The Effectiveness of Implementing Sterilization for Thailand, Indonesia, the Republic of Korea and Malaysia after the Asian Financial Crisis

by

YI-YU (Kelly) Lin

Claremont Graduate University

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APPROVAL OF THE REVIEW COMMITTEE

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Dr. Thomas Willett, Chair

Claremont Graduate University

Horton Professor Economics and Director of the Claremont Institute for Economic Studies

Dr. Arthur Denzau

Claremont Graduate University

Professor of Economics

Dr. Levan Efremidze

Claremont Graduate University

Assistant Professor of Economics

Abstract

The Effectiveness of Implementing Sterilization for Thailand, Indonesia, the Republic of Korea, and Malaysia after the Asian Financial Crisis

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This dissertation considers the effectiveness of implementing sterilization of capital inflows for Thailand, Indonesia, the Republic of Korea, and Malaysia after the Asian financial crisis. If they are not fully sterilized, capital inflows result in the increase of the money supply. This increase of the money supply leads to credit expansion. The increase of the money supply from capital inflows would additionally affect the money market and credit market. This dissertation also investigates whether capital inflows lead to expansions of credit over and beyond their effects on the money supply, that is, whether they cause the credit multiplier to increase.

This dissertation applies Granger's error correction model (ECM), which is based on the macroeconomic framework for an open economy. The co-integration equation specifies the multivariate time series model as a monetary response functions to investigate the impacts of exogenous shocks. This dissertation also applies Chow's dummy variable approach to the ECM. If dummy variables are significant, a structural change in the economy occurs because of the shocks. The additive dummy variables respond to the impacts of the exogenous shocks. The multiplicative dummy variables respond to the impacts of shocks induced by domestic policies.

By taking the first difference of endogenous variables to make these variables stationary, this dissertation also applies the previously used ordinary least squares (OLS) methodology to

estimate the value of the sterilization coefficient and offset coefficient. The impulse response functions are the same as the monetary response functions, which provide information on the impacts of shocks on current and future values of the endogenous variables in the system. Thus, this dissertation will compare the results from the OLS methodology and from the impulse response functions. Because the error terms of OLS models are not white noise, serial correlation can be found in the errors, which means the models are spurious. Consequently, we adopt the results of the ECM instead. This dissertation demonstrates the degrees of sterilization and capital mobility for four East Asian countries in particular. This dissertation finds perfect sterilization in Thailand and Malaysia under high capital mobility. However, in Korea, it finds a high degree of sterilization under high capital mobility, and, in Indonesia, a medium degree of sterilization under a medium degree of capital mobility. It finds there is no significant relationship between the money supply and money multiplier, and that the credit multiplier does not increase in the face of capital inflows when governments implement efficient sterilization policies.

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Chapter 1: Introduction

Massive capital inflows can result in overheating and financial fragility. Sterilization is a common response to capital inflows, and sterilization policy combines monetary policy and exchange rate policy. East Asian countries are small ocean countries with high capital mobility and, when the Asian financial crisis hit Asia, it especially affected the East Asian countries of Thailand, Indonesia, Malaysia, and the Republic of Korea. Before the Asian financial crisis, Asian countries operated under fixed exchange rate regimes with imperfect capital mobility. After the Asian financial crisis, these countries adopted flexible exchange rate regimes in part to reduce the market risks of high capital mobility.

When sterilized intervention in the foreign exchange market occurs, a government purchases foreign currency to avoid the appreciation of its own currency, and it simultaneously issues domestic bonds to eliminate the impact of growing reserves on its monetary base. The purpose of sterilization is to control the growth of the money supply and inflation in the face of capital inflows. Sterilization in the face of massive capital inflow should avert overheating problems and control the growth of credit. Through prudential regulations, a credit boom and asset price bubbles can be avoided.

Purpose of the Study

This dissertation examines the effectiveness of sterilization for stabilizing the growth of money and credit in response to capital flows for four East Asian countries, namely Thailand, Indonesia, Malaysia, and the Republic of Korea. It examines sterilization in these four Asian countries from January 2002 to December 2010. To investigate the effectiveness of sterilization in the face of shocks, the error correction model (ECM) with a dummy variable approach is adopted.

The ordinary least squares (OLS) methodology provides in-sample data analysis using the first difference of the data and makes the data stationary. The OLS analysis could be explained as using the sterilization coefficient and offset coefficient to capture the impacts of sterilization and capital mobility when the economic state does not deviate from the long-run equilibrium. The structural break analysis tests the sterilization coefficient and offset coefficient for consistency. The structural break analysis also provides the critical time point at which to impose the dummy variables on the transitional dynamics. This dissertation gives a detailed specification of this econometric model.

This dissertation contributes to the literature in three respects. First, it analyzes the effectiveness of sterilization and the growth of money in response to capital flows for the four East Asian countries of Thailand, Indonesia, Malaysia, and the Republic of Korea from January 2002 to December 2010. Second, it analyzes credit growth as well as money growth, whereas previous studies have focused only on money growth. Third, it uses more appropriate econometric techniques than used in previous studies and compares the results of these techniques with those from previous methods.

Chapter 1 introduces and outlines this dissertation. Chapter 2 reviews relevant previous literature and considers how this literature relates to the issue of sterilization. Chapter 3 provides economic background and data analysis that demonstrates that the macroeconomic framework is the foundation for model specification and shows how the nature of the data determines the selection of an econometric methodology. Chapter 4 introduces different econometric methodology for model specification and explains how a macroeconomic framework supports a co-integration equation. Chapter 5 demonstrates the econometric model specification for the sterilization coefficient and offset coefficient. Chapter 6 provides all the econometric results and empirical interpretations of economic activities related to sterilization and capital mobility. Chapter 7 concludes the study, summarizing its empirical results and making suggestions for related future research.

Chapter 2: Literature Review

The papers relevant to this study demonstrate the conditions necessary for implementing sterilization policy efficiently and describe the existing methodology for constructing the monetary response functions for the sterilization coefficient and offset coefficient. These papers are discussed as follows.

Frankel (1993) states that sterilization is more difficult if the level of government debt is already high; this level is captured using bonds stock as a determinant, along with other components of wealth and demand for money. According to Frankel, capital controls should be removed after domestic financial liberalization has been removed and not before. Capital mobility is high but not perfect due to the continued presence of certain capital controls, transaction costs, default risks, foreign exchange risks, or perceived risks of future capital controls. Sterilization entails a steadily increasing stock of domestic debt. The logic behind this is that, eventually, the debt-service will become increasingly expensive relative to the GNP. If the investment and money demand remain relatively unresponsive to the interest rate, the IS and LM curves respectively become steep. This can potentially cause market failures, and the country may become excessively indebted and vulnerable to a sudden reversal of confidence. Such market failures would call for credit measures to discourage capital inflows.

Laban and Larrain (1993) state that removing the restrictions on capital outflows eliminates the irreversibility of investing in domestic assets. This means that, under the assumptions that capital inflows are initially fully liberalized and foreign investors are risk neutral, the relaxation of capital outflows can lead to an increase in net capital inflows. The quasi-fiscal costs of sterilization are bound by the given exchange rate regime and degree of capital mobility.

Takagi and Esaka (1997) state capital inflows have both benefits and costs. Among the benefits, capital inflows promote investment and economic growth in recipient countries, allow smoothing of inter-temporal consumption, and thus raise welfare across countries. As for the costs, they may lead to a rapid monetary expansion, excessive rise in domestic demand and inflationary pressures, appreciation of the real exchange rate, and widening of current deficits. They may even increase the vulnerability of recipients to a sudden reversal in capital flows. Under narrowly defined sterilization, domestic interest rates rise to induce market participants to hold a greater amount of domestic assets willingly. Under broadly defined sterilization, domestic interest rates rise to clear the money market, given the restricted money supply. With the multiplicative dummy variables, the dummy indicates the intensity of sterilization. DUM is the dummy variable for the value of unity when sterilization is considered particularly intense. Sterilization is considered intense if open market operations are large in scale and accompanied by increased reserve requirements or transfers of government deposits from commercial banks to the central bank.

Montiel (1999) points out that, in exchange rate overvaluation, the domestic economic costs of a high interest rate from sterilization could cause currency crises in the presence of high capital mobility. Monteil (1999) also considers which policies might best address the overheating problem caused by capital inflows. According to him, it is helpful to be concrete about the source of the shock that triggers the inflow. Sterilization stabilizes the aggregate demand and efficiently prevents overheating (or a credit boom).This makes the conceptualization of credit transactions in the economy an important issue.

Christensen (2004) states that high-yielding sterilization bonds and credible, fixed exchange rate systems induce banks to borrow extensively from abroad and invest in domestic bonds. This means a sterilization game plays out between the commercial banks and monetary authorities. Sterilization policy could not be efficient without other macroeconomic policies to support it, and monetary authorities must enact appropriately tight fiscal policies. Christensen used VAR to specify the model used to capture the impacts of exogenous one-time shocks.

Ouyang, Rajan, and Willett (2006) undertook an empirical investigation to assess the extent of sterilization and capital mobility. They used monthly data from mid-1999 to late 2005 and found China has successfully sterilized most of its reserve increases. They applied a VAR model to trace the path of the various shocks on the variables over time and to construct monetary response functions for measuring the sterilization coefficient and offset coefficient.

