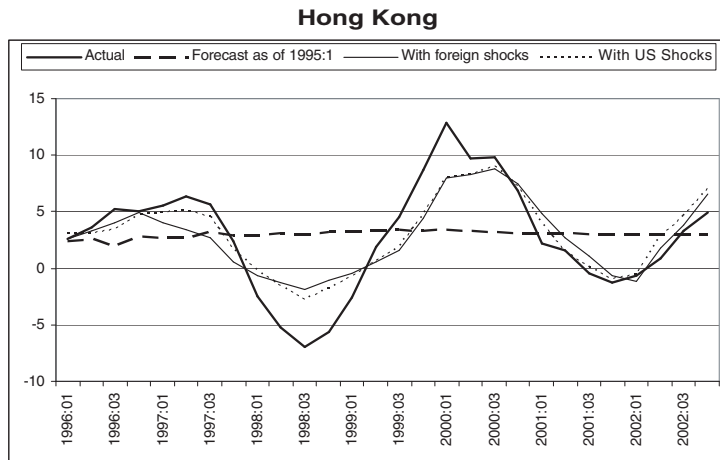
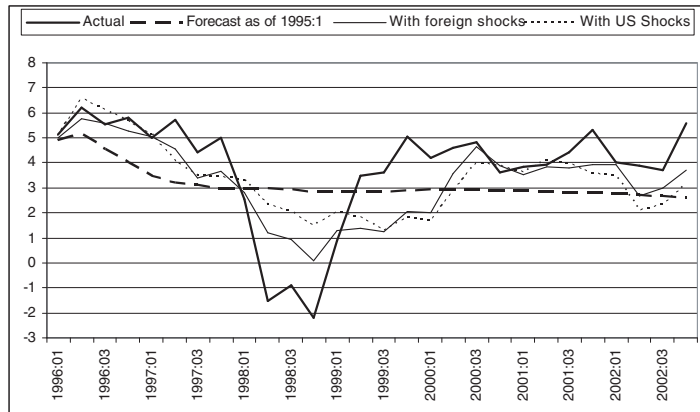
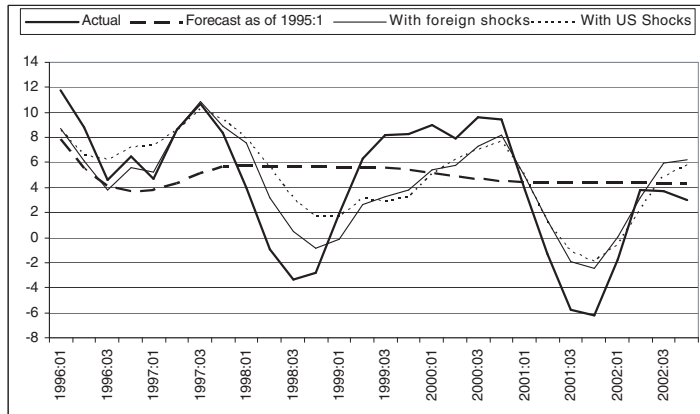


Chart 5. Historical decomposition of year-on-year growth rates of real GDP (continued)

**Philippines**



**Singapore**



**Malaysia**

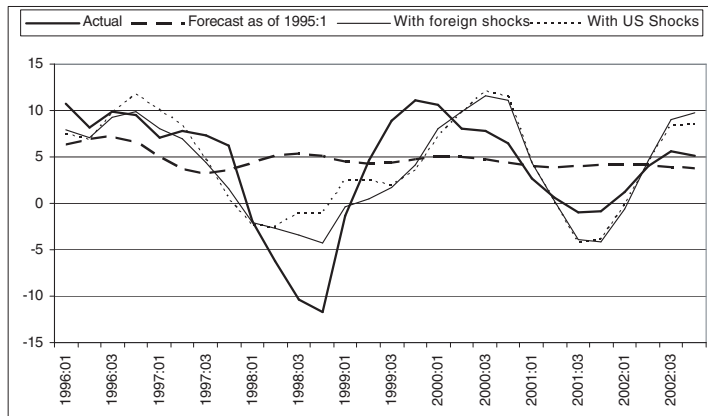


Chart 5. Historical decomposition of year-on-year growth rates of real GDP (continued)

