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The Impact of Real Exchange Rate on Output and Inflation in Vietnam: A VAR approach

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Abstract

This paper examines the impact of the real depreciation on economic performance in Vietnam using VAR approach. The study shows that although the main sources of variance in output and price level are “own shocks”, innovations in the real exchange rate account for a higher proportion in the variation of output than that of price level. A real devaluation has positive impact on both output and inflation. The devaluation shock may affect inflation and output growth via raising money supply and improving trade balance. However, the real exchange rate changes do not have significant effect on output in the long run.

Keywords: VAR model, Impulse response functions, Variance decompositions, Real exchange rate, Output, Inflation, Vietnam.

JEL classification: C32, F30.

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1. Introduction

Although Vietnam's *Doi moi* (renovation) was initiated in 1986, it was only in 1989 that Vietnam embarked on a comprehensive reform process towards a market economy. The aims were to stabilize the economy, stimulate exports and investments, and enhance economic growth. Many measures have been taken, especially in removing administrative controls and introducing greater autonomy and competition into production and business. The reforms have shown successes and Vietnam has been so far considered as one of the most active economy in the region.

Exchange rate regime of the country has also been under critical reform. In 1989, the official exchange rate was considerably devaluated and there was a unification of official and market exchange rates. Since then, many measures have been implemented to make the exchange rate regime more market-based. The exchange rate has been considered by the government as an important macroeconomic instrument for ensuring low inflation rate and a stable financial system, promoting exports, controlling imports, and enhancing economic growth. To assess the soundness of the reform policies in the exchange rate regime, it is worthy to analyses the impact of the changes in exchange rate on macroeconomic indicators.

So far, a few studies have been conducted in specifying the impact of exchange rate on economic activities in Vietnam. The majority of them have merely described the exchange regime with some verbal comments. Among existing empirical studies, some have limited their research to the possible impact of devaluation on the trade balance by simply checking the Marshall-Lerner condition (Le and Tran, 1995; Pham and Nguyen, 1999). Vo *et al.* (2000) employs a simply single equation to examine impact of real devaluation on output and shows that devaluation of real exchange rate increases output in both the short and long run. Nguyen and Kalirajan (2006), using monthly data from 1991 to 1999 and vector autoregression approach, investigate the impact of nominal effective exchange rate on inflation in Vietnam and find that the impact of nominal devaluation on inflation is positive but insignificant.

To the best of our knowledge, there are no published studies on the impact of the real exchange rate changes on both output and inflation in Vietnam and other transition economies. Moreover, the relationships between the real exchange rate and output and inflation are recently important and controversial topics for developing countries. Majority of the econometric analyses for developing countries indicate that devaluation was associated with a reduction in output and an increase in inflation (Kamin and Roger, 2000, for Mexico; Odusola and Akinlo, 2001, for Nigeria; Berument and Pasaogullari, 2003, for Turkey). However, Klau (1998) investigating this issue for twenty-two Sub-Saharan countries and find that the real devaluation increases both output and inflation. For an economy in the transition like Vietnam, understanding the characteristics of the above mentioned relationship will be helpful not only in assessing the soundness of economic policies but also in setting up these policies in the years to come.

The purpose of this paper is, therefore, to examine the impact of changes in real exchange rate on output growth and inflation in Vietnam. We base our findings on the theoretical framework of the core model suggested by Kamin and Rogers (2000). The vector autoregression (VAR) model is applied to estimate impulse response functions and variance decompositions for output and price level in order to determine how output and price respond to a shock to the real devaluation, and what proportion of output and price level variance can be explained by the real exchange rate. The impact of real exchange rate on output and inflation are also investigated through testing Granger causality.

The rest of the paper is organized as follows. In next section we look at the historical of exchange rate arrangement in Vietnam. Section 3 considers the theoretical explanations about relationships between the real exchange rate and output as well as the real exchange rate and inflation. Section 4 reviews some previous empirical studies. Section 5 provides empirical methodology and data. Section 6 analyses the empirical results. The final section is the conclusion of the study.

2. Exchange rate arrangement in Vietnam

Before 1989, Vietnam adopted a multiple exchange rate policy with three-tier exchange rate system: trading, non-trading and internal exchange rates. The trading exchange rate was applied to trading payments. Exchange rate for non-trading used for the inward remittances and all the other invisible transactions such as tourisms, educations, heaths, and sports among socialist countries. The internal exchange rate was applied to business relations between domestic banks and other domestic business entities using foreign exchange and was also used for state budgeting in regard to foreign aid coming from the former Council of Mutual Economic Assistant (CMEA) and the former Soviet Union. The internal exchange rate was set up since 1958 and fixed until 1986. It was removed in March 1989. For almost the entire period, the country applied a fixed exchange rate regime under which the exchange rate was predetermined by the state. The exchange rates in the black markets were always substantially higher than the official exchange rate. In 1981 the market rate of VND against USD was four times higher than the official rate and it increased to 11 times in 1985 (Le, 2005). The large difference in the official and parallel exchange rate showed that the official exchange rate was set up at levels that significantly overvalued the VND. Although trade deficit was very high, the ratio of Vietnam's imports to exports with Soviet Union was around 4:1 in the first half of the 1980s and around 3:1 in 1986-1988 (Fforde, 1996), the issue of trade deficit did not pose any pressure for changes in exchange rate management because in most of the cases it was financed by long-term soft loans and used as project assistance of CMEA, especially the Soviet Union

The exchange rate regime was pushed to change when the country started trading with countries other than the socialist countries, especially after the Soviet Union and former socialist nations collapsed. Since the official exchange rates were always much lower than parallel exchange rate, business entities and households who held the foreign currencies attempted to avoid selling it to the state bank. This not

only caused problems for the government budget but also promoted illegal activities in the black market. The government had to issue money to address budget deficits which, in turn, caused hyperinflation.

In March 1989, the two official exchange rates were unified into a single rate and adjusted to VND 4500/USD, approaching the level in the parallel market (Vo *et al.*, 2000). Since then, the exchange rate determination has become more market-oriented. The official exchange rate was adjustable in principle based on inflation rate, interest rate, balance of payment situation and the exchange rate in the free market. Commercial banks were allowed to set exchange rates for their own transactions within a band of 5% more or less than the official exchange rate. During 1990-1993, although it was announced that the official exchange rate was set based on market supply and demand, in reality the official exchange rate was often set at levels that were below those prevailing in the free markets. In 1991, the government established two official foreign exchange transaction floors in Ho Chi Minh City and Hanoi. Based on the auctioned rates at these two floors, the Stated Bank of Vietnam (SBV) set up the official exchange rate. The introduction of this arrangement seemed to make the exchange rate more market-based. Nevertheless, in effect, it was still controlled by SBV who could buy and sell large amount of foreign exchange to set the predetermined exchange rate level. Anyhow, it was a remarkable and noteworthy step towards market-based mechanism. In 1994, an inter-bank foreign exchange market was established in replacing the two transaction floors. In the new system, the SBV also remained influential as the “last seller and buyer” of foreign exchange and continued setting the official exchange rate. During 1993-1996, both the official and parallel rate of VND against USD remained relatively stable. They fluctuated around the level of 11000VND/USD. The official exchange rate followed the rate of free market but was still at levels that overvalued the VND (Vo *et al.*, 2000). Maintaining a stable exchange rate for a long time played an important role on controlling inflation, attracting foreign direct investment, and encouraging domestic currency deposits. Inflation rates remained at relatively low level. Nevertheless, the exchange rate arrangement reduced the incentive to export and therefore increased trade deficit to about 16% of GDP in 1996. The pressure of current account deficits as a result of the

drop in capital inflows during the Asian financial crisis in 1997 led to the VND devaluated twice, resulting in a total VND devaluation of 16.3% in 1998 (Vo *et al.*, 2000). Furthermore, in order to increase the possibility of exchange rate fluctuation, the exchange rate band was increased. Even though the exchange rate was said to be set based on the rates in the inter-bank market, the official exchange rate announced by the SBV was still depressed and did not fully reflect the demand and supply of foreign exchange in the economy. The commercial bank's exchange rates, which were always set at the upper bound allowed by the SBV, demonstrated upward trend of the exchange rate in the free markets. It is a phenomenon that the SBV strove to change. In this period, the economic growth rate sharply decreased from 9% in 1996 to 4.8% in 1999. Inflation rate increased from 4.5% in 1996 to 9.2% in 1999.

