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Abstract

The pass-through effects of exchange rate changes on the domestic prices in the East Asian countries are examined using a VAR analysis including several price indices and domestic macroeconomic variables as well as the exchange rate. Results from the VAR analysis show that (1) the degree of exchange rate pass-through to import prices was quite high in the crisis-hit countries; (2) the pass-through to CPI was generally low, with a notable exception of Indonesia: and (3) in Indonesia, both the impulse response of monetary policy variables to exchange rate shocks and that of CPI to monetary policy shocks are positive, large and statistically significant. Thus, Indonesia's accommodative monetary policy as well as the high degree of the CPI responsiveness to exchange rate changes was important factors that resulted in the spiraling effects of domestic price inflation and sharp nominal exchange rate depreciation in the post-crisis period.

Keywords: exchange rate pass-through, structural shocks, vector autoregression, East Asia

JEL Classification Codes: F12, F31, F41

1. Introduction

The objective of this paper is to examine pass-through effects of the exchange rate changes using a VAR analysis on the domestic prices among the East Asian countries. The crisis-affected Asian countries have different experiences to the initial shock of currency depreciation. In some countries, such as Korea, a sharp nominal depreciation was followed by a sharp reversal several months later, with little effects on domestic inflation. In some other countries, such as Indonesia, a very large depreciation resulted in high inflation, so that the real exchange rate did not change much to promote exports.

Whether the exchange rate changes have significant impact on the domestic prices has several important implications to thinking of the role of the exchange rate in macroeconomic policy design. If the degree of pass-through is high, the exchange rate changes will change the relative prices of tradables and non-tradables, so that the adjustment in trade balances will be relatively prompt. For example, imported goods become expensive, if pass-through is high, so that expenditure switching from imports to domestic goods will occur and external balances will be corrected in several months. On the other hand, if the degree of pass-through is low, the exchange rate does not have much impact on the trade balance.

Another important aspect is the interaction between the exchange rate and domestic prices including both tradables and non-tradables. Suppose a country is experiencing trade deficits and the exchange rate depreciates, that would be one mechanism to make export competitiveness stronger, resulting in improvement in external balances. However, if domestic prices in general respond to the nominal exchange rate depreciation one-to-one—that is, pass-through not only to import prices but to CPI in general—then any export competitiveness from nominal depreciation

would be cancelled out. A combination of nominal depreciation and high inflation leaves the export competitiveness unchanged, while corporations and financial institutions that had net foreign-currency liabilities become burdened by larger real debts and nonperforming loans.

Hence, from the viewpoint of using the exchange rate changes as an instrument for correcting (reducing deficits and possibly making surpluses in) the trade balance, the pass-through to import prices and possibly wholesale prices to force expenditure switching is good, but the pass-through to CPI, raising all price levels, is bad.

Post-crisis Asian countries provide a rich "natural" experiment of large exchange rate changes and different domestic responses. In order to examine what exactly happened in the post-crisis Asian economies in terms of pass-through of different levels, we need to build a framework that included different kinds of price indices as well as the nominal exchange rate. The pass-through question is to examine the direction from the exchange rate to domestic prices. However, domestic inflation may affect the exchange rate. In order to examine a reinforcing mechanism, a VAR analysis is necessary.

The novelty of this paper is two-fold: to use a VAR that would allow the reverse causality from inflation to the exchange rate; and to use several domestic price indices so that we may examine how pass-through effects may be watered down as weights of domestic (nontradable) value added increase, from import prices to wholesale prices, to consumer price indices.

The rest of this paper is organized as follows. Section two describes the brief history of currency movements of the Asian currency crisis. Section 3 discusses the analytical framework of this paper. The results of a VAR analysis are presented in

Section 4. Section 5 concludes.

2. Experiences of the Asian Countries

In the episode of the Asian currency crisis, the interaction of the exchange rate and domestic prices varied from one country to another. After the floatation of the Thai baht on July 2, 1997, some Asian currencies immediately depreciated, while others held on for several months before experiencing a large depreciation. Although the Asian currency crisis was considered to be a case of rapid contagion across Asia from Thailand to Indonesia, to Korea, the process took more than several months before the full crisis developed in December 1997. In some interpretation, the Asian currency crisis was not due to a single shock to Thailand but multiple shocks to Thailand, Indonesia, and Korea with reinforcing spillover to each other.[3] Reasons for the downfall of the currencies seemed to be different in different countries.

Reasons for a crisis are different in several countries, and recovery processes are also different. It is well recognized that the crisis was most severe and the recovery took much longer in Indonesia than others. By several measures, Indonesia suffered most damages in the financial crisis of 1997-98. The Indonesian rupiah depreciated to one-sixth of the pre-crisis level in the mid-January 1998, about 16,000 rupiah/dollar. The rupiah recovered somewhat in the spring, but again went to the 15,000 in May 1998, when the political crisis reached a climax, that resulted in the resignation of President Suharto. Capital outflows continued, and the recovery of nominal exchange rate from that trough was very much delayed.

The value of Asian currencies other than the Indonesian rupiah recovered

[3] See Ito and Hashimoto (2002).

from January to December of 1998, and then they were stabilized at around 60 to 70% of the pre-crisis level by the mid-1998. The recovery of the Indonesian rupiah was much slower and never recovered to the level (relative to the pre-crisis level) of other Asian currencies. Figure 1 shows the development of the Asian exchange rates.

*** Insert Figure 1. ***

It was not only the exchange rate but the inflation rate in Indonesia that was different from other countries. The inflation rate of Indonesia became very high for any country in 1998 and 1999 and remained higher than most Asian countries in the period from 2000 to 2003 (Figure 2). Although the Indonesian exchange rate depreciated much more than other countries, inflation cancelled out some of price competitiveness that came from depreciation. By 2004, the real exchange rate of Indonesia became similar to that of Thailand, the Philippines, and Malaysia. The export advantage of Indonesia was offset by 2004 (Figure 3).

*** Insert Figures 2 and 3. ***

So far, the story is told in terms of the bilateral nominal and real exchange rate vis-à-vis the US dollar. However, export competitiveness of a county is most accurately measured in the real effective exchange rate (the multilateral version of the real exchange rate). The trade weights can be used for defining multilateral effective exchange rate.[4] The pass-through should be defined as the exchange rate changes of

[4] To be precise, price elasticities should be taken into account. See Ito, Ogawa, and Sasaki (1998).

trading partners and the impact should be measured as the weighted average of those exchange rates.

3. Analytical Framework

The exchange rate is determined by, among others, the interest rate, inflation rate, and other macroeconomic variables that are subject to monetary and fiscal policies. It is well-known that high inflation rate (vis-à-vis the trading partner countries) will surely depreciate the currency and that the low interest rate tend to depreciate the currency. On the other hand, many empirical studies have found that the exchange rate is statistically exogenous to (Granger-cause) many macroeconomic variables. The changes in the exchange rate tend to affect pricing behaviors of the firms and to influence on macroeconomic policies. Therefore, ideally, any analysis of interaction between the exchange rate and domestic inflation should allow bi-directional causal relationship: from the exchange rate to domestic variables and from domestic variables to the exchange rate.

In the fixed exchange rate regime, policies are assigned to keep the exchange rate at the committed exchange rate. Macroeconomic shocks, including those shocks to investors' assessment of the country as destination of portfolio investment, are countered by policies, so that the interest rate and inflation rate may fluctuate, but the exchange rate. In the floating exchange rate regime, the exchange rate is only one of the macroeconomic variables that respond to economic policies. Since the exchange rate and inflation rate are expected to be influencing each other in many theoretical models, it is most appropriate to estimate a system that would treat both of them endogenous. In particular, during the currency crisis period, however, a large swing of exchange rate is likely to affect domestic macroeconomic variables. A vector

autoregression (VAR) is a useful approach to allow for such interaction between exchange rate and domestic variables.[5]

A VAR analysis of the exchange rate pass-through has the following advantages. First, a VAR technique enables us to identify structural shocks through a Cholesky decomposition of innovations. Effects of structural shocks to other macroeconomic variables on domestic inflation are also investigated under a VAR framework. Second, previous studies typically analyze the exchange rate pass-through into a single price by employing a single-equation-based approach. A VAR approach, in contrast, allows us to investigate the exchange rate pass-through into a set of domestic prices along the pricing chain.

This paper analyzes the pass-through effect on domestic inflation in the following way. First, we employ a 5-variable VAR including exchange rate, consumer price index (CPI) and other macroeconomic variables. Structural shocks to exchange rate and other variables are identified through a Cholesky decomposition of innovations. It is investigated how domestic macroeconomic variables respond to exchange rate shocks through the impulse response function analysis. Second, instead of CPI, we try other domestic price variables, i.e., producer price index (PPI) and import price index (or import unit values). We include each price variable one by one and compare estimated results between three price variables. We also include all three price variables together in a 7-variable VAR and examine the pass-through effects of exchange rate shocks on a set of prices along the pricing chain. Third, in addition to the analysis for the whole sample period, we conduct estimation for the sub-sample period ranging from 1997M7 to the present, as most countries started to change their

[5] Recent studies, such as McCarthy (2000), Hahn (2003) and Faruqee (2004), use a VAR approach for an analysis of pass-through of several types of shocks to domestic inflation.

exchange rate regime from the *de facto* US dollar peg into more flexible exchange rate system once hit by the crisis. This additional analysis with the sub-sample reveals how the pass-through effect has changed after shifting to a post-crisis exchange rate regime.

We set up the following VAR model (baseline model) with the vector of five endogenous variables, $x_t = (\Delta oil_t, gap_t, \Delta m_t, \Delta efexr_t, \Delta p_t)'$, where oil_t denotes the natural log of oil prices, gap_t the output gap, m_t the natural log of money supply (base money or M1), $efexr_t$ that of nominal effective exchange rate, and p_t that of domestic prices. Δ represents the first difference operator. As will be discussed below, we take the first-difference of all variables except for gap_t to ensure the stationarity of variables. Whereas previous studies, such as MaCarthy (2000) and Hahn (2003), use a 7- or 8-variable VAR, our baseline model includes just five variables owing to the relatively small sample size. In the later section, we also attempt to extend the baseline model to a 7-variable VAR including three price variables together to check the robustness and directly investigate the pass-through effect across the prices.