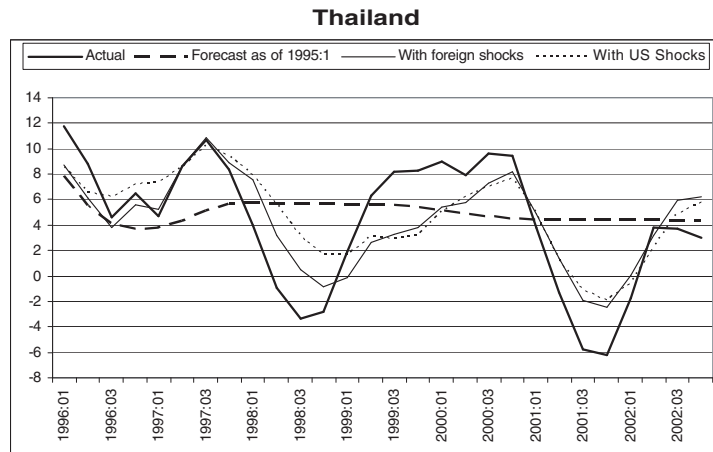


Chart 6. The contribution of US shocks to inflation.

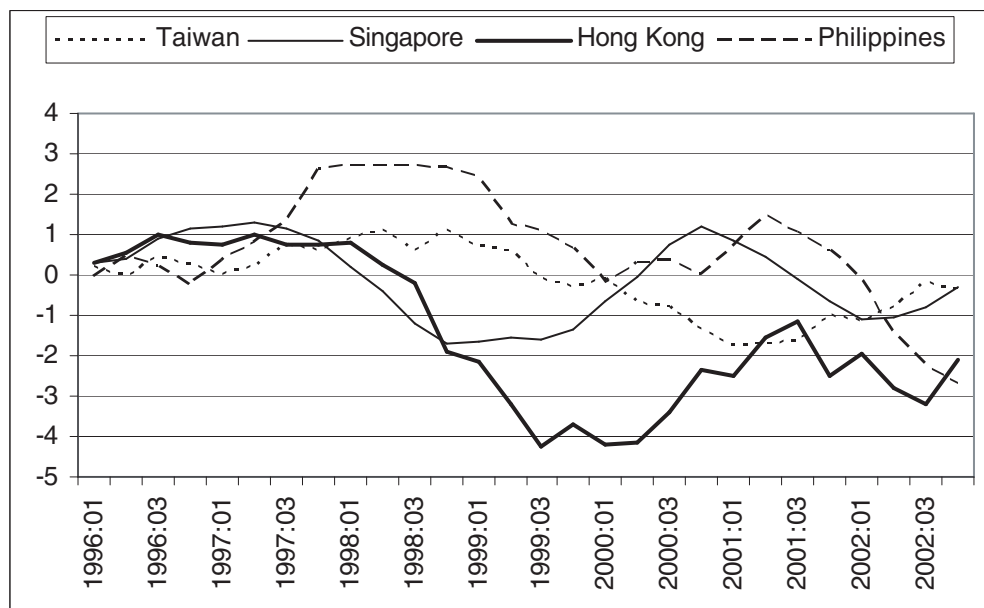
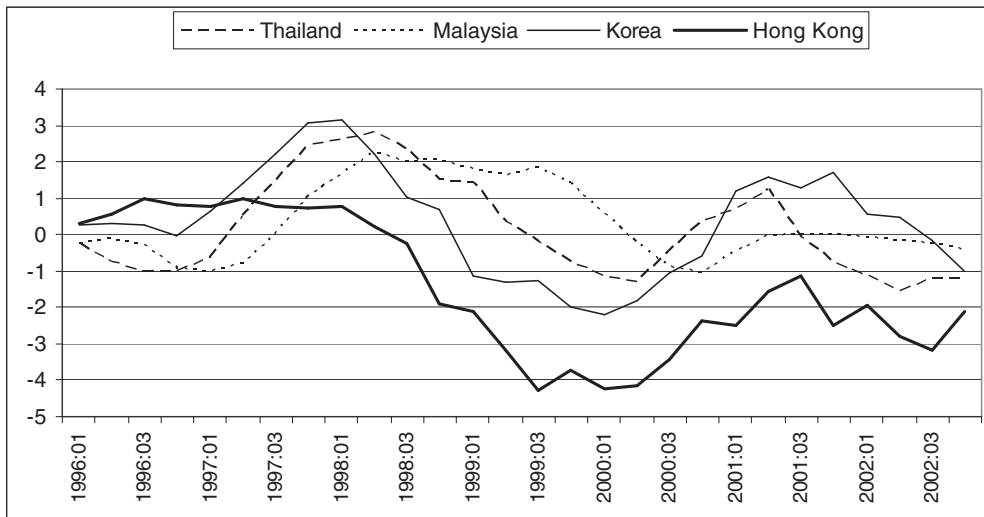