On 25th February 1999, the government introduced a new principle for setting the exchange rate. An average inter-bank rate of exchange between VND and USD would be official exchange rate in the following day. However, the exchange rate band within which the credit and financial institutions could trade was narrowed to 0.1% and extended to 0.25% for spot transactions since 2002. Thus, the exchange rate system was reclassified as a crawling peg. This new arrangement has been viewed as a turning point in the exchange rate policy in Vietnam, moving country closer to a flexible exchange rate regime. Under the new arrangement, both official and parallel exchange rates remained stable and the differences between them were narrowed. In recent years, economic growth rates are high, 7% per annum on average. Inflation maintained at a relatively low level (except for 2004 and 2005 due to some external elements such as bird flu, increasing international rice demand and record-high oil prices). Total trade volume exceeded USD 50 billion a year and trade deficit accounts for 10% of the GDP. In December 2005, the Decree Law on foreign exchange management was issued with the aim of boosting the economic growth, improving the balance of payment, achieving a phased approach to the convertibility of VND in foreign transactions and perfecting the foreign exchange management system of Vietnam. It comes into effect in June 2006.

However, the policy on foreign currency control still has a number of shortcomings which adversely affect investors in export-oriented ventures and give rise to partial excesses or shortages in foreign currency, and tensions in foreign currency supply and demand. Vietnam officially maintains a managed floating exchange rate regime; however, the exchange rate has de facto been pegged to the US dollar in recent years. The rate of VND against US depreciated by less than 1 per cent in 2004 and 2005 and appreciated by 0.3 per cent in the first half of 2006. However, a widening of the inflation differential, the real effective exchange rate has appreciated. The import coverage of reserves has remained low, at around 8.5 weeks of imports and heavy foreign currency borrowing from domestic banks has increased the economy's exposure to exchange rate risks (IMF, 2006).

All those mentioned above have sketched out the movements in the exchange rate and the evolution of exchange rate policy in Vietnam during its economic reform process. This overview helps understand the role of exchange rate policy in the country's macroeconomic system in this critical period. All these facts guide us in explaining the results of our estimation and analysis in the next sections.

3. Theoretical explanations for linkages of output – real exchange rate and inflation - real exchange rate

3.1 Real exchange rate determination – output and price level

The real exchange rate can be analytically defined in many different ways. In this paper, the real exchange rate is defined as the nominal exchange rate by the rate of the foreign to the domestic price level. It is expressed by the following equation.

$$RER = E \frac{P^*}{P}$$

where RER is real exchange rate, E is the nominal exchange rate, P^* is the foreign price, and P is the domestic price. In this equation, the increase in E (RER) implies a depreciation of the domestic

currency.

The change in domestic prices directly affects the real exchange rate in a negative direction. If nominal exchange rate was fixed, an increase in domestic price (inflation) results in an appreciation of domestic currency.

According to the monetary approach, an increase in domestic economic activity will give rise to an increase in the demand for domestic money, and this increase in the demand for money then leads to an appreciation of the domestic currency. The monetary approach asserts that changes in the supply of and demand for money are the primary determinants of exchange rate movement. The monetary model of exchange rate determination can be derived from a basic model of the demand for money. If purchasing power parity (PPP) holds at all the times, the equilibrium exchange rate can be shown to be completely determined by trends in relative money supply growth, relative GDP growth, and relative interest rate differentials. In contrast, in the Mundell-Fleming and balance of payment flow models, an increase in domestic economic activity will give rise to an increase in import demand, which should cause the trade balance to deteriorate. The deterioration of the trade balance should then exert downward pressure on the domestic currency (Rosenberg, 2003).

3.2 Impact of exchange rate on inflation

Exchange rate movements can influence domestic prices via their effect on aggregate supply and demand.

On the supply side, exchange rates could affect prices paid by the domestic buyers of imported goods directly. In an open small economy (an international price taker), when the currency depreciates it will result in higher import prices and vice versa. Exchange rate fluctuations could have an indirect supply effect on domestic prices. The potentially higher cost of imported inputs associated with an exchange rate depreciation increases marginal cost and leads to higher prices of domestically produced goods (Hyder and Shah, 2004). Further import-competing firms might increase prices in response to an

increase in foreign competitor price in order to improve profit margins. The extent of such price adjustment depends on a variety of factors such as market structure, nature of government exchange rate policy, or product substitutability.

Exchange rate variations can also affect aggregate demand. To a certain extent, exchange rate depreciations (appreciations) increase (decrease) foreign demand for domestic goods and services, causing increase (decrease) in net exports and hence aggregate demand (Hyder and Shah, 2004). This may increase real output. Furthermore, the expansion in domestic demand and gross national product may bid up input prices and accelerate wage demands by workers seeking higher wages to maintain real wages. The nominal wage rise may result in further price increases.

3.3 Impact of exchange rate on output

Traditional views such as the elasticities, absorption, and the Keynesian approach assert that devaluations have positive effect on output. The elasticities approach states that devaluation will improve trade balance as long as the Marshall Lerner condition is satisfied. According to the absorption approach, through its expenditure switching and expenditure reducing effects, a devaluation will generate an increase in real output. The Keynesian approach, in which output is assumed to be demand determined and the economy operates below its potential – full-employment condition - states that a devaluation will have a positive impact on output and employment. The monetary approach, however, argues that exchange rate changes influence real magnitudes mainly through the real balance effect in the short-run but leave all variables unchanged in the long run (Domac, 1997).

In contrast, there are some various channels that explain the contractionary effect of devaluations such as nominal rigidities in the economy, balance-sheet effects, capital account problems, weakening confidence, and associated economic policies (Krugman and Taylor, 1978; Domac, 1997; Kamin and Rogers, 2000; Berument and Pasaogullari, 2003).

4. Literature reviews

There are many empirical studies investigating the effect of changes in the real exchange rate on output and as well as that on inflation. However, the results are varied as different analysis techniques and data samples are adopted.

As for the effort of studying the impact of the real exchange rate on output, some studies find that devaluations have a negative impact on output (Sheehey, 1986, for sixteen Latin American countries; Rogers and Wang, 1995, for Mexico; Terence and Pentecost, 2001, for Slovakia), some support the idea that devaluations may have a negative or positive impact on output in the short-run but neutral in the long-run (Edwards, 1986, for 12 developing countries, Kamin and Klau, 1998, for twenty-seven countries; Terence and Pentecost, 2001, for Czech Republic and Hungary). The others show that devaluations increase output both in the short and long run (Vo *et al.*, 2000, for Vietnam; Terence and Pentecost, 2001, for Poland).

Related to the relationship between the real exchange rate and inflation, it is explicitly concluded in some studies that exchange rate devaluation is a major factor for the upsurge of inflation (Kamin, 1996, for Mexico; Dornbusch *et al.*, 1990, for Argentina, Brazil, Peru, and Mexico). However, the others do not find significant impact of devaluation on inflation (Dornbusch *et al.*, 1990, for Bolivia; Kamas, 1995, for Colombia).

There are very few studies which examined *the impact of change of real exchange rate on both output and inflation*. Klau (1998) investigating this issue for twenty-two Sub-Saharan countries for 1980-1996 period find that the real devaluation increases both output and inflation. The devaluations have a positive impact economics activity both in the short and long run. Kamin and Rogers (2000) examine Mexican quarterly data by using several VAR models with four main variables (the real exchange rate, output, price index, US interest rate) for 1981-1995 period and show that although the variation of output is explained mostly by its own innovations, a depreciation shock leads to a sustained

reduction in output and an increase in inflation in Mexico. Odusola and Akinlo (2001) use a six-variable VAR (official exchange rate, parallel exchange rate, prices, income, money supply, and interest rate) for Nigeria and reveal the existence of mixed results regarding the impact of the exchange rate depreciation on output: the contractionary impact of the depreciation on the output can only be represented in the first quarter. Thereafter, the depreciation generates expansionary impact on the output. Their analysis also shows that positive shocks of official exchange rate are followed by significant increases in prices. These results tend to suggest that the adoption of a flexible exchange rate system does not necessarily lead to output expansion, particularly in short term. Berument and Pasaogullari (2003) estimate several VAR models for Turkey and find that real exchange rate movements are an important factor in the variability of output and inflation. The response of output is negative and permanent after a real devaluation. The devaluation is inflationary. These findings also hold in the alternative setting in which the possible effect of external variables is controlled.