Chapter 3: Economic Background and Data Analysis

Data Analysis

According to the Mundell-Flemming theory, a decrease in the foreign interest rate leads to an increase in capital inflows. Net foreign assets increase in the face of capital inflows, and a government has to sell the necessary amount of bonds (net domestic assets) to achieve sterilization and avoid inflation. This dissertation selects monthly and quarterly data from the International Financial Statistics (IFS) and U.S. Federal Reserve Bank. The research for this dissertation focuses on the impacts of East Asian countries' sterilization policies and capital motilities after the Asian financial crisis. The selected monthly data comes from between January 2004 and December 2010. Key terms and equations include the following:

NFA: net foreign assets of the central bank

NDA: net domestic assets of the central bank

EX: the nominal exchange rate (national currency/U.S. dollar)

LEX: logarithm of exchange rate

R_t: foreign interest rate

I_t: three-month U.S. T-Bill rate

NFA = NFA (NDA, M2, Q, EX, R, CPI, DC, FR)

NDA = NDA (NFA, M2, Q, EX, R, CPI, DC, FR)

$R_t = I_t + E(LEX_{t+1})$

Net domestic assets (NDA), net foreign assets (NFA), money supply (M2), consumer price index (CPI), domestic credit(DC),exchange rate (EX), and foreign reserves (FR) are selected from the IFS. The three month U.S. treasury bill rate is selected from the U.S. Federal Reserve’s Bank. Taking the logarithm of M2 and money multiplier of M2 (Q) ensure equal volatilities of these two variables within other variables (Shiler 1982). According to the definition of the error correction model (ECM), the economic variables grow in accordance with the time trend, and common economic transactions ensure a co-integration relationship among variables. Thus, the variables we select are not stationary, but the linear combination of the endogenous variables should be stationary. The first differences of these variables (NFA, NDA, LQ, LM2, and CPI) must be stationary. By using the Augmented Dickey-Fuller (ADF) test, we are able to test the stationarity of the data.

LQ: taking logarithm of M2 money multiplier

LM2: taking logarithm of M2

The net foreign assets (NFA) are equal to the foreign reserves time exchange rate minus the foreign liability. The NFA and foreign liabilities are in the national currency. The foreign reserves have been converted to domestic currency by multiplying them by the exchange rate, as follows:

NFA = Foreign Reserves ($) * EX (national currency/$) - foreign liabilities of the central bank

The net domestic assets (NDA) equal the monetary base (MB) minus the NFA:

NDA = MB - NFA

The money multiplier (Q) equals the money supply (M2) divided by the MB:

Q= M2/MB

The money multiplier (Q) is the most common mechanism used to measure this increase in the money supply. The money multiplier measures the actual monetary expansion. Domestic credit (DC) is regarded as the bank credit for the private sector. In order to apply the ECM, we have to assure the co-integration relationship between all variables, and the first difference of all variables must be stationary.

Concepts of Sterilization

Sterilization

Sterilization requires keeping the money supply as stable as possible and prevents unwanted changes in money supply.

1. MB = NFA +NDA; ΔMB = ΔNFA + ΔNDA

2. M2 is equal to MB multiplied by the money multiplier. M2 is the broad money supply that presents better economic activities.

M2 = Q*MB

M2 =M2 (NDA, NFA)

NFA= foreign assets *exchange rate – foreign liabilities of the central bank

The four East Asian countries this paper addresses are small nations with high capital mobility. In cases of high capital mobility, discussions of quasi-fiscal costs of sterilization are bound by the given exchange rate regimes, as the following section demonstrates.

Sterilization in response to capital inflows under a fixed exchange rate regime with high capital mobility

The foreign exchange market functions as follows: foreign reserves increase in accordance with the capital inflows (NFS increases and MS increases; LM shifts right), and the money supply increases. In the foreign exchange market, the capital inflows are denominated in foreign currency and acquired in exchange for national currency. They result in the appreciation of national currency. In order to maintain a fixed exchange rate, monetary authorities need to buy foreign reserves with national currency. Monetary authorities must also sell more domestic bonds to implement sterilization policy. Thus, the cost of sterilization under a fixed exchange rate regime is higher.

The money market: capital inflows will bring about excess money supply in the money market. The excess money supply will shift the LM curve to the right and lower the interest rate. It will also bring about inflation. The monetary authorities implement sterilization policy by selling domestic bonds to prevent interest rates from falling and avoid inflation caused by the excess money supply.

Sterilization responds to capital inflows under fixed exchange rate

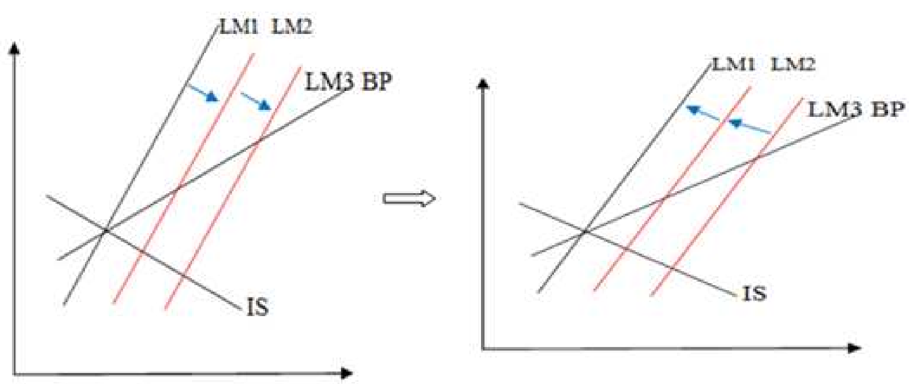


Figure 1 demonstrates sterilization under the fixed exchange rate regime with high capital mobility.

Sterilization in response to capital inflows under a floating exchange rate regime with high capital mobility

As stated above, because the foreign reserves increase in accordance with the capital inflows (NFS and MS increase. while LM shifts right), and the money supply increases, the demand for national currency in the foreign market increases due to the capital inflows. This then leads to the appreciation of national currency. Under the sterilization policy, the monetary authorities sell domestic bonds to maintain the quasi-fixed money supply (NDA decreases; ΔNDA = ΔNFA). Money supply decreases because of sterilization and the LM curve shifts left. Because the monetary authorities sell fewer bonds to implement sterilization under a floating exchange rate regime, the cost of implementing sterilization should be lower than it is under a fixed exchange rate.

In the money market, capital inflows will bring about excess money supply. This excess supply will lead to inflation. Under sterilization policy, the excess money supply will be reduced through bond sales, and the pressure of inflation should be released.

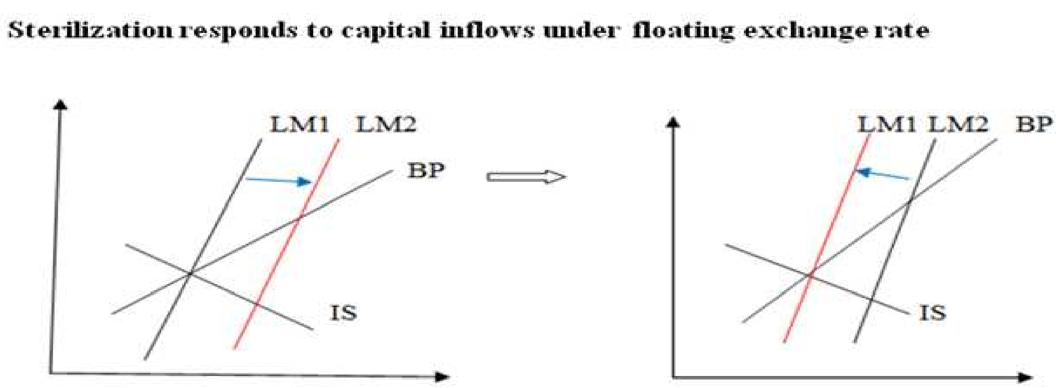


Figure 2 demonstrates sterilization under a floating exchange rate regime with high capital mobility.

The quasi-fixed cost is the cost of monetary authorities exchanging high yielding domestic bonds for low yielding foreign reserves. The quasi-fixed cost of sterilization includes both the physical cost of selling domestic bonds and the opportunity cost of playing the sterilization game. As expected, the quasi-fixed cost is higher under a fixed exchange rate regime than under a floating exchange rate regime.

Capital Inflows, Credit Boom, and Credit Multiplier

This dissertation also investigates whether capital inflows lead to expansions of credit over and beyond their effects on the money supply, i.e., whether they cause the credit multiplier to increase. Capital inflows result in an increase in money supply if they are not fully sterilized. The increase in money supply could lead to credit expansion and even a credit boom if financial liberalization is not adequately supervised. Such a credit boom would result in asset price inflation. After the Asian financial crisis, Thailand and Indonesia enhanced their financial supervision and, as a result, their banks should bear fewer bad loans.

Significant net capital inflows provide important benefits that are necessary for sustained and higher growth rates. However, massive capital inflows without full sterilization result in inflation, current account deficits due to the appreciation of real exchange rates, and overheating problems in goods market due to the excess aggregate demand. Capital inflows place downward pressure on real exchange rates (appreciation). Removal of controls on capital outflows can reduce the downward pressure on the exchange rate, which also lowers the cost of sterilization. Countries implement policies, such as increased controls on capital inflows and liberalization of capital outflows. Liberalization of capital outflows may be an effective device to offset a capital inflow. The below graphic illustrates this chain of events:

Massive Capital Inflows ⟹ Appreciation on Real Exchange Rate ⟹ Removal of Controls on Capital Outflows ⟹ Reduction of Downward Pressure on the Real Exchange Rate

Sterilization has been the most common policy tool for stabilizing aggregate demand in response to massive capital inflows. However, sterilization is not always feasible for the following reasons (Monteil 1999). First, sterilization may not be possible if domestic assets and foreign assets are perfect substitutes. Second, even if sterilization is possible, it may not insulate the domestic aggregate demand from the expansionary effects of capital inflows. Third, sterilization might be undesirable because of its side effects. The side effects include high interest rates on bonds when sterilization magnifies capital inflows, quasi-fiscal costs, and significant foreign assets and domestic currency liabilities. The quasi-fiscal costs from sterilization would be higher under a fixed exchange rate than under a floating exchange rate. They would also be charged to the government under a sterilization game that allows public financial institutes and private sector institutions to borrow cheaply from overseas and purchase high yielding sterilization bonds. Thus, the short-term foreign debt and vulnerabilities of financial systems increase.