Chart 7. The contribution of US shocks to growth of real GDP

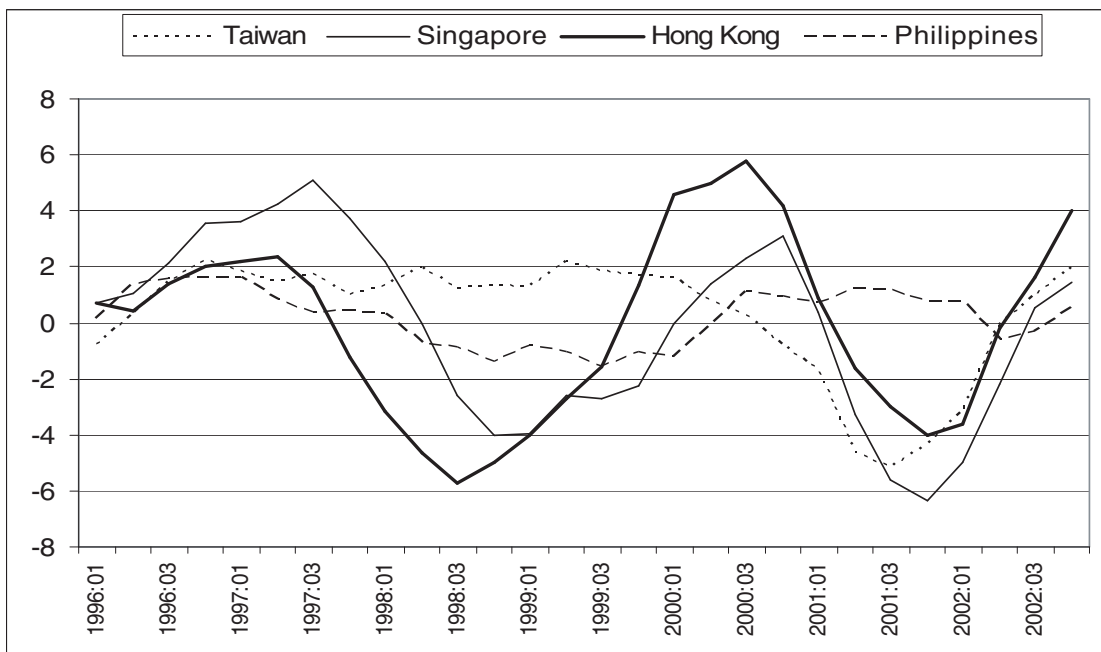
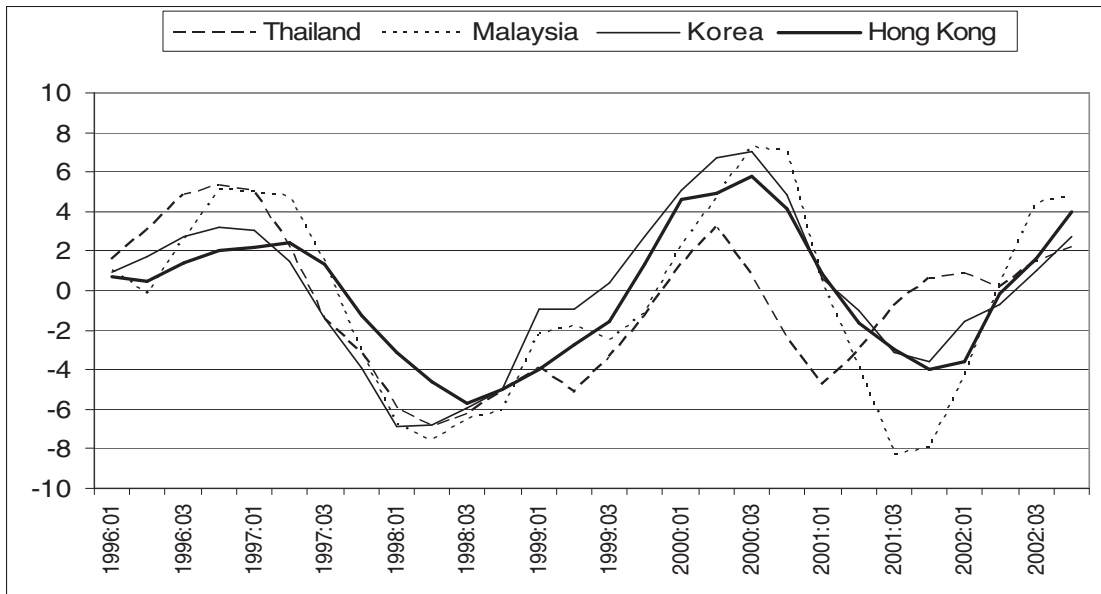