5. Empirical methodology and data

Following the approach employed in some above-mentioned studies, in this paper we use a VAR model to examine the interrelationship between real exchange rate and output and that between real exchange rate and price level in Vietnam's economy. We base our findings on the theoretical framework of the core model suggested by Kamin and Rogers (2000). The core model can be expressed as follows:

$$x_t = \sum_{i=1}^k A_i x_{t-i} + \sum_{i=1}^k B_i z_{t-i} + \Psi D_t + \varepsilon_t \quad (1)$$

where x_t is a vector of 3 endogenous variables: *LIO* (log of real industrial output), *LCPI* (log of consumer price index), and *LRER* (log of real exchange rate); z_t is a vector of exogenous variable, *USINT* (nominal United States interest rate); D_t is a vector of deterministic components; A_i and B_i are matrices of coefficients; ε_t is a white noise error term.

Macroeconomic time series are often characterized by a high degree of persistence. Frequently, the

persistence is well described by a so-called unit root process, e.g. a random walk. In such cases, at least some shocks have a permanent effect on x_t , i.e. x_t is non-stationary, and standard asymptotic results may not be applicable. Therefore, we first determine the order of integration or the stationarity of each series by applying Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests. If the series do not have the same order of integration, we must establish transformation. If the order of integration of the series is the same, it is possible that these series are cointegration. This is assessed by using Johansen's cointegration test. In this case, the VAR model may be rewritten as a so-called vector error correction (VEC) model. The number of cointegrating vectors (r) is determined by using the λ_{trace} or λ_{max} test statistic (Johansen and Juselius, 1990). A VEC model should be used for analyzing the relationship among variables in both the long run and short run if there is the cointegrating vector. However, there is much controversy over which approach is the best. Cochrane (1997, updated 2005) commented that when it is unknown whether there is cointegration or what the vector is, the autoregressive in level approach is probably better than the approach of a battery of tests for cointegration plus estimates of cointegrating relations followed by a companion or error correction VAR. This comment will be considered in this paper.

The lag length will be selected on the basis of adjusted Likelihood ratio (LR) test for small sample, the Akaike information criterion (AIC) and/or Schwarz information criterion (SC). All the criteria are discussed in Lutkepohl (1991). However, as these statistical criteria can sometimes give misleading results, sensible judgement based on the nature of the data remains important.

The paper employs forecast error variance decompositions and impulse response functions which permit the partitioning of the variance of the forecast error of each the dependent variable. In the short run the links between the real exchange rate and output, the real exchange rate and inflation can be studied more clearly through testing Granger causality. First, the paper tests bivariate relationships in a VAR setting with optimal lags determined by using adjusted LR criterion for small sample and computes

chi sq - statistics (Wald test) to perform the causality test in Granger's sense. After that, Granger causality test will be applied to multivariate analysis. Cointegration tests are performed to determine the way of Granger causality test: if there is no cointegration, first difference is used; if the variables are cointegrated, Lag Augmented-VAR approach (Toda and Yamamoto, 1995) will be employed; and if it is full rank, a VAR model in levels will be applied for testing Granger causality.

As mentioned above, the core model in this paper uses three potentially endogenous variables *LIO*, *LCPI* and *LRER* and one exogenous variable *USINT*. All the variables are seasonally adjusted (except *USINT* and *LRER*) and are taken logs (except *USINT*), therefore, their first differences represent growth rate. The real industrial output is a proxy for GDP (Terence and Pentecost, 2001; Kamin, 1996). The real exchange rate is the bilateral rate of VND against the US dollar, measured as the nominal exchange rate adjusted to the domestic and US consumer price indices. An increase in the real exchange rate implies the depreciation of the domestic currency. The nominal US interest rate, the proxy for the foreign interest rate, is the rate of return of three-month US Treasury Bill. In order to explore the channels through which the real exchange rate affects output and inflation and to determine the robustness of the core model, two variables, *LMS* (money supply- M1) and *LTB* (trade balance deficit), will be added into the core model to create two alternative models. The alternative models are only used for analyzing the impulse response functions and variance decompositions. In the core model, the sample comprises 160 observations in total, covering monthly data from January 1992 to April 2005 (the sample of the alternative model added money supply covers from 1995 January to 2005 April and that of the other covers from 1998 January to 2005 April). The data of the real industrial output are obtained from Vietnam General Office Statistics and that of CPI and money supply are derived from the data base of State Bank of Vietnam. The trade balance data is available in Intellasia News and Information Services website (http://www.intellasia.com/pdf_stats/main.htm). All other data are collected from International Financial Statistics of International Monetary Fund.

6. Results

6.1 Univariate analysis

Both ADF and PP tests will be employed in all series in their levels and first differences. Serial correlation test is performed by using Lagrange Multiplier (LM) statistics to check the robustness of ADF tests. Lag length are determined by using Akaike Information Criteria (AIC).

Table 1. Unit root test using ADF and PP tests

Variables	ADF test			PP test		
	Level	LM test	1 st difference	LM test	Level	1 st difference
LIO	1.07 [0.99]	0.78 [0.46]	-7.35 [0.00]	0.51 [0.60]	-0.70 [0.84]	-27.26 [0.00]
LCPI	-1.94 [0.31]	1.55 [0.22]	-3.41 [0.01]	0.04 [0.96]	-1.96 [0.30]	-8.19 [0.00]
LRER	-1.20 [0.67]	0.83 [0.44]	-5.66 [0.00]	0.74 [0.48]	-2.04 [0.27]	-37.96 [0.00]
LTB	-1.18 [0.68]	0.48 [0.62]	-7.54 [0.00]	0.92 [0.40]	-2.00 [0.28]	-12.74 [0.00]
LMS	-0.38 [0.91]	1.26 [0.29]	-6.41 [0.00]	1.39 [0.25]	-0.37 [0.91]	-15.53 [0.00]
USINT	-1.72 [0.42]	0.01 [0.99]	-4.01 [0.00]	0.07 [0.93]	-1.29 [0.63]	-8.49 [0.00]

Note: P-values are reported next to test statistics, in parentheses

Table 1 summarized the results of unit root test in both level and first difference. It is obvious that, at 5% level of significance, we cannot reject the null hypothesis of a unit root in all cases of level. However, in the case of first difference, the null hypothesis of unit roots is overwhelmingly rejected. Therefore, it is possible to conclude that all the six series follow a unit root process and are integrated of order one or I(1). Since all series are integrated of the same order, the series will be tested for the existence of long-term relationship among them, i.e. cointegration.

6.2 Bivariate data analysis

Before the multivariate analysis of data for Vietnam being carried out, bivariate correlations between the real exchange rate and output as well as the real exchange rate and inflation are evaluated first. To analyze these relationships, we first perform cross correlation between them. Then, the Granger causality test statistics will be applied in order to determine the direction of causality. The bivariate relationship

between the real exchange rate and output (or the real exchange rate and price level) might logically be affected by the exchange rate regime. Therefore, it is more reasonable to test the model in separate periods according to the change in the exchange rate regime in Vietnam in 1999. We divide our sample into two sub-samples: sub-sample 1 from January 1992 to August 1999 and sub-sample 2 from September 1999 to April 2005.

Table 2. Cross correlation between output (price level) and real exchange rate

period	Full sample		Sub-sample 1		Sub-sample 2	
	log form	1st difference of log form	log form	1st difference of log form	log form	1st difference of log form
Output and the real exchange rate						
-12	0.40	-0.05	-0.68	-0.16	0.63	-0.07
-9	0.44	-0.05	-0.69	-0.09	0.65	-0.06
-6	0.47	-0.01	-0.68	-0.05	0.65	0.00
-3	0.49	0.01	-0.65	0.09	0.64	0.00
0	0.51	0.23	-0.64	-0.06	0.63	0.43
3	0.55	-0.01	-0.49	-0.05	0.45	-0.01
6	0.58	0.02	-0.37	0.09	0.30	-0.02
9	0.61	-0.03	-0.25	0.06	0.16	-0.08
12	0.62	-0.18	-0.15	-0.06	0.05	-0.28
Price level and the real exchange rate						
-12	0.10	0.01	-0.67	0.13	0.64	0.02
-9	0.13	-0.21	-0.70	-0.14	0.57	-0.21
-6	0.15	-0.07	-0.73	0.02	0.47	-0.11
-3	0.17	-0.21	-0.73	-0.16	0.34	-0.21
0	0.18	-0.52	-0.76	-0.54	0.20	-0.40
3	0.26	-0.16	-0.61	-0.08	0.07	-0.22
6	0.33	-0.23	-0.48	-0.21	-0.03	-0.21
9	0.39	-0.28	-0.36	-0.32	-0.11	-0.13
12	0.45	0.01	-0.24	0.04	-0.17	-0.03

Note: The lag number indicates the number of months by which the real exchange rate is lagged relative to output and price level.. Negative values in Period column indicate that the real exchange rate is lagged relative to output and price level, and positive values indicate that output and price level is lagged relative to the real exchange rate.

