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THREE ESSAYS ON EXCHANGE RATE ECONOMICS

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ABSTRACT OF DISSERTATION

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A dissertation submitted in partial fulfillment of the
requirements for the degree of Doctor of Philosophy in the
College of Business and Economics
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By
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Lexington, Kentucky

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A country's economy is becoming more and more dynamic and complicated in its scale and mobility. So, the concerns of exchange rate economics have become more popular. My research interest is in international economics with its major factor, exchange rates and other macroeconomic variables. Chapter 1 presents a brief introduction of the three studies.

Chapter Two investigate the role of exchange rate changes with particular attention to international capital flows. With liberalization of capital movements, international capital movements became free and unrestricted in many emerging market economies as well as developed countries. Using a Vector Auto-regressive (VAR) model for a small open economy in which the endogeneity of exchange rate changes is fully taken into account, I find that capital movements are more likely to be a cause of output fluctuations and current account deficits in developing countries than a channel of equilibrium changes. I also find that domestic currency depreciation is far more likely to be contractionary on domestic output in developing countries than in developed countries. Interestingly, the trade balance improves after depreciation regardless of its output consequence. These findings suggest that there are important differences between developed and developing economies in the way capital movements and exchange rate changes affect and are affected.

Chapter Three demonstrates the dynamic relationship between the current account and the real exchange rate in response to permanent and temporary shocks using structural VAR models for seven developed countries and five developing countries. Special focus is given to the issue of the stationarity of the current account. Capital flows are also included to capture external shocks as well as potential structural breaks due to financial liberalization. I find that the results for unit root tests for the current account are ambiguous. By testing two different VAR models, each taking an opposing stance on the stationarity of the current account, I conclude that responses based on a stationary current account are a better fit to the current theoretical view than those based on a nonstationary current account process. Additionally, the real exchange rate and the current account are positively correlated under a permanent shock while two variables are negatively correlated under a monetary shock. I also find that real exchange rate is an endogenous variable, which is not closely related to the temporary factors that affect the current account in the short run.

Chapter Four examines the long-run mean reverting behavior of the real exchange rates with its six different definitions for 27 economies using annual data from 1974 to 2003. I find that Purchasing Power Parity (PPP) holds better, and the half-life of the real exchange rates is shorter when the wholesale price index, rather than consumer price index, is used as price level measure. Somewhat surprisingly, there is no evidence that PPP holds better with trade-weighted real exchange rates than with bilateral ones regardless of the price index used. Strong evidence for

PPP emerges only with the use of Im, Pesaran, and Shin (2003) panel tests but not with the Levine, Lin, and Chu (2002).

KEY WORDS: Exchange Rates, Vector Autoregression, Current Account, Purchasing Power Parity, Half-life

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THREE ESSAYS ON EXCHANGE RATE ECONOMICS

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October 1, 2009

RULES FOR THE USE OF DISSERTATIONS

Name	Date

DISSERTATION

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To my parents, my husband and my son

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Chapter One
Introduction

This dissertation contains three independent essays within exchange rate economics. In this dissertation, I wanted to examine the effect of devaluation on the economy, the dynamic response of the current account and exchange rate under structural shocks, and the long-run behavior of the exchange rate. The effect of devaluation has been an issue for developing countries as it may have contractionary effect on the output. Among many reasons, the balance-sheet effect has received attention as an additional channel of contractionary devaluation, especially in developing countries. Due to the inability to borrow in their own currency, business firms in developing countries are likely to have a currency mismatch in their balance sheets – liabilities denominated in hard currencies (mainly in the US dollar), while assets and earnings primarily in the domestic currency. In such a situation, a depreciation of the domestic currency increases the domestic currency value of the debt. The increased debt service burden reduces the profits and thus brings in the recessionary effect to the economy. Many researchers emphasize the significance of the balance sheet effects in the 1997 Asian financial crisis (Krugman 1999; Corsetti *et al*., 1999). Frankel (2005) argues that the balance sheet effect was a major contractionary channel of the currency crises in developing countries in the 1990s.

International capital movement has received attention as one of the most important factors of output and exchange rate determination (Calvo *et al*., 1996; Kamin and Rogers, 2000; Kim, 2000; Kim and Ying, 2001). While international capital flows bring a number of benefits to the receiving country, they may also cause important problems as well. Among other things, the country becomes vulnerable and risks a freeze of capital inflows and an eventual financial crisis. As Reinhart (2000) maintains, devaluation in developing countries can lead to a loss of access to international capital markets and, thus, generate contractionary effects on output. The role of the capital accounts in the developed countries also cannot be ignored. After financial crisis in Asian countries, massive capitals came to the U.S. to find safe and riskless assets. This large demand for riskless assets by foreigners induces bubbles in the financial markets and eventually a financial crisis in the U.S. (Caballero *et al*., 2008; Caballero and Krishnamurthy, 2009).

In Chapter 2, I investigate the role of changes in the exchange rate while paying particular attention to international capital flows. Using a vector auto-regression (VAR) model for a small open economy, in which the endogeneity of exchange rate changes is fully taken into account, I find that capital movements are more likely to be a cause of output fluctuations and current account deficits in developing countries than a channel of equilibrium changes. I also find that domestic currency depreciation is far more likely to be contractionary on domestic output in developing countries than in developed countries. Interestingly, the current account balance improves after depreciation regardless of its output consequences. These findings suggest that there are important differences between developed and developing economies in the way capital movements and exchange rate changes affect and are affected by other economic factors.

In Chapter 3, I investigate the effect of the exchange rate on output by taking into account the dynamic relationship between the current account and the exchange rate. The stationarity of the current account has been an issue for a long time. Many researchers, such as Shibata and Shintani (1998), Husted (1992), Ghosh and Ostry (1995), Wu et al. (1996), Bergin and Sheffrin (2000), Nason and Rogers (2002), Baharumshah et al. (2003), and Spagnolo and Sola (2004) could not support the stationary current account process with their empirical results. Given the uncertainty regarding the stationarity of the current account, I consider both the case where it is assumed to be stationary and the case where it is nonstationary. I also go beyond the existing studies by including capital flows. Previous studies indicate that capital inflows have played an important role in the determination of the current account and the real exchange rate especially in emerging market economies that recently had financial liberalization.

I find that the results for unit root tests for the current account are ambiguous. By testing two different VAR models, each taking an opposing stance on the stationarity of the current account, I conclude that the responses based on the assumption of a stationary current account are a better fit to the current theoretical view than those based on a nonstationary current account process. A permanent shock induces a positive correlation – that is, increasing the current account while appreciating the real exchange rate. On the other hand, under a temporary shock, the correlation of the two variables is negative – that is, an increase in the current account is associated with a real depreciation.

In Chapter 4, I re-examine the PPP hypothesis with various definitions of the real exchange rate for the post-Bretton Woods period of floating exchange rates. I compare the conventional univariate tests and the panel tests. In panel tests, we employ both the test of Levine, Lin, and Chu (LLC, 2002) and the more recent test by Im, Pesaran, and Shin (IPS, 2003).

Some of important findings of this chapter can be summarized as follows: 1) PPP holds better and the half-life of the real exchange rate is shorter when the WPI rather than the CPI is used as the price index; 2) There is no evidence that PPP holds better with trade-weighted real exchange rates than with bilateral ones regardless of the price index used; 3) Strong evidence for PPP emerges only with the use of IPS panel tests; 4) I find the median of half-live estimates to be less than 3 years, which shorter than the current consensus.

Chapter Two
Exchange Rate Changes and Output: Developed vs. Developing Economies

2.1 Introduction

The effects of currency devaluation have been studied in a voluminous literature. According to a typical textbook description, devaluation or depreciation of the domestic currency boosts exports while discouraging imports, and thereby stimulates aggregate demand and output growth (Krugman and Obstfeld, 2005).[1] Eichengreen and Sachs (1985) show that devaluation under the gold standard in the 1930s led to an increase in economic growth in countries such as the United Kingdom, Finland, Denmark, and Norway. Empirical studies such as Goldstein and Khan (1985) and Gylfason and Schmid (1983) provide evidence of the expansionary effects of devaluation in the short- and medium-run in a number of countries – both less developed as well as industrialized. Dornbusch and Werner (1994) also suggest that policies that keep the real exchange rate competitive encourage output growth as well as prevent balance of payment crises. In a recent empirical study, Shi (2006) finds that the appreciation of the renminbi causes the contractionary effect on output in China.

A rich literature including Hirschman (1949), Diaz-Alejandro (1963), and Krugman and Taylor (1978) have discussed numerous possible channels of the contractionary effects of devaluation, especially in the context of developing countries. The contractionary effects of devaluation may work through the demand side – such as a reduction of the trade balance or a redistribution of income leading to a decrease in domestic spending. The trade balance declines if the sum of the price elasticities of the import and export demand is less than one or if the trade balance is initially in a large deficit. Devaluation also causes a redistribution of income from wage earners who have a low saving propensity to profit earners who have a high saving propensity, thereby reducing aggregate demand for domestic output. If there are ad valorem taxes on traded goods, devaluation also redistributes income in the short-run from the private sector, which has a relatively low propensity to save, to the government sector, which has a higher propensity to save (almost unit saving propensity). These channels lead to a reduction in aggregate demand.[2]

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[1] In this paper, we use the terms "devaluation" and "depreciation" interchangeably for convenience. In fact, devaluation refers to a discrete exchange rate change under a fixed exchange rate. It is more likely to be infrequent and large in magnitude. Whether the effects of exchange rate changes are equivalent regardless of the exchange rate regime in which they occur is a subject of contentious debate. See Ahmed *et al.*,(2002) for more about the debate.

[2] See Diaz-Alegjando (1963) and Krugman and Taylor (1978).

In monetarist models, the contractionary effect of devaluation arises as it increases the domestic price level through higher imported goods prices and, given the stickiness of nominal money wage and money supply, reduces the real money balance and real income. On the supply side, the contractionary effect can be due to a higher price of imported goods and an overall increase in the cost of production (Findlay and Rodriguez, 1977; Marston, 1982).

In recent experiences, the balance sheet effect has received attention as an additional channel of contractionary devaluation, especially in developing countries. Due to the inability to borrow in their own currency, business firms in developing countries are likely to have a mismatch currency in their balance sheets – liabilities denominated by hard currencies (mainly in the US dollar), while assets and earnings primarily in the domestic currency. In such a situation, a depreciation of the domestic currency increases the domestic currency value of the debt. The increased debt service burden reduces the profits and thus brings in the recessionary effect to the economy. Many researchers emphasize the significance of the balance sheet effects in the 1997 Asian financial crisis (Krugman 1999; Corsetti *et al*., 1999). Frankel (2005) argues that the balance sheet effect was a major contractionary channel of the currency crises in developing countries in the 1990s.

Several papers compare the effects of devaluation in developed and developing economies. Kamin and Klau (1998) find that for 27 developed and developing countries – when the sources of spurious correlation and reversal causality are controlled for – contractionary effects are significant only in the short-run but not in the long-run. And they find no evidence that this effect is any stronger in developing countries than in industrialized countries. Bahmani-Oskooee and Miteza (2003) conclude that the results of devaluation depend on country-specific characteristics, the model, and estimation techniques. For instance, papers which mainly focus on the channel of demand for developed countries are more likely to find that devaluations are expansionary while the studies of the supply-side channels for developing countries are more likely to arrive at the opposite conclusion. Kim and Ying (2007) find that there is no evidence on the contractionary effects for East Asian countries after controlling for structural breaks and conclude that the results may depend on the definition of the exchange rate and the period of estimation.[3] Ahmed *et al.,* (2002) also find the contractionary effects of devaluation on output in developing countries are due to economic fundamentals and a failure of the pegged exchange rate regime.

Positive correlation between the real exchange rate and real income should not necessarily be treated as evidence of contractionary effects of devaluation. It may be a spurious correlation due

[3] For instance, the authors show that devaluations were never contractionary in East Asia before the 1997 financial crisis and if the exchange rate is measured as the bilateral rate against the US dollar.

to the influence of third factors. For instance, devaluations frequently have occurred in response to adverse shocks, such as deterioration in terms of trade or an adverse shock to the capital account. These problems tend to depress economic activity even in the absence of devaluation. Studies that control for third factors also find that output declines in the aftermath of devaluation. Edwards (1986) analyzes the contractionary effect of devaluation on output in developing countries during 1965-1980. The results of an empirical model incorporating monetary and fiscal policy and terms of trade show that devaluation generates a contractionary effect in the short-run but is neutral in the long-run.[4] Holding constant the terms of trade, import growth, the money supply, and the fiscal balance, Morley (1992) finds that devaluation causes contractionary effects in the short-run (in two years) due to a sharp decrease in investment. Using several vector autoregressive (VAR) models, Kamin and Rogers (2000) also control for third factors, such as capital account, and find that devaluation leads to an output contraction in Mexico.

Recently, international capital movement has received attention as one of the most important factors of output and exchange rate determination (Calvo *et al.*, 1996; Kamin and Rogers, 2000; Kim, 2000; Kim and Ying, 2001). An inflow of international capital causes an appreciation of the real exchange rate and increases in current account deficits. Consequently, the country becomes vulnerable and risks a freeze of capital inflows and, an eventual financial crisis. As Reinhart (2000) maintains, devaluation in developing countries can lead to a loss of access to international capital markets and, thus, generate contractionary effects on output.

In this paper, we investigate the effects of currency devaluation in nine relatively small open economies: Australia, Canada, Switzerland, Italy, the Netherlands, Spain, Mexico, Korea, and Malaysia. We employ a VAR model, similar to the one used by Kim and Roubini (2000) and Kim and Ying (2007), to account for the endogeneity of the exchange rate. The above discussion establishes the importance of controlling for third factors, such as external shocks, to have a correct understanding of the connection between the exchange rate and economic activity. More importantly, we take into account the important role of capital flows as a cause and effect of exchange rate changes.

The empirical results of this paper can be summarized as follows. We find that in Mexico and Malaysia devaluation leads to a significant decline in output even if the effects of third variables such as capital flows are taken into account. However, there is no evidence of contractionary effects of devaluation in developed countries. We also find that output in developing countries is

[4] However, the author points out that using annual data for empirical tests, one may not capture the dynamics of exchange rate behavior accurately. Also, the author could not verify the channel of contractionary effect in the short-run.

more vulnerable to external shocks such as capital flows and exchange rate changes. This seems to indicate that the nature of capital flows and other external shocks is fundamentally different in industrial countries than in emerging market economies, as suggested by Lane (2003).[5]

The structure of this paper is as follows. Section 2 describes preliminary data analysis, and Section 3 discusses the econometric method and the assumptions employed for identification. Section 4 provides the empirical results; and the conclusion and implications for policymakers are summarized in Section 5.

2.2 Preliminary Data Analysis

The data are obtained from nine countries. Among developing countries in Latin American and Asian countries, we select Mexico, Korea, and Malaysia. For comparison, six developed countries, Australia, Canada, Switzerland, Italy, Spain, and the Netherlands are chosen. The choice of countries is dictated by the availability of relevant data. We use quarterly data collected from *International Financial Statistics* (IFS) and *Direction of Trade Statistics* (DOTS). The sample periods are as follows: Australia (1976:Q2-2004:Q4), Canada (1971:Q2-2004:Q4), Switzerland (1976:Q2-2004:Q2), Spain (1976:Q2-2004:Q2), Italy (1971:Q2-2004:Q2), the Netherlands (1971:Q2-2004:Q2), Korea (1976:Q1-2004:Q4), Malaysia (1981:Q1-2004:Q4), and Mexico (1981:Q1-2004:Q4).[6] The sample period includes both fixed exchange rates and floating exchange rate regimes for several countries. The periods of fixed exchange rate regimes and currency crises or large exchange rate changes are in Tables 2.1a and 2.1b.[7]

Tables 2.1a and 2.1b here

Variables are defined as follows: capital flow and current account are measured as ratio to GDP and coded as KAR and CAR.[8] The financial account and the current account data in the IFS are used for all countries except Malaysia. Due to the lack of necessary data, the current account balance for Malaysia is calculated by subtracting imports from exports using DOTS data. Real output (IP) is measured by the index of seasonal adjusted industrial production from the IFS. The

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[5] Lane (2003) argues that emerging market economies, in comparison to developed countries, have different economic infrastructure which makes them more volatile and causes greater cyclical fluctuations after currency devaluation. He shows that the presence of substantial foreign-currency debt, along with credit market frictions, is one of the major characteristics of emerging countries which increase the volatility of output and leave them more exposed to business cycles.