The selection of variables for our baseline model is based on the following considerations. First, we include the oil price and the output gap in a VAR model following McCarthy (2000) and Hahn (2003). Supply shocks are identified by the oil price inflation. The US dollar denominated oil price is used for our analysis so that we can investigate the effect of oil price changes per se, not the effect of large changes in the bilateral exchange rate vis-à-vis the US dollar.[6] To capture the demand side

[6] The fluctuation of local currency oil prices for East Asian countries from the mid-1990s largely reflect the changes in bilateral exchange rate vis-à-vis the US dollar rather than the oil price fluctuations per se.

effect, we include the output gap which is constructed by applying the Hodrick-Prescott (HP) filter to industrial production index.[7]

Second, the base money is used to allow for the effects of monetary policy on inflation. McLeod (2003) argues that Indonesia's high inflation after the currency crisis is primarily caused by the increase in base money that reflects the monetary policy of the Bank Indonesia (the central bank of Indonesia). The VAR approach enables us to identify monetary policy shocks, which reveals whether domestic inflation was caused by the mismanaged monetary policy or a sharp depreciation of exchange rates.

Third, the nominal effective exchange rate is used in our VAR. Although many studies have used the bilateral exchange rate vis-à-vis the US dollar, the effective exchange rate is the right concept to use when the total effect of the exchange rate changes is attempted to measure in a country with diversified trading partners. In addition, most East Asian countries had (and, have, for some) adopted a *de facto* US dollar peg at least up to the currency crisis of 1997, the bilateral rate vis-à-vis the US dollar is an inappropriate variable to use for this study. We also conduct estimation for a sub-sample starting from the crisis period, as most countries started to change the *de facto* US dollar peg into more flexible exchange rate system once hit by the crisis. The estimation for the sub-sample enables us to investigate whether such changes in exchange rate policy affected the pass-through effect in the countries concerned.

Fourth, to measure the domestic price inflation, the consumer price index (CPI) is included in the baseline model. We also take into consideration the exchange rate pass-through into other types of prices, i.e., the producer price index (PPI) or the

[7] We follow Hahn (2003) and the cyclical components generated by applying the HP filter to industrial production index are used as the output gap.

import price index, motivated by McCarthy (2000), Hahn (2003) and Faruqee (2004). To investigate the difference in response to shocks between respective price variables, we attempt to include PPI or the import price index instead of CPI in the baseline model and compare the results between them. Furthermore, we attempt to estimate a 7-variable VAR including three types of price variables together to directly analyze the effects of shocks on prices at different stages of pricing chain, i.e., how external shocks are transmitted from one price stage to the next.

The primary objective of this paper is to explore to what extent the exchange rate and other types of shocks affect domestic price inflation. To recover these structural shocks, we use a Choleski decomposition of the matrix Ω, a variance-covariance matrix of the reduced-form VAR residuals (u_t), to generate structural disturbances (ε_t). The relationship between the reduced-form VAR residuals and the structural disturbances can be written as follows:[8]

$$\begin{pmatrix} u_t^{oil} \\ u_t^{gap} \\ u_t^{m} \\ u_t^{efexr} \\ u_t^{p} \end{pmatrix} = \begin{pmatrix} S_{11} & 0 & 0 & 0 & 0 \\ S_{21} & S_{22} & 0 & 0 & 0 \\ S_{31} & S_{32} & S_{33} & 0 & 0 \\ S_{41} & S_{42} & S_{43} & S_{44} & 0 \\ S_{51} & S_{52} & S_{53} & S_{54} & S_{55} \end{pmatrix} \begin{pmatrix} \varepsilon_t^{oil} \\ \varepsilon_t^{gap} \\ \varepsilon_t^{m} \\ \varepsilon_t^{efexr} \\ \varepsilon_t^{p} \end{pmatrix}. \qquad (1)$$

The structural model is identified because the $k(k-1)/2$ restrictions are imposed on

[8] A unique lower-triangular matrix *S* can be derived given the positive definite symmetric matrix Ω. That is, the Choleski decomposition of Ω implies $\Omega = PP'$ where the Choleski factor, *P*, is a lower-triangular matrix. Since $\Omega = E(u_t u_t') = SE(\varepsilon_t \varepsilon_t')S' = SS'$ where structural disturbances are assumed to be orthonormal, i.e., $E(\varepsilon_t \varepsilon_t') = I$, the lower-triangular matrix *S* is equal to the Choleski factor *P*.

the matrix S as zero restrictions where k denotes the number of endogenous variables. The resulting lower-triangular matrix S implies that some structural shocks have no contemporaneous effect on some endogenous variables given the ordering of endogenous variables.

Determining the reasonable order of the endogenous variables is particularly important to identify structural shocks. The change in oil prices is ordered first because the reduced-form residuals of oil prices are unlikely affected contemporaneously by any other shocks except oil price (supply) shocks per se, while oil price shocks likely affect all variables in the system contemporaneously. The output gap is ordered next as we assume that the output gap is contemporaneously affected by only oil price shocks while output gap (demand) shocks have a contemporaneous impact on other variables except oil prices. The base money is ordered third because it is included as a representative of monetary policy and, hence, it seems more reasonable to assume that monetary policy shocks have a contemporaneous effect on the exchange rate than vice versa. Furthermore, the reduced-form residuals of the base money do not react contemporaneously to price shocks, while monetary policy shocks affect the domestic price inflation contemporaneously.[9] The nominal effective exchange rate is ordered prior to the domestic price, which implies that the nominal effective exchange rate responds contemporaneously to supply, demand and monetary policy shocks but not to price shocks. The exchange rate shocks are assumed to have a contemporaneous effect

[9] Hahn (2003) also orders the monetary policy variable (call rate) prior to exchange rate and prices by assuming that monetary policy reacts not to realized inflation but to expected inflation. In contrast, McCarthy (2000) orders the money supply last in a VAR model. Hence, the different ordering is also attempted to check the robustness and the result is reported in Section 4.2d.

only on domestic inflation. Finally, the price variable is ordered last by assuming that the price variable is contemporaneously affected by the four shocks but price shocks have no contemporaneous impact on the other variables.

4. Empirical Analysis

4.1. Data

The five East Asian countries, i.e., Indonesia, Korea, Thailand, Malaysia and Singapore, are taken up in this study. Taiwan, the Philippines and China are not studied because of the difficulty in obtaining the data. The data are monthly from 1993M1 to 2005M8 except for Indonesia (1993M3-2005M8) and Thailand (1993M1-2004M10). All price series and the industrial production index (2000=100) are seasonally adjusted. As an exchange rate variable, we use the nominal effective exchange rate index (2000=100) that indicates that an increase in index means depreciation. As a monetary policy variable, the seasonally adjusted base money is used for Indonesia, Korea and Thailand. Since the data on base money is not available, the narrow money (M1) is alternatively used for Malaysia and Singapore. The output gap is derived by applying the HP filter to the natural log of the industrial production index.[10] The data sources are IMF, *International Financial Statistics*, CD-ROM; IMF, *Direction of Trade Statistics*, CD-ROM; and the CEIC Asia Database. The details are described in Appendix 1.

*** Insert Table 1 around here. ***

[10] The HP filter is applied with much longer sample: the sample of 1980M1-2005M8 for Korea and Malaysia. Owing to the data availability for the industrial production index, the sample starts from 1993M3 for Indonesia, from 1989M1 for Singapore, and from 1987M1 for Thailand.

The time series properties of variables are tested by the augmented Dickey-Fuller Test (ADF) test and the Phillips-Perron (PP) test. The result is reported in Table 1 that shows that the oil price, three types of domestic prices, the monetary policy variables (base money and M1) and the nominal effective exchange rate appear to be non-stationary in level but stationary in first-differences for all countries. The result of unit-root tests also suggest that the output gap is an I(0) process. Thus, the endogenous variables in the VAR model are assumed to be stationary and we proceed to the VAR estimation.[11] The lag order of the VAR model is selected based on the likelihood Ratio (LR) test.[12]

4.2. Empirical Results

4.2a. Exchange Rate Pass-Through into Domestic Prices

This subsection discusses to what degree exchange rate shocks are passed through into domestic variables, especially the domestic price level, in five East Asian countries. We first estimate the baseline model including CPI and perform the impulse response function analysis. The accumulated impulse responses (solid line in Figures) are presented over a twenty-four months time horizon. All shocks are standardized to one-percent shocks and, hence, the vertical axis in Figures reports the approximate percentage change in domestic prices in response to a one percent shock. The dotted line in Figures denotes a two standard error confidence band around the

[11] Previous studies suggest to including in a VAR the output gap in level together with other variables in first-differences. Hence, we conduct the structural VAR analysis rather than cointegration tests.

[12] The lag order of the baseline mode is as follows: Indonesia (4), Korea (2), Thailand (6), Singapore (8) and Malaysia (3).

estimate.

*** Insert Figure 4 around here. ***

Figure 4 shows the response of CPI, base money and output gap to exchange rate shocks. First, as for a response of CPI to exchange rate shocks, Indonesia exhibits a very large response to exchange rate shocks. The CPI response to exchange rate in Korea and Thailand is also positive and statistically significant, but the degree of response is far smaller than that in Indonesia. The CPI response to exchange rate shocks in Malaysia is not statistically significant and much smaller than that in Korea and Thailand. Singapore, which was relatively immune to the currency crisis, indicates a slightly negative and insignificant response to exchange rate shocks.

Second, the response of the base money to exchange rate shocks is also significantly positive and quite large in Indonesia, which indicates that the Bank Indonesia reacted to exchange rate shocks by increasing the base money. Among other crisis-hit countries, Korea and Thailand show negative and insignificant responses to exchange rate shocks, though only the initial response is positive and significant in Korea. Malaysia also exhibits the negative response but it is statistically significant. Third, the response of the output gap to exchange rate shocks is very large and negative in all countries except Singapore, but the response is statistically significant only in Indonesia.

Overall, the response of domestic variables to exchange rate shocks is far larger and significant in Indonesia than in other countries. The response of CPI to exchange rate shocks is positive and significant in Korea and Thailand, but the degree of exchange rate pass-through is much smaller in these countries than in Indonesia.

We have also found that the Bank Indonesia expanded base money in response to exchange rate shocks, which also contrasts markedly with the other countries.

Another aspect that is not quantitatively shown in the VAR analysis of this paper is the impact of nonperforming loans problem and reactions of the central banks. In the early stage of the Asian currency crisis, some commercial banks and non-bank financial institutions became insolvent as many corporations failed under difficult economic conditions. Some banks tried to keep corporations alive by providing liquidity, and the central bank, in turn, provided liquidity to commercial banks so that banks would not fail. The liquidity support resulted in an expansion of bank loans and M2. The liquidity support happened in different Asian countries in the different stage of currency crisis (the first in Thailand, and Indonesia and Korea much later), and with different magnitude. Indonesia had certainly the most severe case in liquidity provision, as most banks had negative equity position before massive capital injection by the government in 1998. Efforts of keeping banks alive and maintaining the financial stability, some necessary and some misguided, explain why M2 were increasing in Indonesia and resulted in inflation.