Chapter 4: Econometric Methodology

The error correction model (ECM) introduced by Granger (1981) can lead to a better understanding of the nature of economic activities with respect to growth in the sample period and specify the multivariate time series model with respect to the impacts of shocks. ECM analysis provides multivariate analysis based on the macroeconomic framework. The plots of the variable data show that data grows according to trends and that data from different variables become tangled with each other. They are not stationary, but the first difference of the data is stationary, which is the definition of co-integration. Thus, the ECM includes two parts: the co-integration equation (long-run equilibrium) and the multivariate time series model (the short run equilibrium or impulse response function). The ECM is a variant of the partial adjustment model. In the partial adjustment model, dependent and independent variables have a long-run relationship in which the estimator of the dependent variable corresponds to independent variables. The disequilibrium is measured by the error correction term, that is, the deviation from the long-run equilibrium identified by the co-integrated relationship. We regress the error correction term in the short-run dynamics, which reveals which system corrected the previous disequilibrium. The short-run dynamics provide detailed explanations of how monetary policies respond to the previous exchange rate, foreign interest rate, and foreign reserves. All of these effects are significant for sterilization and capital mobility.

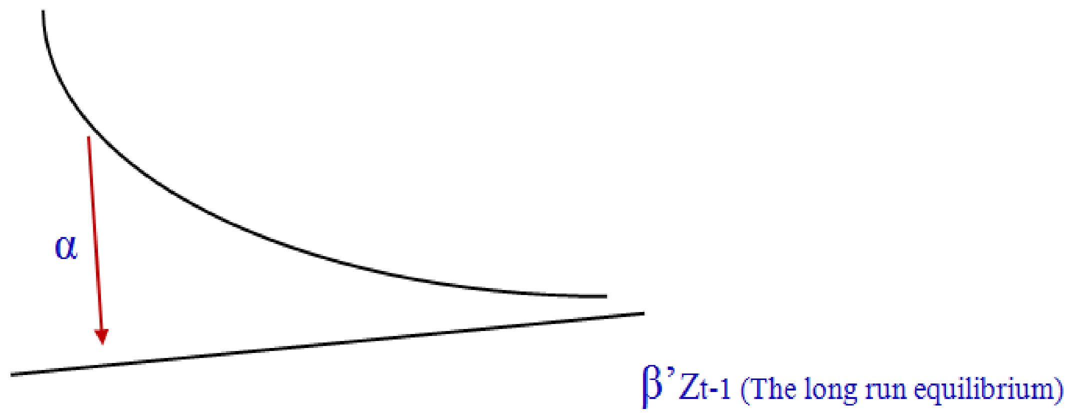


Figure 3 demonstrates that the system corrects previous disequilibrium. Shocks generate error correction vector (α) that deviates from the stable economic state ($\beta' Z_{t-1}$).

If the data is normally distributed, we are able to apply an OLS model to analyze the economic activities, and the linear combination of data will be normally distributed. Thus, the model is well-specified and the error term of the model should be white noise. If the data is not normally distributed but follows the trend of economic growth with I(1) nature, we have to apply the ECM co-integration equation to analyze economic activities. While the data is not stationary in such cases, the first difference of the data is stationary and the linear combination of the data is stationary.

The co-integration equation of the ECM demonstrates the long-run ECM equilibrium. The co-integration equation is founded on a macroeconomic framework. The co-integration equation can be utilized to develop a refined dynamic model with a focus on the long run or a transitory aspect. The error term of the co-integration equation (or long-run equilibrium) is the error correction term. The error correction term needs to be saved and regressed in the short-run dynamics. The error correction term should be stationary to ensure the well-specification of the long-run equilibrium. If the error correction term is not stationary, the long-run equilibrium model is spurious (or nonsense). We could apply the Augmented Dickey-Fuller (ADF) test to determine the stationarity of the error correction term.

The error correction term equals the disequilibrium in the co-integration equation and pulls the variables back into long-run equilibrium. We have to regress the error correction term on the short-run equilibrium (multivariate time series model). The system then corrects previous disequilibrium in the short-run dynamics. The multivariate time series equation is the impulse response function, which explains the impacts of the shock to the system variables on the dependent variable. The short-run dynamic equation should have no serial correlation in the errors (white noise) if it is specified correctly; we can adjust the lags of the variables to make sure that this holds. This is the lag-order selection step. The multivariate time series analysis (impulse response function) is the in-sample data analysis, and it is capable of responding to the shocks. The variables of the multivariate time series equation (impulse response function) need to be stationary, and their stationarity can be tested using the ADF test.

To ensure the well-specification of the short-run dynamic equation, the error term should be white noise. Strong white noise also has the quality of being independent and identically distributed, which implies no autocorrelation. More specifically, if the error term is distributed normally with a mean of zero and standard deviation σ, the error term is Gaussian white noise. In the results of short-run dynamics, the coefficient of the error correction should be negative, which tells us at what rate it corrects the system disequilibrium of the previous period. When the coefficient of the error correction term is significant and contains a negative sign in the short-run dynamics, it confirms that the system corrects the previous disequilibrium.

The short-run dynamic equation is the impulse response function, which describes how the economy reacts over time to exogenous impulses, which economists usually call shocks. Impulse response functions (IRF) describe the reaction of exogenous macroeconomic variables. The IRF of a dynamic system is its output when presented with a brief input signal, called an impulse. More generally, an impulse response refers to the reaction of any dynamic system in response to some external change (shock). The impulse response describes the reaction of the system as a function of time or possibly as a function of independent variables that parameterize the dynamic behavior of the system.

There are two types of shocks in the economy. The first type is exogenous and the second is induced by domestic policies. This dissertation applies Chow's dummy variable approach in the ECM. The additive and multiplicative dummy variables need not be applied simultaneously—if we believe that there is only a parallel shift in the regression when going from one regime to another, we should use the additive dummy alone. However, if we believe that the intercept is the same across regimes but the effect of the explanatory variable is different across regimes, we should use only the multiplicative dummy variables. In the absences of a priori information on the nature of the regime change of the coefficients, we usually allow for both types of changes, hence the common use of Chow tests with both multiplicative and additive dummies in the regression equation. The multiplicative dummy variables should be present simultaneously in the model to respond to shocks from exogenous disturbances and shocks induced by domestic variables. The significance of multiplicative dummy variables that can present the effects of the explanatory variable differs over regimes.

By using the first difference of endogenous variables to make them stationary, this dissertation also applies the previously used OLS methodology to estimate the value of the sterilization coefficient and offset coefficient. Because R_t is equal to a US T-Bill rate for three months (It) plus the logarithm value for one month ahead of the exchange rate (Rt = It + E(LEXt+1)), the OLS results demonstrate the impacts of shocks of the endogenous variables in the system as well as impulse response functions. The OLS methodology cannot demonstrate how short-run dynamics deviate from the long-run equilibrium as well as the ECM can. If the error term of the OLS equation is not white noise but stationary, there is a serial correlation in the errors and the model is spurious. Thus, the model of OLS tends to be spurious (or mis-specified) when the error term is stationary but not when it is white noise. This dissertation compares the results from the OLS methodology and impulse response functions.

Approach

Capital inflows and the financial crisis are associated with shocks. Sterilization is a common response to the capital inflows. The macroeconomic framework uses comparative statistics to ensure the co-integration relationship between the endogenous variables, which ensures the econometric model will lead the economic activities to the equilibrium on the track of macroeconomic foundation. Based on this foundation, economists are able to construct the impulse response functions for the random walk economic activities.

Econometrics presents the beauty of the economic theory in application. The impulse response function is the monetary response function, which captures the impacts of the shocks to the system variables on the dependent variable. Montiel (1999) states there are two types of shocks. The first type of shocks is exogenous and the second is induced by domestic policies. Capital inflows occur in association with a shock to an economic environment. This dissertation demonstrates how to specify efficiently and in detail an econometric model of sterilization, which includes the macroeconomic foundation and sustains the policy challenges to the economy in the presence of shocks.

Structural break analysis tests the consistency of the sterilization coefficient and offset coefficient. This step also makes sure to identify the critical point at which to impose the dummy variables. Dummy variables try to capture the structural changes of the economy in the transitional dynamics. Based on the application of Chow's dummy variable approach, the additive dummy (0 or 1) and the multiplicative dummy variables should be present simultaneously in the model to respond to the shocks from exogenous disturbances and the shocks induced by domestic policy. The additive and multiplicative dummy variables need not be applied simultaneously, especially if we believe that there is only a parallel shift in the regression when going from one regime to another, we should use the additive dummy only. However, if we believe that the intercept is the same over regimes but the effect of the explanatory variable is different, we should use the multiplicative dummy variables only. In the absences of a priori information on the nature of the regime change in the coefficients, we usually allow for both types of changes hence the common use of Chow tests with both multiplicative and additive dummies in the regression equation. The multiplicative dummy variables should be present simultaneously in the model to respond the shocks from exogenous disturbances and the shocks induced by domestic variables. The significance of multiplicative dummy variables would present the effects of the explanatory variable is different over regimes. Sterilization is considered to be intense when open market operations are large in scale (Takai and Esaka 1997).

