Exchange rate pass-through and volatility: Impacts on domestic prices in four Asian countries

Sek, Siok Kun and Kapsalyamova, Zhanna
Christian Albrechts University of Kiel

01. August 2008

Exchange Rate Pass-Through And Volatility: Impacts On Domestic Prices In Four AsianCountries[†]

Siok Kun Sek*
Christian Albrechts University of Kiel

Zhanna Kapsalyamova*
Christian Albrechts University of Kiel

June 1st, 2008

Abstract

The paper undertakes a comparative empirical analysis on the effects of shocks on domestic prices in four Asian countries before and after the financial crisis of 1997. We apply two different estimation methodologies, namely a structural VAR and a single equation approach. The results of the two methods are consistent, although the magnitude of the elasticities of the exchange rate pass-through are different due to the inclusion of different variables, lag terms and different assumptions made in both methods. The results show that the degrees of the exchange rate pass-through are different across countries and over time. In most cases, the pass-through rates are incomplete. The degree of the exchange rate pass-through is the highest on import prices, moderate on PPI and is the lowest on CPI. In some cases, the pass-through rates on CPI are even negative. The effect of the import price shock is stronger as compared to that of the exchange rate shock in determining the movement of the domestic prices in these countries. Trade openness has a weak correlation with the degree of the exchange rate pass-through.

JEL classification: C22, C32, F41

Keywords: domestic prices, exchange rate pass-through, SVAR, single equation approach

[†] We are grateful to Prof. Yoshino from the Takushoku University (Tokyo), Björn van Roye from the Kiel Institute for the World Ecoonomy for their invaluable comments on the earlier drafts of this paper.
*Corresponding authors: Siok Kun Sek & Zhanna Kapsalyamova, Social Science and Economics Department, Christian-Albrechts-Universitz zu Kiel, Olshausenst. 40, D-24098 Kiel, Germany. Tel: +49(0)8803351. Email: emilysek@gmail.com, Kapsalyamova@bwl.uni-kiel.de.

1. Introduction

One of the main issues in international macroeconomics is the relationship between the exchange rate movement and the price adjustment of the traded goods, the so-called exchange rate pass-through. Exchange rate pass-through is defined as the percentage change in the domestic/ imported prices led by a one percentage change in the exchange rate between the importer and exporter currency. According to Sahminan (2002) and An (2006), exchange rate movement transmits to the domestic prices through three channels: imported consumption goods, imported intermediate goods and domestic goods priced in foreign currency prices.

The economy faces a full/ complete pass-through when there is a one-to-one response of the domestic prices to the exchange rate changes. On the other hand, a partial/incomplete pass-through occurs when there is a less than one-to-one response in prices as a result of the exchange rate changes. In a real situation, exchange rate pass-through into domesstic prices is incomplete. For instance, Campa & Goldberg (2001) estimate exchange rate pass-through equation for 25 OECD countries for a period between 1975 and 1999. They find that hypothesis of the complete short run pass-through can be rejected in 22 out of 25 countries. But in contrast, they are only able to reject complete long run pass-through in 9 of 25 countries. Another evidence of the imperfect pass-through is shown in Campa & Gonzalez (2002).

Lower degree of the pass-through implies lower expenditure switching effects on the domestic monetary policy and monetary policy may deal more effectively with the real shocks. On the other hand, the effectiveness of monetary policy can be affected if the pass-through rates are endogenous to a country's relative monetary stability (Campa & Goldberg, 2002). Therefore, it is very important to know and understand the determinants of the exchange rate pass-through as well as the transmission of the shocks under different degrees of the pass-through to the economy.

In general, the literature on the exchange rate pass-through can be divided into two strands as discussed in An (2006): micro and macro level. The first strand of the literature focuses on the analysis of the exchange rate pass-through into domestic prices based on the micro level such as the foreign firm's pricing behavior, disaggregated product bundles/ industries and the market structures. The second strand of the literature on the other hand, studies the exchange rate pass-through at the macro level. It investigates the exchange rate pass-through from the monetary policy view. It estimates exchange rate pass-through into producer prices index (PPI), import price index (IMP) and consumer prices index (CPI). Our study contributes to this strand of the literature. Although there exists a number of researches on the exchange rate pass-through, its primary focus is on the industrial countries. Analysis of it based on the emerging Asian economies is limited (Sahminan, 2002, Sato et.al, 2005). To fill this gap this study focuses on some emerging economies of Asia, namely Korea, Malaysia, Singapore and Thailand. To have a complete picture on the exchange rate pass-through in the Asian economies we should have included other Asian countries. However this analysis was not possible due to the unavailability of data for other countries.

Korea, Malaysia, Singapore and Thailand are strongly affected by the developed countries such as US and Japan, given that the US and Japan are main trade partners. Most of the trade is in the US dollar even among the Asian countries. For instance, in year 1980, 96.1% of export and 93.2% of import in Korea were invoiced in US dollar.

This figure remained high in year 2000 where 84.8% of exports and 80.4% of imports correspondingly were invoiced in the US dollar. Similar trade invoicing condition is relevant for Thailand. In 2000, 87% of export and 79% of import in Thailand were invoiced in US dollar. This implies that US dollar is the main currency used in trade within Asian countries and even with the countries outside Asia that trade with these countries (Kamps, 2006).

Table 1: Imported Intermediate goods on total imports (%)

Countries	Average % intermediate goods on total imports	
	1980-1996	1999-2005
Indonesia	57.03	61.00
Korea	45.39	54.83
Malaysia	59.62	71.71
Philippines	53.31	72.13
Singapore	46.89	62.82
Thailand	58.95	60.64
Average	53.53	63.86

Source: the original series for annually imported intermediate and consumption goods are obtained from RIETI-TID.
The values in the table are calculated by the author.

Another feature of the countries in the sample is that the trade components comprise a large part of the intermediate goods (see Table 1). For instance, from year 1980 to 1996, the imported intermediate goods on total imports in six East Asian countries is 53.53%. It increases to 63.86% in periods 1999 to 2005. This implies that prices in these countries might be strongly affected by the external shocks through imported inflation of intermediate goods.

Korea, Malaysia, Singapore and Thailand are among those countries which were hit by the financial crisis of 1997-1998, which first started in Thailand, when the baht was floated in July 2, 1997. Financial crisis has prompted the crisis-hit Asian countries to alter their monetary policy and the exchange rate regimes. Before the crisis, these countries adopted the narrow or more rigid exchange rate regimes and the policy authorities were focused on the monetary base targeting. After the crisis, drastic actions were taken to reconstruct the monetary policy implementation. Most of these countries have moved to the more flexible or floating exchange rate regimes. At the same time, few countries have adopted the inflation targeting regime. Starting in Korea in April 1998, the inflation targeting regime is then adopted by Indonesia in 2000, Thailand in May 2000 and Philippines in January 2002[1]. Malaysia and Singapore do not adopt inflation targeting but move to managed floating regime. These drastic changes in the monetary policy and regimes draw some implications on in the economies in these countries. By comparing the data before and after the financial crisis in three Asian countries, Osawa (2006) finds that the exchange rate volatility in these countries has increased over time. At the same time, the foreign exchange reserves and interest rate in these countries have declined. These changes are due to the change in the monetary policy and regimes from the rigid one to the more flexible one.

Inflation rates in these countries have declined slightly after the financial crisis or after the implementation of the new monetary policy. The M2 growth in these countries also declines over time. Additionally, these countries have improved their

[1] Korea officially adopted an inflation targeting regime in April 1998 with headline CPI as inflationary target but switched to core CPI targeting from January 2000.

current account balance from negative to positive balances. These countries also show the increase in the degree of trade openness over time. Malaysia and Singapore are very open in trade compare to the other Asian countries (Asia Development Bank, countries' key indicators, 2007).

Referring to the theory of the 'Impossibility of the Holy Trinity', Mishkin & Savastano (2001), claim that inflation targeters should float the exchange rate for a well functioning of inflation targeting regime. Limiting the movement of exchange rate may result in two risks. The first risk is associated with the risk of transforming the exchange rate into a nominal anchor which will takes over the inflation target. The second risk is the movement of exchange rate may depend on the nature of the shocks (Mishkin, 2004). Due to these reasons, it is argue that the adoption of the inflation targeting regime may generate costs in the form of higher exchange rate volatility. However, some empirical studies, for instance Edwards (2006) show that there is no evidence that the adoption of inflation targeting leads to higher volatility in the exchange rate.