4.2b. Pass-Through Effects on Different Domestic Prices

In considering the pass-through of exchange rate shocks into domestic prices, the pass-through effects on several types of domestic prices and the interaction between them are worth investigating. Previous studies, among others McCarthy (2000), Hahn (2003) and Faruqee (2004), attempt to examine the pass-through of exchange rate shocks on domestic prices at different stages of distribution. The larger the share of tradable goods in a certain price index, the more likely the effect of shocks is to be passed through to the price index. This paper takes up import price index and

PPI in addition to CPI for the pass-through analysis. It is expected that the import price index exhibits the largest degree of pass-through while CPI show the least degree of pass-through, because non-tradable goods are included in CPI and distribution costs along the pricing chain cause a decline in the degree of pass-through from upstream to downstream prices. To make a rigorous analysis of exchange rate pass-through into prices at different stages, we first estimate the baseline model including not CPI but PPI or import price index and compare the results of pass-through across three prices. Second, we extend the baseline model to a 7-variable VAR by including three price variables together to investigate the extent of transmission in shocks across these prices.

*** Insert Figure 5 around here. ***

Figure 5 reports the response of import prices and PPI to exchange rate shocks. The response of Malaysian import price index to exchange rate shocks is not presented owing to the difficulty in obtaining the data. The response to exchange rate shocks is significantly high in both import price index and PPI for all countries except Singapore. The response is higher in import price index than in PPI. Interestingly, the Indonesia's response is far higher than that of other countries for both import prices and PPI. Taking into account the response of CPI to exchange rate shocks (Figure 4), we have found that the degree of pass-through is the highest in import price index, the next in PPI and the lowest in CPI in East Asian countries affected by the crisis. It is important to note that Indonesia's price response, especially the CPI response, is by far the largest among the countries concerned.

Next, to support the above findings, we use a 7-variable VAR with the vector

of $x_t = (\Delta oil_t, gap_t, \Delta m_t, \Delta efexr_t, \Delta imp_t, \Delta ppi_t, \Delta cpi_t)'$ where imp_t, ppi_t and cpi_t denote the import price index (or import unit value), PPI and CPI, respectively. To identify the structural shocks under the 7-variable VAR, we employ the following order in Choleski decomposition:[13]

$$\begin{pmatrix} u_t^{oil} \\ u_t^{gap} \\ u_t^{m} \\ u_t^{efexr} \\ u_t^{imp} \\ u_t^{ppi} \\ u_t^{cpi} \end{pmatrix} = \begin{pmatrix} S_{11} & 0 & 0 & 0 & 0 & 0 & 0 \\ S_{21} & S_{22} & 0 & 0 & 0 & 0 & 0 \\ S_{31} & S_{32} & S_{33} & 0 & 0 & 0 & 0 \\ S_{41} & S_{42} & S_{43} & S_{44} & 0 & 0 & 0 \\ S_{51} & S_{52} & S_{53} & S_{54} & S_{55} & 0 & 0 \\ S_{61} & S_{62} & S_{63} & S_{64} & S_{65} & S_{66} & 0 \\ S_{71} & S_{72} & S_{73} & S_{74} & S_{75} & S_{76} & S_{77} \end{pmatrix} \begin{pmatrix} \varepsilon_t^{oil} \\ \varepsilon_t^{gap} \\ \varepsilon_t^{m} \\ \varepsilon_t^{efexr} \\ \varepsilon_t^{imp} \\ \varepsilon_t^{ppi} \\ \varepsilon_t^{cpi} \end{pmatrix}. \qquad (2)$$

*** Insert Figure 6 around here. ***

The primary objective of this 7-variable VAR model is to investigate to what degree shocks are transmitted across domestic prices. We first look at the exchange rate pass-through into each domestic price and compare the results with those of the baseline model. Figure 6 shows that the response of import prices, PPI and CPI is very similar to the result obtained from the baseline model. Second, the response of PPI to import price shocks is significantly positive in Korea and Singapore at least for the first seven months. The response of PPI to import price shocks is positive in Indonesia and Thailand, but the response is not significant in Indonesia and significant only

[13] The lag order of the 7-variable VAR is as follows: Indonesia (5), Korea (4), Thailand (3) and Singapore (8). The zero restrictions imposed in (2) are similar to Hahn (2003) and McCarthy (2000).

within 2-3 months in Thailand. The insignificant response of PPI in Indonesia is perhaps due to the data problem. That is to say, the import price index is not available in Indonesia and the import unit value is alternatively used, which might affect the estimated impulse responses. Third, the response of CPI to PPI shocks is significantly positive in Indonesia for the first eight months. In contrast, only the initial response is significantly positive and the degree of response is far smaller in Korea, Thailand and Singapore than that in Indonesia.

In summary, the pass-through of exchange rate shocks to import prices and PPI is significantly positive in all countries except Singapore. We have also found that the degree of the pass-through to exchange rate shocks varies across the different stages of distribution, i.e., the pass-through effect of exchange rate shocks is the largest on the import price index, the second on PPI and the smallest on CPI. In addition, the degree of response is far larger in Indonesia than in other countries. The pass-through into CPI is also significantly positive in Korea and Thailand, but the degree of pass-through is much smaller in these countries than in Indonesia. Such difference in the degree of pass-through between Indonesia and other countries might be attributed partly to the shock transmission from PPI to CPI, because only Indonesia exhibits a large and significant response of CPI to PPI shocks.

4.2c. Effects of Exchange Rate and Macroeconomic Shocks on Prices

As mentioned earlier, the degree of responsiveness in domestic prices to exchange rate shocks has important implications for the economic recovery process in the crisis-hit countries. An increase in domestic inflation immediate after a sharp depreciation of the currency would prevent the improvement of the export price competitiveness and, hence, delay the economic recovery of a country in question.

Thus, the economic recovery process after the currency crisis crucially depends upon the inflation performance of the country. We examine this connection between the pass-through effect and the economic recovery process using the impulse response function analysis.

During the crisis period, the exchange rate of the crisis-hit countries' currency depreciated sharply. A question is whether such large depreciation caused a high inflation in a country concerned. As we have so far discussed, however, East Asian countries hit by the crisis exhibited a relatively low level of CPI inflation except for Indonesia, which is partly due to severe downturn of domestic demand. Figure 4 supports the above discussion, because the crisis-hit countries show the large negative response of output gap to exchange rate shocks though it is statistically significant only in Indonesia.

Another important factor is the central bank's reaction to exchange rate shocks during the crisis. Among the crisis-hit countries, it is only Indonesia that responded to exchange rate shocks by increasing the base money significantly (Figure 4), which conforms to the fact that Indonesia's base money growth was far greater after the crisis than other crisis-hit countries.[14] In Indonesia, the currency crisis induced the domestic financial crisis as well as internal political instability, which deteriorated the supply side of the economy. Under the framework of the AD-AS model, the AS curve shifted leftward to a large extent in Indonesia. As the AD curve shifts rightward at the same time due to an increase in the domestic money supply, not only a fall in GDP growth rates but also a far larger increase in inflation rates occurred simultaneously. The above arguments are supported by the results of impulse

[14] McLeod (2003) compares the increase in base money between Indonesia, Korea, Thailand and Malaysia, and reaches the same conclusion.

response functions. Figure 7 shows that only in Indonesia, the response of CPI to monetary policy shocks is significantly positive and the corresponding response of output gap is significantly negative. Furthermore, it is only in Indonesia that the response of CPI to exchange rate shocks is significantly positive and also the corresponding response of output gap is significantly negative (Figure 4).

*** Insert Figure 7 around here. ***

To further support the above discussion, we conduct the variance decomposition analysis, which provides the information on the percentage contribution of various shocks to the variance of the *k*-step ahead forecast errors of respective variables. Figure 8 reports the result of variance decomposition of CPI and output gap over a forecast horizon of twenty-four months in order to check the relative importance of each shock in explaining the variation of CPI and output gap.[15]

*** Insert Figure 8 around here. ***

As for the variance of CPI, exchange rate shocks are an important determinant in Indonesia and Korea, where about 40 percent of variation are accounted for by the exchange rate shocks in Indonesia and about 30 percent in Korea. Interestingly, monetary policy shocks are the second important determinant for the first nine months in Indonesia, implying that the initial response of CPI is largely affected by the monetary policy shocks as well as the exchange rate shocks in Indonesia. In Thailand,

[15] The contributions of own price shocks (for VD of CPI) and own output gap shocks (for VD of output gap) are not reported in Figure 8 for the sake of clearness.

Malaysia and Singapore, exchange rate and other three shocks account for only a small share in variance of CPI, which indicates that the own price (CPI) shocks are the most important in explaining its variation. Regarding the variance of output gap, oil price shocks appear to be the most important determinant in Korea, Thailand and Malaysia. In contrast, monetary, exchange rate and CPI shocks are more important in explaining the variation of output gap in Indonesia.

*** Insert Figure 9 around here. ***

Thus, our empirical results suggest that a remarkable difference in the post-crisis inflation performance between Indonesia and other crisis-hit countries is attributed to the Bank Indonesia's monetary policy reaction. The remaining question is why the base money growth was extremely high in Indonesia. Although not quantitatively considered in our empirical analysis, the base money growth was kept high by the central bank in reaction to large depreciation, which was worsened by political turmoil and capital flight. When the rupiah depreciated substantially after the crisis due to a deep political crisis, capital flight exacerbated the depreciation. In addition, depreciation of the rupiah drove many domestic financial institutions into insolvency. To prevent the complete collapse of the banking sector, the Bank Indonesia injected enormous funds into the banking system.[16] Figure 9 shows the series of structural shocks to base money and exchange rate. Only in Indonesia, we observe a high correlation between the two shocks during the crisis period, reflecting the Bank Indonesia's monetary policy reaction to stave off the collapse of the financial

[16] de Brower (2003) also emphasizes this point.

system.[17] We may therefore conclude that it is the Bank Indonesia's monetary policy to prevent the collapse of the banking system that results in the growth of base money and, hence, domestic price inflation in Indonesia and further depreciation of the rupiah.