Table 2 analyses the correlation between various transformations of the real exchange rate and output as well as that of real exchange rate and price level at various leads and lags. The cross correlations give us the first sight of the relationships between the real exchange rate and output, the real exchange rate and price level. The results suggest that the relationships in level are much clearer and more significant than those in the case of first difference. Then, we use the relationships in level to

analyze cross correlations.

It is obvious that there is a positive correlation between the real exchange rate and output and that between the real exchange rate and price level in the full sample and in the second sub-sample. However, these relationships are negative in the first sub-sample. The change in the characteristic of the relationships from sub-sample 1 to sub-sample 2 can be attributed to the effect of the transition of the exchange rate regime to a more flexible one, which dues to the introduction of the new exchange rate policy in 1999. In full sample, the direction of the causality seems to run from output and price level to the real exchange rate as the magnitudes of the cross correlations are greater in lead periods than in lag periods. Conversely, in the sub-samples, the direction of causality is opposite: correlations appear to be stronger running from lagged the real exchange rate to output and price level. Therefore, the assumption that the bivariate relationships between the real exchange rate and output (or price level) would be affected by the exchange rate regime is logical. The analyses of the relationships in separate sub-samples show that exchange rate policy did affect the performance of economy in both sub-samples.

Table 3. Granger causality test - Bivariate analysis

Null Hypothesis	Optimal lag	Rank	Method	Chi-sq	df	P-value	Conclusion
All sample : 1992:1 – 2005:4							
Output does not GC to Real exchange rate	13	0	VAR in first	31.12	12	0.00	Output → Real exchange rate
Real exchange rate does not GC to Output			difference	4.99	12	0.96	
Price does not GC to Real exchange rate	13	1	LA-VAR	35.66	13	0.00	Price → Real exchange rate
Real exchange rate does not GC to Price				5.67	13	0.95	
Sub-sample 1: 1992:1 – 1999:8							
Output does not GC to Real exchange rate	14	0	VAR in first	21.16	13	0.07	Output → Real exchange rate
Real exchange rate does not GC to LIO			difference	11.78	13	0.55	
Price does not GC to Real exchange rate	11	2(full rank)	VAR in level	24.47	11	0.01	Price ↔ Real exchange rate
Real exchange rate does not GC to Price				17.96	11	0.08	
Sub-sample 2: 1999:9 – 2005:4							
Output does not GC to Real exchange rate	14	1	LA-VAR	29.19	14	0.00	Output ↔ Real exchange rate
Real exchange rate does not GC to Output				46.34	14	0.00	
Price does not GC to Real exchange rate	12	1	LA-VAR	45.85	12	0.00	Price → Real exchange rate
Real exchange rate does not GC to Price				2.84	12	0.99	

Note: Determination of optimal lags and ranks are showed in Appendix A

The results of bivariate Granger causality tests are presented in Table 3. Applied over the full sample, the tests indicate that the lagged real exchange rates do not help explain movements in both output and

price level. However, the lagged real exchange rates do help to explain movements in price level in the first sub-sample and in output in the second sub-sample. And the lags of output and price level do help explain the real exchange rate in both the full sample and sub-samples cases.

The dissimilarity between the result of Granger causality test derived from using the full sample with that derived from using the sub-samples can be explained by the fact that the fourteen-year sample period is a long period associated with considerable changes in the economic conditions in Vietnam, especially the major changes concerning monetary policy and related policy tools. For example, before 1999, the objective of fiscal and monetary policies in Vietnam was primarily to achieve market stability. Hence, the exchange rate tool was used mainly in the disinflation strategy. However, since 1999 the government has focused on enhancing economic growth and therefore has relaxed the exchange rate regime in order to improve international competitiveness. The mentioned dissimilarity may be also explained by the fact that it is impossible to remove the possible effects of exogenous variables from the considered endogenous variables in the test. In other words, the other economic variables may have possible effects on both variables, and their effects may limit the usefulness of the Granger causality test.

6.3 Multivariate analyses

The analysis described above suggests that in the case of full sample, the causality runs from output and price level to the real exchange rate rather than from the latter to the former. However, the bivariate results did not exclude the possibility of spurious correlation, nor did they provide information regarding the channels by which the real exchange rate might affect output and inflation. In this section, by employing the VAR model used in Kamin and Rogers (2000) and utilizing the available data, we address these issues.

Determination lag length

To determine the set of variables to be included in the VAR, it is important to determine the appropriate

lag length. Table B1 (Appendix B) presents some statistical criteria for selecting lag length or the core model. The SC suggests order 2, AIC and LR selects order 13. In addition, this study use monthly data, then it is reasonable to take order 13 in the model.

Testing for the significance of the 1997 Asian financial crisis

After the Asian financial crisis in 1997, the official exchange rate was devaluated more than 16% in 1998. Economic growth rate decreased sharply from 9.3 % in 1996 to 4.8 % in 1999 and inflation rate increased in 9.2 % in 1998. The effect of the crisis can be tested by introducing the dummy variable ($D97$) covering the turmoil period from 1997 August to 1999 July. The model to be estimated is presented as follows.

$$x_t = \sum_{i=1}^k A_i x_{t-i} + \sum_{i=1}^k B_i z_{t-i} + \Psi D_t + \gamma D97 + \varepsilon_t \quad (2)$$

where γ is a 3×1 vector of coefficients

The null hypothesis to be tested is: $\gamma = 0$. The LR statistic for testing the deletion of financial crisis dummy: $LR = 2(L_{UR} - L_R) = 19.7$ while the critical value of chi-sq with 3 d.f. at 1% level of significance is 11.3. Hence, the null hypothesis is rejected at 1% significance level, suggesting that the Asian financial crisis has a significant impact on output, consumer price index, and the real exchange rate of Vietnam (testing for the alternative models is presented in Appendix C).

Cointegration test

The cointegration rank can be tested using $\lambda_{\max}$ and λ_{trace} . The results for the whole period are presented in Table 4. The results based on the λ_{trace} statistic reveal that at 5% significance level the null hypothesis $r \leq 0$ is rejected while the null hypothesis $r > 0$ is not rejected. Hence, at 5% level of significance, the tests based on the λ_{trace} suggest that there is one cointegration. The results based on the $\lambda_{\max}$ statistic also suggest same as those based on λ_{trace} . In short, statistical tests show that there

is one cointegrating relation among the three variables of interest in the system.

Table 4. Cointegration test for the real exchange rate, output and price level

λ_{trace}				λ_{max}			
<i>Null</i>	<i>Alter.</i>	Eigenvalue	Statistic	<i>Null</i>	<i>Alter.</i>	Eigenvalue	Statistic
$r \leq 0$	$r > 0$	0.18	36.65*	$r = 0$	$r = 1$	0.18	29.30*
$r \leq 1$	$r > 1$	0.04	7.35	$r = 1$	$r = 2$	0.04	5.29
$r \leq 2$	$r > 2$	0.01	2.06	$r = 2$	$r = 3$	0.01	2.06

*: reject null hypothesis at 5% significance level

We now estimate the long run equilibrium relationships. In order to obtain the vector cointegration for *LIO*, *LRER* and *LCPI*, the Johansen (1995) reduced rank maximum likelihood (ML), ordinal least square (OLS) and dynamic ordinal least square (DOLS) techniques are applied. Since there is one cointegrating vector linking the variables, an economic interpretation of the results can be obtained by normalizing the cointegrating vector in *LIO* or *LCPI*. The results are presented in Table 5.