Previous studies show that the exchange rate shocks in emerging economies tend to transmit into aggregate inflation faster than in the industrial economies. Exchange rate pass- through is very rapid for emerging markets but slow for advanced economies (Devereux and Lane (2001)). How true do these statements apply to Asian countries? Does the exchange rate pass-through change in these countries after moving to the more flexible exchange rate regime and inflation targeting? Is there any difference in the pass-through rates among Asian countries?

This study seeks to answer the above questions and has three main objectives. First, we seek to compare the degrees of the exchange rate pass-through into different domestic prices (import price, PPI and CPI) before and after the financial crisis of 1997 (or after moving to new monetary policies) in the countries in the sample. Second, we compare the effects of exchange rate shock with other shocks on domestic prices. For instance Hahn (2003) finds that the pass-through of import price shock is largest and faster on domestic prices. It is important to investigate how large the effect of exchange rate shock relative to other shocks. If the pass-through rate is high but the relative effect of exchange rate is small, then the exchange rate pass-through will not have a significant and large effect on determining the domestic price stability. Third, using the same range of data and applying the structural vector autoregressive model (SVAR) and single equation approaches, we estimate the degree of the exchange rate pass-through in these countries.

The results from both methods are consistent to each other. Our findings are in line with the results of previous studies where exchange rate pass-through is incomplete in the short-run (and the long-run). The pass-through rate is the highest on import prices, moderate on PPI and the lowest on CPI. Exchange rate pass-through does not decline in all countries considered in this study. Additionally we find a weak correlation between trade openness and the degree of the exchange rate pass-through. In general, the effect of the exchange rate shock on domestic prices is lower than that of the import price shock.

The paper is organized as follows. In section 2, we describe the methodology and data. Section 3 discusses estimated results from SVAR and single equation approaches. Section 4 concludes.

2. Data and Estimation Methods

This section describes the data used in the estimation and our methodology. As the financial crisis started in July 1997, the monthly data are divided into two sub-periods: 1991M1- 1997M7 (pre-crisis) and 1999M1-2007M5 (post-crisis). We apply two different approaches: single equation approach and structural VAR estimation. In doing so, we attempt to compare the robustness of the results using these two techniques. We estimate the exchange rate pass-through into domestic prices (import price, PPI and CPI) and analyze dynamic effects of shocks to the economy in the Asian countries.

2.1 Data

All the monthly data are obtained from International Financial Statistics (IFS), IMF. These data include oil price index, money or M1, nominal effective exchange rate, import price, producer price index (PPI), consumer price index (CPI) and industrial/ manufacturing production index (IP). All the series are seasonally adjusted using Census X11 program and are transformed into the logarithms form (except the output gap variable). The output gap is constructed as the log difference between the actual output (IP) and potential output (HP filter adjusted industrial production index[2]).

The main problem in this study is the availability of data. Most of the Asian countries do not have long enough series. Malaysia does not have the import price series and therefore we only apply the 6-variable VAR model (excluding the import price variable). Thailand has shorter series, starting from 1999 M1, thus the analysis is made only for the second sub-period.

2.2 Single Equation Approach

The single equations of LS and IV (instrumental variables) techniques are applied in order to estimate short run and long run exchange rate pass-through on domestic prices. There is a huge debate around the methods of estimation of long run pass-through. Theoretically import prices, the exchange rate and foreign price level should have long run Engle and Granger cointegrating relationship. However in reality, empirical literatures show that the relationship does not hold always (Campa and Goldberg, 2005).

De Brandt, Banerjee and Kozluk (2007) use time series and up-to-date panel data techniques test for cointegration with the possibility of structural breaks. They show that in the long run, the relationship may be restored in the estimation. According to De Brandt et.al, (2007), the lag order and introduction of the structural breaks may change the results of cointegration tests significantly. Due to the effects of financial crisis 1997 in Asian, the data is divided into two sub-periods. Applying different lag orders suggested by SC, AIC, FPE and HQ information criteria, two different cointegration tests namely Johansen trace test and Saikkonen & Lütkepohl tests are conducted on the two sub-periods data separately. Since none of the tests outperforms the other, our conclusions are based on the results from the two tests applied. We test

[2] Thailand uses the GDP instead of the Industrial Production index series due to the unavailability of the corresponding series.

for cointegration between CPI (PPI, import price index), exchange rate and foreign price level as well.

If the cointegration relationship is revealed we apply error-correction model (ECM). When it is not the case we use LS procedure suggested by Campa and Goldberg (2005). The ECM is estimated using standard LS techniques in two steps. First we estimate ECM as follows:

$$\Delta p_{k,t} = -(1-\theta_1)p_{k,t-1} + \theta_2 s_{k,t-1} + \sum_{j=1}^{p-1} b_j \Delta p_{k,t-j} + \sum_{j=0}^{q-1} a_j \Delta s_{k,t-j} + \sum_{j=0}^{r-1} c_j y_{k,t-j} + \sum_{j=0}^{z-1} d_j \Delta p^*_{us,t-j} + u_t \quad (1)$$

where $p_{k,t}$ represents home CPI (home PPI or import price index) for country k, $s_{k,t}$ is the nominal effective exchange rate, $y_{k,t}$ is the output gap, $p_{us,t}^*$ is the PPI of the US. All variables are expressed in logs, Δ indicates first difference. Long run pass-through is $\beta = \frac{\theta_2}{1-\theta_1}$ Coefficient $\hat{a}_0$ is interpreted as short run exchange rate pass-through.

The lag order of the $\Delta s_{k,t}$, $\Delta p_{k,t}$, $y_{k,t}$ and $\Delta p_{us,t}^*$ are determined on the basis of the AIC and SC criteria and significance of the parameters. After the final model is formulated, its residual is checked again for the stationarity by means of the ADF test with the lag order based on the AIC and SC information criteria. Given that the estimated residual follows nonstandard distributions, we use critical values for the ADF cointegration tests. Inclusion of the deterministic variables trend or intercept depends on the behavior of the times series. In the case where variables exhibit trend behavior we include trend into the cointegrating equation, if not we don't.

The disadvantage of this model is that it does not provide the standard errors of the long run estimate directly. To calculate them we apply Bewley transformation of the ECM in the following form:

$$p_{k,t} = \beta s_{k,t-1} - \sum_{j=1}^{p-1} \frac{\hat{b}_j}{1-\theta_1} \Delta p_{k,t-j} - \sum_{j=0}^{q-1} \frac{\hat{a}_j}{1-\theta_1} \Delta s_{k,t-j} - \sum_{j=0}^{r-1} \frac{\hat{c}_j}{1-\theta_1} y_{k,t-j} - \sum_{j=0}^{z-1} \frac{\hat{d}_j}{1-\theta_1} \Delta p^*_{us,t-j} + \frac{u_t}{1-\theta_1} \quad (2)$$

with $\hat{b}_j = \sum_{i=j+1}^{p} b_i$, $\hat{a}_j = \sum_{i=j+1}^{q} a_i$, $\hat{c}_j = \sum_{i=j+1}^{r} c_i$ $\hat{d}_j = \sum_{i=j+1}^{z} d_i$, $\hat{a}_0 = -a_0$ for $j \geq 1$

Given that the $\Delta p_{k,t}$ is correlated with the disturbance u_t we estimate this equation using instrumental variables (IV) estimation with the instrument $p_{k,t-1}$ for $\Delta p_{k,t}$. We drop later the subscript k for simplicity.

However one should take into account that the second step is possible only if the $1-\theta_1$ is significantly different from zero. Thus before continuing with the second step we test whether $1-\theta_1$ is zero. If it is the case we apply standard two steps Engle Granger procedure.