$NDA_{t+1} = NDA_t + \mu_{t+1};$

$\Delta NFA_{t+1} = NFA_{t+1} - NFA_t = \varepsilon_{t+1}$

$\Delta NDA_{t+1} = NDA_{t+1} - NDA_t = \mu_{t+1}$

$NFA_{t+1} = NFA_t + \Delta NFA_{t+1} = NFA_t + \varepsilon_{t+1}$

$NDA_{t+1} = NDA_t + \Delta NDA_{t+1} = NDA_t + \mu_{t+1}$

$NFA_t = NFA_{t-1} + \Delta NFA_t,$

$NDA_t = NDA_{t-1} + \Delta NDA_t;$

$\Delta NFA_t = NFA_t - NFA_{t-1}$

$$hat(\Delta NFA_t) = F[(L)\Delta NDA_t, (L)\Delta NFA_t, (L)\Delta LM2_t, (L)\Delta LQ_t, (L)\Delta CPI_t, (L)\Delta DC_t, (L)\Delta R_t, (L)\Delta EX_t, (L)\Delta FR_t \ldots]$$

$\Delta NFA_t = hat(\Delta NFA_t) + \varepsilon_t$

$\Delta NDA_t = NDA_t - NDA_{t-1}$

$$hat(\Delta NDA_t) = G[(L)\Delta NFA_t, (L)\Delta NDA_t, (L)\Delta LM2_t, (L)\Delta LQ_t, (L)\Delta CPI_t, (L)\Delta DC_t, (L)\Delta R_t, (L)\Delta EX_t, (L)\Delta FR_t \ldots]$$

$\Delta NDA_t = hat(\Delta NDA_t) + \mu_t$

(L) : lag operator; $t = 1 \ldots . T$

Note: $R_t = I_t + E[L(EX_{t+1})]$; $LEX_{t+1} = \log(EX_{t+1})$

Thus, $E[hat(\Delta NFA_t)] = \Delta NFA_{t+1} = \varepsilon_{t+1}$; $E[hat(\Delta NDA_t)] = \Delta NDA_{t+1} = \mu_{t+1}$

We defined the foreign interest rate R_{ates} equal to U.S three month T-Bill rate plus the one-month ahead logarithm value of the exchange rate since the incentive to move funds is given by the interest differential plus the expected change in the exchange rate. As a proxy for these expectations, we assume that investors correctly anticipate exchange rates. Multivariate time series functions, which are impulse response functions, can demonstrate ΔNFA_t and ΔNDA_t Data of net domestic assets (NDA), Net foreign assets (NFA), money supply (M2), consumer price index (CPI), domestic credit(DC), exchange rate (EX) and foreign reserves (FR) are selected from IFS.

The shocks (ε_{t+1} and μ_{t+1}) are random variables. Sample data consists of available observations for analysis. The definition of a random variable is a function that turns observations into a number. By using multivariate time series analysis, random variables can be generated as an impulse response function that turn observations into a number if we plug the values of variables into this function. In real time, it would be similar to investigating how well your model fits the out-of-sample data and so would not add much new information. Thus, the impulse response function provides the information on the effects of a one-time shock on current and future values of the endogenous variables in the system. The impulse response functions provide the impacts of the shocks to the system variables on the dependent variable within the sample period.

We use the following equations:

Error correction Model (ECM):

*** The Co-integration Equation (Long-run equilibrium)**

$NFA_t = NFA\,(NDA_t, M2_t, Q_t, EX_t, R_t, CPI_t, DC_t, FR_t) + ECNFA_t$

$NDA_t = NDA\,(NFA_t, M2_t, Q_t, EX_t, R_t, CPI_t, DC_t, FR_t) + ECNDA_t$

ECNFA and ECNDA are error correction terms need to be stationary but not necessary to be white noise.

*** Impulse response functions**

$$\Delta NFA_t = F[(L)\Delta NDA_t\ ,\ (L)\Delta NFA_t, (L)\Delta LM2_t, (L)\ \Delta LQ_t, (L)\Delta CPI_t, (L)\Delta DC_t, (L)\Delta R_t,$$
$$(L)\Delta EX_t,\ (L)\Delta FR_t,\ (L)ECNFA_t \ldots..] + \varepsilon_t$$

$$\Delta NDA_t = F[(L)\Delta NDA_t, (L)\Delta NFA_t, (L)\Delta LM2_t, (L)\ \Delta LQ_t, (L)\Delta CPI_t, (L)\Delta DC_t, (L)\Delta R_t,$$
$$(L)\Delta EX_t,\ (L)\Delta FR_t,\ (L)ECNFA_t \ldots..\ ] + \mu_t$$

ε_t and μ_t need to be white noise.

Using the ECM shows the error correction term of the co-integration equation to be innovation. The co-integration equation (long-run equilibrium) demonstrates the nature of endogenous variables based on the macroeconomic framework. The impulse response function should regress the error correction term, because the term is an innovation among all endogenous variables from the macroeconomic framework.

Most papers use the vector auto-regression model (VAR) in the vector error correction model (VECM), shown below, to specify the impulse response function:

Vector Error Correction Model (VECM):

$\Delta Z_t = \sum_{i=0}^{k} \Gamma_i \Delta Z_{t-i} + \alpha \beta Z_{t-1} + \Phi D_t + \varepsilon_t$

$\Delta Z_t = (\Delta NDA_{t-i}, \Delta NFA_{t-i}, \Delta LM2_{t-i}, \Delta LQ_{t-i}, \Delta CPI_{t-i}, \Delta DC_{t-i}, \Delta R_{t-i},, \Delta EX_{t-i}, \Delta FR_{t-i})'$ by normalizing ΔNDA to estimate offset coefficient

or

$\Delta Z_t = (\Delta NFA_{t-i}, \Delta NDA_{t-i}, \Delta LM2_{t-i}, \Delta LQ_{t-i}, \Delta CPI_{t-i}, \Delta DC_{t-i}, \Delta R_{t-i},, \Delta EX_{t-i}, \Delta FR_{t-I})'$ by normalizing ΔNFA to estimate sterilization coefficient

$\sum_{i=0}^{k} \Gamma_i \Delta Z_{t-i}$:VAR (vector auto-regression)

α : error correcting vector; α is orthognal to the cointegrating equation ($\beta' Z_{t-1}$)

β : co-integrating vector

$\beta' Z_{t-1}$: co-integration equation

D_t : dummy variables including seasonal dummy variables, multiplicative dummy variables, and additive dummy variable

ε_t : error term needs to be white noise

This methodology is founded on the maximum likelihood of Johansen's VECM, in which likelihood is approximate but not precise. As long as the order of other endogenous variables in the ΔZ_t changes, co-integrating vector and impulse response functions will have changes. The error correction vector is orthogonal to the co-integration equation ($\boldsymbol{\beta}' Z_{t-1}$). The VAR does not incorporate the error correction vector from the VECM. Furthermore, the impulse response function from the VAR does not regress the innovation that causes the deviation from the model's steady state. Rather, shocks generate an error correction vector that deviates from the stable economic state ($\beta' Z_{t-1}$).

Ordinary least squares (OLS), also known as linear least squares, can be used as a method for estimating the unknown parameters in a linear regression model. The OLS method provides minimum-variance, mean-unbiased estimation when the errors have finite variances. Under the additional assumption that the errors be white noise (normally distributed),we apply the single OLS equation to obtain the sterilization coefficient and offset coefficient.

OLS methodology:

$$\Delta NDA_t = \lambda_0 + \lambda_1 \Delta NFA_t + \lambda_2 \Delta LM2 + \lambda_3 \Delta LQ_t + \lambda_4 CPI_t + + \lambda_5 \Delta DC_t + \lambda_6 \Delta R_t$$

$$+ \lambda_7 \Delta EX_t + \lambda_8 \Delta FR_t + \Phi D_t + \mu_t$$

μ_t : error term needs to be white noise

λ_1 : the average sterilization coefficient within sample period

$$\Delta NFA_t = \Phi_0 + \Phi_1 \Delta NDA_t + \Phi_2 \Delta LM2 + \Phi_3 \Delta LQ_t + \Phi_4 CPI_t + + \Phi_5 \Delta DC_t + \Phi_6 \Delta R_t$$

$$+ \Phi_7 \Delta EX_t + \Phi_8 \Delta FR_t + \Theta D_t + \mu_t$$

μ_t : error term needs to be white noise

Φ_1 : the average offset coefficient within sample period

By taking the first difference of the data to make the data stationary, the OLS methodology estimates the sterilization coefficient and offset coefficient in the sample period. R_t is equal to a US T-Bill rate for three months (I_t) plus the logarithm value of the exchange rate for one month ahead ($R_t = I_t + E(LEX_{t+1})$). We will demonstrate how to specify the model in Chapter 5. Furthermore, in Chapter 6, we will compare the OLS results and the results of the ECM (Granger 1981) and explain why we choose to adopt the ECM results.

Chapter 5: Model Specification for Degree of Sterilization and Degree of Capital Mobility – Co-integration Equation (Long-run equilibrium) and Short-run Dynamic Equation (Impulse Response Function)

Steps for Model Specification

There are three steps to specifying the error correction model (ECM). First, the structure break of the data must be checked to ensure the coefficient consistency and determine the critical point at which to impose the dummy variables (additive dummy and multiplicative dummy variables). Second, the economic data must always accord with economic growth. According to the main concept of the ECM, the in-sample data analysis is based on the macroeconomic framework—that is, the co-integration relation among all variables. Third, contemporaneous IRF analysis should be conducted to capture the impacts of shocks through multivariate time series analysis.

Structural Break Analysis

The importance of structural break analysis is that it ensures the coefficient consistency for the sterilization coefficient and offset coefficient. Thus, this is the first step in model specification, and this dissertation applies Chow's dummy variable approach for structural break analysis. The financial crisis is associated with shocks that are exogenous, but which affect the endogenous variables. Although the global financial crisis occurred in late 2008, the economy likely experienced impacts of shocks before the crisis. Structural break analysis allows us to find the specific time point that demonstrates that the shocks associated with financial crisis affect the variables. After finding the critical breakpoint, we impose the dummy variables according to the structural change of the economy in transitional dynamics. There are two types of shocks. The first is exogenous and the second induced by domestic policy. The significance of dummy variables means that a structural change in the economy has occurred.