Table 5. Cointegration vector

Technique	ML		OLS		DOLS	
Normalizing in Vector	IO	CPI	IO	CPI	IO	CPI
<i>LIO</i>	-1	0.40*	-1	0.02	-1	-0.04
<i>LCPI</i>	2.48*	-1	0.28	-1	0.40	-1
<i>LRER</i>	1.30*	-0.53*	0.20	-0.47*	0.50	-0.48*
<i>USINT</i>			-0.01	0.01*	-0.01	0.02*
<i>constant</i>	-12.70	5.12	1.52	6.15*	1.02	6.34*
<i>trend</i>			0.01*	0.004*	0.01*	0.01*
<i>D97</i>			-0.04*	0.05*	0.002	0.03*
Serial corr. test			0.14 [0.93]	269 [0.00]	1.22 [0.30]	134 [0.00]
Heter. test			0.98 [0.37]	95 [0.00]	1.8 [0.16]	82 [0.00]

Note: * is significant at the 1% level. P-values are reported in parentheses.

It shows that the equations obtained by normalizing in *LIO* are significant because the null hypotheses of no serial correlation and heteroskedasticity cannot be rejected at 5% level of significance. However, the estimators obtained by normalizing in *LCPI* seem biased because the null hypotheses of no serial correlation and heteroskedasticity are rejected at 5% significance level. Thus, we will use the

equation normalized in output to analyze the long run relationships.

The results also show that a real depreciation has a positive and significant impact on *LIO* in the long run when ML technique is applied but not when OLS and DOLS techniques are applied. The long run relationship seems ambiguous. It can be argued that there is not enough evidence to assert some conclusions about the long run relationship.

Granger causality test

Granger causality has been performed in above bivariate analyses. However, the bivariate results may omit some channels by which real exchange rate affects output and price level. Therefore, it is necessary to perform Granger causality test in multivariate analyses. These tests are also conducted using both the full sample and sub-samples. The summarized results of Granger causality test are showed in Table 6.

Table 6. Granger causality test – Multivariate analysis

Null hypothesis	<i>Full sample</i>			<i>Sub-sample 1</i>			<i>Sub-sample 2</i>		
	Chi-sq	df	Prob.	Chi-sq	df	Prob.	Chi-sq	df	Prob.
Output equation									
<i>Real exchange rate</i> does not GC to <i>Output</i>	8.72	13	0.794	10.89	10	0.366	30.11	14	0.007
<i>Price</i> does not GC to <i>Output</i>	5.14	13	0.972	20.74	10	0.023	21.74	14	0.084
<i>US interest rate</i> does not GC to <i>Output</i>	10.49	13	0.654	9.56	10	0.480	18.26	14	0.195
Price equation									
<i>Real exchange rate</i> does not GC to <i>Price</i>	16.06	13	0.246	19.46	10	0.035	17.64	14	0.224
<i>Output</i> does not GC to <i>Price</i>	19.02	13	0.122	38.93	10	0.000	30.04	14	0.008
<i>US interest rate</i> does not GC to <i>Price</i>	21.83	13	0.058	58.23	10	0.000	30.33	14	0.007
Real exchange rate equation									
<i>Output</i> does not GC to <i>Real exchange rate</i>	32.01	13	0.002	19.38	10	0.036	20.26	14	0.122
<i>Price</i> does not GC to <i>Real exchange rate</i>	26.82	13	0.013	27.06	10	0.003	26.01	14	0.026
<i>US interest rate</i> does not GC to <i>Real exchange rate</i>	13.52	13	0.409	36.51	10	0.000	28.30	14	0.013

Note: Determining optimal lags and ranks of sub-samples to choose the way of Granger causality test is presented in Appendix B.

Multivariate analysis also shows that the lags of output and price level help explain the real exchange rate in both cases of the full sample and of sub-samples. It is also found in the test that the US interest rate plays a significant role in explaining the movements of the real exchange rate and price level in Vietnam in the future.

Multivariate Granger causality test generally hints the same conclusion as bivariate analyses. The real exchange rates do not help explain changes in the future of both output and price level. However, the lagged real exchange rates do help explain the fluctuations of the price level before 1999 and changes in the real industrial output after 1999. Moreover, the dual Granger causality between the output and the price level expose clearly in the case of sub-samples, but not in the case of full sample. This implies that there have been actual changes in the characteristics of the economic activities, monetary policies and related instruments over the whole period. The analyses using sub-samples, therefore, may be more meaningful than that using the full sample. However, if the size of the sub-samples is too small, it may cause spurious results. This suggests that the full sample should be used in variance decompositions and impulse response functions analyses.

Variance decompositions and impulse response functions analyses will be established by VAR models in level because of the following three reasons. *First*, when the variables are cointegrated (cointegration test is also performed in the alternative models, see Appendix C), using a VAR model in level is consistent (Sims, Stock and Watson, 1990; Cochrane, 1997, updated 2005). *Second*, since the characteristic of the long run relationship among real exchange rate, output and price level is ambiguous in both theory and reality in case of Vietnam, the VAR in level approach is probably better than the approach of VEC (Cochrane, 1997, updated 2005). *Third*, the cross correlation analyses show that relationship between output and the real exchange rate as well as that between price level and the real exchange rate in level exposed very clearly while in the case of first difference those relationships are indeterminate.

The covariance matrices of errors from all VAR models are considered diagonal matrices since their covariances are very small and approaching zero. This suggests that the combinations of variables in this model are linear. Therefore, the orthogonal case for variance decompositions is applied in this study. Cholesky decomposition technique developed by Sim (1980) is used to orthogonalize the residual.

Forecast error variance decompositions

Table 7 presents the variance decompositions of the variables used in the model which are reported at the different periods. The results show the fraction of the forecast error variance for each variable that is attributable to its own innovations and to innovations in the other variables in the system.

Table 7. Variance decompositions of output, price and the real exchange rate

Period	Variance decompositions of Output						Variance decompositions of Price						Variance decompositions of Real exchange rate					
	3	6	9	12	18	24	3	6	9	12	18	24	3	6	9	12	18	24
Output	96.53	95.30	93.60	90.71	87.51	84.29	1.54	0.80	3.17	3.50	8.92	16.84	1.76	2.92	2.59	1.97	6.15	9.32
Price	1.61	2.54	2.87	3.05	6.24	7.43	98.27	98.76	94.58	92.89	86.82	79.50	34.98	46.56	60.29	74.69	77.98	77.25
Real ER	1.86	2.16	3.53	6.24	6.26	8.28	0.18	0.44	2.24	3.61	4.26	3.67	63.26	50.52	37.12	23.34	15.87	13.43

The most important source of variation in output forecast error is its own innovations, which account for 85 to 90 per cent of the variance of its forecast value. Similar to the real output, innovation in price level accounts for 70 to 75 per cent of its forecast error variance. In contrast, the innovations of the real exchange rate are not the most important source in explaining the forecast error variance of the real exchange rate. Price level is the most important source of the forecast variance errors in the real exchange rate, accounting for 65 to 70 per cent and the significance of this source increases over time. Thus, it cannot be argued that the real exchange rate is an exogenous variable as in some other studies.

Innovations in the real exchange rate account for about 6 per cent of the forecast error variance in the real output and about 3 per cent of that in the price level. This suggests that real exchange rate movements affect the variation of the forecast error of industrial output more strongly than those of inflation. Innovations in the real exchange rate, however, are not important in explaining the variation in both output and inflation.

After obtaining the forecast error variances of the endogenous variables in the core model, we compute the variance decompositions in the alternative models to assess the robustness of the results. All of these models use the US interest rate (*USINT*) as exogenous variable and test for the significance of

the 1997 Asian financial crisis (*D97*) (Appendix C).

From results of variance decompositions in the alternative models (Appendix C), it is evident that the predominant sources of variance in both output and price index forecast error are the “own shocks”, accounting for 50 to 60 per cent of the forecast error variance in the medium term. The real exchange rate movements affect the variability of the forecast error of output more strongly than those of price level. Innovations in the real exchange rate account for 6 to 10 per cent of the forecast error of output and 2 to 4 per cent of that of price level. The output and price level are helpful in explaining the forecast error variance of the real exchange rate. In total, they account for 60 to 65 per cent after 12 periods.