If the evidence of cointegration is not found we apply ad hoc method suggested by Campa and Goldberg (2005) which in our case is defined as follows:

$$\Delta p_t = c + \sum_{j=0}^{12} a_j \Delta s_{t-j} + \sum_{j=0}^{r-1} c_j y_{t-j} + \sum_{j=0}^{z-1} d_j \Delta p^*_{t-j} + u_t \quad (3)$$

The lag order of the output gap and foreign price index as before are determined on the basis of the AIC, SC information criteria and the significance of the parameter estimates. Since the data are monthly, we include exchange rate series up to lag of order 12 in order to get approximate measure of the long run pass-through. Since this assumption is ad hoc, one should not completely rely on these estimates, they can be interpreted as the benchmark estimates of the long run pass-through only. Short run pass-through in the present case is a parameter which determines the contemporaneous effect of the exchange rate on the price level equal to $\hat{\boldsymbol{a}}_0$ in our case.

Given that we might have endogeneity problem in the regression we reestimate our model using two stages least squares method (TSLS) and use as the instruments 13 lags of the exchange rate, 12 lags of output gap, 13 lags of foreign price index and 13 lags of the dependent variable. The number of lags for instruments is subject to variation (Mihailov, 2005). For comparative purposes we present obtained pass-through estimates from OLS and TSLS in the Table 1.

2.3 Structural Vector Autoregression Model (SVAR)

Following the construction of SVAR model in analyzing the effects of shocks in previous studies (Ito and Sato, 2006 and McCarthy, 2006), the SVAR model consists of seven variables:

$$x_t = \left(\Delta OIL_t \quad GAP_t \quad \Delta M_t \quad \Delta NEER_t \quad \Delta IMP_t \quad \Delta PPI_t \quad \Delta CPI_t\right) \tag{4}$$

where OIL_t stands for the oil price index of US, GAP_t the output gap, M_t the monetary aggregate or M1, $NEER_t$ the nominal effective exchange rate and IMP_t the import price, PPI_t producer price index and CPI_t consumer price index. Δ denotes the first differenced operator. All the variables are in logarithms except the output gap and are seasonally adjusted using the Census X11 program. All the series are tested with the unit-root stationarity test and become stationary after the first differenced transformation.

Changes in the oil price can be interpreted as supply shocks, in output gap as demand shocks, in monetary aggregate as policy shocks, in NEER as exchange rate shocks and in the three domestic price indices as non-oil price shocks.

The Choleski decomposition is applied to identify the structure of the shocks in such a way that the decomposition of the variance covariance matrix of the reduced form residuals is written in a lower triangular matrix. Totally n(n-1)/2 restrictions are imposed on the triangular matrix in order to identify the structural shocks where some of the structural shocks do not have contemporaneous impacts on other variables. The reduced-form VAR residuals (e_t) is correlated with the structural disturbances (ε_t) in the following form:

$$\begin{pmatrix} e_t^{OIL} \\ e_t^{GAP} \\ e_t^{M} \\ e_t^{NEER} \\ e_t^{IMP} \\ e_t^{PPI} \\ e_t^{CPI} \end{pmatrix} = \begin{pmatrix} S_{11} & 0 & 0 & 0 & 0 & 0 & 0 \\ S_{21} & S_{22} & 0 & 0 & 0 & 0 & 0 \\ S_{31} & S_{32} & S_{33} & 0 & 0 & 0 & 0 \\ S_{41} & S_{42} & S_{43} & S_{44} & 0 & 0 & 0 \\ S_{51} & S_{52} & S_{53} & S_{54} & S_{55} & 0 & 0 \\ S_{61} & S_{62} & S_{63} & S_{64} & S_{65} & S_{66} & 0 \\ S_{71} & S_{72} & S_{73} & S_{74} & S_{75} & S_{76} & S_{77} \end{pmatrix} \begin{pmatrix} \varepsilon_t^{OIL} \\ \varepsilon_t^{GAP} \\ \varepsilon_t^{M} \\ \varepsilon_t^{NEER} \\ \varepsilon_t^{IMP} \\ \varepsilon_t^{PPI} \\ \varepsilon_t^{CPI} \end{pmatrix} \tag{5}$$

The ordering of the variables determines the structure of the shocks. The first variable has impacts on all variables below it but it does not receive any impacts from these variables. The second variable only receives the impacts from the first variable. It does not have any impact on the first variable but it can influence all the variables below it. This rule applies to the all subsequent variables.

Following Ito and Sato (2006), the oil price index first is ordered first as the oil price shocks may affect the other variables but are unlikely affected contemporaneously by other shocks. The output gap is ordered next. It is assumed to be affected by the oil price shocks only and can affect all the variables in the system except oil price shocks. The money supply can be interpreted as the monetary policy variable and it is reasonable to put this variable before the exchange rate. The next variable is import price, PPI and CPI. The import price is affected by all shocks in the system except production price and non-oil price shocks. CPI is ordered last as it is assumed to be affected by all shocks and it does not affect any variables contemporaneously. It is possible to estimate the SVAR model in different ordering of variables for robustness comparisons.

Ito & Sato (2006) use the nominal effective exchange rate to represent the exchange rate variable and argue that the bilateral exchange rate with US Dollar is not appropriate to use in this study as most of the Asian countries had adopted de facto US Dollar before the crisis. In this study, we run the baseline SVAR model using the nominal effective exchange rate series.

The advantages of applying the structural VAR in this paper are first it solves the endogeneity problem that is arisen under the single equation method; second, this technique enables us to analyze the effects of shocks through a Cholesky decomposition of innovations and third, it enables us to investigate the effect of exchange rate and the pass-through rate on the chain of domestic prices (import price, PPI and CPI) in the same system equation.

For the purpose of robustness, we run the VAR model using two different ordering schemes such that:

$$x_t = \left(\Delta OIL_t \quad GAP_t \quad \Delta M_t \quad \Delta NEER_t \quad \Delta IMP_t \quad \Delta PPI_t \quad \Delta CPI_t\right), \tag{6}$$

which is Model I in our case and

$$x_t = \left(\Delta OIL_t \quad GAP_t \quad \Delta NEER_t \quad \Delta M_t \quad \Delta IMP_t \quad \Delta PPI_t \quad \Delta CPI_t\right), \tag{7}$$

which is Model II in the present case.

Exchange rate is assumed to influence the decision of monetary policy in Model II. The two different ordering variables of model are estimated separately for each country for both sub-periods. The number of lags is determined based on the

suggestions of SC, AIC and HQ information criteria. However, the final decision is made based on the results from the diagnostic tests for the residuals. The results of the first ordering are compared with the results of that of the second ordering.

According to Mihailov (2005), under the structural VAR estimation, the exchange rate pass-through at horizontal lag ( ) is obtained through the accumulated impulse response of domestic prices (P) with respect to an innovation of one standard deviation in the exchange rate (NEER) equation of the VAR. The partial derivatives can be written as:

$$\frac{\partial(d\ln P_t)}{\partial \varepsilon_t^{NEER}}, \quad >0$$

On the other hand, the exchange rate pass-through under the single equation estimation is:

$$\frac{\partial(d\ln P_t)}{\partial \ln NEER_t}, \quad >0$$

According to Mihailov (2005), there is no direct comparison of the elasticity of exchange rate pass-through between the two methods. In order to make the pass-through rates obtained from structural VAR and the single equation estimations comparable, transformation or normalization of the impulse response to an innovation in NEER generated by SVAR equation is made in the following way:

$$\frac{\partial(d\ln P_t) \Big/ \partial \varepsilon_t^{NEER}}{\partial \ln NEER_t \Big/ \partial \varepsilon_t^{NEER}}, \quad >0$$

3. Empirical Results

This section presents empirical results from the single equation and SVAR estimations. Additionally it conducts comparative analysis on the exchange rate pass-through obtained using these two approaches.

3.1 Single Equation Estimation Results

This section summarizes on the comparison of exchange rate pass-through across countries and over times (see Table 2).

Focusing on the degree of exchange rate pass-through into import price, it is observed that Korea and Singapore have incomplete pass-through into import prices. Short run exchange rate pass-through into import prices in general is lower that its long run counterparts, except that of Korea in the second period. Exchange rate pass-through into import prices in Korea is very rapid in the short run. However import price in Korea get adjusted in the long run so that the effect of the exchange rate changes has declined over time. This is in line with the empirical findings obtained by Ito, Sasaki and Sato (2005). Comparing exchange rate pass-through elasticities across LS and TSLS we find no large difference between them. Since we there may be endogeneity problem in the OLS estimation, we rely more on the results of TSLS. Comparing the pass-through on import prices across periods in the long run, we observe a decline in Korea, but an increase in Singapore.