Capital inflows and the financial crisis are associated with shocks. The capital account is endogenous. The dummy variables investigate the change of the economy because of the shocks. There are two types of potential shocks (Montiel 1999). The first type of shock is exogenous, and we impose the additive dummy variables to respond to the impacts from the exogenous shocks. The second type of shock is induced by domestic policies. We impose multiplicative dummy variables to respond to the policy challenges associated with these shocks. Multiplicative dummy variables are equal to the endogenous variables of the additive dummy times, which demonstrate the uncertainties from the shocks induced by domestic policies. The sample data is the information set for model specification. Identifying the break point of the sample data is important for making the information set more precise and properly imposing the dummy variables.

Chow's Dummy variable approach in the long run equilibrium:

In the co-integration equation, dummy variables present the structural break and provide more degrees of freedom to incorporate the disturbances from shocks.

$$X1_{,t} = b0 + \sum_{i=2}^{n} bi\ Xi_{,t} + r\ D_t + (\sum_{i=1}^{n} \alpha i\ D_t\ Xi_{,t}) + EC$$

t= 1, 2, 3 ..., T

$D_t = 0$ for t= 1, 2, 3 ....., τ-1

$D_t = 1$ for t= τ, τ+1 ....., T

τ is the break point

D_t is the additive dummy variable

($D_t\ Xi_{,t}$) is the multiplicative dummy variable or structural dummy variable.

EC: the error correction terms for the short run equilibrium.

The Models applied in many papers with dummies but it seems they do not follow Chow's dummy variable approach.

Chow's Dummy variable approach in the short run equilibrium:

$$\Delta X1_{,t} = b0 + \sum_{i=1}^{I} \alpha i \, \Delta X1_{,t-i} + \sum_{i=0}^{I} \gamma i \, \Delta X2_{,t-i} + \ldots + \sum_{i=0}^{I} \Phi i \, \Delta Xn_{,t-i} + r \, Dt$$

$$+ \sum_{i=0}^{I} \beta i \, EC_{t-i} + \sum_{i=1}^{n} \Psi i \, Dt \, \Delta Xi_{,t} + \varepsilon t$$

ε_t : the error term of the short run equilibrium needs to be white noise for well specification of the model.

Macroeconomic Framework for an Open Economy

Mundell-Flemming theory states that a change in foreign interest rates causes a change in capital flows. A decrease in a foreign interest rate causes capital inflows and increases the money supply. The purpose of sterilization is to avoid the emergence of inflation and maintain the equilibrium in the money market, so that money demand equals money supply. Money demand (MD = L(Y, I)) is the function of domestic aggregate outputs and the domestic interest rate. Money supply (MS) is equal to net domestic assets (NDA) plus net foreign assets (NFA), or domestic credit plus foreign reserves. NDA is a function of the domestic aggregate outputs, domestic interest rate, broad money supply (M2), and money multiplier (Q). The foreign asset position is the function of domestic aggregate outputs, domestic interest rate, foreign interest rate, and foreign exchange rate. The domestic aggregate outputs are a function of broad money supply (M2), money multiplier (Q), exchange rate (EX), foreign interest rate (R), domestic credit (DC), and foreign reserves (FR). The domestic interest rate is a function of consumer price index (CPI). Monetary authorities raise the domestic interest rate to avoid inflation when the CPI increases.

Model Specification of the Error Correction Model

Macroeconomic Framework:

MS= NDA +NFA = DC + FR

MD = L(Y, I);

Y = F (M2, Q, EX, R, DC, FR), I = G (CPI)

NFA = J(Y, I, R, EX)

NDA= H(Y, I, M2, Q)

MD = L (M2, Q, EX, R, CPI, DC, FR)

In equilibrium: MS = MD $\Longrightarrow$ NFA+ NDA = L (M2, Q, EX, R, CPI, DC, FR)

Using comparative statics to analyze equation of sterilization between NFA and NDA:

NFA = L(M2,Q,EX,R,CPI,DC,FR) –NDA = NFA(NDA, M2,Q,EX,R,CPI,DC,FR)

NDA = L(M2,Q,EX,R,CPI,DC,FR) –NFA = NDA(NFA, M2,Q,EX,R,CPI,DC,FR)

MS: money supply, MD: money demand, Y: domestic aggregate outputs, I: domestic interest rate, R: foreign interest rate, EX: exchange rate, DC: domestic credit, FR: foreign reserves, NFA: net foreign asset, NDA: net domestic assets, Q: the money multiplier of M2

In the macroeconomic framework, net foreign assets (NFA) area function of net domestic assets, money supply, money multiplier of M2, exchange rate, foreign interest rate, consumer price index, domestic credit, and foreign assets.Net domestic assets (NDA) are a function of NFA, money supply, money multiplier of M2, exchange rate, foreign interest rate, consumer price index, domestic credit, and foreign assets. According to the Mundell- Flemming theory, the decrease of foreign interest rate would cause capital inflows and increase the money supply. Sterilization is a common policy for leading the economy toward equilibrium in the face of capital inflows. As the goal of sterilization is to make money demand equal to money supply, it supports the co-integration functions in the long run and constructs the monetary response functions in the short-run dynamics. In this way, economic theory supports the co-integration equation.

The co-integration equation for capital mobility:

$$NFA_t = £_0 + £_1 NDA_t + £_2 LM2_t + £_3 LQ_t + £_4 CPI_t + £_5 DC_t + £_6 R_t + £_7 EX_t$$

$$+ £_8 FR_t + \sum_{i=1}^{11} \gamma_i D_i + £_9 DUM + £_{10} DUM\ NFA_t + £_{11} DUM\ NDA_t$$

$$+ £_{12} DUM\ LM2_t + £_{13} DUM\ LQ_t + £_{14}\ DUM\ CPI_t + £_{15}\ DUM\ R_t$$

$$+ £_{16} DUM\ EX_t + £_{17} DUM\ FR_t + ECNFA_t$$

ECNFA is the error correction term of capital mobility, which needs to be regressed in the short run dynamics ; the error correction term is not necessary to be white noise but needs to be stationary to make co-integration equation well specified.

NFA: net foreign assets

NDA: net domestic assets

M2: broad money multiplier; because there is no monthly data for GDP and M2 is co-integrated with GDP, M2 becomes the instrumental variable of GDP.

LM2: log transformation of M2

Q: M2 money multiplier

LQ: log transformation of Q

CPI: consumer price index

R: $R_t = I_t + E(LEX_{t+1})$; R_t: foreign interest rate is equal to US T-Bill rate for three months (I_t) plus exchange rate for one month ahead

DC: domestic credit

EX: the nominal exchange rate (national currency/U.S. dollar)

LEX: log transformation of EX

Di: seasonal dummy variable

DUM: additive dummy variable (DUM =0 before break point and DUM =1 after break point)

FR: foreign reserves

The impulse response function tests for the degree of capital mobility:

$$\Delta NFA_t = \alpha_0 + \sum_{i=0}^{2} \alpha_{1,i}\, \Delta NDA_{t-i} + \sum_{i=1}^{2} \alpha_{2,i}\, \Delta NFA_{t-i} + \sum_{i=0}^{2} \alpha_{3,i}\, \Delta LM2_{t-i}$$

$$+ \sum_{i=0}^{2} \alpha_{4,i}\, \Delta LQ_{t-i} + \sum_{i=0}^{2} \alpha_{5,i}\, \Delta CPI_{t-i} + \sum_{i=0}^{2} \alpha_{6,i}\, \Delta DC_{t-i} + \sum_{i=0}^{2} \alpha_{7,i}\, \Delta R_{t-i}$$

$$+ \sum_{i=0}^{2} \alpha_{8,i}\, \Delta EX_{t-i} + \sum_{i=0}^{2} \alpha_{9,i}\, \Delta FR_{t-i} + \sum_{i=0}^{2} \alpha_{10,i}\, ECNFA_{t-i} + \sum_{i=1}^{11} \gamma_i D_i$$

$$+ \alpha_{11}\, DUM + \alpha_{12}\, DUM\ \Delta NFA_t + \alpha_{13}\, DUM\ \Delta NDA_t + \alpha_{14}\, DUM\ \Delta LM2_t$$

$$+ \alpha_{15}\, DUM\ \Delta LQ_t + \alpha_{16}\, DUM\ \Delta CPI_t + \alpha_{17}\, DUM\ \Delta R_t + \alpha_{18}\, DUM\ \Delta EX_t$$

$$+ \alpha_{19}\, DUM\ \Delta FR_t + \varepsilon_t$$

ε_t : error term needs to be white noise

$\alpha_{1,0}$ is the offset coefficient ; if $\alpha_{1,0}$ =-1, there exists perfect capital mobility in the economy

The co-integration equation for sterilization:

$$NDA_t = \rho_0 + \rho_1\, NFA_t + \rho_2\, LM2_t + \rho_3\, LQ_t + \rho_4\, CPI_t + \rho_5\, R_t + \rho_6\, EX_t$$

$$+ \rho_7\, DC_t + \rho_8\, FR_t + \sum_{i=1}^{11} \gamma_i D_i + \rho_9\, DUM + \rho_{10}\, DUM\ NFA_t$$

$$+ \rho_{11}\, DUM\ NDA_t + \rho_{12}\, DUM\ LM2_t + \rho_{13}\, DUM\ LQ_t + \rho_{14}\, DUM\ CPI_t$$

$$+ \rho_{15}\, DUM\ R_t + \rho_{16}\, DUM\ EX_t + \rho_{17}\, DUM\ DC_t + \rho_{18}\, DUM\ FR_t + ECNDA_t$$

ECNDA is the error correction term of sterilization equation, which needs to be regressed in the short run dynamics ; the error correction term is not necessary to be white noise but needs to be stationary to make co-integration equation well specified.