4.2d. Robustness: Different Sample Period and VAR Orderings

We have analyzed the degree of pass-through of exchange rate and other types of shocks using the baseline model, $x_t = (\Delta oil_t, gap_t, \Delta m_t, \Delta efexr_t, \Delta p_t)'$, with the sample of 1993M1 through 2005M8. However, it is interesting to do the same analysis with the sample starting from 1997M7 when Thailand was first hit by the crisis. The currency crisis drove the countries to abandon the *de facto* US dollar peg policy and to adopt more flexible exchange rate policy such as managed floating except for Malaysia. Hence, it is worth trying to check the results obtained by the baseline mode with those using the sub-sample starting from 1997M7, although the sample size becomes smaller. In addition, we may try the different ordering of variables in a VAR model to check the robustness of the above empirical results.

*** Insert Figure 10 around here. ***

The first two rows in Figure 10 report the results obtained from the baseline model with the sub-sample from 1997M7 to 2005M8. Owing to the space limitation, only the response of CPI to monetary policy shocks as well as exchange rate shocks is presented. The result is quite similar to that with the full sample from 1993M1 to

[17] The correlation between monetary policy and exchange rate shocks over the sample period is very high in Indonesia (0.77) while close to zero or negative in other countries: Korea (-0.12), Thailand (-0.13), Singapore (-0.21) and Malaysia (0.11).

2005M8, although the degree of CPI response to exchange rate shocks becomes smaller in Korea and Thailand. The response of CPI to monetary policy shocks becomes even negative in Korea and Thailand when using the sub-sample. In contrast, the CPI response to monetary policy shocks in Indonesia becomes larger and statistically significant over the 24 months. The excessive monetary expansion by the Bank Indonesia and its impact on domestic inflation becomes more evident when using the sub-sample for a VAR analysis.

Next, we propose the two more different and plausible orderings of endogenous variables by modifying the baseline model. First, we assume the lagged availability of information on the output gap, which results in no contemporaneous effect of output gap shocks on the central bank's monetary policy. We also assume that the nominal effective exchange rate responds contemporaneously to oil price shocks and monetary policy shocks, not to output gap shocks. Accordingly, the "Alternative Model 1" is $x_t = (\Delta oil_t, \Delta m_t, \Delta efexr_t, gap_t, \Delta p_t)'$. Second, the nominal effective exchange rate may be ordered prior to the money supply variable by assuming that exchange rate shocks at monthly frequency are driven by exogenous asset market disturbances and, hence, domestic monetary disturbances are unlikely to affect the nominal effective exchange rate contemporaneously. Thus, this "Alternative Model 2" is just to change the order of the nominal effective exchange rate and the money supply, i.e., $x_t = (\Delta oil_t, gap_t, \Delta efexr_t, \Delta m_t, \Delta p_t)'$.

The results of CPI response to both exchange rate and monetary policy shocks based on the above two alternative models are reported in Figure 10. For the comparison purpose, the results using the sub-sample are reported. The third and fourth rows present the results of the Alternative Model 1, which shows that the CPI response is quite similar between the baseline model and the alternative model. The

fifth and sixth rows exhibit the results of CPI response obtained from the Alternative Model 2. Again the results are similar to those of the other models, although the Indonesia's CPI response to monetary policy shocks becomes insignificant after four months.

Overall, we have confirmed that the difference in the degree of CPI response to exchange rate and monetary policy shocks is more evident between Indonesia and other crisis-affected countries if we use the shorter sub-sample period for estimation. The result of impulse response is quite similar even if we use the different VAR orderings.

5. Concluding Remarks

In this paper, we have investigated the pass-through effects from the exchange rate changes to imported prices, producer (wholesale) prices, and consumer prices for East Asian countries. The VAR analysis of the exchange rate pass-through has revealed several new important findings. First, the degree of pass-through to exchange rate shocks varies across the different price indices: the pass-through effect is the largest on the import price index, the second on PPI and the smallest on CPI. Second, the degree of domestic price response to exchange rate shocks is far larger in Indonesia than in other countries. The CPI response to exchange rate shocks is particularly larger in Indonesia than in other countries. Moreover, only Indonesia exhibits a large and significant response of CPI to PPI shocks, implying the smooth transmission of shocks from PPI to CPI. Third, a notable difference in the post-crisis inflation performance between Indonesia and other crisis-affected countries is attributed to the Bank Indonesia's monetary policy reaction. It is only in Indonesia that both the impulse response of monetary policy variables to exchange rate shocks

and that of CPI to monetary policy shocks are positive, large and statistically significant. Fourth, when focusing on the post-crisis period, the difference in the pass-through effect into CPI becomes more evident between Indonesia and other crisis-affected countries.

The pass-through examination using the VAR technique provides an important insight into a crisis propagation mechanism in emerging market economies. When depreciation results in domestic inflation, that makes the resolution of a crisis much harder. The estimated results show that the Indonesia's disappointing recovery process after the crisis can be attributed to the high pass-through of exchange rate shocks to CPI, the shock transmission from PPI to CPI, and the central bank's monetary policy reaction. Domestic inflation of Indonesia had eliminated price competitiveness, relative to neighboring countries, due to a large depreciation by 2005.

Several tasks are left for future research. Refinement of a VAR analysis is desirable. More structural investigations for demand and supply factors to CPI are needed to differentiate the role of the exchange rate and other factors in the inflation process. Second, the sample can be expanded to other countries, if some data are obtained.

Appendix 1: Data Description

A. Common Variable

Oil price: The US dollar-basis oil price index (2000=100, monthly series) is taken from IMF, *International Financial Statistics (IFS)*, CD-ROM.

B. Country-Specific Variables

B1. Indonesia

Base money: The monthly series of base money is used from the CEIC Asia Database. Seasonality is adjusted using the Census X12 program.

Nominal effective exchange rate: The monthly series of the nominal effective exchange rate index (2000=100) is constructed by the weighted average of eighteen major trading partner countries (exports plus imports). The bilateral exchange rate and the trade share are, respectively, obtained from IFS and IMF, *Direction of Trade Statistics*, CD-ROM.

Industrial production index: The monthly series of the manufacturing industrial production index (2000=100) is taken from the CEIC Asia Database. Seasonality is adjusted using the Census X12 program.

CPI: The monthly series of CPI (2000=100) is taken from IFS. Seasonality is adjusted using the Census X12 program.

PPI: The monthly series of wholesale price index (including petroleum; 2000=100) is taken from IFS. Seasonality is adjusted using the Census X12 program.

Import prices: The monthly series of the import unit value index (2000=100) is constructed by dividing the total import value by the total import volume. The US dollar based total import values are converted into local currency values by suing an index of bilateral nominal exchange rate of rupiah vis-à-vis the US dollar (2000=1.00).

The data for the total import value and volume are obtained from the CEIC Asia Database. Seasonality is adjusted using the Census X12 program.

B2. Korea

Base money: The monthly series of base money is used from the CEIC Asia Database. Seasonality is adjusted using the Census X12 program.

The monthly series of the nominal effective exchange rate index (2000=100) is constructed by the weighted average of twenty major trading partner countries (exports plus imports). The bilateral exchange rate and the trade share are, respectively, obtained from IFS and IMF, *Direction of Trade Statistics*, CD-ROM.

Industrial production index: The monthly series of the industrial production index (2000=100) is taken from the CEIC Asia Database. Seasonality is adjusted using the Census X12 program.

CPI: The monthly series of CPI (2000=100) is taken from the CEIC Asia Database. Seasonality is adjusted using the Census X12 program.

PPI: The monthly series of producer price index (including all commodities and services; 2000=100) is taken from the CEIC Asia Database. Seasonality is adjusted using the Census X12 program.

Import prices: The monthly series of the import price index (the Korean won basis; 2000=100) is obtained from the CEIC Asia Database. Seasonality is adjusted using the Census X12 program.

B3. Malaysia

Money supply: The monthly series of money supply, M1, is used from the CEIC Asia Database. Seasonality is adjusted using the Census X12 program

Nominal effective exchange rate: The monthly series of the nominal effective exchange rate index (2000=100) is obtained from IFS.

Industrial production index: The monthly series of the industrial production index (2000=100) is taken from the CEIC Asia Database. Seasonality is adjusted using the Census X12 program.

CPI: The monthly series of CPI (2000=100) is taken from the CEIC Asia Database. Seasonality is adjusted using the Census X12 program.

PPI: The monthly series of producer price index (for goods in the domestic economy; 2000=100) is taken from the CEIC Asia Database. Seasonality is adjusted using the Census X12 program.

B4. Singapore

Money supply: The monthly series of money supply, M1, is used from the CEIC Asia Database. Seasonality is adjusted using the Census X12 program.

Nominal effective exchange rate: The monthly series of the nominal effective exchange rate index (2000=100) is obtained from IFS.

Industrial production index: The monthly series of the industrial production index (2000=100) is taken from the CEIC Asia Database. Seasonality is adjusted using the Census X12 program.

CPI: The monthly series of CPI (2000=100) is taken from IFS. Seasonality is adjusted using the Census X12 program.

PPI: The monthly series of wholesale price index (2000=100) is taken from IFS. Seasonality is adjusted using the Census X12 program.

Import prices: The monthly series of the import price index (2000=100) is obtained from IFS. Seasonality is adjusted using the Census X12 program.

B5. Thailand

Base money: The monthly series of base money is used from the CEIC Asia Database. Seasonality is adjusted using the Census X12 program.

Nominal effective exchange rate: The monthly series of the nominal effective exchange rate index (2000=100) is obtained from the CEIC Asia Database.

Industrial production index: The monthly series of the manufacturing production index (2000=100) is taken from the CEIC Asia Database. Seasonality is adjusted using the Census X12 program.

CPI: The monthly series of CPI (2000=100) is taken from IFS. Seasonality is adjusted using the Census X12 program.

PPI: The monthly series of producer price index (2000=100) is taken from IFS. Seasonality is adjusted using the Census X12 program.

Import prices: The monthly series of the import value index (the Thai Baht basis; 2000=100) is obtained from the CEIC Asia Database. The data is available from January 1996. Seasonality is adjusted using the Census X12 program.