Turning to the results on exchange rate pass-through into PPI, we observe the incomplete pass-through on PPI across countries both in the short and the long run. Exchange rate pass-through on PPI are lower that that on import prices. This is a quite stylized empirical fact, widely supported in the empirical literature such as McCarthy (2000) and Hahn (2003). Short run exchange rate pass-through on PPI is lower than their long run counterparts. Comparing exchange rate pass-through across periods we observe a decline in the PPI in Korea and Malaysia but rise in Singapore.

Comparisons of the results on exchange rate pass-through into import price and PPI, the pass-through into CPI is the lowest and negligible. The estimates obtained are similar in magnitude to the ones obtained by Choudhri and Hakura (2006). As before short run elasticities are lower than their long run estimates. Comparing the long run pass-through on CPI across periods we observe an increase in Korea and Singapore, but a decline in Malaysia in the second period, although of the negligible magnitude. We cannot conduct similar analysis for Thailand because of the data availability problem.

However since most of the analysis made in this part of the paper is based on the ad hoc estimation of the long run exchange rate pass-through rates these estimates should be considered with caution. Further analysis should be made by applying more sophisticated techniques

Table 2
Exchange Rate Pass-Through Rates Across Methodologies and Trade Openness

	OLS		TSLS		VAR		Average Trade openness	
Time horizontal 1 Short run	**Period I**	**Period II**	**Period I**	**Period II**	**Period I**	**Period II**	**Period I**	**Period II**
IMP								
Korea	**-0.393**$^{\clubsuit *}$	**-0.451**$^{\clubsuit}$	**-0.387**$^{\clubsuit *}$	**-0.433**$^{\clubsuit *}$	-0.415	-0.794	0.49	0.64
Malaysia	-	-	-	-	-	-	1.48	1.82
Singapore	-0.033*	-0.388*	-0.032*	-0.384*	-0.118	-0.471	2.84	3.18
Thailand	-	**-1.15**$^{\clubsuit}$	-	**-1.047**$^{\clubsuit}$	-	1.266	0.69	1.12
PPI								
Korea	-0.073*	-0.10*	-0.073*	**-0.097**$^{\clubsuit}$ *	-0.033	-0.147	0.49	0.64
Malaysia	0.013*	-0.142*	0.026*	-0.116*	-0.192	-0.012	1.48	1.82
Singapore	0.089*	-0.262*	0.088*	-0.02*	-0.118	-0.157	2.84	3.18
Thailand	-	-0.182*	-	-0.162*	-	-0.128	0.69	1.12
CPI								
Korea	-0.06*	-0.027*	-0.06*	-0.028*	-0.057	-0.065	0.49	0.64
Malaysia	-0.012*	0.020*	-0.012*	0.025*	-0.000	0.056	1.48	1.82
Singapore	0.056*	-0.016*	0.057*	-0.02*	0.029	0.078	2.84	3.17
Thailand	-	-0.012*	-	-0.012*	-	-0.018	0.69	1.12
Time horizontal 12/ LR	**Period I**	**Period II**	**Period I**	**Period II**	**Period I**	**Period II**	**Period I**	**Period II**
IMP								
Korea	-0.497	-0.158*	-0.589	-0.169*	-0.696	-0.537	0.49	0.64
Malaysia	-	-	-	-	-	-	1.48	1.82
Singapore	-0.380	-0.833	-0.391	-0.827	-0.125	-1.478	2.84	3.18
Thailand	-	-1.61	-	-1.430	-	-1.919	0.69	1.12
PPI								
Korea	**-0.439**$^{\clubsuit}$	-0.146*	**-0.439**$^{\clubsuit}$	-0.136*	-0.048	-0.150	0.49	0.64
Malaysia	-0.30	-0.181	-0.29	-0.159	-0.391	-0.221	1.48	1.82
Singapore	0.070	-0.86	0.011	-0.63	-0.025	-0.696	2.84	3.18
Thailand	-	-0.358	-	-0.342	-	-0.235	0.69	1.12
CPI								
Korea	0.193*	**-0.085**$^{\clubsuit}$	0.191*	**-0.090**$^{\clubsuit}$	-0.040	-0.088	0.49	0.64
Malaysia	**-0.040**$^{\clubsuit}$	0.055*	**-0.040**$^{\clubsuit}$	0.059*	0.055	0.074	1.48	1.82
Singapore	0.099*	-0.052*	0.102*	**-0.06**$^{\clubsuit}$	0.042	-0.130	2.84	3.18
Thailand	-	0.204	-	0.204	-	0.015	0.69	1.12

$^{\clubsuit}$ -denotes that elasticity is significantly different from zero at 1% level
* - denotes that elasticity is significantly different from -1 at a 1% level
In brackets p-values are indicated
The exchange rate pass-through values in the VAR are obtained from the normalized IRF, model I
The trade openness is defined as the total trade divided by GDP.
The figures are calculated by the authors using the annual data from ADB: period I (1990-1996) and period II (1999 2000)

3.2 SVAR empirical results

This section presents the results from SVAR estimations. First, the responses of import prices with respect to various shocks are discussed. The responses of other variables to a one percent increase in the exchange rate shock are also presented (IRF). Second, the relative explanatory power of shocks on domestic prices is compared using the forecast error variance decompositions (FEVD). Finally, the degrees of the pass-through before and after the crisis are compared.

The results of the accumulated impulse response functions are summarized in appendix. In the SVAR model, it is assumed that there are 7 shocks in the economy: oil price shocks, output gap shocks, exchange rate (NEER) shocks, import price shocks, production cost shocks (PPI) and non-oil price (CPI) shocks. The impulse response function shows the response of each variable to a positive one standard deviation of each shock. The middle line represents the responses while the upper and lower dashed lines are two standard error bands. The vertical axis shows the percentage point change in the domestic price index or the percentage of the pass-through and the horizontal axis shows the time (in months). We are only interested to present the responses of domestic prices with respect to NEER and import price shocks.

Figures 1 and 3 in appendix show the graphs of the responses in the domestic prices (IMP, PPI and CPI) to a one percentage increase (appreciation) in the nominal effective exchange rate between the two periods using the model I and II. In general, the results are consistent with the results of the previous studies: an appreciation in nominal exchange rate leads to a decline in domestic prices. Or equivalently, depreciation in the exchange rate causes an increase in the domestic prices. This result holds in all countries between the two sub-periods. However in some cases, depreciation in the exchange rate leads to a decline in CPI in certain periods. This result is in line with the results reported in the paper by Choudhri and Hakura (2006).

In order to have a better comparison on the responses of domestic prices under the exchange rate shock between the two sub-periods, we summarize the numerical values captured when running the impulse response functions, i.e the responses of domestic prices under a 1% exchange rate shock (see Table 3). In general, the percentage changes of a one standard deviation in the innovation in the NEER equations are different across countries. Import price in Thailand shows the highest response to exchange rate shock as compared to other countries. The response of domestic prices to exchange rate shock is highest on import price, moderate on PPI and is the lowest on CPI. The pass-through of the exchange rate changes to import prices is higher in Korea and Thailand but is lower in Singapore.

The cumulative impulse responses of domestic prices to import price shock are summarized in Table 3 as well. From Table 3, it is observed that in general, the percentage changes in domestic prices led by an import price shock are higher than that of the exchange rate shock with the exception of Thailand. As in the case of the exchange rate shock, we observe that the effect on import price shock is highest on import prices, moderate on PPI and the lowest on CPI, with the exception of Singapore. In Singapore, the effect of the import price shock is highest on PPI, followed by import price and CPI. The response of import price to a one percentage change in import price is the highest in Thailand, followed by Korea and Singapore.

However, the effect of import price shock on PPI is the highest in the case of Singapore, followed by Korea and Thailand.

In order to obtain the exchange rate pass-through rates which are comparable with the pass-through rates estimated using the single equation method, we follow the transformation suggested by Mihailov (2005). The results are summarized in Table 2.