[6] Kim and Ying (2007) and others found a major structural break in the 1997 financial crisis in most East Asian countries. However, in this paper, we consider the sample period as a whole since our focus is to see whether there is any difference in the effects of exchange rate devaluation comparing two different country groups.

[7] Ahmed *et al*. (2002).

[8] We use the fitted value of GDP obtained from a regression of the nominal GDP (seasonally adjusted) to a linear trend.

relative price ratio (RCP) is calculated by dividing the domestic price level (CPI) by the foreign price level, which is calculated as the trade-weighted average of the price levels for four major trading partners. The price level is represented by the consumer price index in all countries but Germany, where the GDP deflator is used instead. The real money balance (MR) is calculated by dividing the money supply by the domestic price level. As for the money supply, we used M1 for Australia, Canada, Italy, the Netherlands, and Spain; and we use money in the national definition for Switzerland, Korea, Mexico, and Malaysia. The nominal exchange rate (NX) is the weighted average of the bilateral exchange rates against the US dollar from IFS using the same weighting scheme as for the foreign price level.[9] The foreign price level and foreign output are similarly defined as the trade-weighted average of corresponding figures. The real exchange rate (RX) is obtained by dividing NX by RCP. The U.S. three-month Treasury bill interest rate is used as the foreign interest rate for all countries except Switzerland which uses the German government bond yield instead. All variables are in logarithm except for the interest rates and the capital and current account ratios.

Tables 2.2 and 2.3 here

Tables 2.2 and 2.3 report the results of the unit root and cointegration tests. The augmented Dickey-Fuller test (ADF) with four lags is used for these tests. The results indicate that the presence of unit roots is not rejected at the five percent significance level for most variables in most countries. This implies that most variables in the model are likely to be nonstationary. Table 2.3 shows the result of the cointegration tests labeled CI1, CI2, and CI3. We first consider CI1, which is the test of cointegration for real output and the real exchange rate. We then consider CI2 and CI3, which expand the cointegration relationship by adding foreign income in CI2, and then adding foreign income, the capital account-output ratio, and real money supply in CI3. The results indicate that there is little evidence of cointegration between variables except for particular cases, such as the CI3 test for Canada and CI2 test for Korea. Based on these results, we precede with the assumption that variables are nonstationary and noncointegrated. We thus transform all variables into the first-differenced form in the VAR model.[10]

[9] The weighting schemes are as follows: for Australia, (US, Japan, UK) = (0.33, 0.33, 0.33), for Spain, (Germany, France, Italy) = (0.4, 0.4, 0.2), for Italy, (Germany, France) = (0.6, 0.4), for the Netherlands, (Germany, Belgium, UK, France) = (0.4, 0.2, 0.2, 0.2), for Korea, (US, Japan) = (0.5, 0.5) and for Malaysia, (US, Japan) = (0.6, 0.4). For Canada and Mexico, the US is considered as the foreign country while, for Switzerland, Germany takes the role due to the preeminent role of each country for each group.

[10] With first differencing, the presence of a unit root is rejected for all variables. Complete results are available upon request.

2.3 The Econometric Method and Model's Identification

To investigate the response of output under devaluation, we estimate a VAR model for each country that includes the capital account-output ratio (KAR), industrial production (IP), relative price ratio (RCP), money supply (MR), the current account-output ratio (CAR), and the nominal exchange rate (NX). The model also includes two measures of external shocks: foreign interest rates, and trading-partner real income to control for exogenous shocks.[11] Using a VAR with the Cholesky decomposition, we eliminate the effects of third factors which may generate spurious correlation between output and the real exchange rate, and contribute to a reverse causality problem. Given the evidence reported in the previous section, all variables are first differenced. The six endogenous variables are ordered as listed in the following equation which summarizes the model in reduced form:

$$\begin{pmatrix} \Delta KAR_t \\ \Delta IP_t \\ \Delta RCP_t \\ \Delta MR_t \\ \Delta CAR_t \\ \Delta NX_t \end{pmatrix} = \begin{pmatrix} a_1 \\ a_2 \\ a_3 \\ a_4 \\ a_5 \\ a_6 \end{pmatrix} + A_{ij}(L) \begin{pmatrix} \Delta KAR_{t-1} \\ \Delta IP_{t-1} \\ \Delta RCP_{t-1} \\ \Delta MR_{t-1} \\ \Delta CAR_{t-1} \\ \Delta NX_{t-1} \end{pmatrix} + B_{ij}(L) \begin{pmatrix} \Delta y_t^* \\ \Delta i_t^* \end{pmatrix} + \begin{pmatrix} e_{1t} \\ e_{2t} \\ e_{3t} \\ e_{4t} \\ e_{5t} \\ e_{6t} \end{pmatrix}$$

where $A_{ij}(L)$ and $B_{ij}(L)$ are 6x6 and 6x2 matrices of polynomials in lag operator L. We capture external shocks by including foreign income and the foreign interest rate. Since we employ quarterly data, we assume that the domestic variables can be affected by the external shocks within the same time period.

The ordering of the endogenous variables can be justified as follows. First, capital flows are treated as the driving force of the macroeconomic variables. Empirical evidence indicates that capital flows are one of the important determinants of output and the exchange rate; and capital flows are strongly influenced by external shocks such as the world interest rate and U.S. business cycle.[12] By positioning the capital account at the top of the variables, we assume that it is the most exogenous variable among the endogenous variables. In other words, innovations on the capital account have contemporaneous effects on the other endogenous variables in the system, but innovations from the other variables have no contemporaneous effects on the capital account.

Second, real money supply is included since the behavior of real money can be an important key to understanding the effects of devaluation. The identification assumption is that output does

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[11] This means that we decompose the real exchange rate into the nominal exchange rate and the price level.
[12] See Calvo, *et al*., (1996), Kamin and Rogers (2000), and Kim (2000).

not contemporaneously react to money supply changes. Based on this assumption, output is ordered ahead of real money in the model. Third, the real exchange rate is separated into the nominal exchange rate and the relative price. With this separation, we can examine the hypothesis whether the behavior of the real exchange rate is invariant with respect to the exchange rate regime. The hypothesis implies, for instance, that a depreciation of the real exchange rate can be obtained by a depreciation of the nominal exchange rate or a decline in the domestic price level.

Fourth, in this model, the nominal exchange rate is treated as the most endogenous variable and is, thus, placed at the bottom. This means that contemporaneous changes in the exchange rate due to other variables are removed from innovations on the nominal exchange rate. As a result, we can examine the pure effects of exchange rate changes. This methodology is adapted by Kim and Roubini (2000) and also Kim and Ying (2007).[13]

2.4 Empirical Results

2.4.1 Granger Causality between Current Accounts and Capital Flows

Before presenting formal results of the VAR analysis, we first perform the Granger causality tests between the current account balance and capital flows. The two hypotheses are: (1) current account deficits cause capital inflow; and (2) capital inflows cause current account deficits. Table 2.3 shows the results of Granger causality tests for the bilateral relationship between KAR and CAR with four lags. The main pattern is that current account deficits cause capital inflows in the group of developed countries while, in developing countries, capital flows cause current account deficits, with an exception of Malaysia.

Table 2.4 here

The results suggest that capital flows tend to be accommodating or financing current account deficits in developed countries. On the other hand, in Korea and Mexico, capital flows seem to behave as an autonomous source of disturbance leading ultimately to current account deficits, but not in Malaysia. The following results also corroborate the differences between Malaysia and the other two developing countries.

2.4.2 Impulse Responses

The panels presented in Figures 2.1 and 2.2 present the key results of our analysis: the responses to a one-period, one-standard deviation shock in the nominal exchange rate and the capital account. Recall that the VAR model is estimated using the first differenced data series.

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[13] Kim and Ying (2000) also show that a change in the U.S. real GDP and the interest rates explain more than 50% of capital inflows to in Korea and Mexico.

For ease of interpretation, the impulse responses are converted back to their initial levels. In each graph, the point estimates of the impulse responses are bounded by one-standard-deviation bands, roughly corresponding to 84 percent confidence intervals.[14]

Figure 2.1 here

The panels presented in Figure 2.1 show the responses of the endogenous variables to devaluation (or depreciation) of the domestic currency. In a standard textbook model, the shock would lead to a rise in the current account, output, and the domestic price level. In our results, the devaluation in domestic currency generates different responses in output. Among the developed economies, output increases in all cases except the Netherlands, although, all responses are statistically insignificant except in Italy, which shows significant positive short-term responses for about five quarters. For developing countries, however, output declines significantly and persistently in Mexico and Malaysia, while it increases insignificantly in Korea. This contractionary effect of currency devaluation in developing countries is consistent with Kamin and Rogers (2000), who test the effect of devaluation by controlling for third factors, such as capital account and spurious correlation, and find devaluation indeed causes the contractionary effect observed in Mexico.

The responses of the relative price also exhibit different patterns in the two groups of countries. The relative price ratio – domestic to foreign – increases significantly in all three developing countries while showing little or no responses in developed economies with the exception of the Netherlands. The empirical evidence of exchange rate pass-through supports that there are declines in the rate of pass-through in developed countries, and the pass-through rates are relatively greater in the emerging market economies. See Bailliu and Bouakez, (2004), Gagnon and Ihrig (2004), Campa and Goldgerg (2005), Frankel (2005), and Razmi (2005) for more details. In countries where the relative price rises significantly − i.e. Mexico, Malaysia, and the Netherlands − we also find that real money declines significantly. In other countries, real money supply shows no discernable movements.

The current account improves in all countries but Canada. It is interesting to note that the current account improves significantly even in Mexico and Malaysia where output declines in response to devaluation. Thus, the standard textbook model may be vindicated in assuming the positive response of the current account. However, this suggests that whether currency

[14] Standard errors for the impulse responses and forecast error variance decompositions were computed using Monte Carlo simulations with 1000 iterations.

devaluation will be expansionary or contractionary on domestic output does not depend on the response of the current account. The reason must be elsewhere.[15]

Figure 2.2 here

The panels presented in Figure 2.2 show the impulse responses to a capital inflow, or a positive innovation, in the capital account. They show that output rises significantly in developing countries, with the exception of Malaysia. In Korea and Mexico, real money supply expands while the domestic currency appreciates, and the current account declines. Reflecting the mixed effects of output and monetary expansion in the presence of currency appreciation, the relative price does not show any significant changes. This strong increase in real money balance indicates central banks' intervention to resist currency appreciation. These responses in Korea and Mexico are consistent with a textbook description of the effects of capital inflows in developing countries[16]. On the other hand, capital flows in Malaysia do not generate significant responses in output or the exchange rate. Only real money supply increases the current account declines significantly only in the first few quarters. These findings suggest that perhaps capital controls installed in Malaysia during the financial crisis in 1997-1998, and central bank intervention in the foreign exchange market, have limited the effects of capital flows within the economy.

In contrast to strong and statistically significant responses in developing countries, capital movements seem to have largely insignificant effects in developed economies. Output level remains largely unaffected in all countries but Switzerland. Similarly, real money balance increases significantly only in Switzerland. The exchange rate responses are never significant in developed countries. The relative price tends to rise and the current account tends to decline. However, responses are significant in Italy and Canada only, respectively. On balance, there is little evidence that capital inflows lead to a boom accompanied by a currency appreciation in developed economies.

2.4.3 Forecast Error Decomposition

Tables 2.5 and 2.6 present variance decompositions of output and the nominal exchange rate. They show the fraction of the forecast error variance for each variable that is attributable to innovations in each endogenous variable. The error term ε_t^i denotes innovations from the equation for variable *i*. We present the decomposition for forecast horizons at four and twenty

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[15] Diaz-Alejandro (1965) also shows that devaluation reduces real domestic output significantly even though the trade balance improves.
[16] See, inter alia, Calvo *et al.,* (1996) and Lane (2003).

quarters. The four- (twenty-) quarter horizon may be considered as short- (medium-) run relationships.

Tables 2.5 and 2.6 here

The results of the variance decomposition in Table 2.5 can be summarized as follows. First, the predominant source of variation in output is the own shock (ε_t^{IP}) in all countries. The contribution of own shock is greater in developed economies than in developing countries, and it becomes smaller over extended time periods, from around 90 to 57 percent for developed countries and from 76 to 42 percent for developing countries.[17]

In developed countries, innovations in real money balance are the second most important factor for variations in output. All other factors appear to be minor or insignificant with a few exceptions. On the other hand, in the developing countries, external sectors show up as a prominent cause of output fluctuations. Capital flows in Korea and exchange rate shocks in Mexico and Malaysia are the second most important sources of output fluctuations.[18] In the medium run, shocks to the current account, such as changes in terms of trade become almost as important the two external structural shocks.

Table 2.6 shows that own shocks are also the most important explanatory factor in the variation of the exchange rate in all countries except Korea. No other particular macroeconomic variables in the model contribute to the fluctuation of the exchange rate in developed countries. However, shocks to capital account are a significant factor in explaining the behavior of the exchange rate for developing countries, with the exception of Malaysia. The role of capital flows is exceptionally large in Korea, establishing itself as most important cause of exchange rate fluctuations both in the short and medium run.

2.5 Conclusion

In this paper, we investigate the interaction between output and the exchange rate, in particular, whether currency devaluation is likely to be contractionary in developed countries as well as in Latin and Asian developing countries, as reported in many previous studies with surprising consistency. In econometric analysis, dealing with currency crashes poses problems since – in most cases, there are a number of third factors that move together. Among other things,

[17] The evidence of more volatile output fluctuation in developing countries is also shown in Lane (2003). By controlling other factors, Lane finds that there is an inverse relationship between output per capita and volatility.

[18] Shocks to capital flows play a relatively smaller role for the fluctuation of output in Malaysia than other developing countries. Malaysia is well known to have used capital controls in the 1997 financial crisis, which has presumably helped to maintain stability in the middle of financial turmoil. As a consequence, variations in capital flows have much smaller effects on the exchange rate and output.

data for developing countries are heavily contaminated by the episodes of currency crashes that are induced by the reversal of capital inflows.[19] It is important to see the effects of exchange rate changes that can be considered relatively free from the effects of third factors and endogeneity issues. That is the purpose of the VAR modeling for this paper.

What we find is that even if we remove the effects of third variables, such as capital flows and money supply changes, we still see strong evidence of contractionary devaluation in developing countries like Mexico and Malaysia (but not in Korea). However, there is no evidence of contractionary effect of devaluation in developed countries.

We also find that developing-country output is more vulnerable to external shocks such as capital flows, exchange rate changes, and variations in the current account. This seems to suggest that the nature of capital flows and other external shocks is fundamentally different in industrial countries than in emerging market economies (Lane, 2003). For instance, in developed economies, capital flows are more likely to be financing current account imbalances instead of a source of disturbance in the economy. In Korea and Mexico, the opposite seems to be the case.

With financial liberalization, devaluation in a typical emerging market economy may now be more likely to be contractionary as it worsens the balance sheet of domestic firms with heavy foreign-currency liabilities.[20] Moreover, currency devaluation may result in serious interruption of external financing through a loss of credibility with international financial investors. Thus, as Mussa (2000) points out, high openness to international capital flows, especially with large portion of short-term debt, can be dangerous. Malaysia is the exception in this regard. We suspect that the results are perhaps due to capital controls on capital outflows installed by the Malaysian government during the 1998 financial crisis. With the restrictions on free capital account transactions installed during the 1997-1998 financial crises, Malaysia's exchange controls seem to have minimized the effects of capital flows and the contractionary influence of devaluation that arises with the reversal of capital flows.[21]

The policy implications of the findings of this paper are significant. The likelihood that devaluation can be contractionary poses difficult problems for policy makers. One cannot simply revalue the domestic currency to boost the domestic economy because devaluation would be

[19] For instance, Ahmed *et al.,* (2002) find that contractionary effects of devaluation in emerging countries are a result of abandonment of pegged exchange rate regimes and the unique structure of developing economics.

[20] See Bebczuk et al (2007) for more recent evidence.

[21] The Malaysia's capital controls mandated foreigners to wait a year before converting ringgit from the sales of Malaysian securities into hard currencies. Additionally, Malaysians also were forbidden from investing abroad without prior approval from the central bank, Bank Negara. By restricting on capital outflows as well as short term capital inflows, the government has tried to prevent economic disaster from capital flight (Abdelal and Alfaro, 2003).

contractionary. “This is the strategy that got Mexico into trouble in 1994, and given time, the same strategy would certainly lead to a new financial crisis in the future” (Kamin and Rogers, 2000, p.103). If currency depreciation in the aftermath of an adverse shock to the economy causes further deepening of a recession, the case for flexible exchange rates in such an economy is diminished. The debate over the appropriate exchange rate regime in emerging market economies is not over yet. However, focusing on the role of the exchange rate regime per se seems to be futile. No exchange rate regime would be a good substitute for a stable macroeconomic environment supported by high trade openness and a well-managed financial system.