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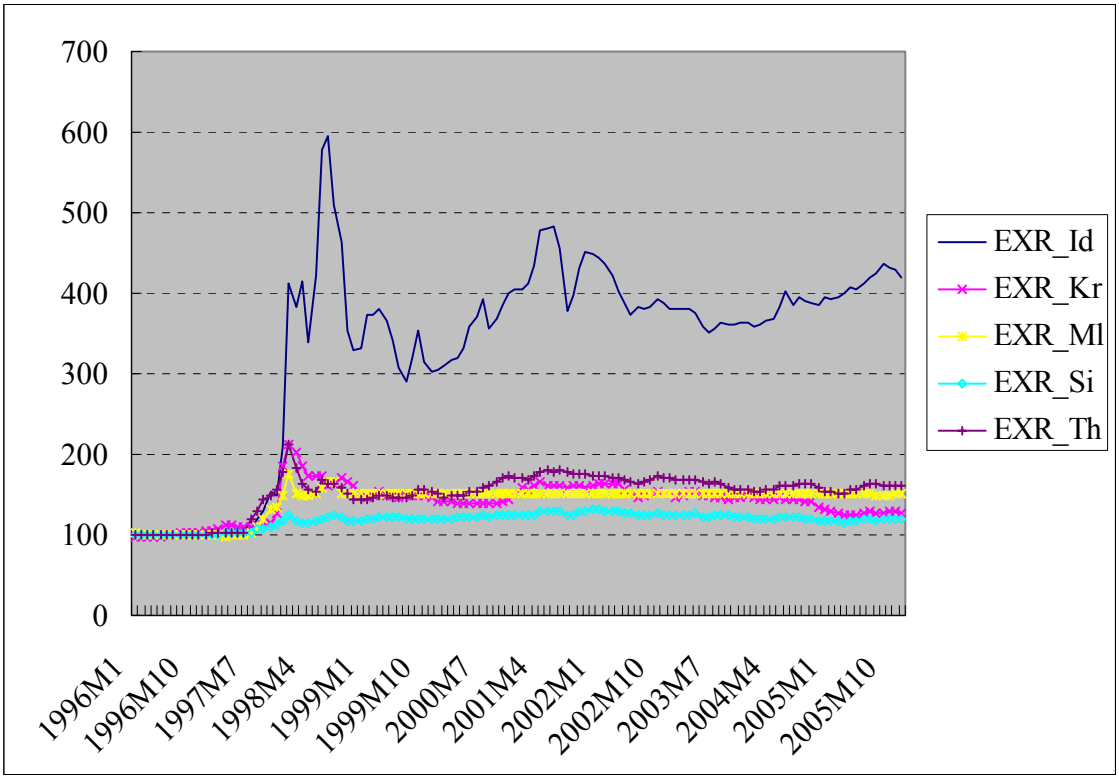
Table 1. Unit Root Tests

Variable	Indonesia	Korea	Malaysia	Singapore	Thailand
Augumented Dickey-Fuller (ADF) Test					
oil	-1.54				
Δoil	-11.49 **				
gap					
(in level)	-10.54 **	-3.06	-3.21 #	-3.59 *	-3.43 #
m	-1.47	-1.87	-2.48	-3.00	-2.26
Δm	-16.20 **	-19.01 **	-14.03 **	-18.19 **	-13.17 **
efexr	-1.90	-2.87	-2.25	-1.94	-3.04
$\Delta efexr$	-10.01 **	-8.57 **	-10.37 **	-10.52 **	-8.24 **
cpi	-1.69	-2.02	-1.24	-2.83	-2.04
Δcpi	-5.20 **	-9.06 **	-11.36 **	-13.20 **	-3.34 *
ppi	-1.59	-2.16	-2.10	-0.98	-2.46
Δppi	-7.41 **	-6.95 **	-8.70 **	-9.30 **	-8.14 **
imp	-3.10	-2.96	-	-1.41	-1.91
Δimp	-15.31 **	-8.58 **	-	-9.97 **	-10.73 **
Phillips-Perron (PP) Test					
oil	-1.71				
Δoil	-11.50 **				
gap					
(in level)	-11.18 **	-6.06 **	-4.28 **	-8.72 **	-6.53 **
m	-1.64	-2.20	-2.59	-3.80 *	-2.91
Δm	-16.20 **	-20.35 **	-13.97 **	-18.31 **	-21.67 **
efexr	0.76	-2.45	-2.25	-1.97	-2.56
$\Delta efexr$	-9.96 **	-8.21 **	-10.40 **	-10.54 **	-8.10 **
cpi	-1.59	-1.79	-1.30	-2.83	-1.52
Δcpi	-4.99 **	-9.06 **	-12.04 **	-13.32 **	-9.85 **
ppi	-1.61	-1.79	-1.69	-0.26	-2.12
Δppi	-7.31 **	-6.81 **	-8.57 **	-9.26 **	-8.09 **
imp	-2.95	-2.84	-	-1.19	-2.46
Δimp	-15.40 **	-6.96 **	-	-10.00 **	-10.82 **

Notes: Double asterisks (**), a single asterisk (*) and a sharp (#), respectively, denote the significance at the one percent, five percent and ten percent level. Sample period: 1993M1-2005M8. The null hypothesis of the ADF and PP tests is that the variable is nonstationary. For the level of variables, constant and time trend are included. For the first-difference of variables, only constant is included.

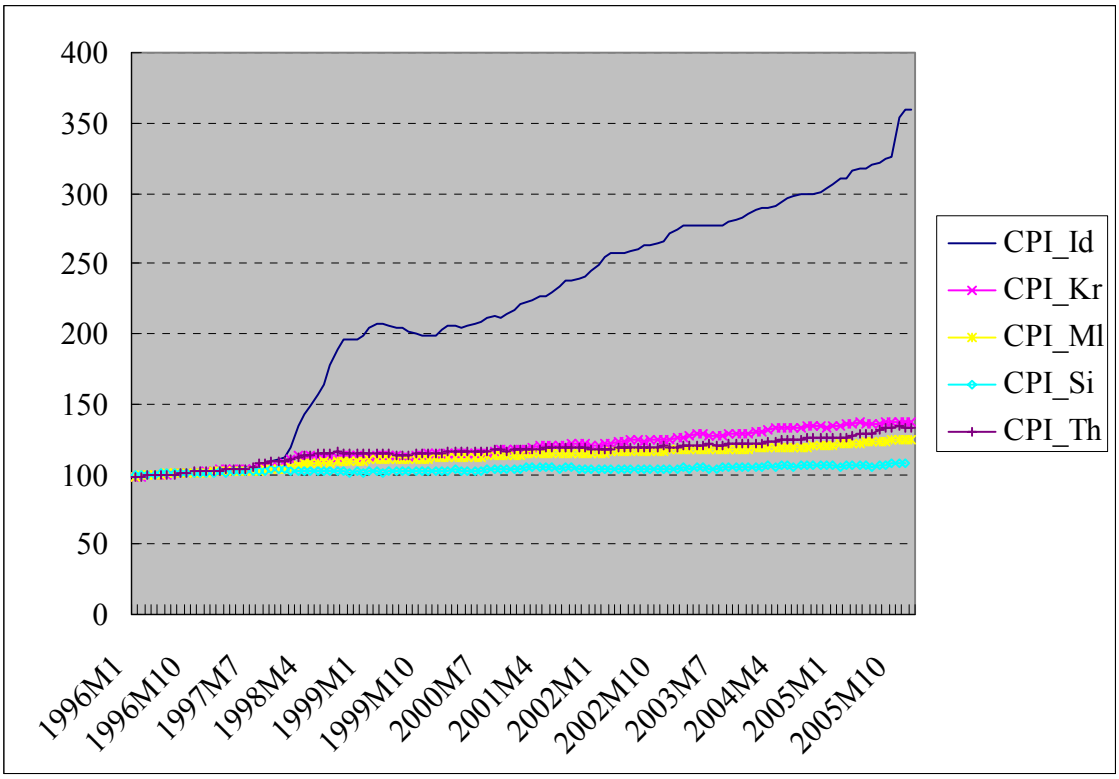
Figure 1. Nominal Exchange Rate vis-à-vis the US Dollar (1996=100)



Note: Id (Indonesia), Kr (Korea), Ml (Malaysia), Si (Singapore) and Th (Thailand).

Sources: IMF, *International Financial Statistics*, CD-ROM; The CEIC Asia Database.

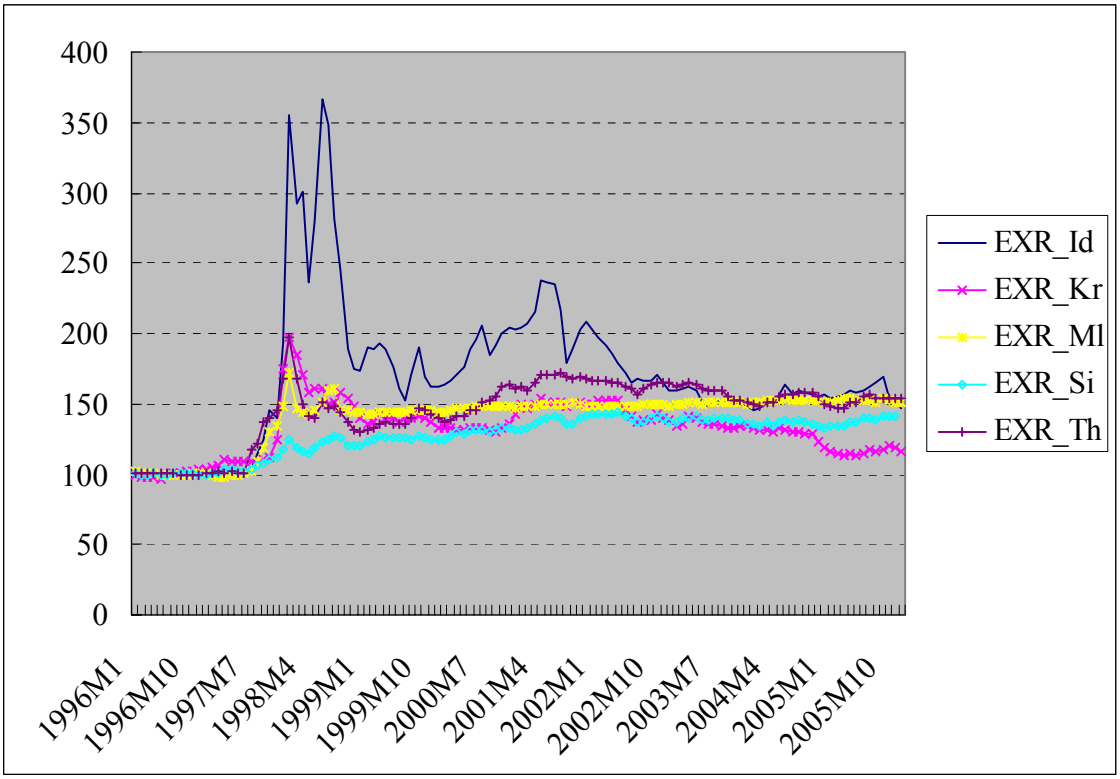
Figure 2. CPI (1996=100): East Asian Countries



Note: Id (Indonesia), Kr (Korea), Ml (Malaysia), Si (Singapore) and Th (Thailand).