The impulse response function tests for the degree of sterilization:

$$\Delta NDA_t = \beta_0 + \sum_{i=0}^{2} \beta_{1,i}\, \Delta NFA_{t-i} + \sum_{i=1}^{2} \beta_{2,i}\, \Delta NDA_{t-i} + \sum_{i=0}^{2} \beta_{3,i}\, \Delta LM2_{t-i}$$

$$+ \sum_{i=0}^{2} \beta_{4,i}\, \Delta LQ_{t-i} + \sum_{i=0}^{2} \beta_{5,i}\, CPI_{t-i} + + \sum_{i=0}^{2} \beta_{6,i}\, \Delta DC_{t-i} + + \sum_{i=0}^{2} \beta_{7,i}\, \Delta R_{t-i}$$

$$+ \sum_{i=0}^{2} \beta_{8i}\, \Delta EX_{t-i} + \sum_{i=0}^{2} \beta_{9i}\, \Delta FR_{t-i} + \sum_{i=0}^{2} \beta_{10i}\, ECNDA_{t-i} + \sum_{i=1}^{11} \gamma_i D_i$$

$$+ \beta_{11} DUM + \beta_{12} DUM\ \Delta NFA_t + \beta_{13} DUM\ \Delta NDA_t + \beta_{14} DUM\ \Delta LM2_t$$

$$+ \beta_{15} DUM\ \Delta LQ_t + \beta_{16} DUM\ \Delta CPI_t + \beta_{17} DUM\, \Delta\, R_t + \beta_{19} DUM\ \Delta EX_t$$

$$+ \beta_{20} DUM\ \Delta FR_t + \mu_t$$

$\beta_{1,0}$ is the sterilization coefficient ; if $\beta_{1,0} = -1$, there exists perfect sterilization in the economy

μ_t : the error term needs to be white noise

The structural break analysis ensures coefficient constancy in response to changes in capital inflows. According to the definition of co-integration, the co-integrated variables do not need to be stationary, but the linear combination of co-integrated variables is stationary. The error correction term could be specified as the linear combination of explanatory variables and independent variable. That means the error terms (or historical shocks from long-run equilibrium) of the long-run equilibrium of the ECM need to be stationary. The co-integrated variables are I(1), or the first difference of co-integrated variables are stationary. The error terms of the impulse response functions (short-run equilibrium) should be white noise, which could be diagnosed by using the Q-statistics. Q-statistics are applied to test for the high-order serial correlation of error terms. If there is no serial correlation in the residuals, the autocorrelations and partial autocorrelations at all lags should be nearly zero, and all Q-statistics should be insignificant with a large p-value. The null hypothesis assumes there are no autocorrelations or partial autocorrelations in the error terms. When the p-value is greater than five percent, we do not reject the null hypothesis, as the results of the test show there are no autocorrelations in the error term. This test ensures the error terms should be white noise, and, importantly, ensures the well-specification of econometric modeling.

***OLS Methodology for Sterilization Coefficient**

$$\Delta NDA_t = \lambda_0 + \lambda_1 \Delta NFA_t + \lambda_2 \Delta LM2 + \lambda_3 \Delta LQ_t + \lambda_4 \Delta CPI_t + + \lambda_5 \Delta DC_t + \lambda_6 \Delta R_t$$

$$+ \lambda_7 \Delta EX_t + \lambda_8 \Delta FR_t + \sum_{i=1}^{11} \gamma_i D_i + \lambda_9 DUM + \lambda_{10} DUM \ \Delta NFA_t$$

$$+ \lambda_{11} DUM \ \Delta NDA_t + \lambda_{12} DUM \ \Delta LM2_t + \lambda_{13} DUM \ \Delta LQ_t$$

$$+ \lambda_{14} DUM \ \Delta CPI_t + \lambda_{15} DUM \ \Delta R_t + \lambda_{16} DUM \ \Delta EX_t + \lambda_{17} DUM \ \Delta FR_t + \mu_t$$

μ_t : error term needs to be white noise

λ_1 : the average sterilization coefficient within sample period

***OLS Methodology for Offset Coefficient**

$$\Delta NFA_t = \Phi_0 + \Phi_1 \Delta NDA_t + \Phi_2 \Delta LM2 + \Phi_3 \Delta LQ_t + \Phi_4 \Delta CPI_t + + \Phi_5 \Delta DC_t + \Phi_6 \Delta R_t$$

$$+ \Phi_7 \Delta EX_t + \Phi_8 \Delta FR_t + \sum_{i=1}^{11} \gamma_i D_i + \Phi_9 DUM + \Phi_{10} DUM \ \Delta NFA_t$$

$$+ \Phi_{11} DUM \ \Delta NDA_t + \Phi_{12} DUM \ \Delta LM2_t + \Phi_{13} DUM \ \Delta LQ_t$$

$$+ \Phi_{14} DUM \ \Delta CPI_t + \Phi_{15} DUM \ \Delta R_t + \Phi_{16} DUM \ \Delta EX_t + \Phi_{17} DUM \ \Delta FR_t + \mu_t$$

μ_t : error term needs to be white noise

Φ_1 : the average offset coefficient within sample period

***Specify the model to find if money multiplier increases when money supply increases**

The broad money supply is equal to the monetary base times money multiplier

M2 = MB*Q

M2: broad money supply

MB: Monetary base

Q: money multiplier of M2

MB is collinear with M2. We choose M2 as money supply for sterilization so we keep MB as constant. Thus, we are able to specify econometric model to find the relationship between M2 and Q without singular problem.

Co-integration Equation (Long Run equilibrium)

$$LQ_t = \rho_0 + \rho_1 LM2_t + \rho_2 DUM + \rho_3 DUMLQ_t + \rho_4 DUMLM2_t + ECLQ_t$$

ECLQ : error correction term of sterilization equation for short run equilibrium; ECLQ needs to be stationary.

Multivariate Time series analysis (Short-run analysis)

$$\Delta LQ_t = \beta_0 + \beta_1 \Delta LM2_t + \Sigma_{i=1}^{I} \beta_{2,i} \Delta LM2_{t-i} + \Sigma_{i=1}^{I} \beta_{3,i} \Delta LQ_{t-i} + \Sigma_{i=0}^{I} \beta_{4,i} \Delta ECLQ_{t-i}$$

$$+ \beta_5 DUM + \beta_6 DUMDLQ_t + \beta_7 DUMDLM2_t + \mu_t$$

μ_t : the error term needs to be white noise

*** Specify if credit multiplier increases with capital inflows**

DC = CQ * MS(NFA, NDA)

DC: domestic credit

CQ: credit multiplier

We apply the broad money (M2) as money supply.

MS = MS (NDA, NFA)

Money supply is a function of net domestic assets and net foreign assets.

NDA: net domestic assets

NFA: net foreign assets

Co-integration Equation (Long Run equilibrium)

$$LCQ_t = \alpha_0 + \alpha_1 LNFA_t + \alpha_2 LNDA_t + \alpha_3 LDC_t + \alpha_4 DUM + \alpha_5 DUMLCQ_t + \alpha_6 DUMLNFA_t + \alpha_7 DUMLNDA_t + \alpha_8 DUMLCD_t + ECCQ_t$$

ECCQ : error correction term of sterilization equation for short run equilibrium ,which needs to be stationary but does not need to be white noise.

Multivariate Time series analysis (Short-run dynamic analysis)

$$\Delta LCQ_t = \beta_0 + \sum_{i=0}^{I} \beta_{1,i} \Delta LNFA_{t-i} + \sum_{i=0}^{I} \beta_{2,i} \Delta LNDA_{t-i} + \sum_{i=1}^{I} \beta_{3,i} \Delta LCQ_{t-i} + \sum_{i=0}^{I} \beta_{4,i} \Delta LDC_{t-i} + \sum_{i=0}^{I} \beta_{5,i} \Delta ECCQ_{t-i} + \beta_6 DUM + \beta_7 DUMDLCQ_t + \beta_8 DUMDLNFA_t + \beta_9 DUMDLNDA_t + \beta_{10} DUMDLDC_t + \varepsilon_t$$

Chapter 6: Empirical Results

We define the foreign interest rate as the three month U.S. Treasury Bill rate plus the logarithm value of expected exchange rate for one month ahead ($R_t = I_t + E(LEX_{t+1})$). This dissertation assumes the exchange rate can be predicted with perfect foresight and uses a proxy for exchange rate expectations. Additionally, this dissertation applies an error correction model (ECM) to demonstrate the impacts of capital inflows. To ensure the well-specification of the model, the error correction terms of the co-integration equations for all countries should be stationary and the error term of short-run dynamic equation should be white noise. We apply the structural break analysis before we specify the model. The structural break analysis tests for the coefficient consistency of the sterilization coefficient and offset coefficient. This ensures the co-integration relationship among variables and consolidates the macroeconomic framework for model specification. The error correction term guides the model to correct the disequilibrium. In other words, the error-correction term pulls the variables back to the long-run equilibrium.

Deviations from the long-run equilibrium will occur when the error correction term is estimated to be significant. The coefficient of the error correction term in the short-run dynamic equation should be negative in order to correct the previous period's disequilibrium. If the coefficient of the error correction term is not significant in the short-run dynamic equation, the system will not deviate from the long-run equilibrium significantly. If the coefficient of the error correction term is significant and contains a negative sign, the system will correct its previous period's disequilibrium in the short-run dynamic equation. The empirical results for all countries are as follows:

Thailand

Table T1 reports the results of co-integration equations in the long run.