Figure 2.1 The Impulse Responses to the Nominal Exchange Rate

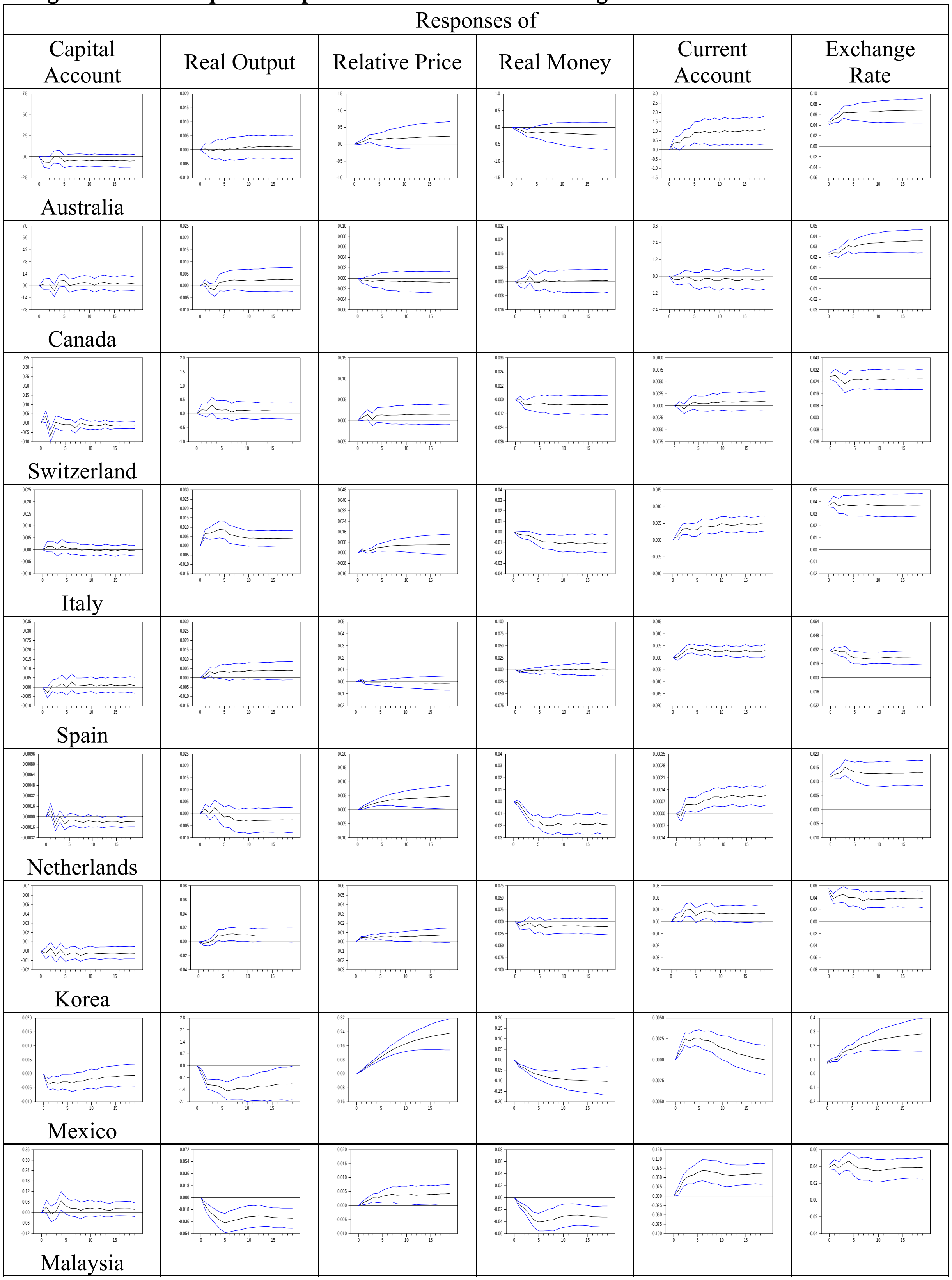

Figure 2.2 The Impulse Responses to a Capital Inflow Shock

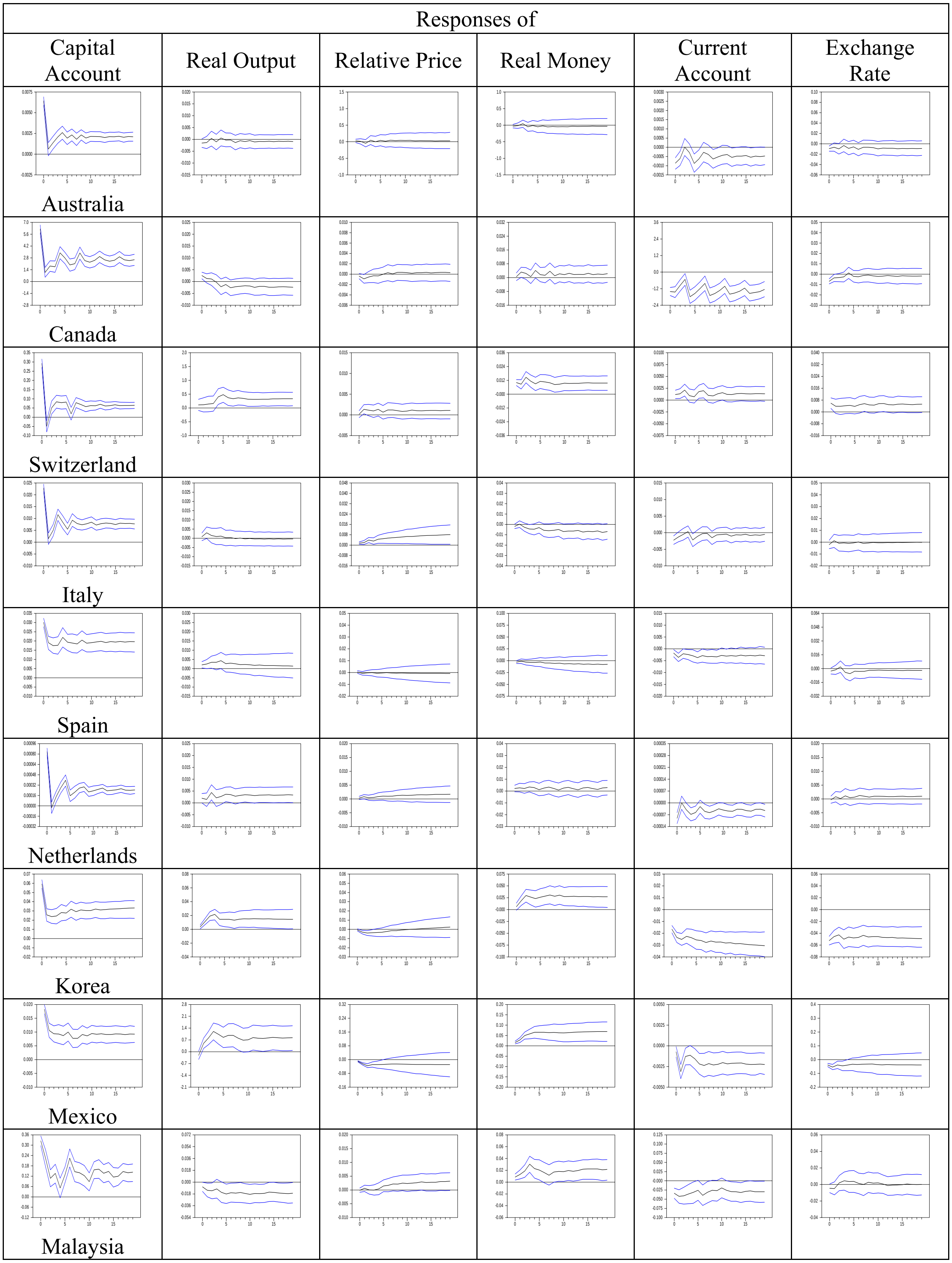

Table 2.1a Fixed Exchange Rate Regimes in the Sample

Country	Period	Regime
Spain	January 1989 – present	Pegged to the ECU
Italy	February 1973 – September 1992 November 1996 – present	Pegged to the ECU
Netherlands	1979 – present	Pegged to the ECU
Korea	May 1964 – February 1980	Pegged to the US dollar
Malaysia	September 1975 – September 1997 and September 1998 – present	Pegged to the US dollar
Mexico	March 1977 – December 1994	Pegged to the US dollar

Table 2.1b Currency Crisis or Large Exchange Rate Changes

Country	Period
Spain	September 1992
Italy	September 1992
Netherlands	September 1992
Korea	January 1980, November 1997
Malaysia	September 1998
Mexico	December 1994

Table 2.2 Unit Roots Tests

	Variables						
	KAR	IP	RCP	MR	CAR	NX	RX
Australia	-2.4	-0.44	-0.44	-0.97	-3.16**	-1.45	-0.39
Canada	-2.14	0.10	-2.27	1.37	-2.54	-1.86	-1.78
Switzerland	-3.35**	-0.00	-2.80	-0.47	-2.07	-2.07	-2.42
Italy	-3.02**	-2.06	-2.97**	-0.09	-3.59***	-3.23**	-2.23
Spain	-4.05***	-2.82	-2.66	-0.58	-3.04**	-1.58	-2.12
Netherlands	-2.92**	-1.83	-2.06	-0.24	-1.80	-2.32	-2.91**
Korea	-2.56	-1.48	-2.29	-0.69	-2.55	-1.83	-2.07
Mexico	-2.56	0.06	-3.46**	-1.30	-2.01	-2.62	-2.53
Malaysia	-2.21	-1.18	-0.58	-0.53	-2.29	-2.08	-2.49

- Critical values: 1%= -3.479, 5%= -2.883
- '**' ('***') indicates significance at 5 (1) percent level.
- Although the sample periods vary for countries, the sample sizes are close enough to use the same critical value.

Table 2.3 Cointegration Test

	CI1	CI2	CI3
Countries	(IP, RX)	(IP, RX, y^*)	(IP, RX, y^*, KAR, MR)
Australia	-2.72	-3.24	-3.68
Canada	-1.65	-3.18	-4.69*
Switzerland	-1.11	-3.94	-3.53
Italy	-1.97	-3.51	-3.25
Spain	-2.49	-3.60	-3.15
Netherlands	-1.43	-3.44	-3.65
Korea	-2.11	-4.61*	-3.92
Mexico	-0.99	-3.11	-2.69
Malaysia	-1.04	-3.76	-3.63

- Critical values:

	CI1		CI2		CI3	
	1%	5%	1%	5%	1%	5%
Australia, Canada, Switzerland, Italy, Spain, Netherlands	-4.40	-3.81	-4.78	-4.18	-5.44	-4.83
Korea	-4.42	-3.82	-4.81	-4.20	-5.48	-4.86
Mexico, Malaysia	-4.45	-3.84	-4.84	-4.22	-5.53	-4.89

Table 2.4 Granger Causality Tests

	Dependent variables	Lagged variables	
		KAR	CAR
Australia	KAR		7.19 (0.00)***
	CAR	1.72 (0.15)	
Canada	KAR		3.72 (0.01)***
	CAR	1.78 (0.14)	
Switzerland	KAR		1.18 (0.32)
	CAR	0.80 (0.53)	
Italy	KAR		7.18 (0.00)***
	CAR	0.18 (0.95)	
Spain	KAR		0.86 (0.49)
	CAR	0.48 (0.75)	
Netherlands	KAR		8.74 (0.00)***
	CAR	1.60 (0.18)	
Korea	KAR		1.83 (0.13)
	CAR	4.56 (0.00)***	
Mexico	KAR		1.88 (0.12)
	CAR	7.20 (0.00)***	
Malaysia	KAR		2.77 (0.03)**
	CAR	0.05 (0.99)	

Table 2.5 Variance Decomposition of Output

	ε_t^{KAR}		ε_t^{IP}		ε^{RCP}		ε_t^{MR}		ε_t^{CAR}		ε_t^{NX}	
	(4)	(20)	(4)	(20)	(4)	(20)	(4)	(20)	(4)	(20)	(4)	(20)
Australia	0.44	0.28	89.38	68.49	0.42	8.34	8.41	21.05	1.32	1.58	0.03	0.26
Canada	0.75	1.2	84.45	72.36	0.34	4.29	12.07	9.96	1.95	10.95	0.44	1.25
Switzerland	0.75	4.68	90.51	57.64	2.00	1.68	4.36	31.63	0.92	3.42	1.46	0.95
Italy	0.56	0.2	86.59	59.55	2.53	6.35	4.06	27.7	0.04	0.11	6.23	6.1
Spain	2.09	2.96	85.80	81.95	1.61	2.38	3.80	5.73	3.72	3.75	2.99	3.22
Netherlands	1.98	2.91	95.46	88.03	0.26	1.67	1.35	4.95	0.21	0.81	0.75	1.63
Korea	16.8	9.35	72.1	72.37	0.82	4.82	9.65	8.67	0.38	1.55	0.21	3.25
Mexico	13.45	9.25	53.67	42.39	0.79	1.73	3.69	1.40	9.39	20.20	19.01	25.03
Malaysia	3.80	5.96	76.25	43.86	0.18	0.20	3.63	4.27	3.91	20.27	12.24	25.43

Table 2.6 Variance Decomposition of the Nominal Exchange Rate

	ε_t^{KAR}		ε_t^{IP}		ε^{RCP}		ε_t^{MR}		ε_t^{CAR}		ε_t^{NX}	
	(4)	(20)	(4)	(20)	(4)	(20)	(4)	(20)	(4)	(20)	(4)	(20)
Australia	1.69	1.32	3.62	4.89	0.54	9.27	0.06	0.20	0.92	0.57	93.17	83.75
Canada	2.66	0.50	2.83	0.45	4.89	13.39	3.02	8.88	0.78	1.47	85.82	75.32
Switzerland	2.31	2.56	4.13	2.78	1.94	0.67	2.63	5.85	5.30	6.21	83.69	81.92
Italy	0.1	0.03	0.81	0.9	6.21	10.2	0.5	4.94	0.04	0.12	92.34	83.81
Spain	0.69	0.59	0.61	1.20	18.16	41.76	4.07	11.00	0.41	1.45	76.07	44.00
Netherlands	0.21	0.33	3.46	6.82	2.25	1.43	14.63	22.50	0.11	0.11	79.33	68.82
Korea	45.96	50.67	2.15	0.69	6.73	6.58	1.02	1.30	0.52	0.77	43.63	39.99
Mexico	11.19	2.11	0.08	0.20	5.28	4.86	5.40	7.91	3.62	5.55	74.43	79.39
Malaysia	0.58	0.22	13.06	28.40	0.97	0.30	0.94	0.25	0.53	1.67	83.91	69.17

Chapter Three
The Real Exchange Rate and the Current Account

3.1 Introduction

The real exchange rate and the current account balance are two of the most important variables in modeling an open economy. In early models, the relationship between the two variables is described as more or less a unidirectional one with causation stemming from the real exchange rate. Conventional wisdom has been that real depreciation will lead to a decrease (increase) in the current account deficit (surplus). A more accurate view would be to treat both as endogenous and responding to other shocks.

Intertemporal models typically consider two types of shocks: permanent and temporary. In most cases, permanent shocks are induced from innovations in productivity, changes in resource endowment, and preference while temporary shocks are due to monetary policy. Studies by Ghosh and Ostry (1995), Obstfeld and Rogoff (1995), Glick and Rogoff (1995), Alquist and Chinn (2002), Nason and Rogers (2002), Chinn and Prasad (2003), and Bussiere et al. (2005) find that a permanent shock leads to a current account deficit and an appreciation of the real exchange rate. An increase in investment along with a decline in saving and the resulting capital inflows induces a current account deficit and real appreciation of the domestic currency. A temporary shock such as a monetary expansion by the central bank leads to a decline in the domestic interest rate, a capital outflow and currency deprecation. This currency depreciation improves the current account (Obstfeld and Rogoff, 1995; Glick and Rogoff, 1995; Giuliodori, 2004).