Sources: IMF, *International Financial Statistics*, CD-ROM; The CEIC Asia Database.

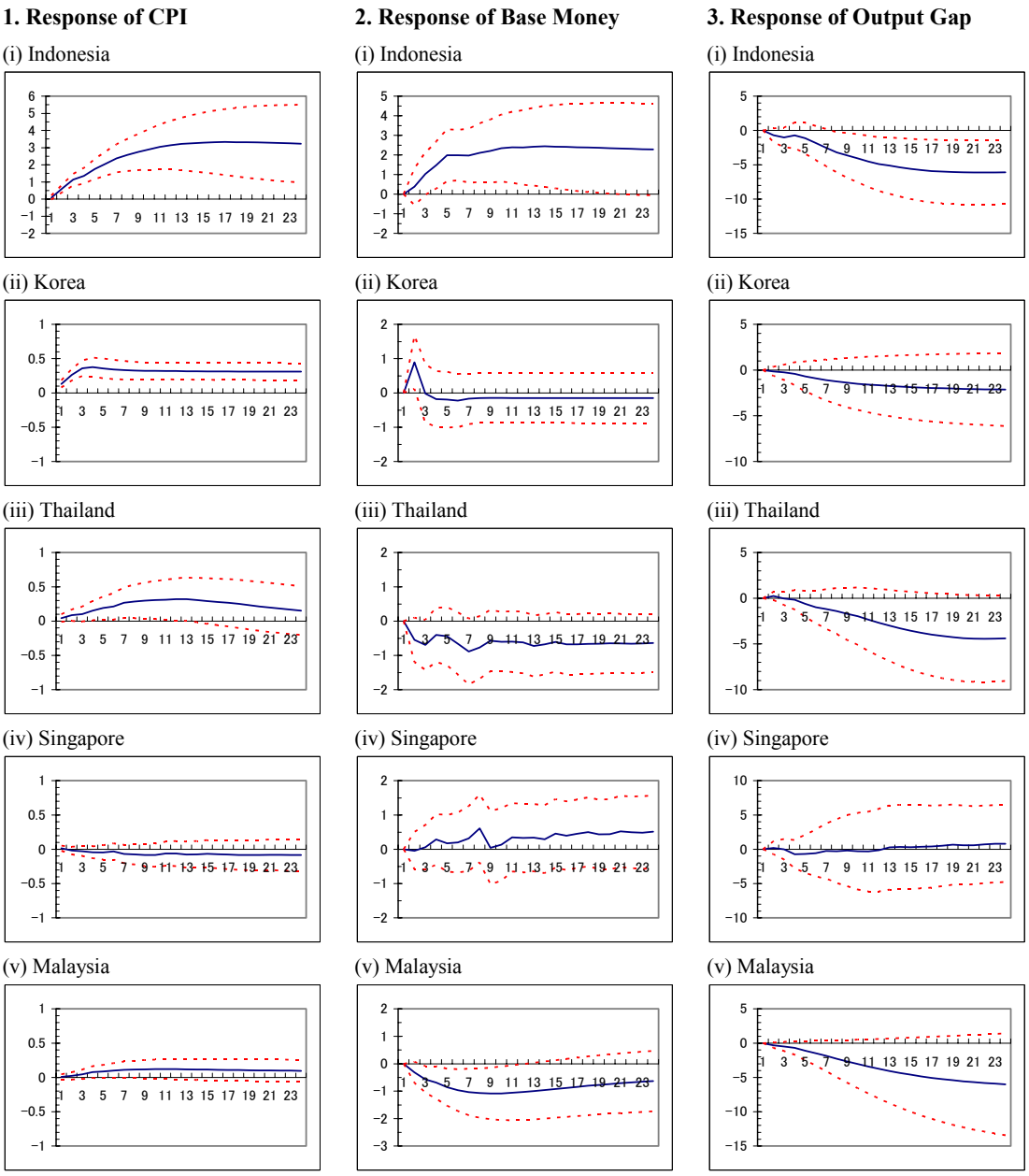
Figure 3. Real Exchange Rate vis-à-vis the US Dollar (1996=100)



Note: Id (Indonesia), Kr (Korea), Ml (Malaysia), Si (Singapore) and Th (Thailand).

Sources: IMF, *International Financial Statistics*, CD-ROM; The CEIC Asia Database.

Figure 4. Impulse Response to Exchange Rate Shocks

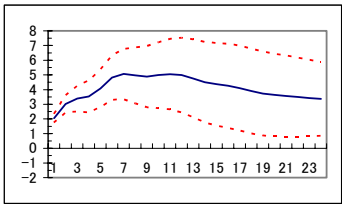


Notes: Baseline model (5-variable VAR). The accumulated impulse responses are presented. All shocks are standardized to one-percent shocks. The vertical axis indicates the approximate percentage change in response to a one percent exchange rate shock. The horizontal axis represents the time horizon (1 through 24 months). The dotted line denotes a two standard error confidence band around the estimate.

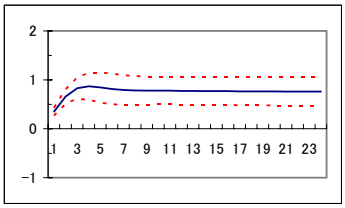
Figure 5. Impulse Response of PPI and Import Prices to Exchange Rate Shocks