Figure 1.

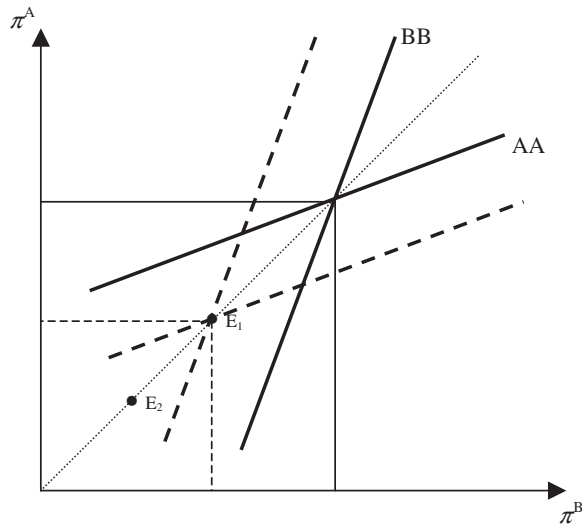


Figure 2.

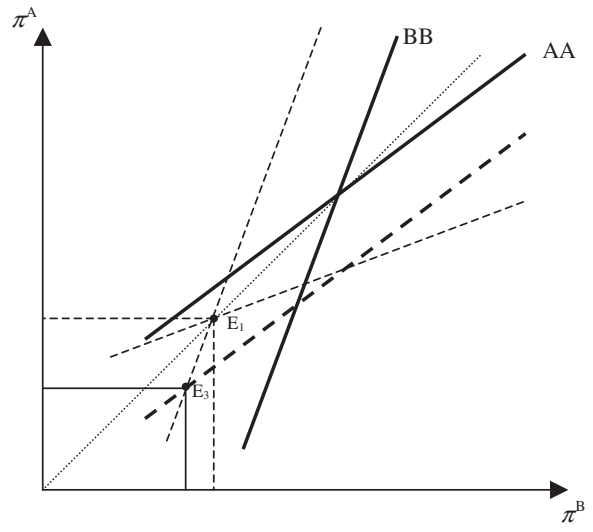


Figure 3.

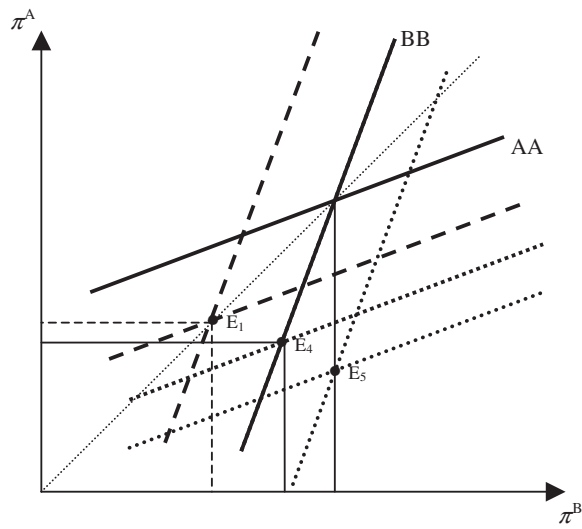


Figure 4.