Lee and Chinn (2006) find that, in response to a temporary shock, the real exchange rate depreciates and the current account improves. This implies that the two variables are negatively correlated under a monetary shock. They also find that a permanent shock leads to a positive correlation - the real exchange rate appreciates while the current account improves. Blanchard et al. (2005) and Chinn and Lee (2009) consider changes in the preferences for the home goods as a permanent shock on the real exchange rate. According to Chinn and Lee (2009), a positive home good preference shock can bring an appreciation of the real exchange rate while the current account improves. An empirical study by Leonard and Stockman (2002) finds that the real exchange rate tends to appreciate during episodes of current account surplus, especially from the middle to the end of current account surplus episodes using 18 countries' quarterly data from 1974-1997. Devereux and Genberg (2007) report that the estimated currency appreciation actually improves China's current account by over 1% of GDP.

In their vector autoregressive (VAR) model, Lee and Chinn (2006) proceed with the assumption that the current account is stationary while the real exchange rate is nonstationary. This assumption of the stationary current account is supported by various models. In the intertemporal models - which assume perfect capital mobility and consumption smoothing behavior - the current account behaves as a buffer to consumption shocks.[22] Trehan and Walsh (1991) and Shibata and Shintani (1998) conclude that the current account is stationary. Ghosh (1995) also finds that the current account is stationary although the nonstationarity hypothesis of the saving-output and investment-output ratios cannot be rejected.

Although the assumption is fairly standard in most empirical work, it is not without controversy. For instance, Shibata and Shintani (1998), Husted (1992), Ghosh and Ostry (1995), Wu et al. (1996), Bergin and Sheffrin (2000), Nason and Rogers (2002), Baharumshah et al. (2003), and Spagnolo and Sola (2004) could not reject the unit root hypothesis.[23] Cavallari (2001) and Nason and Rogers (2002) find that there is a possibility that the current account has a unit root. They test the response of the current account under certain shocks. Cavallari (2001) presents empirical evidence of the role of monetary shocks on current account fluctuation for G7 countries. Using first differenced data on output and current account balances along with interest rate levels she finds that current account balances are improved in the longer horizon as a result of positive monetary shocks.

Panel unit roots tests also provide mixed results. Using a panel seemingly unrelated regressions augmented Dickey-Fuller (SURADF) test for 21 African countries, Holmes (2003) finds strong evidence to support the stationarity hypothesis. Lau and Baharumshah (2005), on the other hand, conclude that there is a mixture of I(0) and I(1) processes in the current account of 12 Asian countries. Wu (2000) examines the stationary of current account using the tests developed by Levin, Lin and Chu (LLC, 2002) and Im, Pesaran and Shin (IPS, 2003) and concludes that current account balances are stationary in ten OECD countries.

Given the uncertainty regarding the stationarity of the current account, we consider both the case where it is assumed to be stationary and the case where it is nonstationary. We also go beyond the existing studies by including capital flows. Previous studies indicate that capital inflows have played an important role in the determination of the current account and the real exchange rate especially in emerging market economies that recently had financial liberalization.

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[22] In a typical model such as Obstfeld and Rogoff (1995), a permanent shock does not affect the current account as permanent shocks cannot be smoothed away while a temporary shock leads to a (temporary) increase in the current account. This assumes that the response of investment is not large enough.

[23] Shibata and Shintani (1998) show that they could not reject the unit root null in a Dickey-Fuller test while the results from KPSS shows stationarity of the current account. They conclude that the current account is stationary.

Including capital flows appears necessary to capture external shocks as well as potential structural breaks due to financial liberalization, which are often ignored in conventional theoretical models.

The purpose of this paper is to investigate the responses of the current account and the real exchange rate to permanent and temporary shocks. Since the stationarity of the current account is an unresolved issue, we consider both the case where it is assumed to be stationary and the case where it is nonstationary. We investigate unit root tests, cointegration tests, Granger causality tests, and conduct VAR analysis for both industrial and emerging countries over the period 1970-2006. The VAR model with the Blanchard and Quah decomposition is adopted for this paper as in Lee and Chinn (2006) which classifies permanent and temporary shocks according to their long-run effects on the real exchange rate.[24] Following the traditional approach, we assume that permanent shocks represent real disturbances such as changes in resource endowment, technology and preference. Temporary shocks, on the other hand, are of a monetary nature and do not have long-run effects on the real exchange rate.[25]

The structure of the rest of this paper is as follows. Section 2 describes the econometric specification for our model. Section 3 shows the data description and preliminary analysis results. Section 4 provides the empirical test results. Finally, the conclusions and implications for policymakers are summarized in Section 5.

3.2 Econometric Model

This section introduces and discusses the econometric specification of the model for the logarithm of real exchange rate (RER_t) and the current account-GDP ratio (CAR_t). The vector of structural shocks is denoted as ε_t , $\varepsilon_t = \begin{bmatrix} \varepsilon_t^P \\ \varepsilon_t^T \end{bmatrix}$ with $E(\varepsilon_t) = 0, E(\varepsilon_t \varepsilon_t') = I$ and $E(\varepsilon_t \varepsilon_s') = 0$ where $t \neq s$. ε_t^P and ε_t^T are permanent and temporary shocks, respectively. They are pure noise and i.i.d. Note that the VAR residuals are composites of the pure innovations, ε_t^P and ε_t^T (Enders, 2006). Empirical results reported in the next section show that there is convincing evidence that the real exchange rate contains a unit root. The real exchange rate is thus differenced. On the other hand, it is difficult to decide whether the current account (as ratio to

[24] We define the structural shocks as only country specific shocks based on the results of Glick and Rogoff (1995). They find that global shocks have no effects on current accounts while country specific shocks do.

[25] This interpretation has been used by Lastrapes (1992), Enders and Lee (1992), Chen and Wu (1997), Giuliodori (2004), and Lee and Chinn (2006). However, there is a consideration that large nominal shocks could have permanent effects on the real exchange rate. See Chen and Wu (1997), and Giuliodori (2004) for more on this.

GDP) contains a unit root or not. Thus, we proceed to estimate two different sets of VAR models. In Model 1, we use the current account-GDP ratio in level form. In Model 2, the variable is differenced. As discussed in the previous section, we also consider adding capital flows measured as the capital account-GDP ratio (KAR_t) as an exogenous variable to capture external shocks and potential structural breaks.

Model 1:
$$\begin{bmatrix} \Delta RER_t \\ CAR_t \end{bmatrix} = C(L) \begin{bmatrix} \Delta RER_t \\ CAR_t \end{bmatrix} + A(L) KAR_{t-1} + \begin{bmatrix} e_t^{rer} \\ e_t^{car} \end{bmatrix}$$

Model 2:
$$\begin{bmatrix} \Delta RER_t \\ \Delta CAR_t \end{bmatrix} = C(L) \begin{bmatrix} \Delta RER_t \\ \Delta CAR_t \end{bmatrix} + A(L) KAR_{t-1} + \begin{bmatrix} e_t^{rer} \\ e_t^{car} \end{bmatrix}$$

We employ the maximum likelihood ratio (LR), Akaike Information Criterion (AIC), and Akaike's Information Corrected Criterion (AICC) to determine the optimal lag length. However, we choose the conventional lag length of four for the VAR model for quarterly data as various leg lengths are suggested by different criteria. Table 3.1 shows the results of optimal lag length.

Table 3.1 here

3.3 Data Description and Preliminary Analysis

3.3.1 Data

Quarterly data are obtained for 12 countries: the U.S., Canada, the UK, Japan, Germany, France, Italy among developed countries and Korea, Malaysia, Indonesia, Mexico, and the Philippines among developing countries. The sample periods are different due to data availability. For G7 countries and Korea, we use data from 1970:Q1 to 2006:Q2. But shorter data spans are used for Germany (1979:Q3 to 2006:Q2), Indonesia (1991:Q1 to 2006:Q2), Mexico, Malaysia and the Philippines (1981:Q2 to 2006:Q2).

The real exchange rate is defined as EP/P*, where E is the nominal exchange rate – the foreign currency price of a unit of domestic currency – P and P* are the domestic and foreign price levels. An increase in EP/P* (E) is a real (nominal) appreciation of the domestic currency.

The nominal exchange rate is the weighted average of bilateral exchange rates vis-à-vis major trading partners, with the weights determined by the size of total bilateral trade from 1989 to

1994. (Bilateral trade data are obtained from the *Direction of Trade Statistics*, DOT).[26] The foreign price level is obtained in a similar manner using the same weighting schemes.

The current account is approximated as exports less imports of goods and services, also obtained from *International Finance Statistics* (IFS).[27] The raw data is converted to its national currency. The current account is defined as a ratio to nominal GDP, following the usual tradition.[28]

3.3.2 Preliminary Analysis

3.3.2.1 Unit Roots Tests for RER and CAR

Figures 3.1 and 3.2 show the RER and the CAR for each country. There is little evidence of a time trend for either variable. The deep depreciation in the real exchange rates indicates the financial crisis in 1994 for Mexico and in 1997 for Korea, Indonesia, and Malaysia. As we can see from the graphs, the U.S. has had a current account deficit since around 1975 while there is a surplus in Japan. In Germany, a huge drop of the current account balance results from unification around 1990. The current account surplus has been maintained in Indonesia and Malaysia since the late 1990's.

[26] The each country's weight for total trade is following. Canada: United States (0.87), Japan (0.08), United Kingdom (0.03), Germany (0.03), France: Germany (0.25), Italy (0.15), Belgium-Luxembourg (0.12), United Kingdom (0.12), United States (0.10). Spain (0.08), Netherlands (0.07), Switzerland (0.04), Japan (0.04), Sweden (0.02), Austria (0.01), Germany : France (0.18), Italy (0.13), Netherlands (0.13), United Kingdom(0.11), United States (0.10), Belgium-Luxembourg (0.10), Austria (0.08), Switzerland (0.07), Japan (0.06), Spain (0.04), Indonesia : Japan (0.40), United States (0.18), Singapore (0.10), Korea (0.08), Germany (0.07), Australia (0.05), Netherlands (0.04), United Kingdom (0.03), France (0.03), Malaysia (0.02), Italy : Germany (0.29), France (0.21), United States (0.10), United Kingdom (0.10), Switzerland (0.06), Netherlands (0.06), Spain (0.06), Belgium-Luxembourg (0.06)Austria (0.03), Japan (0.03), Japan : United States (0.42), Korea (0.09), Germany (0.08), Singapore (0.05), United Kingdom (0.05), Australia (0.05), Indonesia (0.05), Thailand (0.04), Malaysia (0.04), Canada (0.04), France (0.03), Netherlands (0.02), Philippines (0.02), Italy (0.02), Korea : United States (0.37), Japan (0.33), Germany (0.07), Singapore (0.04), Indonesia (0.04), Canada (0.03), United Kingdom (0.03), Malaysia (0.03), France (0.02), Italy (0.02), Thailand (0.02), Malaysia: Japan (0.27), United States (0.25), Singapore (0.24), Germany (0.05), United Kingdom (0.05), Australia (0.05), Korea (0.04), Thailand (0.03), France (0.02), Mexico: United States (0.86), Japan (0.05), Germany (0.03), France (0.02), Canada (0.02), Spain (0.02), Philippines: United States (0.40), Japan (0.30), Germany (0.07), Singapore (0.07), Korea (0.06), United Kingdom (0.04), Netherlands (0.03), Australia (0.03), the United States: Canada (0.31), Japan (0.24), Mexico (0.11), Germany (0.08), United Kingdom (0.07), Korea (0.05), France (0.05), Singapore (0.03), Italy (0.03), Netherlands (0.03), and the United Kingdom: Germany (0.24), United States (0.21), France (0.17), Netherlands (0.13), Italy (0.09), Belgium-Luxembourg (0.09), Japan (0.07).

[27] This gives 141 observations for all G7 and Korea, and 108 observations for Germany, and 98 observations for Mexico, Malaysia, and Philippines and 66 observations for Indonesia.

[28] For Malaysia, we use the export and import data for 1981:Q1-2006:Q2 from the DOT. The data for current account GDP ratio in G7 and Mexico are seasonally adjusted from IFS. But for Korea, Malaysia, Indonesia and Philippines, this is constructed to be seasonally adjusted by regressing it on a set of quarterly dummy variables.

Figures 3.1 and 3.2 here

To examine the stationarity of each variable, the augmented Dickey-Fuller (ADF) test, Phillips-Perron test (PP, 1988), Kwiatkowski, Phillips, Schmidt, and Shin test (KPSS, 1992) are used. If the data has near unit roots, then there is a possibility that the ADF tests will not reject the null suggesting nonstationary. To prevent this bias, the PP and KPSS tests are also conducted.[29] As we do not have evidence of a time trend of the real exchange rate and current account from Figures 3.1 and 3.2, only a constant is included in the ADF test.[30] For the ADF test, the following equation is estimated:

$$\Delta y_t = a_0 + \gamma \ y_{t-1} + \sum_{i=2}^{p} \beta_i \Delta y_{t-i+1} + \varepsilon_t$$

where $\Delta y_t = y_t - y_{t-1}$ is the first difference of each variable, a_0 is the constant term, β_i represents the coefficients of the lagged terms of Δy_t , and ε_t is the white noise residual. Following Schwert (1989), the maximum lag length for each country is set at $12(N/100)^{0.25}$, where N is the total number of observations. To determine the optimal lag length (p), the AIC is used for each variable. The coefficient of interest is γ . We test the null hypothesis that $\gamma \geq 0$ against the alternative hypothesis that $\gamma < 0$. The rejection of the null hypothesis supports the stationary of the series.

The results of unit roots tests are shown in Tables 3.2, 3.3, and 3.4. The null which suggests a unit root for RER cannot be rejected at any significance level except for the cases of the U.S. and Korea and only in the ADF test. The results of the KPSS tests also suggest rejecting the stationary null hypothesis for most countries. When using the first differenced data series, the null hypothesis for the unit root can be rejected at the 1 percent significance level in all cases.[31] These results imply that the RER is likely to be nonstationary.

Evidence is mixed for the stationarity of CAR. The null hypothesis which suggests the presence of unit roots in the ADF tests cannot be rejected for most countries, with the exceptions of Japan and Korea. The results from the PP test are more supportive of the stationarity hypothesis. The unit root null hypothesis is rejected for 6 countries: Italy, the UK, Korea, Indonesia, Mexico, and the Philippines. The results from the KPSS test result in the stationarity

[29] If the residuals are heterogeneous or weakly dependent, the PP test can be used as an alternative test (Enders, 2003). The null hypothesis of the KPSS test is that the true data has a stationary movement.
[30] For Germany, the CAR drops down from above 0.06 to -0.01 in 1991:Q1 around the time of unification. This structural break is captured by dummy variable.
[31] The results are upon requests.

hypothesis being rejected for 8 countries Canada, France, Italy, the UK, the US, Korea, Malaysia, and Mexico. These results suggest that the evidence is neither consistent nor strong in its determination of stationarity of CAR. In stark contrast, the KAR can be considered as stationary as reported in Table 3.4.

Given the ambiguity regarding the stationarity of CAR, we proceed with the two different VAR models: in Model 1, only RER is first differenced, and in Model 2, both RER and CAR are first differenced.

Tables 3.2, 3.3, and 3.4 here

3.3.2.2 Cointegration Tests

To see the long-run relationship between CAR and RER we perform cointegration tests, using the Engle-Granger method. We first consider CI1 in which we test cointegration between the two variables. In CI2, we expand the cointegration test by adding the KAR as the external factor. The lag length is set at four. (The results are little affected by small variations in the lag length.) Table 3.5 reports the results. They indicate that there is little evidence of cointegration between CAR and RER except for the case of Korea and Mexico. However, once the capital account is included, the evidence of cointegration in these countries gets weaker. Based on these results, we proceed with the assumption that CAR and RER are not cointegrated.

Table 3.5 here

3.3.2.3 Granger Causality Tests

To see how the two economic variables are related to each other, we also perform the Granger-causality test between CAR and RER. We start with a bivariate model and followed by the same test with KAR added as an exogenous variable. The equations for causality tests are

$$CAR = \alpha_1 + \sum_{i=1}^{m} \beta_{1i} RER_{t-i} + \sum_{i=1}^{m} \gamma_{1i} CAR_{t-i} + \sum_{i=1}^{m} \delta_{1i} KAR_{t-i} + V_{1t}$$

$$RER = \alpha_2 + \sum_{i=1}^{m} \beta_{2i} RER_{t-i} + \sum_{i=1}^{m} \gamma_{2i} CAR_{t-i} + \sum_{i=1}^{m} \delta_{2i} KAR_{t-i} + V_{2t}$$

where V represents the error term; *m*, the lag length, is set at four. The null hypothesis of Granger causality from the RER to the CAR is $\beta_{1i} = 0$ .And the null hypothesis of Granger causality from the CAR to the RER is $\gamma_{2i} = 0$. The rejection of the null implies that the past values of the variable of interest can help predict the dependent variable. Table 3.6 shows the results.