1. Response of PPI

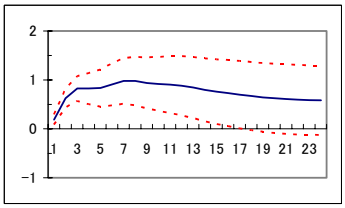
(i) Indonesia



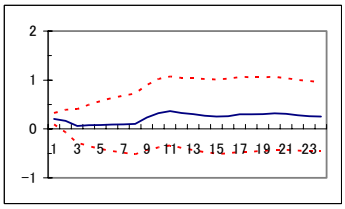
(ii) Korea



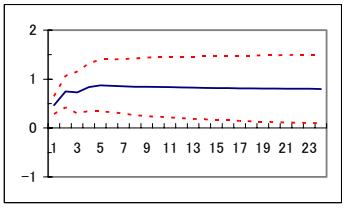
(iii) Thailand



(iv) Singapore

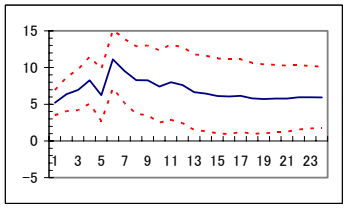


(v) Malaysia

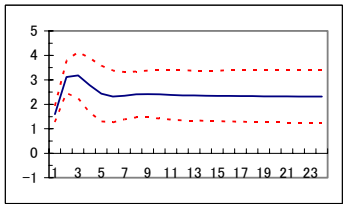


2. Response of Import Prices

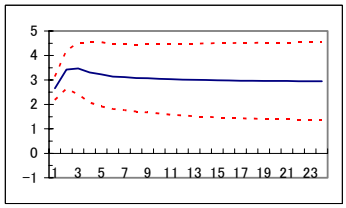
(i) Indonesia



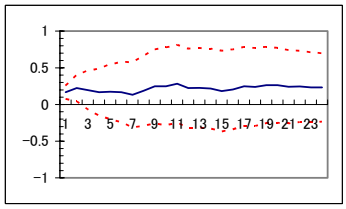
(ii) Korea



(iii) Thailand

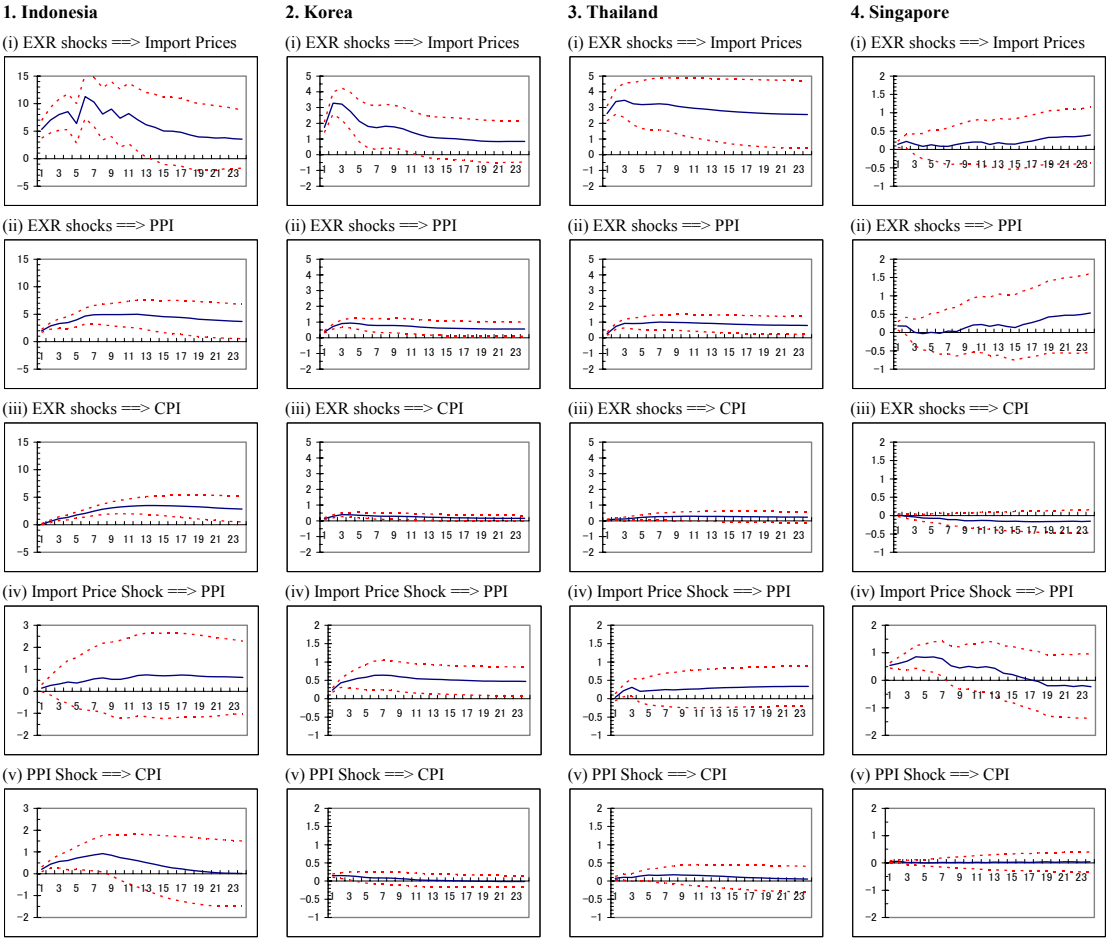


(iv) Singapore



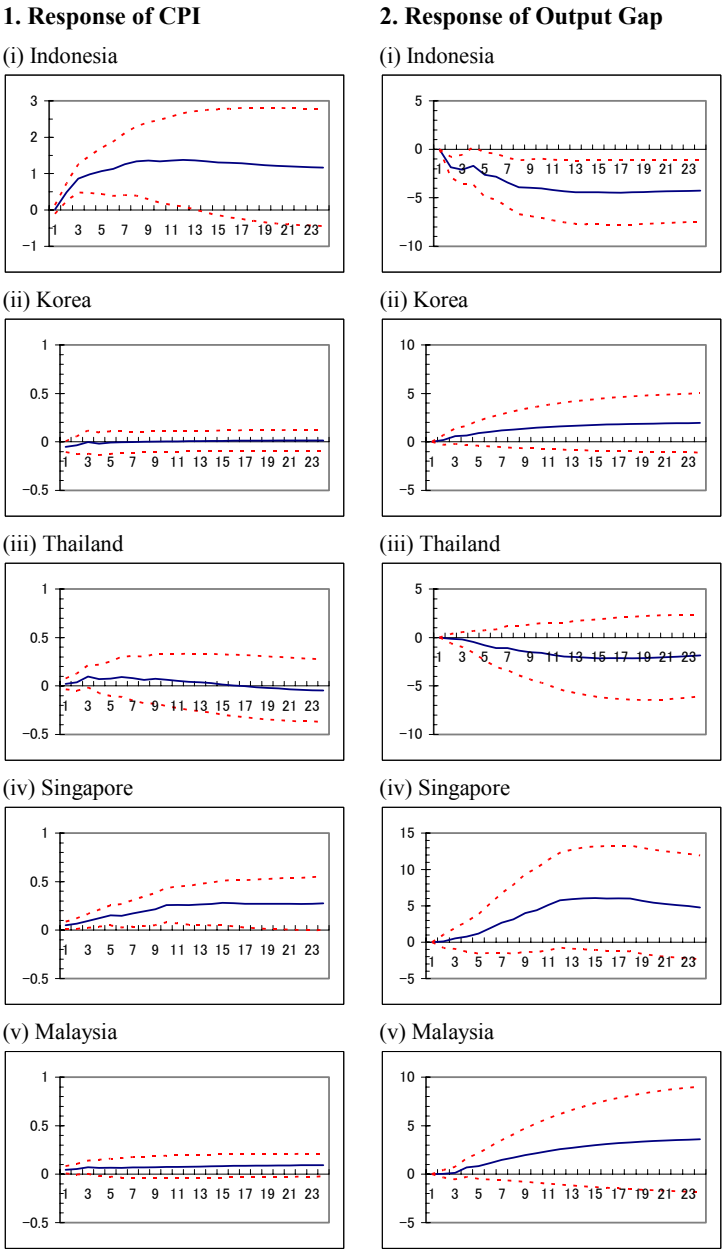
Notes: Baseline model (5-variable VAR). The accumulated impulse responses are presented. All shocks are standardized to one-percent shocks. The vertical axis indicates the approximate percentage change in response to a one percent exchange rate shock. The horizontal axis represents the time horizon (1 through 24 months). The dotted line denotes a two standard error confidence band around the estimate.

Figure 6. Impulse Response to Exchange Rate Shocks: 7-Variable VAR



Notes: 7-variable VAR model. The accumulated impulse responses are presented. All shocks are standardized to one-percent shocks. The vertical axis indicates the approximate percentage change in response to a one percent exchange rate shock. The horizontal axis represents the time horizon (1 through 24 months). The dotted line denotes a two standard error confidence band around the estimate.

Figure 7. Impulse Response to Monetary Policy Shocks

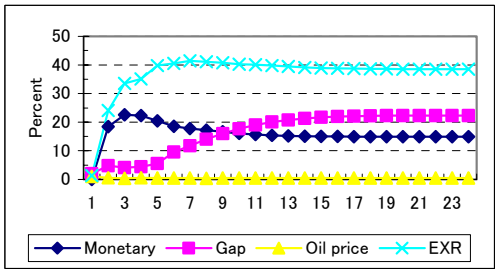


Notes: Baseline model (5-variable VAR). The accumulated impulse responses are presented. All shocks are standardized to one-percent shocks. The vertical axis indicates the approximate percentage change in response to a one percent exchange rate shock. The horizontal axis represents the time horizon (1 through 24 months). The dotted line denotes a two standard error confidence band around the estimate.

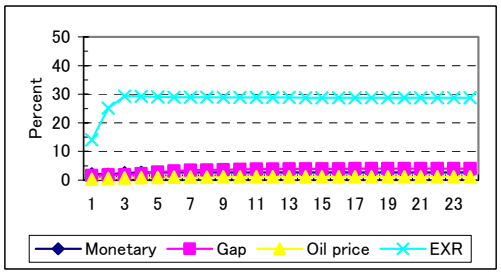
Figure 8. Variance Decomposition (VD) of CPI and Output Gap

1. VD of CPI

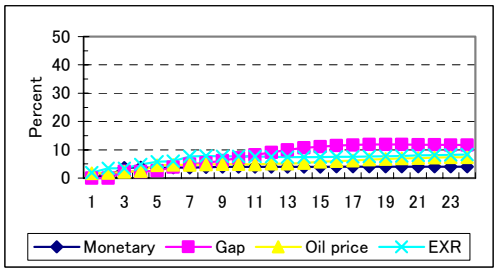
(i) Indonesia



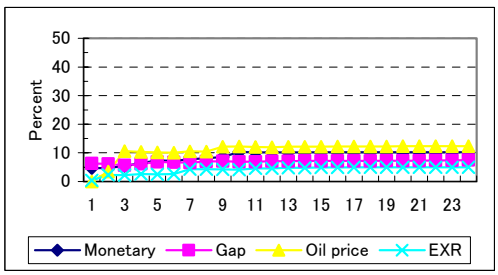
(ii) Korea



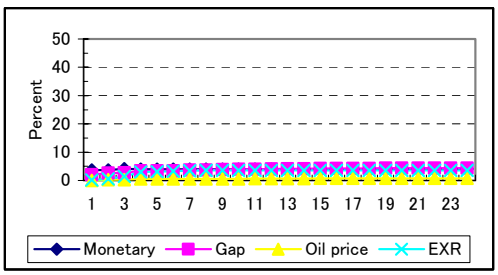
(iii) Thailand



(iv) Singapore

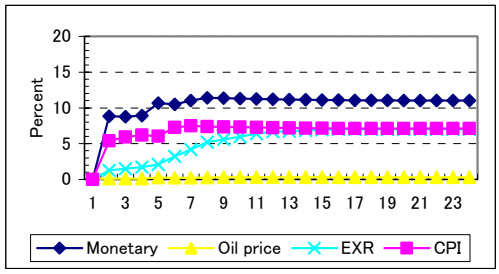


(v) Malaysia

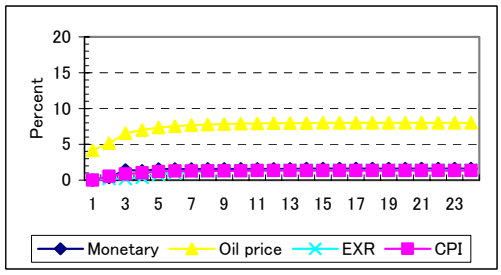


2. VD of Output Gap

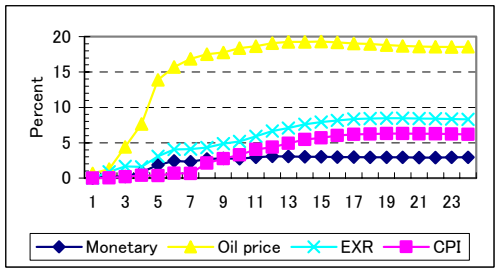
(i) Indonesia



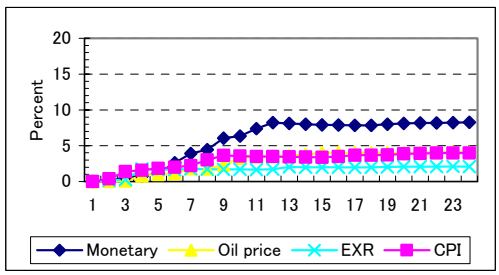
(ii) Korea



(iii) Thailand



(iv) Singapore



(v) Malaysia

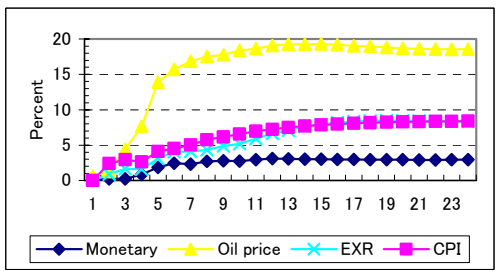
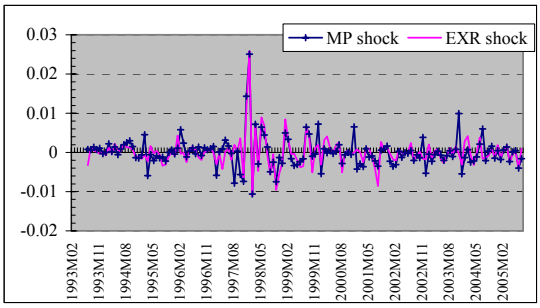


Figure 8. Variance Decomposition (VD) of CPI and Output Gap (cont'd)

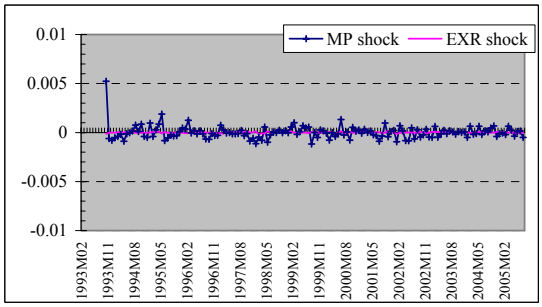
Notes: The results of Variance Decomposition tests using the baseline model are presented. The vertical axis shows the percentage contribution of shocks to the variance of the *k*-step ahead forecast errors of respective variables. The horizontal axis represents the time horizon (1 through 24 months). "Monetary" = monetary policy shocks; "Gap" = demand (output gap) shocks; "Oil price" = oil price shocks; "EXR" = exchange rate shocks; and "CPI" = CPI shocks.