1. The results of ECM for sterilization coefficient and offset coefficient in the long run

Thailand	Main Variable (Significant)	Significant Endogenous Variables	Significant Dummy Variables	Error Term
NDA_t	-0.969 NFA_t	C +8737.74$LM2_t$ +185.55 LQ_t +30.36FR_t − 1038.985R_t	DUM, DUMNDA, DUMNFA,DUMLM2; Seasonal dummies are not significant	Error correction term is stationary
NFA_t	-0.982 NDA_t	C + 8435.76$LM2_t$ + 147.87 LQ_t − 1586.73 R_t +44.2 FR_t	DUM, DUMNDA, DUMNFA,DUMLM2; Seasonal dummies are not significant	Error correction term is stationary

Table T1A reports the results of the short-run dynamic equations.

1A. The results of ECM for sterilization coefficient and offset coefficient in the short run

Thailand	Main Variable (Significant)	Significant Endogenous Variables	Significant Dummy Variables	Error Term
ΔNDA_t (with two lags)	-1.056 ΔNFA_t Sterilization Coefficient	8730.02 $\Delta LM2t$ +35.54 ΔFR_t − 852.039 ΔR_t	DUMDNDA, DUMDNFA,DUMDLM2, DUMDFR; Seasonal dummies are not significant	Error term is white noise
ΔNFA_t (with two lags)	-0.91 ΔNDA_t Offset Coefficient	7936.43 $\Delta LM2t$ +36.95 ΔFR_t − 857.03 ΔR_t	DUMDNDA, DUMDNFA,DUMDLM2, DUMDFR; Seasonal dummies are not significant	Error term is white noise

The structural break analysis indicates a significant break point occurred in December 2003. Thus, new sample data has been selected from January 2004 to December 2010.The constant term is significant in the co-integration equation. The co-integration equations are constructed under the macroeconomic foundation. The short run dynamic equations demonstrate that the impulse response function (IRF) captures the change in the dependent variable when the independent variable changes by one unit. The results show the co-integration equation and short-run dynamics support each other. However, the money multiplier affects net domestic assets and net foreign assets positively in the long-run but not in the short-run dynamics. The error correction term of the long-run equation is stationary and the error terms of the short-run dynamic equations are white noise, which means the models are well-specified.

The foreign interest rate had a significant effect on net domestic assets and net foreign assets. This indicates capital outflows occurred at the same time as capital inflows. The capital inflows would have increased the foreign reserves. The results show that the sterilization coefficient is -1.056 and the offset coefficient is -0.91. Thailand had perfect sterilization and high capital mobility in the sample period.

The seasonal effects for sterilization and capital mobility were not significant in the sample period, which means sterilization and capital mobility would not have significant differentials in all seasons. In the short-run dynamics, the significance of the multiplicative dummy variables indicates the shocks induced by the monetary policies would affect sterilization and capital mobility. The multiplicative dummy variables should be present simultaneously in the model to respond to the shocks from exogenous disturbances and the shocks induced by domestic policies. Concerning sterilization and capital mobility, the effects of net domestic assets, net foreign assets, money supply, and foreign reserves differ across regimes. As mentioned in Chapter 2, Takagi and Esaka (1997) state sterilization is considered intense if open market operations are large in scale and accompanied by increased reserve requirements or transfers of government deposits from commercial banks to the central bank.

Table T2 reports the results of the OLS methodology equation.

2. The results of single equation of OLS methodology for sterilization coefficient and offset coefficient

Thailand The single equation of OLS methodology	Main Variable (Significant)	Significant Endogenous Variables	Significant Dummy Variables	Error Term
ΔNDA_t	-0.958 ΔNFA_t Sterilization Coefficient	8938.22 $\Delta LM2_t$ +0.165 ΔDC_t	Seasonal dummies are not significant	Error term is stationary but not white noise
ΔNFA_t	-0.976 ΔNDA_t Offset Coefficient	8696.22 $\Delta LM2_t$ +0.146 ΔDC_t	Seasonal dummies are not significant	Error term is stationary but not white noise

Error terms of the single OLS equations are stationary but not white noise. Thus, the single OLS equations are mis-specified. We take the first difference of system variables, which ensures all variables are stationary but does not ensure all variables are normally distributed. The single OLS equation could not reflect the impacts of disturbances and disequilibrium in the short run. The results of single OLS equations demonstrate the sterilization coefficient and offset coefficient do not significantly differ from the results of the ECM. This could be because the system variables are highly co-integrated. The results of the single OLS equations show shocks had significant impacts on domestic credit, net domestic assets, and net foreign assets. Furthermore, the single OLS equation is not capable of accommodating the impacts of disequilibrium in the short-run.

Table T3 reports the results of the co-integration equation in the long run.

3. The results for the relationship between money multiplier and money supply in the long run

Thailand	Main Variable (Significant)	Significant Endogenous Variables	Significant Dummy Variables	Error Term
LQt	0.124 LM2t	C (constant term is significant in the long run)	Seasonal dummy are most likely significant.	Error correction term is stationary.

Table T3A reports the results of short-run dynamic equations.

Q: money multiplier of M2

LQ: The logarithm value of Q

3 A. the results for the relationship between money multiplier and money supply in the short run

Thailand	Main Variable (Significant)	Significant Endogenous Variables	Significant Dummy Variables	Error Term
ΔLQ_t (with two lags)	1.043 $\Delta LM2_t$	0.64 $\Delta LM2_{t-1}$	DUMDLQ; Seasonal dummy variables are most likely not significant	Error term is white noise.

In the long run, the system variables are co-integrated along with growth and time trends. Thus, the intercept is significant in the co-integration equation. The results of the co-integration equation show a positive relationship between the money supply and money multiplier within the sample period. The results of the short-run dynamic equations show that increased money supply would increase the money multiplier, which supports the long-run equilibrium. The error correction term of the co-integration equation is stationary and the error term for short-run dynamics is white noise, which means models are well-specified. Monetary policies responded to the previous money supply and the error correction term affected the money multiplier significantly. Thus, the short-run dynamic equation deviates from the long-run equilibrium. The seasonal dummies are most likely not significant. The significance of the multiplicative dummy of the money multiplier indicates that the shocks induced by domestic monetary policies would affect the money multiplier. In the case of Thailand, the results demonstrate that the money multiplier increases when the money supply increases. The first difference of the logarithm value of the variables could be interpreted as a percentage change. For instance, when the money supply increases one percent, the money multiplier increases 1.043 percent. The money multiplier also responds to the previous period's money supply, which means the dynamics of the money market of Thailand should be in transition.

Table T4 reports the results of the co-integration equation in the long run, and Table T4A reports the results of the short-run dynamic equation.

CQ: Credit multiplier

LCQ: the logarithm value of CQ

LNFA: the logarithm value of net foreign assets

4. The following results of ECM for the relationship between credit multiplier and capital inflows in the long run

Thailand	Main Variable (Significant)	Significant Endogenous Variables	Significant Dummy Variables	Error Term
LCQ_t	-0.316 $LNFA_t$	C - 0.634 $LNDA_t$ + 1.017 LCD_t	DUM; D3,D4 and D5 are significant	Error coorection term is stationary.

4A. The following results of ECM are for relationship between credit multiplier and capital inflows in the short run

Thailand	Main Variable (Significant)	Significant Endogenous Variables	Significant Dummy Variables	Error Term
ΔLCQ_t (with two lags)	-0.256 $\Delta LNFA_t$	-0.622 $\Delta LNDA_t$ + 0.947 ΔLCD_t	D5 and D7 are significant	Error term is white noise.

The results show that the models are well-specified to explain the economic activities. The net foreign assets increase with capital inflows and are the index of capital inflows. The results show the credit multiplier decreases when net foreign assets (capital inflows) increase. Capital inflows then increase the money supply. The results show the credit multiplier would increase when domestic credit increases. The seasonal dummies are most likely insignificant, which suggests the credit transaction would have significant seasonal effects. When the net foreign assets increase one percent due to capital inflows, the credit multiplier decreases 0.256 percent. In the face of capital inflows, the effects of net foreign assets and net domestic assets on the credit multiplier were negative, but the effects of domestic credit on the credit multiplier were positive. Thus, the credit multiplier does not increase with capital inflows.

Figure T1 reports that the growth rate of the money supply maintained the same movement and was co-integrated with the money multiplier in 2008, when the global financial crisis occurred, and before 2009. However, the growth of the money supply does not match the movement of the money multiplier in 2010.