Table 3.6 here

Lagged real exchange rates can help to predict the behavior of the current account in the UK, Korea, Indonesia, and Mexico. This implies that the change in the real exchange rate Granger-causes the current account in these countries. On the other hand, the current account Granger-causes the movement of the real exchange rate significantly only for Japan. When the capital account is added to the regression, the results are similar to those of the bilateral tests except for Indonesia where the causal relationship from the current account to the real exchange rate no longer exists. There is also stronger causal evidence from the real exchange rate to the current account for the US.

3.4 Empirical Test Results

3.4.1 Impulse Response Functions

The empirical results that we report in the previous section suggest that the current account (as ratio to GDP) may be either stationary or nonstationary although, the real exchange is most likely to be nonstationary. We thus estimate two sets of the VAR models based on two different assumptions about the stationarity of the current account. Model 1 (Model 2) is the VAR model with stationary (nonstationary) hypothesis of the current account. In both models, the real exchange rate is assumed to be nonstationary. We first estimate the two models without adding the capital account.

Figures 3.3 and 3.4 here

The panels of Figure 3.3 display the point estimates of the impulse responses (the solid lines) bounded by one-standard-deviation bands (the dotted lines), roughly corresponding to 84 percent confidence intervals.[32] A permanent shock leads to significant changes in the real exchange rate and the current account in most countries. With the exception of the Philippines, the correlation between the two variables is positive in most countries. In other words, the real exchange rate appreciates (depreciates) while the current account improves (deteriorates). The significant appreciation, of the real exchange rate after a permanent shock, occurs through several channels.

[32] Standard errors for the impulse responses and forecast error variance decompositions are computed using Monte Carlo simulations with 1000 iterations.

The first, it can be explained by consumption behavior. The (anticipated) productivity gains or a technology shock can trigger both capital inflows and an increase in consumption and investment. Higher capital inflows due to the productivity shock lead to an increase in the demand for domestic currency and its appreciation. Also, the higher demand for domestic goods due to wealth effect leads to currency appreciation (Alquist and Chinn, 2002; Bussiere, 2005; Lee and Chinn, 2006). This channel also leads to a reduction in the current account.

Second, the Balassa−Samuelson hypothesis theory as follows: If the productivity shock in the tradable goods sector leads to a higher relative price of nontradable goods, and if purchasing power parity holds for tradable goods, then the real exchange rate appreciates (Choudhri and Khan, 2004). Since both the supply of and the demand for tradable goods increase, the change in the current account is ambiguous.

Third, Blanchard et al., (2005) and Chinn and Lee (2009) explain the permanent shock as a preference shock which can have long-run effects on the real exchange rate. According to Chinn and Lee (2009), the positive home good preference shock brings an appreciation of the real exchange rate while improving the current account.

In the case of a temporary shock, the responses of the real exchange rate and current account are negatively correlated. In other words, the real exchange rate depreciates (in most countries with exception of the U.K. and the Philippines) while the current account improves (in all countries). This is consistent with the Mundell-Fleming analysis in which a temporary shock such as expansionary monetary policy leads to an incipient decline in the domestic interest rate, leading to a capital outflow and exchange rate depreciation. And this depreciation increases the current account and has an expansionary effect on income.

In Figure 3.4, we examine the impulse responses for Model 2. Under a permanent shock, the correlation of the real exchange rate and the current account responses is now insignificant in the majority of cases. Compared to Figure 3.3 (Model 1), there are more cases of negative correlation, often significant, as in the cases of Indonesia, Korea, Malaysia, and Mexico.

One notable difference from Model 1 is the persistent responses of the current account after a temporary shock. This is not surprising since in this model, the current account is assumed to be nonstationary. What is surprising is that a temporary shock generates significant and permanent changes in the current account while responses in the real exchange rate are negligible. These results are inconsistent with the prevailing presumption that volatility in the (real and nominal) exchange rates is due to monetary or financial shocks that have temporary effects on the real exchange rate. While models exist that show that a temporary shock can have a permanent effect on the real exchange rate and the economy, the combination we observe in Figure 3.4 is difficult to reconcile with those models. These results suggest that Model 1 should be preferred to Model 2.

In Figure 3.5, we augment Model 1 by adding the capital account as an external factor.[33] Compared with Figure 3.3, the correlation becomes insignificant under a permanent shock once the capital account is included for Canada, Germany, Korea, and Malaysia. There are significant differences in the movement of the real exchange rate and the current account in the U.S. after adding the capital account. Also, for France, the response of the exchange rate to a temporary shock becomes stronger and the negative correlation, in the first several quarters, becomes more significant. Other than these, impulse responses to either a permanent or temporary shock remain similar to those of Model 1.

3.4.2 Forecast Error Decomposition

Table 3.7 presents variance decompositions of the current account and the real exchange rate. They show the fraction of the forecast error variance for each variable that is attributable to the permanent and temporary shocks. Model 1 is employed based on the results reported in the previous section. We present the forecast variance decomposition for four and twelve quarter horizons.

Table 3.7 here

The predominant source of variation in the real exchange rate is the permanent shock in most countries with the exception of Korea and Indonesia. For France, Italy, Japan, and the U.K., the contribution of the permanent shock exceeds 95 percent, and it also increases over time. The current account, on the other hand, is almost exclusively driven by temporary shocks in all countries. We have tried other variations. The results are similar except for a few cases.

The results suggest that the real exchange rate and the current account are probably determined by different sources. In particular, the current account is strongly influenced by factors that have temporary effects on the real exchange rate.

3.5 Conclusion

[33] We also conduct the impulse response graph with nonstationary current account with capital account. The results are pretty the same with model 2.

This paper investigates the dynamic relationship between the current account and the real exchange rate in response to permanent and temporary shocks using structural VAR models for seven developed countries and five developing countries. Special focus is given to the issue of the stationarity of the current account. Capital flows are also added to capture external shocks as well as potential structural breaks due to financial liberalization.

We find that the results for unit root tests for the current account are ambiguous. By testing two different VAR models, each taking an opposing stance on the stationarity of the current account, we conclude that the responses based on the assumption of a stationary current account are a better fit to the current theoretical view than those based on a nonstationary current account process. The stationarity of the current account has a fundamental policy implication. It suggests that imbalances on the current account are a short-term phenomenon that will dissipate in the long run. Since a stationary current account balance is consistent with the sustainability of external debts, government intervention to stabilize the current account balance is unwarranted unless the imbalance is excessive (Lau and Baharumshah, 2005).

A permanent shock induces a positive correlation – that is, increasing the current account while appreciating the real exchange rate. On the other hand, under a temporary shock, the correlation of the two variables is negative – that is, an increase in the current account is associated with a real depreciation.

The results on the variance decomposition suggest that the real exchange rate and the current account are probably determined by different sources. In particular, the current account is strongly influenced by factors that have temporary effects on the real exchange rate. On the other hand, factors that drive the real (nominal) exchange rate have little to do with the current account.

These results have important policy implications. Among others, it is important to understand that the current account is mainly driven by temporary shocks such as monetary shocks or disturbances that are behind short-run business cycles. Excessive emphasis on maintaining balance of the current account might be counterproductive. Another implication is that trying to find the equilibrium real exchange rate in connection with the current account, especially defining it as the level at which the current account is in balance (or consistent with long-term capital inflows) is likely to be futile. The real exchange rate is an endogenous variable, which is not closely related to the temporary factors that affect the current account in the short run.