The results show that in most cases, the exchange rate pass-through into domestic prices are incomplete, with the highest pass-through on import price, followed by PPI and CPI. Comparing the results between the two sub-periods across prices, we observe that different prices indices respond differently to the exchange rate changes. Additionally changes in the exchange rate pass-through in domestic prices differ across countries. This might owe to the country specific characteristics and percentage change in commodities composition of the price indices over time.

The FEVDs show the values of the percentage share of variance of the n-step forecast error of a variable that can be explained by the innovation in another variable (Billmeier, 2002). Table 4 shows the maximum effects of seven shocks on domestic prices that are obtained from the FEVD. The results show that the import price shock is the main determinant to the fluctuations of the import price in both periods. Exchange rate shock in its turn can explain considerably well the movement of import prices especially in the case of Korea and Thailand. It can explain at most 24% and 41% of fluctuations in import prices in Korea and Thailand correspondingly (in period II).

A PPI shock can explain mostly the movement of PPI in all countries for both periods with the exception of Singapore. In Singapore, the movement of PPI is mainly determined by the import price shock. An import price shock can explain at most 75% and 85% of the movement of PPI in Singapore for period I and II correspondingly. In general, the explanatory power of the import price shock on domestic prices is higher than that of the exchange rate shock with the exception of Thailand. Exchange rate has a very low effect in determining the movement of domestic prices in Malaysia and Singapore. These results hold in both periods.

Table 3

Impulse response functions: NEER shock and import prices shock (IMP) to domestic prices

Time	Period I NEER to import price				Period II NEER to import price				Period I IMP to import price				Period II IMP to import price			
	Kor	Mal	Sp	Thai	Kor	Mal	Sp	Thai	Kor	Mal	Sp	Thai	Kor	Mal	Sp	Thai
1	-0.51	-	-0.04	-	-1.35	-	-0.24	-1.38	0.63	-	0.60	-	1.90	-	1.00	1.02
4	-0.65	-	-0.02	-	-1.00	-	-0.32	-2.10	1.08	-	0.45	-	1.49	-	0.92	2.32
8	-0.68	-	-0.03	-	-0.51	-	-0.34	-2.36	0.73	-	0.40	-	1.52	-	1.11	1.98
12	-0.87	-	-0.03	-	-0.79	-	-0.34	-2.61	0.57	-	0.44	-	1.61	-	1.13	2.05
16	-0.85	-	-0.05	-	-0.73	-	-0.34	-2.96	0.63	-	0.42	-	1.57	-	1.13	2.21
20	-0.81	-	-0.04	-	-0.73	-	-0.34	-2.96	0.59	-	0.42	-	1.61	-	1.13	2.01
Time	**Period I NEER to PPI**				**Period II NEER to PPI**				**Period I IMP to PPI**				**Period II IMP to PPI**			
	Kor	**Mal**	**Sp**	**Thai**	**Kor**	**Mal**	**Sp**	**Thai**	**Kor**	**Mal**	**Sp**	**Thai**	**Kor**	**Mal**	**Sp**	**Thai**
1	-0.04	-0.29	-0.04	-	-0.25	-0.01	-0.08	-0.14	0.04	-	0.63	-	0.37	-	1.43	0.08
4	-0.09	-0.48	-0.05	-	-0.33	-0.02	-0.15	-0.16	0.25	-	0.48	-	0.33	-	1.28	0.9
8	-0.02	-0.42	-0.07	-	-0.19	-0.13	-0.18	-0.29	0.26	-	0.41	-	0.32	-	1.48	0.13
12	-0.06	-0.43	-0.06	-	-0.22	-0.21	-0.16	-0.32	0.26	-	0.44	-	0.33	-	1.45	-0.06
16	-0.08	-0.43	-0.08	-	-0.24	-0.23	-0.16	-0.36	0.29	-	0.41	-	0.32	-	1.45	0.04
20	-0.07	-0.43	-0.07	-	-0.23	-0.27	-0.15	-0.35	0.27	-	0.41	-	0.33	-	1.43	0.02
Time	**Period I NEER to CPI**				**Period II NEER to CPI**				**Period I IMP to CPI**				**Period II IMP to CPI**			
	Kor	**Mal**	**Sp**	**Thai**	**Kor**	**Mal**	**Sp**	**Thai**	**Kor**	**Mal**	**Sp**	**Thai**	**Kor**	**Mal**	**Sp**	**Thai**
1	-0.07	0.00	0.01	-	-0.11	0.05	0.04	-0.02	0.00	-	0.00	-	0.07	-	0.06	0.00
4	-0.05	0.07	-0.02	-	-0.17	0.06	-0.01	-0.03	0.00	-	0.01	-	0.06	-	0.07	0.16
8	-0.02	0.06	0.02	-	-0.12	0.07	-0.03	0.01	-0.13	-	0.00	-	0.05	-	0.09	0.12
12	-0.05	0.06	0.01	-	-0.13	0.07	-0.03	0.02	-0.16	-	0.01	-	0.07	-	0.10	0.07
16	-0.07	0.06	0.01	-	-0.14	0.06	-0.03	-0.02	-0.17	-	0.01	-	0.06	-	0.10	0.12
20	-0.09	0.06	0.01	-	-0.13	0.05	-0.03	-0.01	-0.20	-	0.01	-	0.07	-	0.10	0.11

Notes:

First half of the table: NEER to domestic prices (import prices, PPI, CPI) show the changes in domestic prices led by one percentage depreciation in exchange rate (the values are subject to multiplication by 10^{-2}).

Second half of the table: IMP to domestic prices (import prices, PPI, CPI) indicate the changes in domestic prices led by one percentage increase in import prices (the values are subject to multiplication by 10^{-2})

The values are obtained by running the impulse response functions

Table 4
Forecast Error Variance Decompositions: Maximum effects of shocks on domestic prices

Period I							
(I) Import price							
	OIL	**GAP**	**M**	**NEER**	**IMP**	**PPI**	**CPI**
Korea	0.10	0.06	0.03	0.25	0.84	0.12	0.03
Malaysia	-	-	-	-	-	-	-
Singapore	0.07	0.06	0.10	0.06	0.89	0.05	0.14
(II) PPI							
	OIL	**GAP**	**M**	**NEER**	**IMP**	**PPI**	**CPI**
Korea	0.07	0.14	0.14	0.14	0.18	0.68	0.04
Malaysia	0.01	0.09	0.02	0.10	-	0.98	0.00
Singapore	0.14	0.08	0.12	0.06	0.75	0.12	0.12
(III) CPI							
	OIL	**GAP**	**M**	**NEER**	**IMP**	**PPI**	**CPI**
Korea	0.09	0.14	0.07	0.10	0.13	0.27	0.60
Malaysia	0.10	0.06	0.01	0.05	-	0.11	0.75
Singapore	0.11	0.08	0.01	0.03	0.12	0.18	0.85
Period II							
(I) Import price							
	OIL	**GAP**	**M**	**NEER**	**IMP**	**PPI**	**CPI**
Korea	0.05	0.02	0.02	0.24	0.71	0.05	0.04
Singapore	0.02	0.03	0.09	0.07	0.91	0.01	0.00
Thailand	0.03	0.08	0.04	0.41	0.52	0.03	0.04
(II) PPI							
	OIL	**GAP**	**M**	**NEER**	**IMP**	**PPI**	**CPI**
Korea	0.02	0.01	0.01	0.19	0.36	0.62	0.05
Malaysia	0.02	0.11	0.14	0.03	-	0.96	0.02
Singapore	0.01	0.04	0.11	0.01	0.85	0.11	0.00
Thailand	0.07	0.06	0.03	0.08	0.08	0.86	0.15
(III) CPI							
	OIL	**GAP**	**M**	**NEER**	**IMP**	**PPI**	**CPI**
Korea	0.03	0.02	0.02	0.14	0.07	0.13	0.75
Malaysia	0.07	0.04	0.19	0.10	-	0.07	0.68
Singapore	0.01	0.06	0.03	0.05	0.12	0.07	0.85
Thailand	0.04	0.15	0.04	0.04	0.07	0.21	0.66

Notes:
All the values are obtained from the forecast error variance decompositions

3.3 Comparisons and Robustness Checking

In this section, we check the consistency and robustness of the results by first, comparing the results of different ordering of variables in the structural VAR model; second, by comparing the results of SVAR with that of the single equation method. We also discuss the link between trade openness with the degree of the exchange rate pass-through and the possible reasons that explain the differences in the overall results across countries.