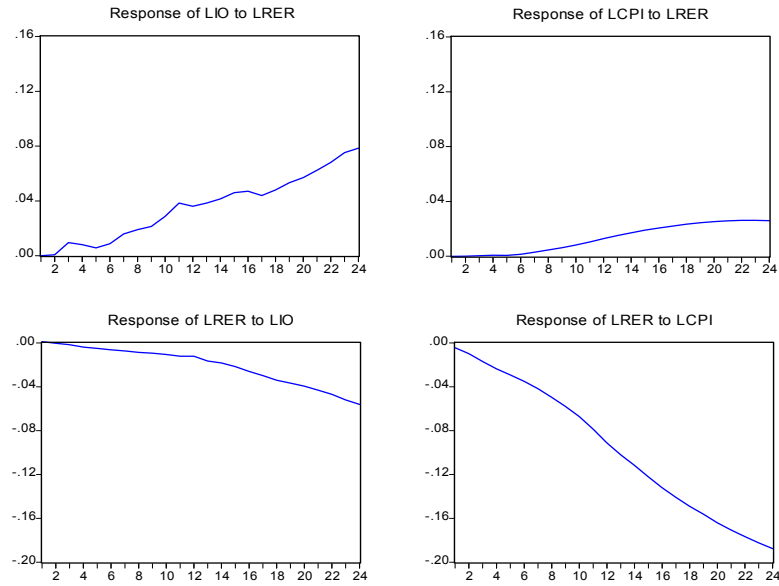
From the findings of forecast error variance decompositions in the core and alternative models, we arrive at the following conclusions: *First*, the real exchange rate is influential in determining the variation of the real industrial output. However, this influence is not so high. The main sources of variance in output and price level forecast errors are “own shocks”. *Second*, real exchange rate movements account for a higher proportions in the variability of the forecast error of output than those of inflation. *Third*, the real exchange rate is determined by output and price level, the endogenous variables in this study.

Impulse response functions

Figure 1 depicts the accumulated impulse response functions of the variables described above, using a horizon of 24 months. It shows the responses of a particular variable to an one-time shock in each of the variables in the system.

A positive real exchange rate (depreciation) shock increases output and price level. However, the magnitude is small and unstable. It seems that one standard deviation shock to inflation appreciates the domestic currency in real terms. It shows that inflation increases the nominal exchange rate less than the change in prices due to the non-tradable component. A positive output shock also appreciates the domestic currency. However, a shock of output may have smaller impact on the real exchange rate than that of inflation.

Figure 1. Accumulated impulse response of the core model



After analyzing the responses of the variables in the core model, we evaluate the responses of the variables to shock of endogenous variables in the alternative models (Appendix C) in order to check the robustness of the results that were presented for the core model.

In line with the finding in the core model, it is also shown that a positive real exchange rate shock raises price level and output in all the alternative models. In addition, the impulse response functions of alternative models help clarify the impact of devaluation on money supply and trade balance. A devaluation shock will increase money supply and improve trade balance. Then, we find that a positive shock to the real exchange rate may affect the price level and output via its impact in raising money supply and promoting exports. In the core model, we have also found that a positive shock of output or inflation appreciates the real exchange rate. The alternative models support this finding. Hence, we come to the following conclusions after examining the impulse response functions in both the core model and the alternative models: *First*, a devaluation shock to the level of the real exchange rate leads to an increase in output and price level. *Second*, positive shocks to price level and output result in the appreciation of the domestic currency. *Third*, the impulse response functions analyses provide some signals to the specific mechanism in which the real devaluation affects output and price level.

7. Conclusion

Since 1989, Vietnam has experienced some considerable changes in the exchange rate policy, with the year 1999 being marked as a striking change when the exchange rate regime was deregulated to a more market-oriented one. The exchange rate has been considered by the Vietnamese government as an important macroeconomic instrument for ensuring low inflation rate and a stable financial system, promoting exports, controlling imports, and enhancing economic growth. Therefore, understanding the characteristics of the relationship between the real exchange rate and the other macroeconomic variables will be helpful not only in assessing the soundness of economic policies but also in setting up these policies in the years to come. This study aims at analyzing the effect of changes in the real exchange rate on the evolution of output and inflation in Vietnam during the period from 1992 to 2005. To reach more reliable results than other studies that examine only the impact of the real exchange rate on either output or inflation separately, we employ a multivariate VAR model, together with some specific econometrical techniques inherent with this model.

The study points out some interesting characteristics of the relationships in question. When analyzing those relationships using the data of the whole period from 1992 to 2005, we can observe that in Vietnam there are Granger causality relationships running from the output and the price level to the real exchange rate. However, when the change in the exchange rate regime is taken into account, the relationship shows somewhat different. Before 1999, there exists the dual causality in the relationship between the real exchange rate and the price level. Between the real exchange rate and the output, the former has no effect on the latter, but the latter does have effect on the former. After 1999 when the country changed the exchange rate regime to a crawling peg one, the dual causality turns to exist in the relationship between the exchange rate and the output level. However, the exchange rate has no statistically significant effect on the inflation (only the latter does affect the former). In addition, the causality between an external shock, the change in the US interest rate, and the variables under

consideration is also examined. The US interest rate has causality to the real exchange rate and price level in Vietnam, but not to output.

Impulse response functions analysis hints that a devaluation shock to the level of the real exchange rate leads to an increase in output as well as in price level. However, results derived from the analysis of forecast error variance decompositions show that the change in the real exchange rate is not the main source of changes in the output and the price level. Although the main sources of variation in output and price level are the “own shocks” the devaluation shock accounts for a higher proportion in the variation of output than that of price level. These impacts of real depreciation on output and inflation also are asserted when trade balance and money supply are taken into the model. A positive shock of real exchange rate may affect price level and output through its impact in raising money supply and improving trade balance.

The results derived in this study support the argument that Vietnam should move to a more flexible exchange rate regime, or Vietnam should not insist on controlling the exchange rate while being under pressure of economic integration that forces the exchange rate regime to a more floating one. It is shown in this study that greater flexibility of the exchange rate will help the economy improve its trade balance and increase the output growth, while the inflation situation is not seriously affected. Furthermore, when Vietnam fully integrates into the world economy in the near future, it will face more foreign competition and external shocks while the functions of other macroeconomic instruments such as tariffs or export subsidies are restricted. Then, greater flexibility would facilitate adjustments to external shocks and rapid structural changes, and allow for a further strengthening of Vietnam’s exchange reserve situation. The change of US interest rate should be taken into consideration in planning and carrying out monetary policies. In addition, in the long-run, the impact of real exchange rate on the output level, though positive, but not so statistically significant. Therefore, not the exchange rate instrument, but enterprise efforts, structural or institutional reforms are the main sources for improving the competitiveness of the economy.

References

- Berument, H. and Pasaogullari, M. (2003) 'Effects of the real exchange rate on output and inflation: evidence from Turkey', *The Developing Economies*, 41 (4): 401-435.
- Cochrane, J. (1997, updated 2005). *Time series for macroeconomics and finance*, Unpublished lecture notes, Graduate School of Business, University of Chicago. Available from Cochrane's web site: http://gsbwww.uchicago.edu/fac/john.cochrane/research/Papers/time_series_book.pdf
- Domac, I. (1997) 'Are devaluations contractionary? Evidence from Turkey', *Journal of Economic Development*, 22 (2): 145-163.
- Dornbusch, R., Sturzenegger, F. and Wolf, H. (1990) 'Extreme inflation: dynamics and stabilisation', *Brooking Papers on Economic Activity*, 2: 1-64.
- Edwards, S. (1986) 'Are devaluations contractionary?', *The Review of Economics and Statistics*, 68 (3): 501 – 508.
- Fforde, de V. (1996) *From plan to market: the economic transition in Vietnam*, Westview Press, Inc., A Division of HarperCollins Publisher.
- Johansen, S. and Juselius, K. (1990) 'Maximum likelihood estimation and inferences on cointegration – with applications to the demand for money', *Oxford Bulletin of Economics and Statistics*, 52: 169-210.
- Johansen, S. (1995) *Likelihood-based inference in cointegrated vector autoregressive models*, Oxford: Oxford University Press.
- Hyder, Z. and Shah, S. (2004) 'Exchange rate pass-through to domestic price in Pakistan', *Working paper*, 5, State Bank of Pakistan.
- International Monetary Fund (2006). IMF Executive Board Concludes 2005 Article IV Consultation with Vietnam.
- Kamas, L. (1995) 'Monetary Policy and Inflation under the Crawling Peg: Some evidence from VARs for Colombia', *Journal of Development Economics*, 46: 145-161.
- Kamin, S. B. (1996) 'Exchange rates and inflation in exchange-rate based stabilizations: an empirical examination', *International Finance Discussion Paper*, 554, Board of Governors of the Federal Reserve System, Washington, DC.
- Kamin, S. B. and Klau, M. (1998). 'Some multi-country evidence on the effect of real exchange rate on output', *International Finance Discussion Papers*, 611, Board of Governors of the Federal Reserve System, Washington, DC
- Kamin, S. B. and Roger, J. H. (2000) 'Output and the real exchange rate in developing countries: an application to Mexico', *Journal of Development Economics*, 61 (1): 85-109.
- Klau, M. (1998) 'Exchange rate regime and inflation and output in Sub-Saharan countries', *Working*

paper, 53, Banking for International Settlements (BIS).