Figure 3.1 The Real Exchange Rate

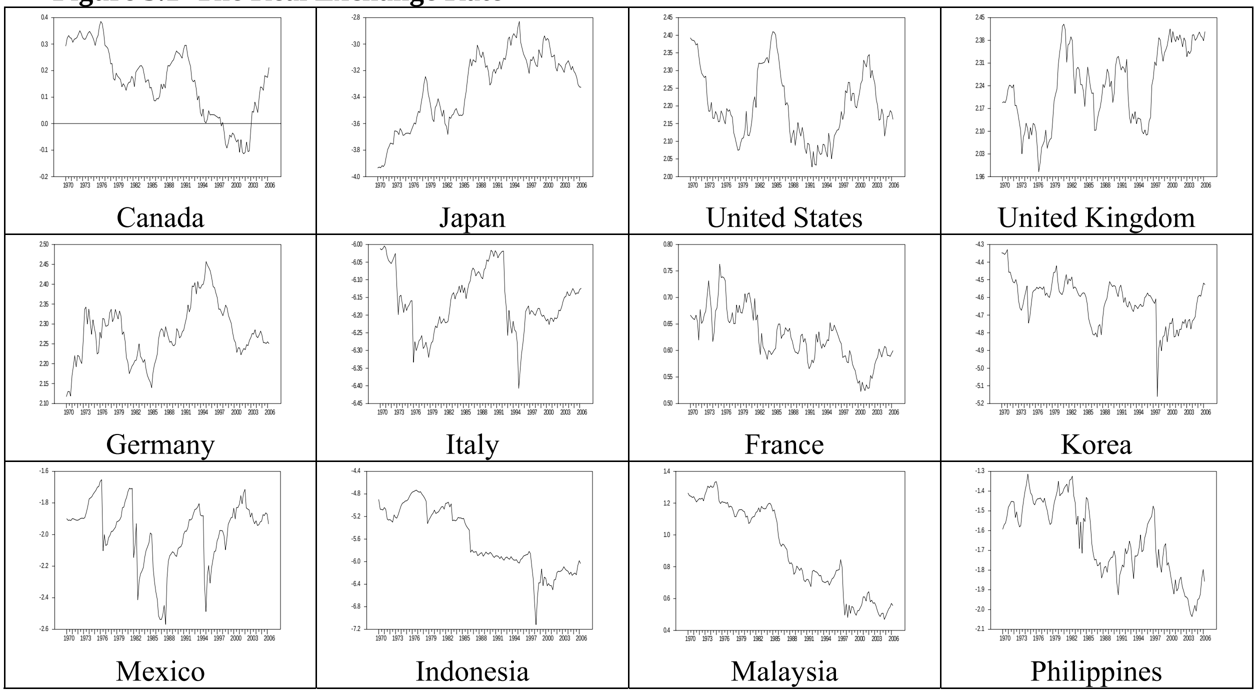


Figure 3.2 The Current Account-GDP Ratio

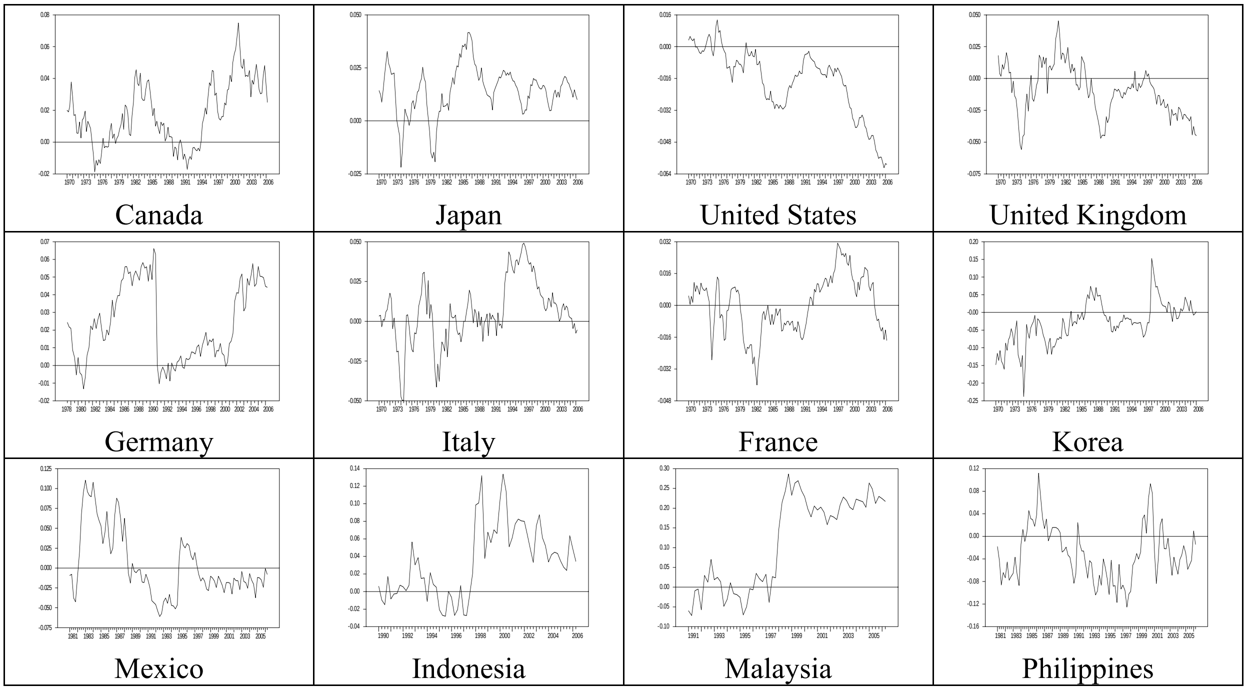


Figure 3.3 The Impulse Responses of Model 1

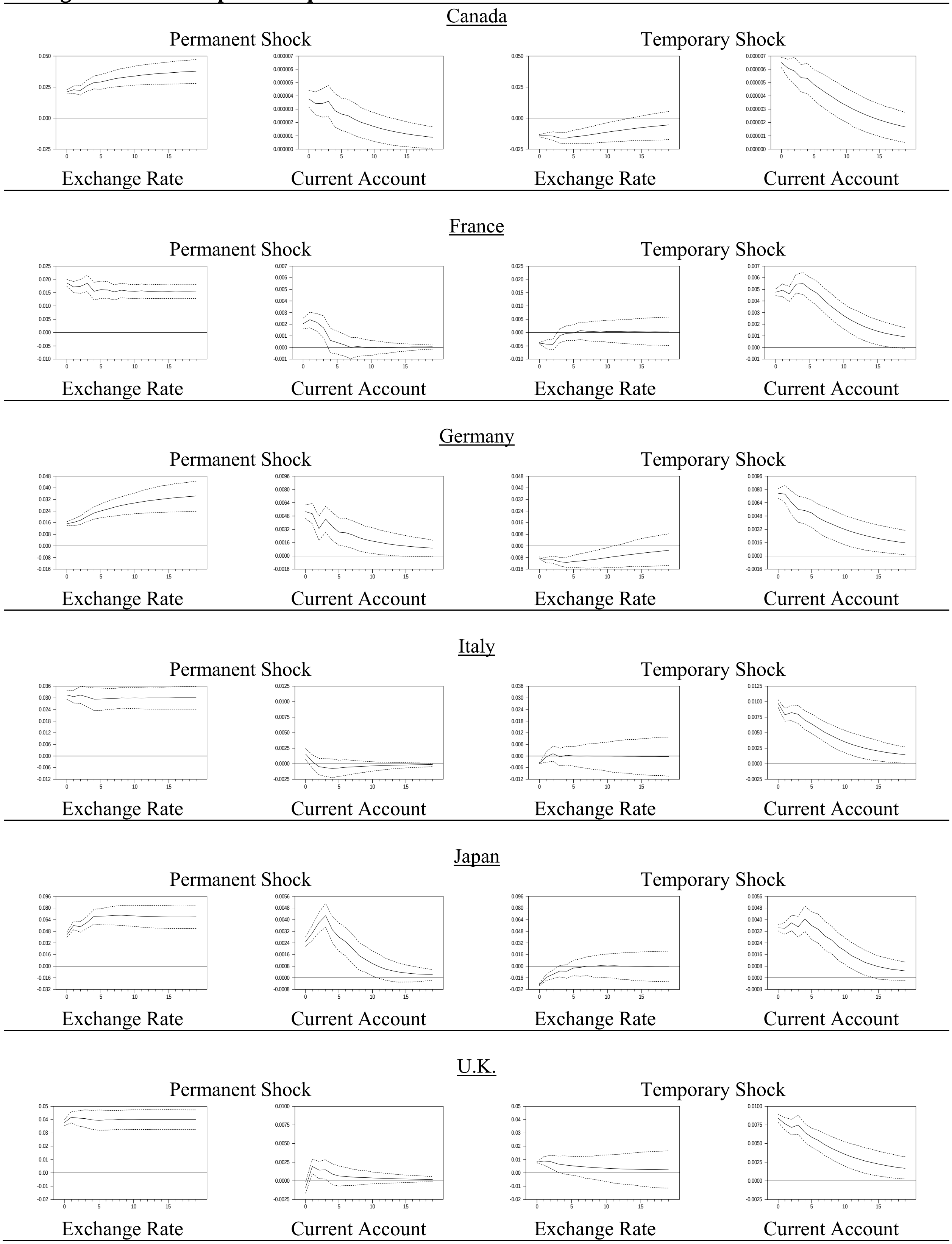


Figure 3.3 The Impulse Responses of Model 1 continued

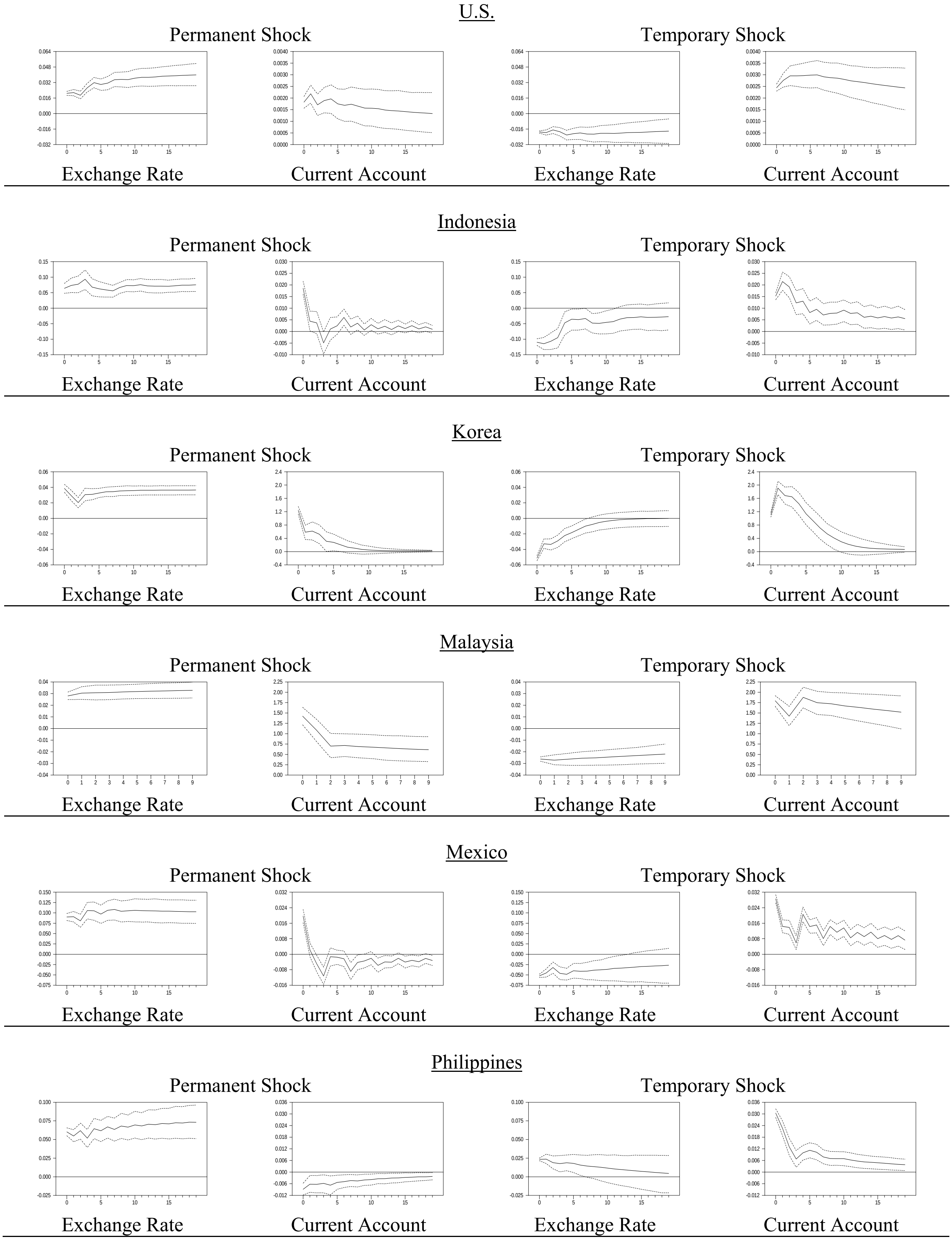
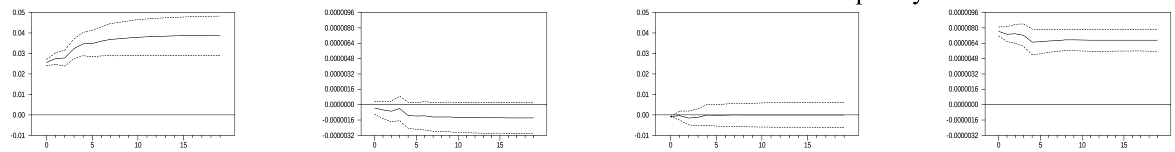


Figure 3.4 The Impulse Responses of Model 2

Canada

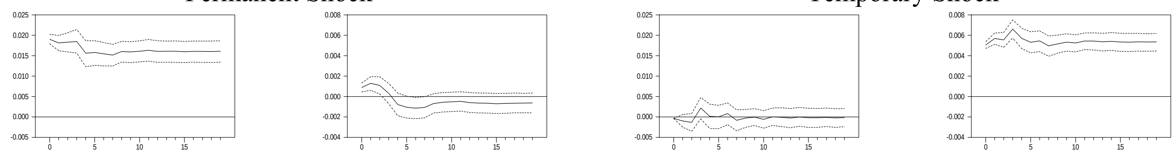
Permanent Shock Temporary Shock



Exchange Rate Current Account Exchange Rate Current Account

France

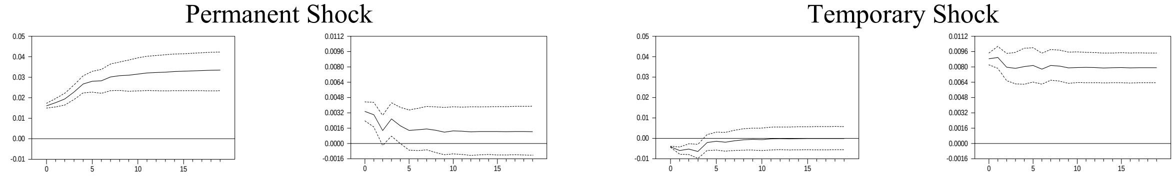
Permanent Shock Temporary Shock



Exchange Rate Current Account Exchange Rate Current Account

Germany

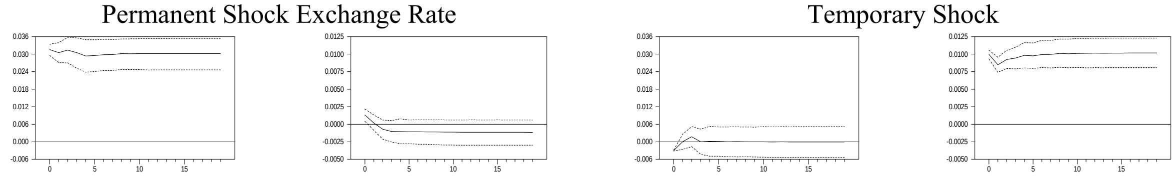
Permanent Shock Temporary Shock



Exchange Rate Current Account Exchange Rate Current Account

Italy

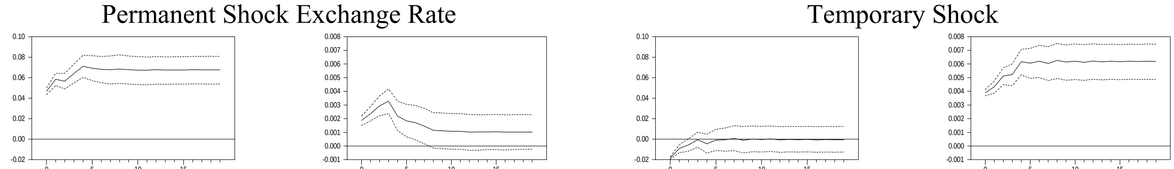
Permanent Shock Exchange Rate Temporary Shock



Exchange Rate Current Account Exchange Rate Current Account

Japan

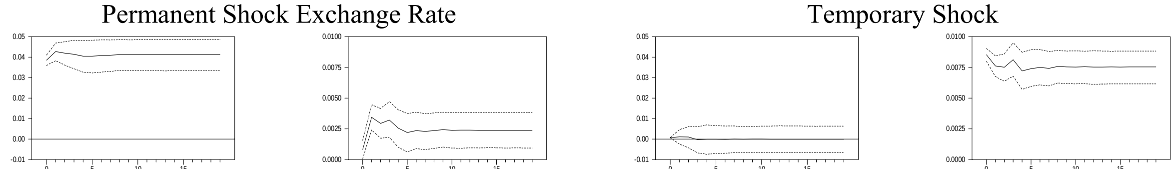
Permanent Shock Exchange Rate Temporary Shock