For the purpose of robustness, we run again the SVAR model using two different ordering schemes, Model I and II as described in the section 2.3. Comparing the results of both ordering (see Figure 1 to 4 in appendix), one can observe that the responses of domestic prices to exchange rate and import price shocks are very similar to each other in all cases. The effect of the exchange rate changes remains low in Malaysia and Singapore. The responses of domestic prices in general are higher under the import price shock as compared to that of the exchange rate shock. The

consistency of the results implies that the results obtained from the structural VAR are robust. Next, we compare the results of structural VAR with that of the single equation results (see the relevant section below).

Comparisons of the results obtained from SVAR and single equation approach techniques show that the magnitude of the exchange rate pass-through elasticities obtained from the two different methods differ to some extents. However in general two methods exhibit similar trends on the behavior of the exchange rate pass-through into domestic prices over time. Similar results are reported in Mihailov (2005) who conducts the analysis in US, Germany and Japan. Comparing the results from generalized VAR and single equation methods, Mihailov (2005) finds that the results from both methods show the same general trends in exchange rate pass-through but the precisions of the elasticities of pass-through depend crucially on the econometric method, data frequency and variable proxy employed.

As in Mihailov (2005), the dissimilarities here may be due to the different methodologies employed, number of lags and variables included in the model. In the SVAR we use 7 variables: nominal effective exchange rate, money base, output gap, PPI, CPI, import price index and oil price index, with all three price indices jointly included into one model. And the shocks are identified based on the certain ordering of the variables. The number of lags for the regressors differs across countries and periods by referring to the AIC, HQ and SC info criteria for lags. Whereas in the single equation approach, we regress CPI, PPI and import prices on exchange rate, output gap and foreign price level independently. We use the same number of lags for the exchange rate variable, whereas the lags of output gap and foreign price level are subject to change.

In general the results from both methods applied are consistent to each other, although there exist some dissimilarities. The exchange rate pass-through into import price is the highest, moderate on PPI and the lowest on CPI across methodologies applied. The behavior of the pass-through rates differs across price indices and countries. As it was mentioned before they might be due to the country specific characteristics and the composition of the commodities in the price indices.

Results from both methods show that appreciation in exchange rate leads to an increase in CPI (in some periods) in the case of Malaysia and Singapore. This result is also found in the previous studies (Choudhri and Hakura, 2006).

There are many factors which contribute to the pass-through rate and explanatory power of the effects of these factors varies across countries. In order to get more consistent estimates of the pass-through rates further research is needed. Inclusion of the regressors into the model should be made based on the specific characteristics of the countries, for instance estimating the fixed effect versus the random effects using the panel data/ dynamic panel analysis.

3.4 Discussions

Why the degree of the exchange rate pass-through is different across countries? Does the trade openness matter? Do exchange rate pass-through rates decline over time across different price indices? We attempt to compare the degree of trade openness with the degree of the exchange rate pass-through across countries for both periods. Table 2 displays the summarized results. In general, the results show that there is a

weak correlation between the trade openness and the degree of exchange rate pass-through. Countries that have higher trade openness do not have higher exchange rate pass-through. For instance, Singapore has the highest degree of trade openness compare to the other three countries; however it does not have the highest degree of the exchange rate pass-through.

The degree of the trade openness has increased over time in all countries. However, not all the countries experience the increase in the degrees of the exchange rate pass-through. For instance, the long run exchange rate pass-through on PPI has declined in Malaysia and that on CPI increased but of negligible magnitude, although the trade openness has increased in this country. This result implies that the trade openness is not the main factor that determines the degree of the exchange rate pass-through in these countries, at least in this study.

The degree of exchange rate pass-through into domestic prices exhibit different trends over time, across price indices and countries. There is no simultaneous change in the pass-through rates over time across countries. This might be due to the factors which are specific for the particular country, for instance the possible change in the trade structure after the financial crisis of the 1997.

So far we have analyzed the pass-through of the exchange rate into domestic prices. The topic that closely link to this research is the investigation on the factors that determine the exchange rate pass-through. However such topic does not cover in this paper but may leave for future research. Besides, for better comparisons, it is possible to repeat the estimation by expanding the time period used in this paper. Given that this study only covers the latest periods of 1990s and 2000s which exclude the crisis periods of 1997-98. For future studies, one can include data from the earlier years (for example 1970s or 1980s), where the Asian economies show higher fluctuation as compared to the periods before and after the crisis covered in the paper. Expansion of the time period is expected to have an effect on the magnitude of the exchange rate pass-through rates. We expect them to be higher. However this extension can be problematic, given the data availability problem.

4. Conclusions

In this paper, we undertake an empirical analysis on the exchange rate pass-through into domestic prices for Korea, Malaysia, Singapore and Thailand. Given that these countries were hit by the financial crisis in 1997 to a different extent, we conduct analysis before and after the crisis in isolation. Several findings have been obtained, which can be summarized as follows.

First, in general, our results partially support the previous results in this area, where the degree of the exchange rate pass-through is different across countries and over time. The changes in the pass-through rates across countries may be due to the change in the structure of trade and monetary policy. As in the case of Singapore, the increase in the exchange rate pass-through may be due to the very high degree of trade openness and low volatility in the exchange rate (as Singapore implements the exchange rate targeting policy). Besides, Singapore is a manufacturing based and non-resource producer country. This implies that Singapore may import products that have higher pass-through rates such as raw materials and fuel/ oil. Second, the degree of the exchange rate pass-through is the highest on import price, moderate on PPI and the lowest on CPI. Third, the pass-through into CPI remains very low in these

countries. In some periods, the appreciation of the exchange rate leads to the increase in CPI in Malaysia and Singapore. Due to the low pass-through into CPI and that the effect of exchange rate shock on domestic prices is relatively low in these countries, the inflation rate in these countries remain stable and does not increase much over time. Fourth, import price shocks have higher explanatory power on the movement in the domestic prices as compared to that of the exchange rate shocks. The effect of the exchange rate shock is very small in the case of Malaysia and Singapore, but the effects of import price shock on domestic prices are very high in all countries especially in the case of Singapore. Fifth, comparing the degrees of the pass-through into domestic prices over time, we find that there is weak correlation between the degree of trade openness and the degree of exchange rate pass-through. Sixth, the effect of depreciation in nominal exchange rate pass-through on CPI across periods and across countries are small in magnitude and even changed its sign from positive (an increase) to negative one (a decline) in some cases. This might be due to the pricing to market behavior of the monopolistic firms, which attempt to set lower price in the countries where they export in order to have higher competitiveness power relative to the local firms.

Our analysis gives a clear indication towards the fact that the degree of exchange rate pass-through into domestic prices is of country specific, given that it is different across countries. However revealing country specific characteristics are not made in this paper and it is left for future research.

References

An, L. 2006. Exchange rate pass-through : Evidence based on vector autoregression with sign restrictions. Munich Personal RePEc. Archive.

Campa, J.M & Goldberg, L.S. 2001. Exchange rate pass-through into import prices: a macro or micro phenomenon? NBER Working Paper. No.8934.

Campa, J.M & Gonzalez, M. 2002. Preferences in exchange rate pass-through in Euro area. Universidad de Navarra. Working Paper.

Campa, J. M. and Goldberg, L. 2005. Exchange Rate Pass-Through into Import Prices. Review of Economics and Statistics 87:4, forthcoming.

Carstensen, K. 2006. Applied Econometrics II. ASP Program. Kiel Institute for the World Economy. Unpublished lecture notes.

Choudhri.E.U & Hakura, D.S. 2006. Exchange rate pass-through to domestic prices: Does the inflationary environment matter? Journal of International Money and Finance 25: 614-639.

de Bandt, O., Banerjee, A., Kozluk. T. 2007. Measuring Long Run Exchange Rate Pass-Through. Working paper 173. Banque de France.

Devereux, M.B & Lane,P.R. 2001. Exchange rate and monetary policy in emerging market economics. CEPR.

Edwards, S. 2006. The relationship between exchange rates and inflation targeting revisited. NBER working paper series no. 12163.