- Krugman, P. R. and Taylor, L. (1978) 'Contractionary effect of devaluation', *Journal of International Economics*, 8 (3), pp. 183-227.
- Le, A. T. (2005) 'Monetary policy in Vietnam: alternatives to inflation targeting', *Working Paper*, prepared for the Danang July 28-30, 2005 Summer Symposium on Continuing Economic and Social Renovation for Development.
- Le, V. D. and Tran, T. H. (1995) 'Ban ve kha nang pha gia o nuoc ta' (On devaluation and the possibility to devalue the currency of our country), *Nghien cuu Kinh te* (Journal of Economic Studies), 3 (205): 11-29 (in Vietnamese).
- Lutkepohl, H. (1993) *Introduction to Multiple Time Series Analysis*. Berlin/Tokyo: Springer Verlag
- Nguyen, N. T. and Kalirajan, K. (2006) 'Can devaluation be effective in improving the balance of payment in Vietnam?', *Journal of Policy Modelling*, 28: 467-476.
- Odusola, A. F. and Akinlo, A. E. (2001) 'Output, inflation, and exchange rate in developing countries: an application to Nigeria', *The Development Economics*, 39 (2): 199-222.
- Pham, C. Q. and Nguyen, V. C. (1999). 'Tac dong cua ty gia doi voi can can thanh toan tai Vietnam tu nam 1989 den nay' (The impact of exchange rate changes on balance of payments in Vietnam since 1989), *Nghien cuu kinh te* (Journal of Economics Studies), 12 (259): 3-21 (in Vietnamese)
- Rogers, J. H. and Wang, P (1995) 'Output, inflation and stabilization in a small open economy: evidence from Mexico', *Journal of Development Economics*, 46: 271-293.
- Rosenberg, M. R. (2003) *Exchange - Rate Determination: Models and Strategies for Exchange - Rate Forecasting*, McGraw-Hill.
- Sheeley, C. A. (1986) 'Unanticipated inflation, devaluation, and output in Latin America', *World Development*, 14: 665 -671.
- Sim, C. A. (1980) 'Macroeconomic and Reality', *Econometrica*, 48: 1 - 49
- Sims, C. A., Stock, J. H. and Watson, M. W. (1990) 'Inference in linear time series model with some unit roots', *Econometrica*, 58 (1): 113-144.
- Terence, C. M. and Pentecost, E. J. (2001) 'The real exchange rate and the output response in four EU accession countries', *Emerging Markets Review*, 2: 418-430.
- Toda, H. Y. and Yamamoto, T. (1995) 'Statistical inference in vector autoregressions with possibly near integrated process', *Journal of Econometrics*, 66: 225-250.
- Vo, T. T., Dinh, H. M., Do, X. T., Hoang, V. T., and Phan, C. Q. (2000) 'Exchange rate arrangement in Vietnam: information content and policy options', Individual Research Project, East Asian Development Network (EADN).

Appendix A - Bivariate analysis

Table A1. Determining optimal lag of bivariate VAR- output and the real exchange rate

<i>Lag</i>	<i>Full sample</i>	<i>Sub-sample 1</i>	<i>Sub-sample 2</i>
0	NA	NA	NA
1	488.9	256.6	150.8
2	2.70	8.00	4.56
3	3.12	1.86	1.34
4	4.11	0.30	5.48
5	1.36	6.29	4.62
6	9.94	2.35	6.37
7	7.01	10.07	7.12
8	4.05	4.15	1.84
9	1.44	1.32	7.86
10	3.19	2.16	3.14
11	2.41	13.83	6.90
12	4.10	1.43	8.30
13	24.63*	9.74	13.77
14	5.79	9.69*	13.29*
15	2.10	2.99	2.39

Note: * indicates lag order selected by the criterion

Table A2. Determining optimal lag of bivariate VAR - price level and the real exchange rate

<i>Lag</i>	<i>Full sample</i>	<i>Sub-sample 1</i>	<i>Sub-sample 2</i>
0	NA	NA	NA
1	978.1	716.5	273.5
2	43.85	17.51	9.67
3	3.67	1.80	1.71
4	3.54	1.86	0.03
5	13.04	7.56	2.00
6	8.73	9.02	1.04
7	5.88	11.43	0.90
8	5.32	3.47	21.15
9	7.52	3.39	3.91
10	4.65	1.95	5.19
11	10.45	13.78*	2.89
12	1.65	3.80	11.349*
13	25.79*	3.28	4.81
14	4.25	3.09	1.64
15	1.17	2.80	4.46

Note: * indicates lag order selected by the criterion

Table A3. Cointegration test for output and the real exchange rate

<i>Hypothesis</i>		Full sample		Sub-sample 1		Sub-sample 2	
Null	Alter.	λ_{trace}	λ_{max}	λ_{trace}	λ_{max}	λ_{trace}	λ_{max}
$r = 0$	$r \geq 1$	3.82	2.90	14.87	11.56	17.54*	15.05*
$r \leq 1$	$r = 2$	0.92	0.92	3.31	3.31	2.49	2.49

*: reject null hypothesis at 5% significance level.

Table A4. Cointegration test for price level and the real exchange rate

<i>Hypothesis</i>		Full sample		Sub-sample 1		Sub-sample 2	
Null	Alter.	λ_{trace}	λ_{max}	λ_{trace}	λ_{max}	λ_{trace}	λ_{max}
$r = 0$	$r \geq 1$	27.14*	20.48*	37.65*	19.33*	45.85*	33.36*
$r \leq 1$	$r = 2$	6.66	6.66	18.32*	18.32*	12.50	12.50

*: reject null hypothesis at 5% significance level.

Appendix B - Multivariate analysis - Core model

Table B1. Determining optimal lag of Core model – Full sample

Lag	LR	AIC	SC
0	NA	-5.44	-4.63
1	1310.22	-15.71	-14.71
2	54.07	-16.02	-14.83*
3	18.54	-16.05	-14.68
4	9.20	-16.00	-14.44
5	16.02	-16.02	-14.27
6	15.43	-16.03	-14.09
7	14.65	-16.04	-13.91
8	13.99	-16.04	-13.73
9	6.46	-15.98	-13.48
10	8.88	-15.94	-13.26
11	16.03	-15.98	-13.11
12	4.34	-15.90	-12.84
13	44.20*	-16.27*	-13.02
14	8.98	-16.24	-12.81
15	6.73	-16.20	-12.58
16	10.20	-16.20	-12.39
17	6.39	-16.15	-12.16
18	10.08	-16.16	-11.98

Note: * indicates the lag order selected by the criterion

Table B2. Determining optimal lag of Core model– Sub-samples

Lag	Sub-sample 1			Sub-sample 2		
	LR	AIC	SC	LR	AIC	SC
0	NA	-14.44	-13.16	NA	-12.92	-11.55
1	216.63	-17.82	-16.27*	191.50	-16.41	-14.74
2	10.19	-17.76	-15.94	9.16	-16.33	-14.37
3	5.32	-17.63	-15.53	9.13	-16.27	-14.02
4	8.54	-17.56	-15.19	7.76	-16.19	-13.65
5	23.34	-17.82	-15.17	4.27	-16.04	-13.20
6	12.52	-17.86	-14.94	20.19	-16.33	-13.20
7	30.23	-18.35	-15.15	11.04	-16.40	-12.97
8	11.01	-18.39	-14.92	23.26	-16.91	-13.19
9	16.71	-18.62	-14.88	13.79	-17.16	-13.14
10	22.58*	-19.07	-15.06	15.17	-17.53	-13.22
11	15.59	-19.36	-15.07	11.22	-17.80	-13.19
12	8.23	-19.43	-14.87	8.94	-18.03	-13.13
13	11.10	-19.66	-14.82	18.75	-19.01	-13.82
14	8.38	-19.83	-14.71	19.70*	-20.39	-14.91
15	16.21	-20.50*	-15.10	5.06	-20.69*	-14.91*

Note: * indicates lag order selected by the criterion

Table B3. Cointegration test for out put, price level and the real exchange rate - sub-samples

<i>Hypothesis</i>		Sub-sample 1		Sub-sample 2	
Null	Alter.	λ_{trace}	λ_{max}	λ_{trace}	λ_{max}
$r = 0$	$r \geq 1$	93.86*	47.17*	180.2*	123.8*
$r \leq 1$	$r \geq 2$	46.69*	35.77*	56.40*	33.84*
$r \leq 2$	$r = 3$	10.93	10.93	22.56*	22.56*

*: reject null hypothesis at 5% significance level.