Exchange Rate Current Account Exchange Rate Current Account

U.K

Permanent Shock Exchange Rate Temporary Shock



Exchange Rate Current Account Exchange Rate Current Account

Figure 3.4 The Impulse Responses of Model 2 continued

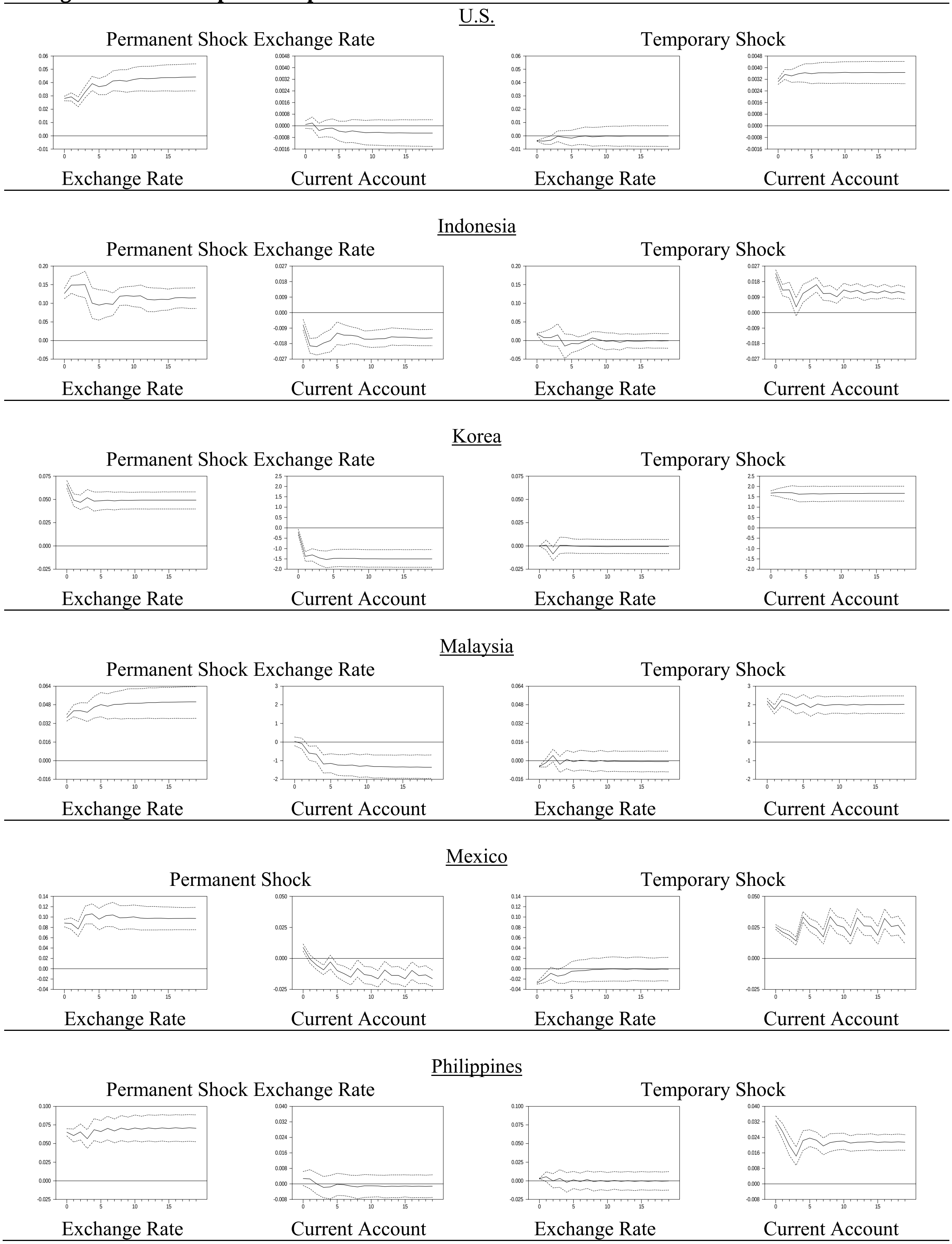


Figure 3.5 The Impulse Responses of Model 3

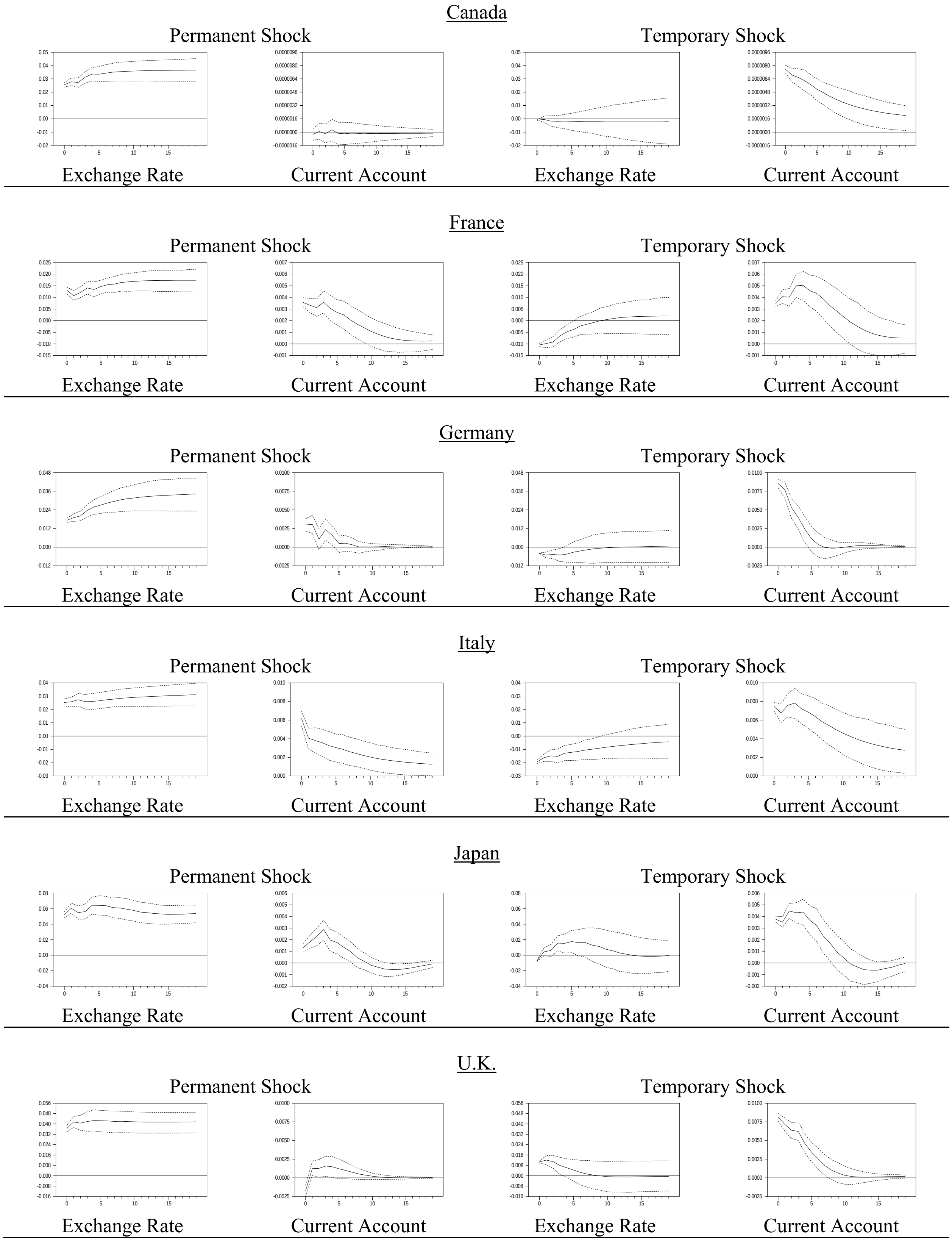


Figure 3.5 The Impulse Responses of Model 3 continued

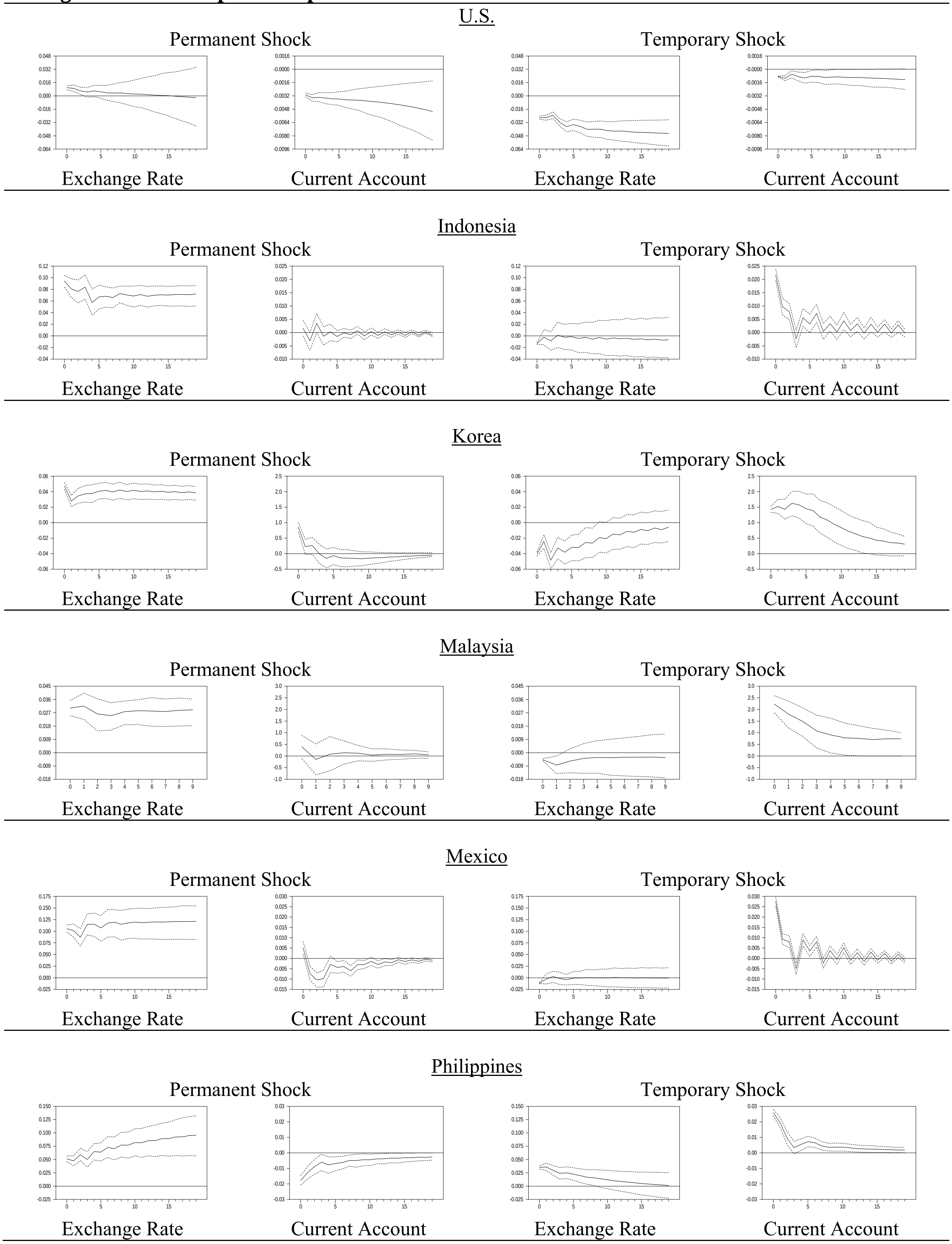


Table 3.1 Optimal Lag Length

	LR	AIC	AICC
Canada	6	1	1
Japan	4	5	2
The U.S	7	3	3
The U.K.	1	1	1
Germany	7	7	1
Italy	6	1	1
France	7	7	7
Korea	3	3	3
Mexico	5	5	5
Indonesia	4	4	1
Malaysia	1	3	1
The Philippines	5	8	1

Table 3.2 Unit Root Tests for the Real Exchange Rate

Country	ADF	PP	KPSS
Canada	-2.02 (6)	-1.48	1.97***
France	-2.35 (0)	-2.34	2.02***
Germany	-2.12 (6)	-2.68	0.58**
Italy	-2.49 (0)	-2.52	0.19
Japan	-2.25 (0)	-2.27	2.28***
United Kingdom	-1.69 (0)	-1.90	1.12***
United States	-3.00** (4)	-2.47	0.28
Korea	-3.11** (1)	-3.46	1.28***
Indonesia	-1.43 (0)	-1.47	2.65***
Malaysia	-0.76 (0)	-0.82	2.86***
Mexico	-2.35 (8)	-3.08	0.35
Philippines	-0.81 (6)	-1.71	2.12***

Note:
Augmented Dickey-Fuller (ADF) Test: Reported are the τ_μ test statistics The number in the parenthesis is the lag length used in each test . The Akaike Information Criteria is used for selection of the lag length. Critical values are 1%= -3.48, 5%= -2.88, and 10%= -2.58.

Phillips-Perron (PP) Test: Four lags are used in the tests. Critical values are 1%= -3.48, 5%= -2.88, and 10%= -2.58.

Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) Test: Four lags are used in the tests. Critical values are 1% = 0.739, 5%=0.46, and 10% = 0.32.

For all tests, we apply the same critical values since the sample sizes are close. ** (***) indicates significance at the 5 (1) percent level.

Table 3.3 Unit Root Test for the Current Account-GDP Ratio

Country	ADF	PP	KPSS
Canada	-2.34 (0)	-2.37	0.72**
France	-2.11 (4)	-2.39	0.68**
Germany	-2.34 (0)	-2.37	0.19
Italy	-2.86 (0)	-2.93**	0.86***
Japan	-3.03 (2)**	-2.61	0.38
United Kingdom	-2.61 (0)	-2.62**	0.65**
United States	-0.84 (1)	-0.72	1.69***
Korea	-3.27** (1)	-3.40**	0.79**
Indonesia	-2.29 (4)	-3.36**	0.26
Malaysia	-1.51 (3)	-1.23	1.22***
Mexico	-2.49 (8)	-3.69***	1.03***
Philippines	-2.03 (3)	-3.41**	0.21

Note: See note for Table 3.1 for details.

Table 3.4 Unit Root Test for the Capital Account-GDP Ratio

Country	ADF	PP	KPSS
Canada	-1.25 (7)	-7.81***	1.49***
France	-2.43 (3)	-10.04***	0.53
Germany	-2.15 (9)	-8.92***	0.30
Italy	-3.06 (9)**	-9.91***	0.26
Japan	-2.82 (2)*	-6.26**	0.27
United Kingdom	-3.39 (3)***	-11.01**	0.63**
United States	-1.31 (3)	-9.92**	1.68***
Korea	-7.81 (0)***	-7.87**	0.09
Indonesia	-4.20 (0)***	-4.29**	0.51**
Malaysia	-2.27 (13)	-5.07**	0.15
Mexico	-1.95 (3)	-6.47**	-1.43
Philippines	-2.44 (3)	-7.70**	0.28

Note: See note for Table 3.1 for details

Table 3.5 Cointegration Tests

	CI1 (CAR, RER)			CI2 (CAR, RER, KAR)		
		-2.66			-3.05	
Canada	1%	5%	10%	1%	5%	10%
	-3.98	-3.38	-3.08	-4.40	-3.80	-3.50
		-2.14			-2.95	
France	1%	5%	10%	1%	5%	10%
	-3.98	-3.38	-3.08	-4.41	-3.81	-3.50
		-2.76			-2.69	
Germany	1%	5%	10%	1%	5%	10%
	-4.00	-3.39	-3.08	-4.43	-3.82	-3.51
		-2.63			-2.75	
Italy	1%	5%	10%	1%	5%	10%
	-3.98	-3.38	-3.08	-4.40	-3.80	-3.50
		-2.65			-1.98	
Japan	1%	5%	10%	1%	5%	10%
	-3.98	-3.38	-3.08	-4.41	-3.81	-3.50
		-1.82			-1.86	
The United Kingdom	1%	5%	10%	1%	5%	10%
	-3.98	-3.38	-3.08	-4.40	-3.80	-3.50
		-3.11*			-2.68	
The United States	1%	5%	10%	1%	5%	10%
	-3.98	-3.38	-3.08	-4.41	-3.81	-3.50
		-3.92**			-2.94	
Korea	1%	5%	10%	1%	5%	10%
	-3.98	-3.38	-3.08	-4.42	-3.82	-3.51
		-2.84			-3.26	
Indonesia	1%	5%	10%	1%	5%	10%
	-4.08	-3.44	-3.11	-4.53	-3.88	-3.55
		-1.54			-2.12	
Malaysia	1%	5%	10%	1%	5%	10%
	-4.01	-3.40	-3.09	-4.90	-4.08	-3.70
		-4.22***			-4.17**	
Mexico	1%	5%	10%	1%	5%	10%
	-4.01	-3.40	-3.09	-4.44	-3.83	-3.52
		-2.69			-2.53	
Philippines	1%	5%	10%	1%	5%	10%
	-4.01	-3.40	-3.09	-4.44	-3.83	-3.52

Note:
The Engle-Granger Cointegration test is used for cointegration analysis. The critical values are for cointegrating relation with a constant term. ** (***) indicates significance at the 5 (1) percent level.
The critical values are obtained from MacKinnon (1991).

Table 3.6 Granger Causality test on CAR and RER

	Dependent variables	Lagged variables (Bilateral)		Lagged variables (Multivariate)	
		RER	CAR	RER	CAR
Canada	RER		0.15 (0.96)		0.12 (0.97)
	CAR	2.37 (0.06)*		2.22 (0.07)*	
France	RER		0.83 (0.51)		1.30 (0.27)
	CAR	1.50 (0.20)		1.06 (0.38)	
Germany	RER		0.29 (0.88)		0.39 (0.82)
	CAR	2.28 (0.07)*		2.19 (0.08)*	
Italy	RER		0.56 (0.69)		0.49 (0.75)
	CAR	0.91 (0.46)		1.30 (0.28)	
Japan	RER		5.32 (0.00)***		2.64 (0.04)**
	CAR	1.03 (0.39)		1.69 (0.16)	
U.K.	RER		0.14 (0.97)		0.32 (0.86)
	CAR	3.66 (0.01)***		3.83 (0.01)***	
U.S.	RER		0.47 (0.76)		0.49 (0.74)
	CAR	2.12 (0.08)*		2.60 (0.04)**	
Korea	RER		1.22 (0.30)		2.16 (0.08)*
	CAR	16.82 (0.00)***		4.46 (0.00)***	
Indonesia	RER		1.33 (0.27)		0.89 (0.48)
	CAR	7.53 (0.00)***		1.476 (0.22)	
Malaysia	RER		2.27 (0.07)*		2.20 (0.13)
	CAR	2.06 (0.09)*		0.86 (0.51)	
Mexico	RER		1.34 (0.26)		0.99 (0.42)
	CAR	5.43 (0.00)***		4.78 (0.00)***	
Philippines	RER		0.84 (0.50)		1.24 (0.30)
	CAR	0.23 (0.92)		0.40 (0.81)	

Table 3.7 The Variance Decomposition with Model 1

	Exchange Rate				Current Account			
	Permanent		Temporary		Permanent		Temporary	
	4	12	4	12	4	12	4	12
Canada	99.74	99.77	0.26	0.23	0.12	0.24	99.88	99.76
France	95.74	98.18	4.25	1.81	14.80	7.24	85.20	92.75
Germany	75.93	85.39	24.06	14.60	31.17	29.01	68.83	70.98
Italy	99.58	99.84	0.41	0.15	1.15	1.20	98.84	98.79
Japan	96.88	95.44	3.11	4.55	21.43	19.39	78.56	80.60
U.K.	96.27	98.02	3.72	1.98	3.60	2.78	96.39	97.21
U.S.	58.65	70.04	41.34	29.95	31.58	27.17	68.42	72.82
Korea	40.34	66.62	59.65	33.37	19.36	15.17	80.64	84.83
Indonesia	34.08	49.39	65.91	50.60	25.04	21.01	74.95	78.98
Malaysia	55.60	61.82	44.39	38.17	26.63	19.55	73.36	80.44
Mexico	80.74	85.34	19.25	14.65	30.39	20.16	69.60	79.83
Philippines	87.58	92.95	12.41	7.04	10.34	14.20	89.66	85.79

Chapter Four

Purchasing Power Parity and Half Life: Another Look

4.1 Introduction

Purchasing power parity (PPP) is one of the most important building blocks in modeling an open economy. It has been studied in a voluminous literature. An emerging consensus after decades of extensive research is that the real exchange rate is stationary but its mean reversion takes an implausibly long time. Studies by Frankel (1986), Abuaf and Jorion (1990), Diebold, Husted, and Rush (1991), Cheung and Lai (1994), and Lothian and Taylor (1996) all reach a similar conclusion. Their estimates of the half-life of the PPP deviations fall between 3 and 5 years.[34] Rogoff (1996) calls the lengthy half-lives in the presence of a high degree of exchange rate volatility "the PPP puzzle." This is puzzling because real shocks cannot account for the majority of the short-run volatility of real exchange rates while nominal or monetary shocks can only have strong effects over a time frame during which wages and prices are sticky. The half-lives of monetary shocks under nominal rigidity would be predicted 1 to 2 years (Rogoff, 1996).

More recent research examines various aspects of the half-life measurement including uncertainty about point estimates (Rossi, 2005), the bias associated with inappropriate aggregation across heterogeneous coefficients (Taylor, 2001), time aggregation of commodity prices (Imbs et al., 2005), and downward bias in estimates of dynamic lag coefficients (Choi et al., 2006). Chortareas and Kapetanios (2005) propose an alternative measure which focuses on the cumulative effects of the shocks. Some are able to find that half-lives are shorter than the "consensus" while others merely confirm the consensus or show that the half-life is even longer. It would be fair to say that the puzzle largely remains unresolved.[35]

In this paper, we investigate the PPP puzzle and the long-run mean reverting behavior of the real exchange rate in its six alternative definitions. We consider the trade-weighted effective real exchange rate as well as the bilateral rate vis-à-vis the US dollar while using both the CPI and the WPI as price indices. We compare the conventional univariate tests and the panel tests. In panel tests, we employ both the test of Levine, Lin, and Chu (LLC, 2002) and the more recent test by Im, Pesaran, and Shin (IPS, 2003). In addition, we investigate the behavior of the relative price of traded goods to nontraded goods and the impact of the Balassa-Samuelson effect on the real exchange rate using the *Penn World Table* (PWT) data.

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[34] The half-life in the above studies is 4.6 years in Frankel (1986), 3.3 years in Abuaf and Jorion (1990), 6 years for dollar-sterling and 3 years for franc-sterling in Lothian and Taylor (1996).
[35] Nonlinear models are not considered in this brief literature survey.

The rest of this paper is organized as follows. Section 2 reviews the six alternative definitions of the real exchange rate and the data used to generate them. Section 3 discusses the empirical methodology and estimation results. Section 4 ends with concluding remarks.

4.2 The Definitions of the Real Exchange Rate

Annual data from 1974 to 2003 are collected for 27 industrial countries and emerging market economies in East Asia and Latin America, yielding between 511 and 811 observations depending on the definition of the real exchange rate. Data for the nominal exchange rates, CPI and WPI for each country are obtained from *International Financial Statistics* (IFS) and the PPP data set is from the PWT.

We consider six alternative definitions of the real exchange rate. The first index of the real exchange rate, RX1, is obtained in the following way.

$$q_t = e_t - p_t + p_t^*$$

e_t is the nominal bilateral exchange rate against the US dollar (an increase thus means a depreciation of the domestic currency), p_t is the domestic CPI and p_t^* is the US CPI.[36] All variables are in logarithm.