Hahn,E. 2003. Pass-through of external shocks to Euro area inflation. ECB working paper no. 243.

Ito, T., Sasaki, Y.N & Sato, K. 2005. Pass-through of exchange rate changes and macroeconomic shocks to domestic inflation in East Asian countries. RIETI Discussion paper series 05-E-020.

Ito, T. and Sato, K. 2006. Exchange rate changes and inflation in post-crisis Asian economies: VAR analysis of the exchange rate pass-through. NBER Working Paper. No.12395.

Kamps, A. 2006. The Euro as invoicing currency in international trade. ECB Working Paper. No.665.

McCarthy, J. 2006. Pass-through of exchange rates and import prices to domestic inflation in some industrialized economies. Federal Reserve Bank of New York.

Mihailov, A. 2005. Exchange Rate Pass-Through on Prices in Macrodata: A Comparative Sensitivity Analysis. Working Paper. Essex DP 568. University of Essex.

Mishkin, F. 2004. Can inflation targeting work in emerging market countries? In Festschrift in Honour of Guillermo Calvo. IMF.

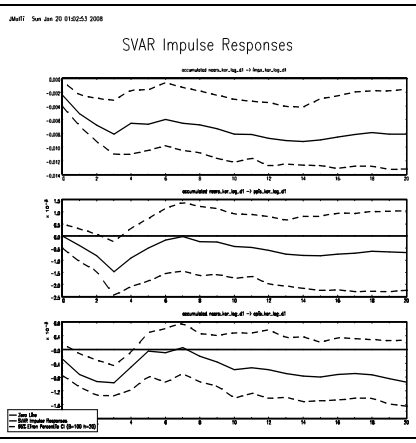
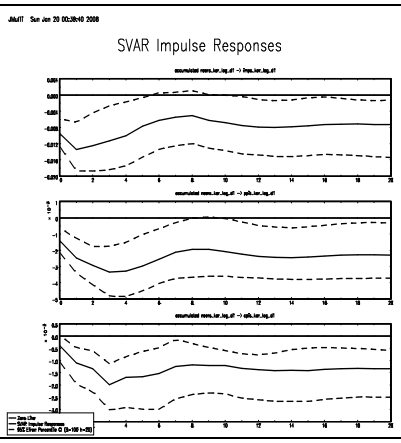
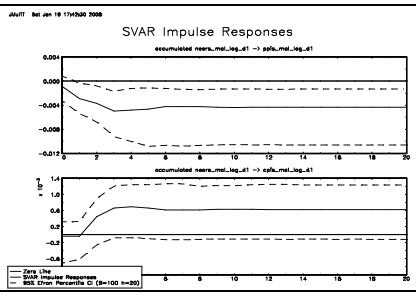
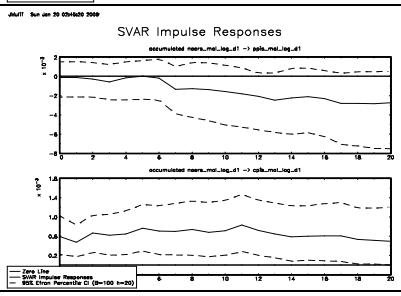
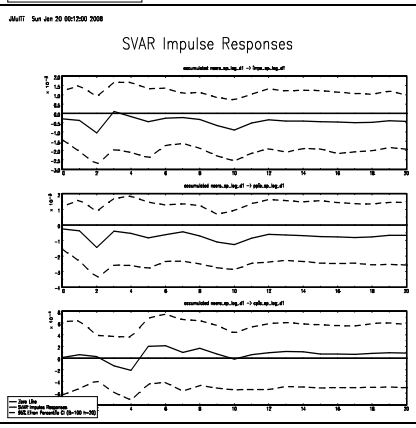
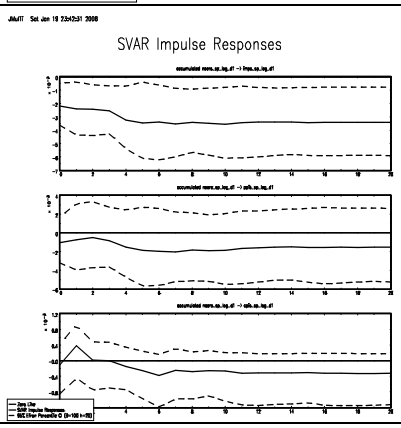
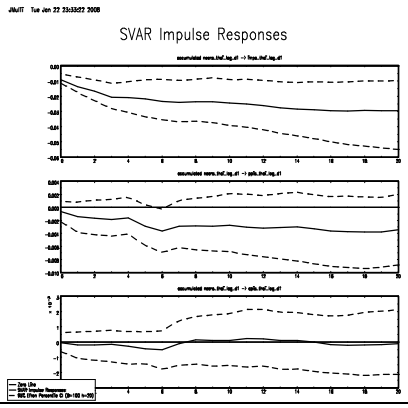
Mishkin, F.S & Savastano, M.A. 2001. Monetary policy strategies for Latin America. Journal of Development Economics. 66: 415-444.

Osawa,N. 2006. Monetary policy responses to the exchange rate: Empirical evidence from three East Asian inflation-targeting countries. Bank of Japan working paper series No. 06-E-14.

Sahminan. 2002. Exchange rate pass-through into import prices: empirical evidences from some Southeast Asian countries. The University of North Carolina at Chapel Hill. Working paper.

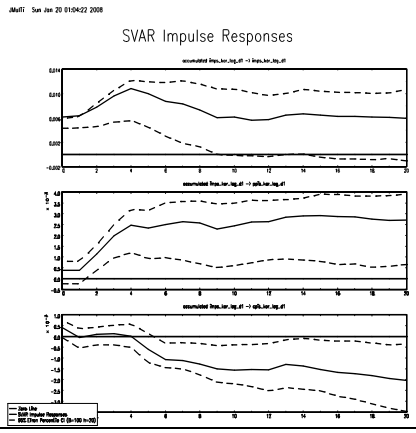
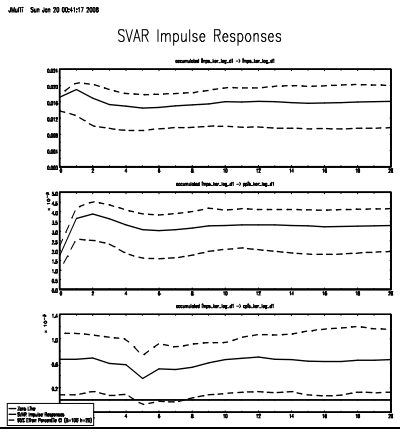
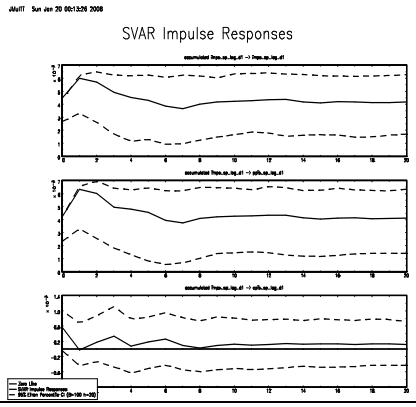
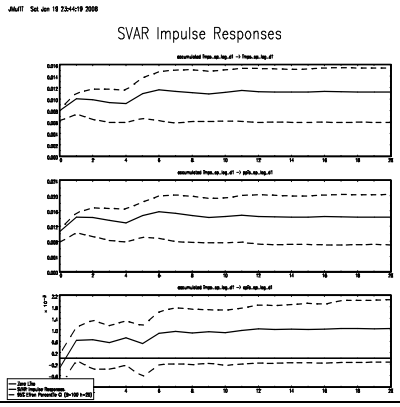
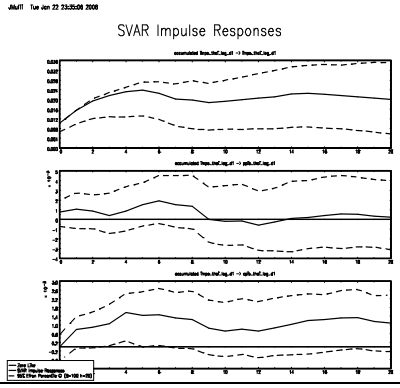
Appendix