Figure 9. Time Series of Structural Shocks to Base Money and Exchange Rate

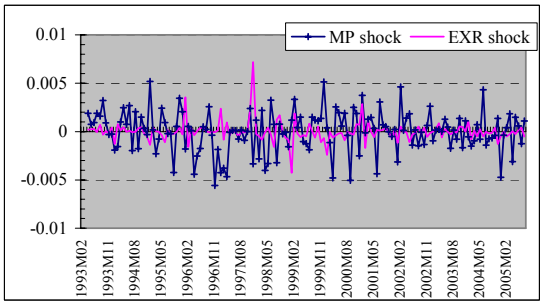
(i) Indonesia



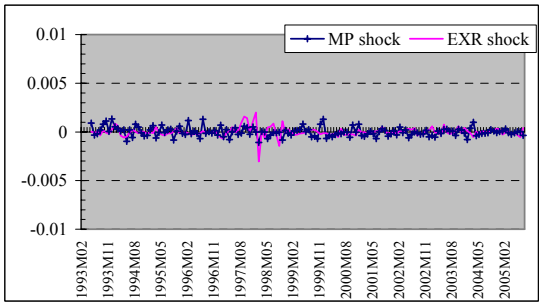
(iv) Singapore



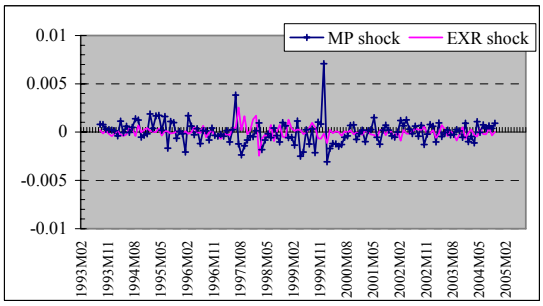
(ii) Korea



(v) Malaysia



(iii) Thailand



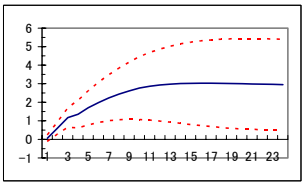
Notes: MP shock and EXR shock denote monetary policy shock and exchange rate shock, respectively. The series of shocks are obtained from the baseline model that includes CPI as a price variable.

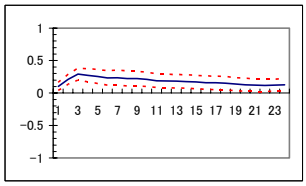
Figure 10. Impulse Response of CPI to exchange rate and monetary policy shocks with Different Sample Period and VAR Orderings

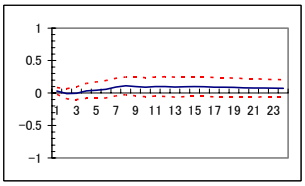
1. Indonesia **2. Korea** **3. Thailand**

Case 1: Baseline Model with the sub-sample from 1997M7 to 2005M8

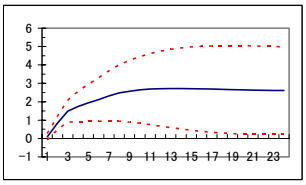
(i) EXR shocks ==> CPI

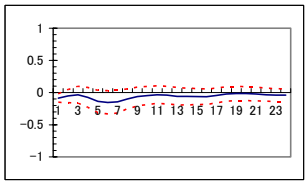


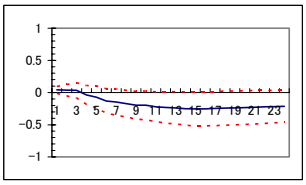




(ii) Monetary policy shocks ==> CPI

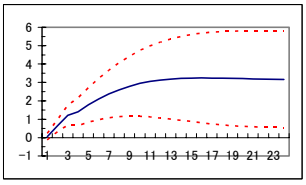


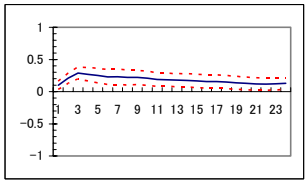


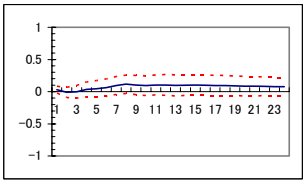


Case 2: Alternative Model 1 with the sub-sample from 1997M7 to 2005M8

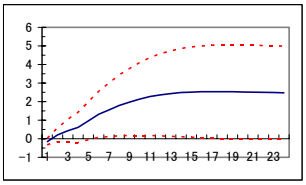
(i) EXR shocks ==> CPI

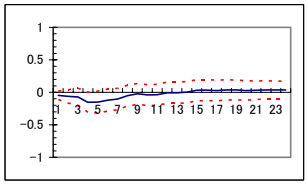


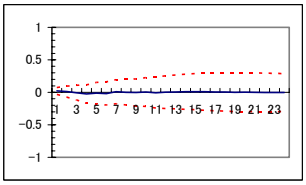




(ii) Monetary policy shocks ==> CPI

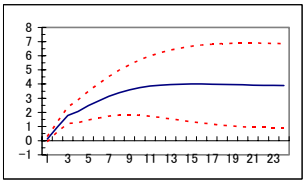


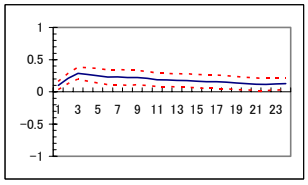


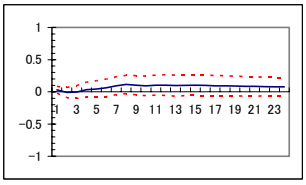


Case 3: Alternative Model 2 with the sub-sample from 1997M7 to 2005M8

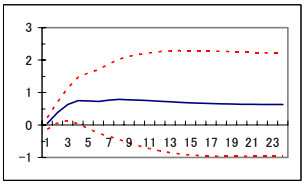
(i) EXR shocks ==> CPI

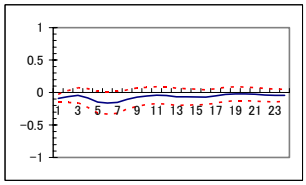






(ii) Monetary policy shocks ==> CPI





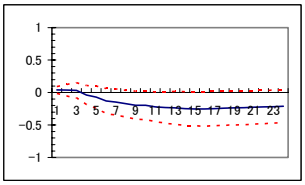
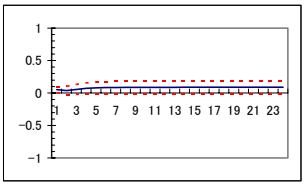


Figure 10. Impulse Response of CPI to exchange rate and monetary policy shocks with Different Sample Period and VAR Orderings (cont'd)

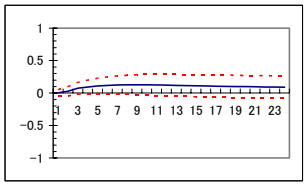
4. Singapore **5. Malaysia**

Case 1: Baseline Model with the sub-sample from 1997M7 to 2005M8

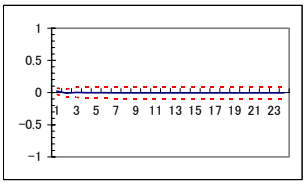
(i) EXR shocks ==> CPI



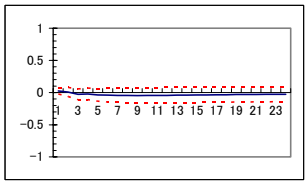
(i) EXR shocks ==> CPI



(ii) Monetary policy shocks ==> CPI

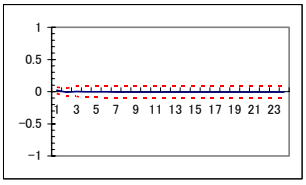


(ii) Monetary policy shocks ==> CPI

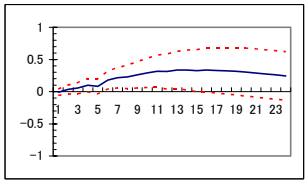


Case 2: Alternative Model 1 with the sub-sample from 1997M7 to 2005M8

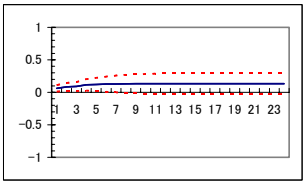
(i) EXR shocks ==> CPI



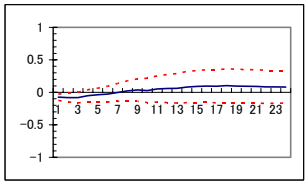
(i) EXR shocks ==> CPI



(ii) Monetary policy shocks ==> CPI

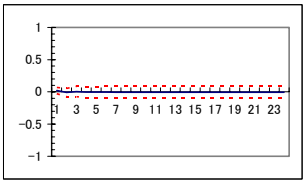


(ii) Monetary policy shocks ==> CPI

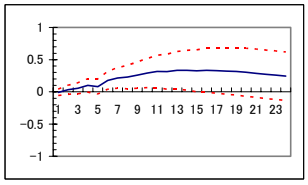


Case 3: Alternative Model 2 with the sub-sample from 1997M7 to 2005M8

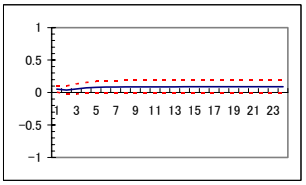
(i) EXR shocks ==> CPI



(i) EXR shocks ==> CPI



(ii) Monetary policy shocks ==> CPI



(ii) Monetary policy shocks ==> CPI

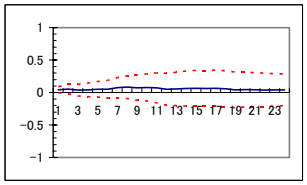


Figure 10. Impulse Response of CPI to exchange rate and monetary policy shocks with Different Sample Period and VAR Orderings (cont'd)

Notes: The response of CPI to exchange rate shocks and monetary policy shocks using the three different models are reported.

The baseline model: $x_t = (\Delta oil_t, gap_t, \Delta m_t, \Delta efexr_t, \Delta p_t)'$.

The alternative model 1: $x_t = (\Delta oil_t, \Delta m_t, \Delta efexr_t, gap_t, \Delta p_t)'$.

The alternative model 2: $x_t = (\Delta oil_t, gap_t, \Delta efexr_t, \Delta m_t, \Delta p_t)'$.