The second index, RX2, is the trade-weighted real effective exchange rate. It is obtained as the trade-weighted average of the bilateral real exchange rates as defined in RX1. The weights are calculated for five major trading partners during the period from 1985 to 1987, based on the total volume of trade, the data for which are from the *Direction of Trade Statistics* (DOT). The third and the fourth indices of the real exchange rate (RX3, RX4) are defined in a way similar to the first and the second, with the CPI replaced by the WPI. When the WPIs of trade partners are not available, we use the CPIs instead.

RX5 is defined as the relative price of tradables to non-tradables in the country. It is defined as,

$$q_t = p_t^T - p_t^N = e_t + p_t^{T*} - p_t^N$$

where the p_t^{T*} stands for the international prices of tradables and p_t^N is the domestic prices of nontradables. Following the tradition, we employ the CPI of the domestic country and the WPI of the base country as the proxy for the price of nontradables and the foreign price of tradables, respectively. (Edwards, S., 1989; Chowdhury, 2004)

[36]As the domestic CPI is not available for Bangladesh, Brazil, and Germany, the GDP deflator is used.

The sixth index of the real exchange rate, RX6, is constructed by the PPP ratio obtained from the PWT and the bilateral dollar exchange rate. The PPP ratio is defined as "the number of currency units required to buy goods equivalent to what can be bought with one unit of the base country. That is, the national currency value of GDP divided by the real value of GDP in international dollars".[37] It is thus similar to the ratio of the domestic and the foreign price indices. The main difference is that, unlike the CPIs or the WPIs that use each country's own weighting systems, both indices are calculated using the same weighting scheme. Thus, using them helps reduce an important source of the index number problem that is inherent in the PPP study. RX6 is obtained by dividing the PPP ratio by the actual nominal exchange rate.

4.3 Empirical Results

4.3.1 The Unit-Roots Tests

We first perform unit-root tests using the augmented Dickey-Fuller test (ADF). The lag length for the ADF test is selected by the Akaike Information Criterion (AIC). The results of these univariate unit-root tests are in Table 4.1. They indicate that we cannot reject the null of nonstationarity with the RX1 index for any country at the 5 percent significance level. With the other definitions, only a small number of cases support that the real exchange rate is stationary. With the ADF test, we are able to find some more cases that support PPP. Nevertheless, the evidence does not seem to be overwhelming enough to reject the nonstationarity of the real exchange rate and accept PPP. These results are consistent with what has been reported in numerous studies including Messe and Rogoff (1988), Lothian and Taylor (1994), and Taylor (2002).

Table 4.1 here

Frankel (1986), Froot and Rogoff (1995), and Lothian and Taylor (1996) attribute the failure of PPP to the low power of the test. One approach to improve the power of PPP testing is to use a longer data span as in Frankel (1986), Abuaf and Jorion (1990), Kim (1990), Lothian and Taylor (1996), Frankel and Rose (1996), and Taylor (2002). Another approach is to use panel data as in, Oh (1996), Wu (1996), and Lothian (1997). Oh (1996) and Wu (1996) employ the test developed by LLC (2002). It may be viewed as a pooled ADF test in which all the first-order autoregressive coefficients of the unit-root tests are assumed to be equal and have a standard normal distribution. The more recent test developed by IPS (2003) relaxes the strong restriction of the equality of the first-order autogressive coefficients as in the LLC test and pools separate cross-section

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[37] An international dollar has the same purchasing power over total US GDP as the US dollar in a given base year (PWT data appendix in Summers and Heston, 1991).

estimates.[38] The $\bar{t}$ statistic of the IPS test is the simple mean of the t-statistics from univariate regressions for individual countries.[39] We apply both the LLC and the IPS panel unit-roots tests. We estimate two models: one without lags, AR(1), and one with optimal lag selected by the AIC, AR(p).[40]

Table 4.2 here

Table 4.3 here

Tables 4.2 and 4.3 provide the empirical results of the two panel unit-root tests. Table 4.2 shows that the t-statistic from the LLC test provides no support for PPP at the 5 percent significant level whether we employ the AR(1) or AR(p) assumption. Also all estimated first-order auto regressive coefficients are greater than 0.7 and close to 1, implying near-nonstationarity of the real exchange rate. In a remarkable contrast, Table 4.3 presents strong evidence for the stationarity of the real exchange rate in all six definitions. First of all, under the assumption of the AR(1) model, we can reject the null at the 5 percent significance level with the $\bar{t}$ statistic in all cases. With an optimal lag length for each country, we can reject the null of nonstationarity for all real exchange rate indices using either statistic at the 5 percent significant level. This suggests that the power and the efficiency of the test clearly matters when testing for PPP. These IPS test results are consistent with results in Wu and Wu (2001).

Another interesting finding is that the null hypothesis is more strongly rejected with the WPI-based real exchange rates (RX3 and RX4) than with the CPI-based ones (RX1 and RX2). This finding is in line with our expectation and previous findings such as those of Kim (1990), Froot and Rogoff (1995), and Wu (1996). Somewhat surprisingly, there is a weaker support for PPP with the trade-weighted real exchange rates than with the bilateral ones whether the real exchange rate is defined with the CPI or the WPI.[41]

4.3.2 The Half-life of Deviations from PPP

The autoregressive representation of the real exchange rate can be used to compute the half-life – the time period for a shock to decay to half of its initial size. Table 4.4 presents the

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[38] Both tests also assume that countries are cross section independent.

[39] See Fleissig and Strauss (2001). In other words, $\bar{t} = (\sum_{i=1}^{N} t_i)/N$, where $t_i = \gamma_i / \sqrt{Var(\gamma_i)}$ and γ_i is the first-order autoregressive coefficient of each country i. The $Z_{\bar{t}}$ statistic, $Z_{\bar{t}} = \sqrt{N(\bar{t}-\mu)}/\sigma$, of the IPS test is distributed as standard normal where $E(t_i) = \mu$, $Var(t_i) = \sigma^2$.

[40] We use Matlab for the IPS tests with the maximum lag length for the AR(p) model restricted to six.

[41] The reason for this finding is not immediately clear. It might be that countries target their real exchange rate against the US dollar and try to keep it stable for international competitiveness or other reasons.

estimates of half-life for individual countries obtained with the AR(p) model.[42] Following Cecchetti *et al*., (2002) and Murray and Papell (2002), we report the mean and median of half-life estimates.[43] The presence of outliers and negative estimates in the case of RX2 and RX5 suggests that the mean is a less reliable guide than the median as a summary statistic.

Table 4.4 here

The results indicate, first of all, in all cases except RX6, the median of the estimated half-life is shorter than 3 years. In the case with RX3, it is less than 2 years. Even with RX6, which has the longest median, it is less than 4 years. Second, the half-life for RX3 is shorter than that for RX1 in the majority of cases. The median is also considerably shorter for RX3 than for RX1. It is consistent with the conventional results that show that PPP holds better with the WPI than with the CPI. Third, the traded-weighted real exchange rates (RX2 and RX4) show longer half-lives and slower convergence than the bilateral rates in most sample countries regardless of the definition of the real exchange rate. For instance, the half-life is longer (shorter) with RX2 than with RX1 in 18 (9) cases. The half-life is longer (shorter) with RX4 than with RX3 in 14 (4) cases.

Fourth, the half-life for RX6 appears somewhat longer than for RX1 or RX3. The table that the half-life is longer (shorter) with RX6 than with RX1 in 19 (8) cases and with RX3 in 15 (3) cases. To the extent that RX6 eliminates some biases due to index number problems arising from using the price indices reported by individual countries, this result seems to suggest that biases and index number problems may not be a major reason for the failure of PPP as reported in previous studies.

4.4 Conclusion

In this paper we have re-examined the PPP hypothesis with various definitions of the real exchange rate for the post-Bretton Woods period of floating exchange rates. Some of important findings of this paper can be summarized as follows: 1) PPP holds better and the half-life of the real exchange rate is shorter when the WPI rather than the CPI is used as the price index; 2) Somewhat surprisingly, there is no evidence that PPP holds better with trade-weighted real exchange rates than with bilateral ones regardless of the price index used; 3) In general, we are unable to reject the unit-root null in univariate tests. Strong evidence for PPP emerges only with

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[42] In the case of the simple AR(1) process, the half-life can be obtained as $\ln(1/2)/\ln(\gamma+1)$, which is the solution to T in the equation $(\gamma+1)^T = 0.5$ where γ is the estimated first-order autoregressive coefficient. For higher autoregressive models, the measurement of half-life is more complicated. Rossi (2005) suggests that the half-life be calculated by $\ln(1/2)b(1)/\ln(\gamma+1)$ where $b(1)$ is the sum of the estimated AR coefficients.

[43] For the IPS test, Cecchetti *et al*., (2002) average half-life across individual countries.

the use of IPS panel tests. In marked contrast, the LLC panel tests provide no evidence on PPP, perhaps due to its homogeneity restriction on the parameter; 4) We find the median of half-live estimates to be less than 3 years, which shorter than the current consensus; 5) Finally, the half-life with estimated the IPS method is shorter than 3 years in all cases except RX6. This is shorter than 3-5 years as surveyed in Rogoff (1996) although, in most cases, still longer than the 1-2 years estimates from models incorporating sticky prices.

Table 4.1 Results of the Augmented Dickey-Fuller Unit Roots Test

Countries	RX1	RX2	RX3	RX4	RX5	RX6
Argentina	-2.22 (2)	-2.36 (1)	-	-	-	-1.78 (1)
Algeria	-0.38 (0)	-0.35 (0)	-	-	-	-0.59 (0)
Australia	-2.57 (1)	-2.01 (0)	-3.06** (1)	-2.33 (0)	-2.79 (1)	-1.76 (0)
Bangladesh	3.74**(8)	-2.71 (0)	-	-	-	-1.07 (8)
Brazil	-2.03 (0)	-1.95 (0)	-1.80 (0)	-1.80 (0)	-1.95 (0)	-3.27** (2)
Canada	-2.23 (1)	-1.78 (0)	-3.09** (1)	-3.15** (1)	-1.72 (1)	-1.74 (3)
Chile	-2.69* (8)	-1.99 (7)	-2.43 (8)	-1.67 (7)	-4.14*** (5)	-2.74 (7)
Colombia	-2.39 (3)	-0.78 (2)	-1.92 (3)	-0.30 (4)	-3.73*** (5)	-1.80 (3)
Denmark	-3.03** (1)	-0.80 (7)	-2.64* (1)	-2.28 (2)	-2.13 (1)	-2.64 (1)
Egypt	-0.69 (6)	-1.31 (1)	-2.04 (1)	-0.65 (0)	-2.74* (5)	-0.70 (6)
Finland	-2.86* (1)	-2.24 (1)	-2.78* (1)	-1.04 (0)	-2.56 (1)	-2.80 (1)
France	-3.20** (1)	-2.71* (1)	-	-	-	-2.91* (1)
Germany	-3.50** (4)	-3.02** (5)	-	-	-	-2.67* (1)
Greece	-2.83* (1)	-1.25 (0)	-0.90 (8)	-3.67** (8)	-0.84 (2)	-1.43 (0)
Hungary	-0.25 (0)	1.62 (7)	-1.21 (0)	-1.00 (0)	0.24 (0)	-1.11 (1)
India	-1.80 (4)	-1.75 (0)	-1.05 (1)	-1.39 (0)	-2.11 (0)	-0.99 (4)
Indonesia	-1.71 (3)	-2.14 (7)	-1.06 (2)	-1.63 (7)	-2.00 (3)	-1.47 (0)
Ireland	-2.90* (1)	-2.00 (0)	-2.95* (1)	-0.96 (1)	-1.29 (0)	-1.49 (0)
Italy	-3.15** (1)	-2.62 (2)	-	-	-	-1.68 (0)
Korea	-2.88* (1)	-2.67 (0)	-2.54 (0)	-0.78 (2)	-3.32** (2)	-2.64 (2)
Mexico	-0.44 (8)	-0.46 (8)	-0.99 (8)	-0.98 (8)	-0.12 (8)	-2.56 (1)
Netherlands	-4.03*** (4)	-2.11 (8)	-2.93* (1)	-2.96** (8)	-2.64* (1)	-2.86* (1)
New Zealand	-3.50** (1)	-2.44 (5)	-2.93 (1)	-3.52** (1)	-2.29 (1)	-4.65*** (1)
Norway	-3.01** (2)	-3.42** (2)	-2.34 (0)	-3.09** (8)	-1.50 (0)	-2.74* (1)
Portugal	-2.25 (1)	-0.65 (0)	-	-	-	-1.67 (1)
Sweden	-3.38 (4)	-1.96 (0)	-3.48** (4)	-2.76* (1)	-2.76* (1)	-3.13** (2)
Thailand	-1.73 (0)	-1.12 (1)	-2.63* (0)	-1.68 (1)	-3.44*** (0)	-1.05 (0)

Table 4.2 Estimation Results with the LLC (2002) Test

	With AR(1) Assumption		With AR(p) Assumption	
	t-statistic	Coefficient	t-statistic	Coefficient
RX1	3.67	0.8431	0.71	0.8136
RX2	1.30	0.9145	1.13	0.9153
RX3	3.25	0.7897	2.21	0.7685
RX4	1.77	0.9294	1.50	0.9273
RX5	4.42	0.8288	2.08	0.7936
RX6	1.23	0.8531	-1.59*	0.8384

***** Note: The critical values are -2.32 (1 percent), -1.64 (5 percent), and -1.28 (10 percent). The maximum lag is set to six for the AR(p) model.

Table 4.3 Estimation Results with the IPS (2003) Panel Unit-Roots Test

	With AR(1) Assumption		With AR(p) Assumption	
	$\bar{t}$ statistic	$Z_{\bar{t}}$ statistic	$\bar{t}$ statistic	$Z_{\bar{t}}$ statistic
RX1	-1.82***	-1.72**	-2.15***	-3.63***
RX2	-1.86***	-1.93**	-1.81***	-1.68**
RX3	-2.10***	-2.86***	-2.40***	-4.26***
RX4	-1.89***	-1.78**	-1.98***	-2.21**
RX5	-1.74**	-1.10	-2.09***	-2.84***
RX6	-1.78**	-1.49*	-2.11***	-3.40***

* Note: This test is for 27 countries for RX1, RX2 and RX6, 20 countries for RX5 and 19 for RX3, RX4. The critical values for t-test are -1.80 (1 percent), -1.73 (5 percent), and -1.69 (10 percent). The critical values for z-test are -2.33 (1 percent), -1.64 (5 percent), and -1.28 (10 percent). The maximum lag is set to six for the AR(p) model.

Table 4.4 Half-life with the IPS Estimation with the AR(p) Model

Country	RX1	RX2	RX3	RX4	RX5	RX6
Algeria	32.66	31.74	-	-	-	15.33
Argentina	1.18	1.06	-	-	-	0.88
Australia	2.48	3.36	1.62	1.94	1.48	3.86
Bangladesh	5.91	1.54	-	-	-	10.04
Brazil	2.48	2.74	2.61	2.68	2.51	4.92
Canada	4.13	4.02	1.70	1.54	4.55	3.79
Chile	3.32	2.84	-	1.58	2.08	3.39
Colombia	5.28	84.18	6.57	121.26	3.11	9.60
Denmark	1.68	1.56	2.12	1.56	3.18	2.26
Egypt	4.44	9.74	3.41	12.12	1.79	3.71
Finland	1.86	3.11	2.14	7.97	2.84	2.00
France	1.57	1.73	-	-	-	1.77
Germany	1.93	2.42	-	-	-	2.12
Greece	2.16	4.48	1.69	1.36	5.22	4.49
Hungary	24.59	-2.10	8.25	8.81	-40.18	8.02
India	9.05	10.03	7.92	11.56	4.31	14.15
Indonesia	8.33	8.56	2.34	3.30	4.85	4.61
Ireland	1.87	2.20	1.76	3.32	4.71	3.60
Italy	1.39	2.32	-	-	-	3.36
Korea	1.09	1.22	1.32	1.94	0.95	2.66
Mexico	1.29	1.27	2.55	2.57	1.95	2.35
Netherlands	1.53	1.97	1.54	7.14	1.95	1.65
New Zealand	1.03	5.08	1.26	0.81	2.35	1.40
Norway	2.30	1.27	-	-	3.61	1.94
Portugal	3.10	7.01	-	-	-	5.95
Sweden	2.94	2.97	1.23	2.42	1.93	1.94
Thailand	2.91	4.27	1.36	1.94	0.72	7.01
Mean	**4.91**	**7.43**	**2.85**	**10.31**	**0.70**	**4.70**
Median	**2.48**	**2.84**	**1.94**	**2.57**	**2.43**	**3.60**

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