Figure 1: IRF (Model I): NEER shocks on domestic prices

Countries	Period I	Period II
Korea		
Malaysia		
Singapore		
Thailand		

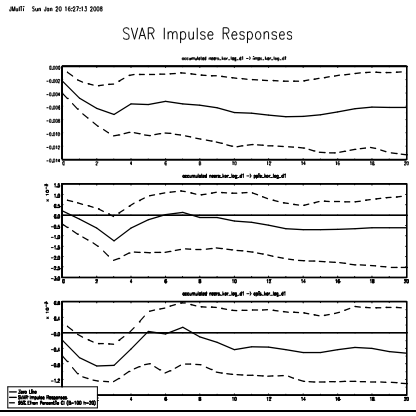
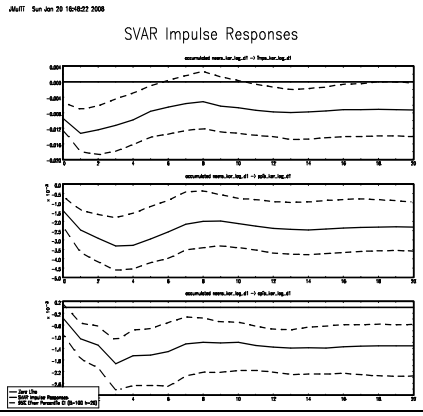
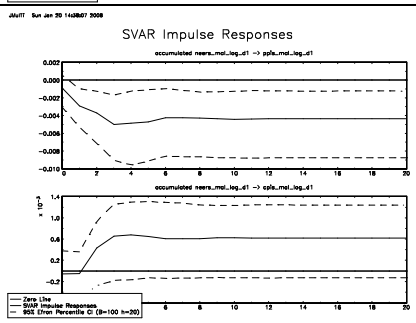
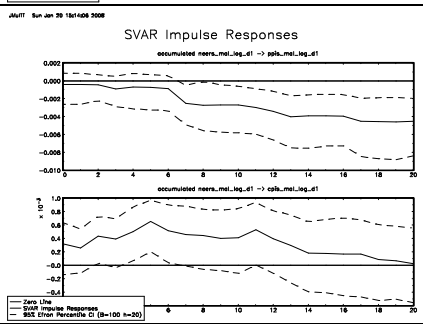
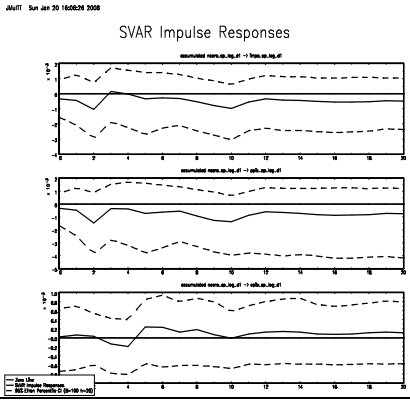
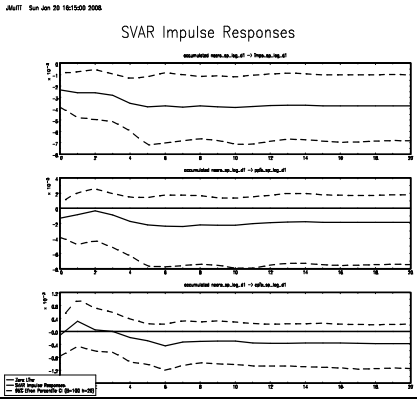
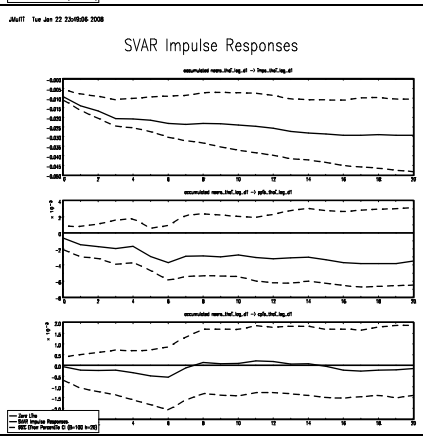
Notes:
Period I is the period before crisis (before 1997M7)
Period II is the period after the crisis (1999M1 onwards)
The figures show the response of domestic prices (IMP, PPI CPI) to the exchange rate shock (1% appreciation)

Figure 2: IRF (Model I): IMP shocks on domestic prices

Countries	Period I	Period II
Korea		
Singapore		
Thailand		

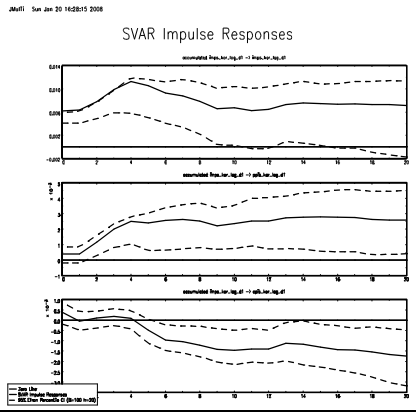
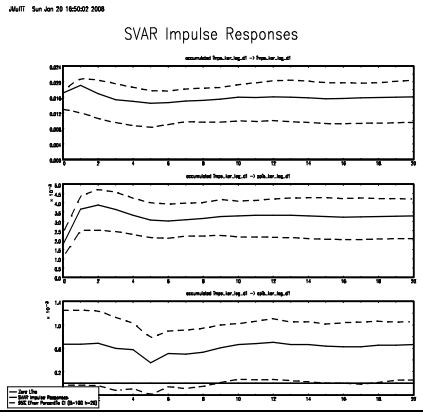
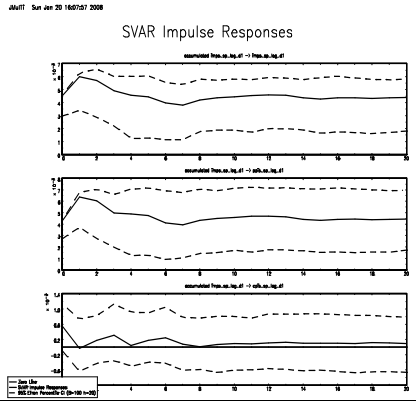
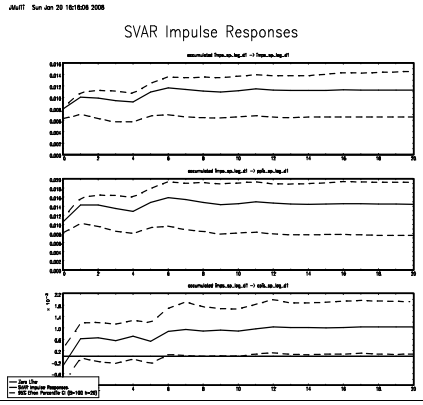
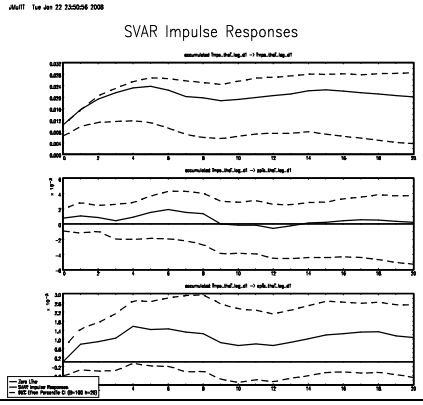
Notes:
Period I is the period before crisis (before 1997M7)
Period II is the period after the crisis (1999M1 onwards)
The figures show the response of domestic prices (IMP, PPI CPI) to a one percentage of import price shock

Figure 3: IRF (Model II): NEER shocks on domestic prices

Countries	Period I	Period II
Korea		
Malaysia		
Singapore		
Thailand		

Notes:
Period I is the period before crisis (before 1997M7)
Period II is the period after the crisis (1999M1 onwards)
The figures show the response of domestic prices (IMP, PPI CPI) to the exchange rate shock (1% appreciation)

Figure 4: IRF: (Model II): IMP shocks on domestic prices

Countries	Period I	Period II
Korea		
Singapore		
Thailand		

Notes:
Period I is the period before crisis (before 1997M7)
Period II is the period after the crisis (1999M1 onwards)
The figures show the response of domestic prices (IMP, PPI CPI) to a one percentage of import price shock