Appendix C - Multivariate analysis - Alternative models

The Alternative 1: Output, Price Index, Real exchange rate, and Money Supply

The Alternative 2: Output, Price Index, Real exchange rate, and Trade Balance Deficit

Table C1. Determining optimal lag of Alternative models

The Alternative 1				The Alternative 2		
Lag	LR	AIC	SC	LR	AIC	SC
0	NA	-9.82	-8.42	NA	-10.92	-9.84
1	955.9	-20.39	-18.58*	256.9	-15.45	-13.82
2	18.32	-20.30	-18.09	27.32	-15.53	-13.35
3	16.76	-20.21	-17.60	14.01	-15.35	-12.62
4	11.31	-20.06	-17.04	34.08	-15.71	-12.45
5	21.78	-20.06	-16.64	16.79	-15.68	-11.87
6	25.27	-20.13	-16.31	39.04	-16.44	-12.08
7	20.30	-20.14	-15.92	9.00	-16.26	-11.36
8	24.92	-20.26	-15.63	25.61	-16.87	-11.42
9	12.25	-20.17	-15.15	12.09	-16.99	-11.01
10	10.18	-20.07	-14.64	28.41	-18.38	-11.85
11	28.49*	-20.36	-14.53	22.02	-19.87	-12.80
12	25.61	-20.64	-14.41	28.91*	-23.50*	-15.88*
13	23.14	-20.92	-14.28			
14	23.34	-21.26	-14.23			
15	21.07	-21.62	-14.18			

Note: * indicates lag order selected by the criterion

Table C2. Testing for the significance of the 1997 Asian financial crisis (D97)

Null hypothesis	Alter. 1	Alter. 2	Critical value		
			1%	5%	10%
D97 does not significant	11.49	83.22	13.28	9.49	7.78

Test statistic is Likelihood Ratio: $LR = 2(L_{UR} - L_R)$

Null hypotheses are rejected at 5% significance level in both alternative models

Table C3. Cointegration test for the real exchange rate, output, price level and money supply

λ_{trace}				λ_{max}			
Null	Alter.	Eigenvalue	Statistic	Null	Alter.	Eigenvalue	Statistic
$r \leq 0$	$r > 0$	0.30	65.58*	$r = 0$	$r = 1$	0.30	40.90*
$r \leq 1$	$r > 1$	0.17	24.68	$r = 1$	$r = 2$	0.17	20.88
$r \leq 2$	$r > 2$	0.03	3.80	$r = 2$	$r = 3$	0.03	3.15
$r \leq 3$	$r > 3$	0.01	0.64	$r = 3$	$r = 4$	0.01	0.64

*: reject null hypothesis at 5% significance level

Table C4. Cointegration test for the real exchange rate, output, price level and trade balance deficit

λ_{trace}				λ_{max}			
<i>Null</i>	<i>Alter.</i>	Eigenvalue	Statistic	<i>Null</i>	<i>Alter.</i>	Eigenvalue	Statistic
$r \leq 0$	$r > 0$	0.804	196.70*	$r = 0$	$r = 1$	0.804	102.70*
$r \leq 1$	$r > 1$	0.619	94.00*	$r = 1$	$r = 2$	0.619	60.83*
$r \leq 2$	$r > 2$	0.409	33.17*	$r = 2$	$r = 3$	0.409	33.09*
$r \leq 3$	$r > 3$	0.001	0.08	$r = 3$	$r = 4$	0.001	0.08

*: reject null hypothesis at 5% significance level

Table C5. Variance decompositions of output, price level and the real exchange rate- Alternative model 1

Period	Variance decomposition of output						Variance decomposition of price level						Variance decomposition of real exchange rate					
	3	6	9	12	18	24	3	6	9	12	18	24	3	6	9	12	18	24
Output	94.40	87.12	75.58	72.50	68.23	64.16	1.68	5.61	9.91	14.20	19.27	24.57	11.77	20.01	24.64	26.40	33.69	34.34
Price level	0.38	2.84	6.54	6.83	10.25	14.27	96.33	90.69	85.00	81.21	75.72	69.14	12.17	15.21	17.79	35.40	33.41	35.40
Real ER	2.16	2.42	4.02	5.88	5.44	5.88	1.67	3.18	4.68	3.33	2.32	2.11	75.92	62.83	55.01	36.46	30.91	28.52
Money supply	3.07	7.62	13.86	14.79	16.08	15.69	0.32	0.51	0.41	1.26	2.68	4.17	0.14	1.95	2.56	1.74	1.99	1.74

Table C6. Variance decompositions of output, price level and the real exchange rate- Alternative model 2

Period	Variance decomposition of output						Variance decomposition of price level						Variance decomposition of real exchange rate					
	3	6	9	12	18	24	3	6	9	12	18	24	3	6	9	12	18	24
Output	68.08	65.56	57.23	50.55	53.13	47.59	14.07	22.55	24.69	29.92	30.31	29.80	1.64	3.16	12.18	13.86	18.73	18.74
Price level	20.96	20.39	24.40	27.68	25.33	31.85	83.46	67.26	61.97	54.39	54.22	55.60	19.51	32.10	47.63	45.69	44.42	51.19
Real ER	1.76	2.87	6.69	11.50	12.17	10.55	2.17	4.04	4.94	5.83	5.49	4.39	76.68	62.54	34.42	33.61	30.76	23.96
TB deficit	9.20	11.17	11.67	10.28	9.37	10.01	0.30	6.15	8.40	9.86	9.99	10.21	2.17	2.20	5.77	6.83	6.09	6.12

Figure C1. Accumulated impulse response functions of the alternative model 1

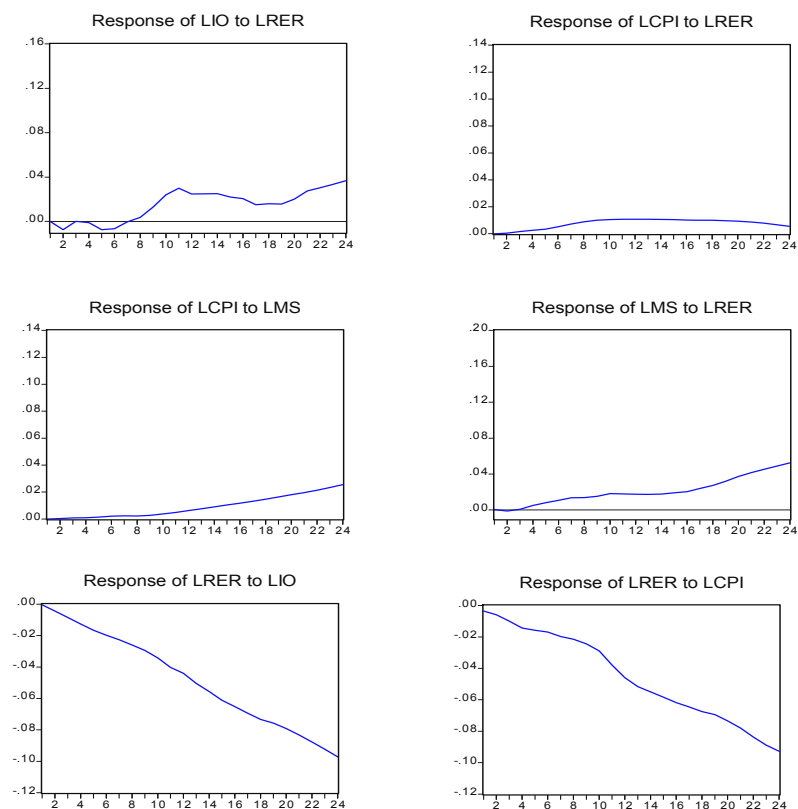


Figure C2. Accumulated impulse response functions of the alternative model 2