Figure T1

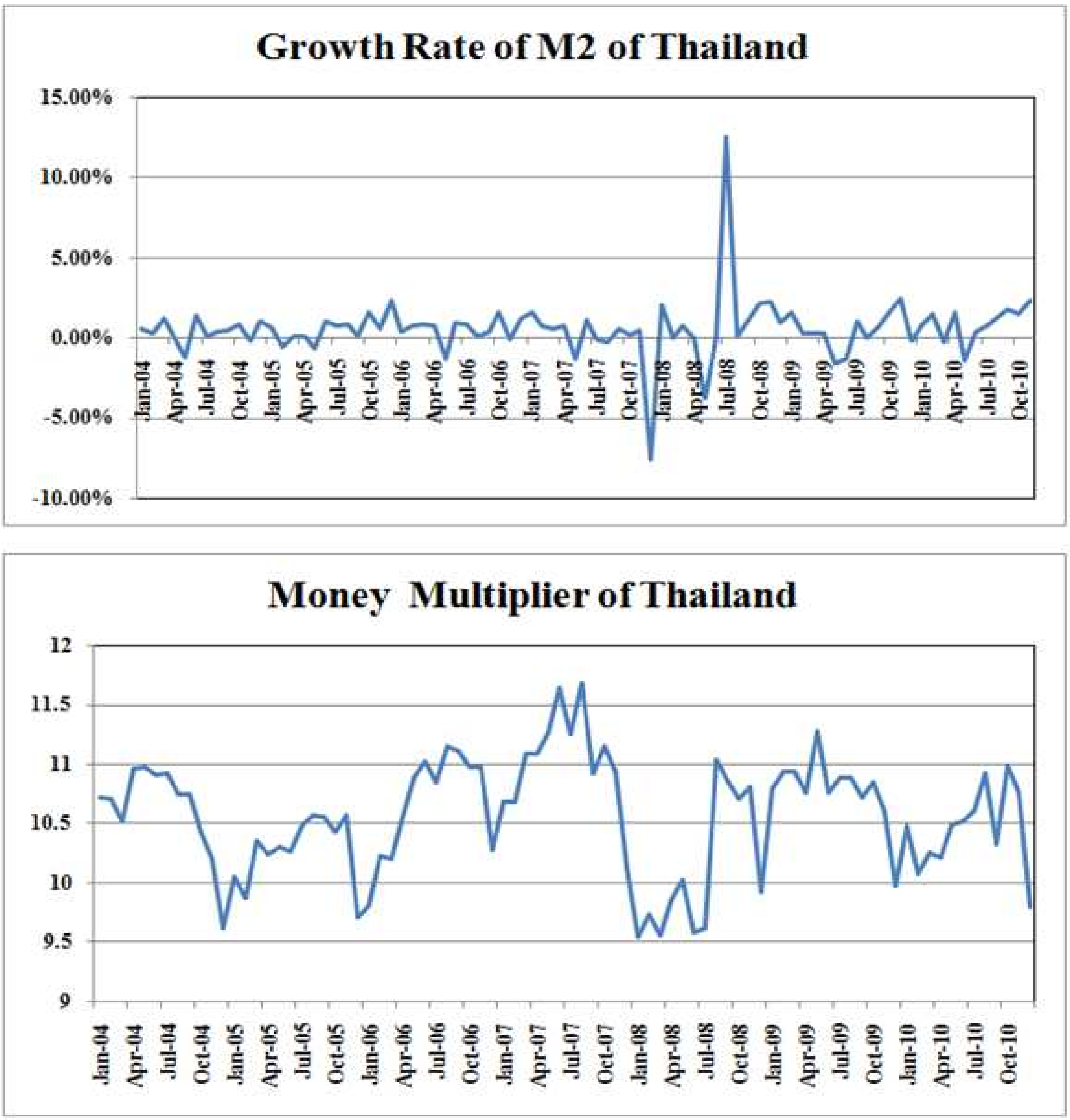
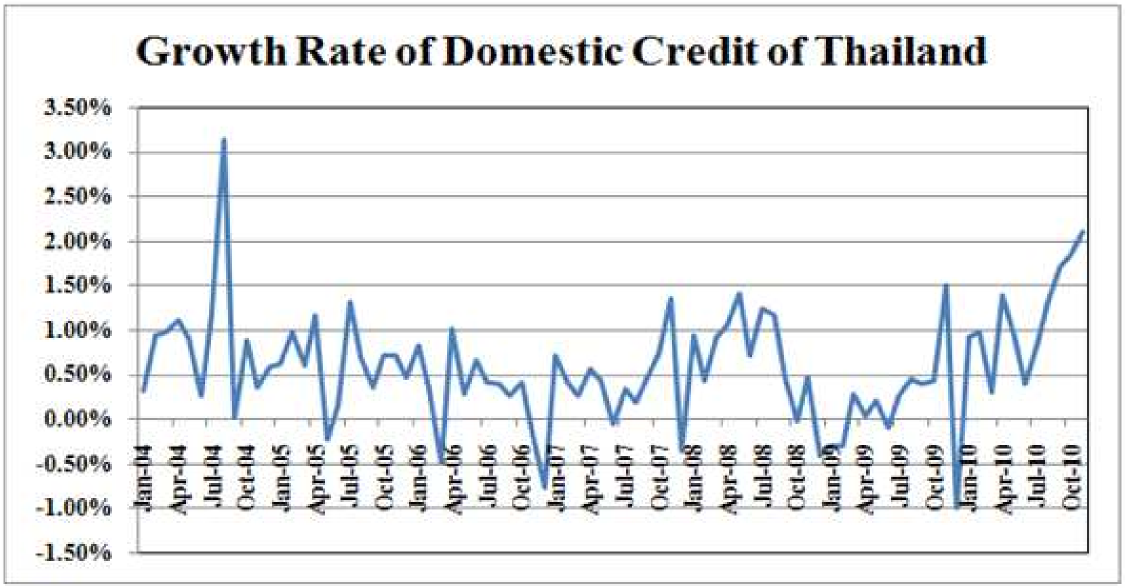


Figure T2 reports that the growth rate of domestic credit maintained the same movement and was co-integrated with the credit multiplier before 2009. From 2009 to 2010, the credit multiplier decreased when the growth of domestic increased. The credit multiplier increased significant in 2008 when the global financial crisis occurred.

Figure T2



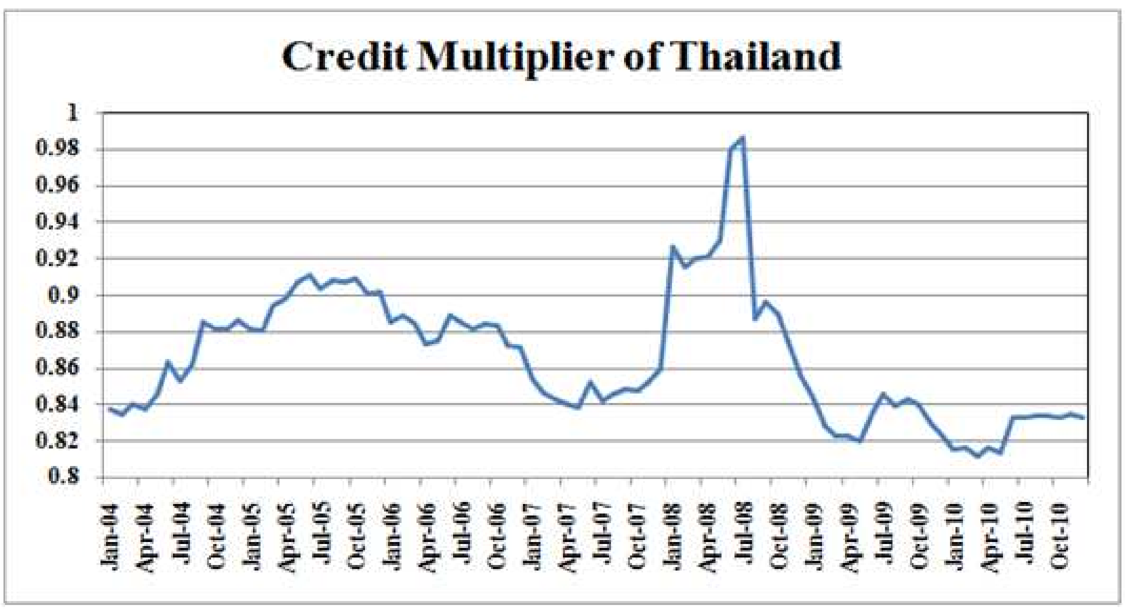
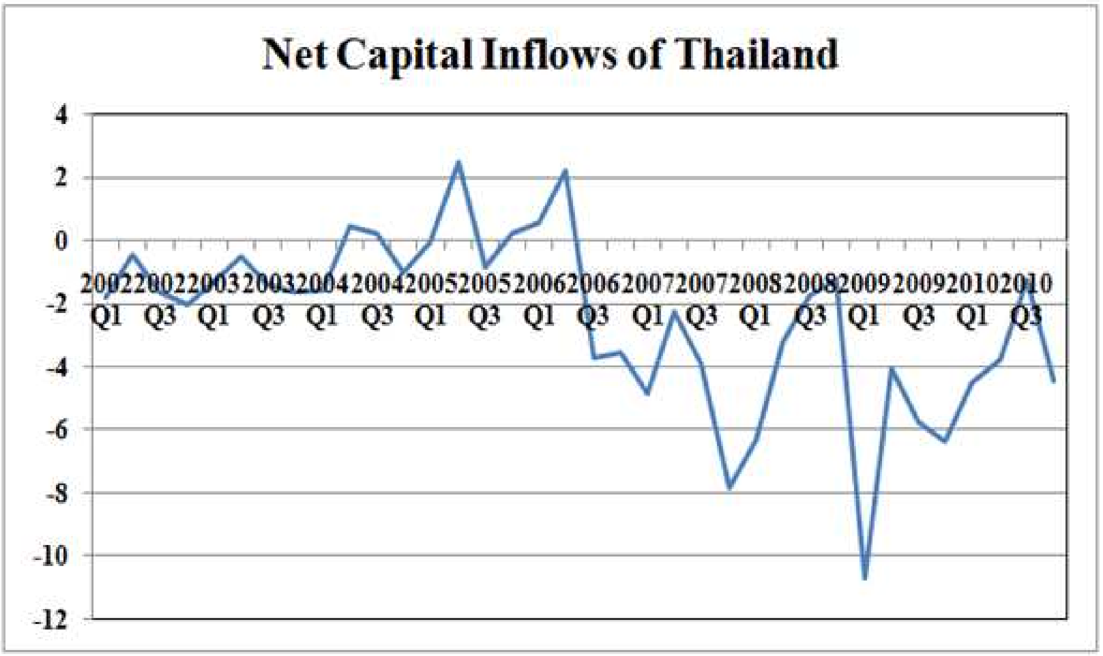
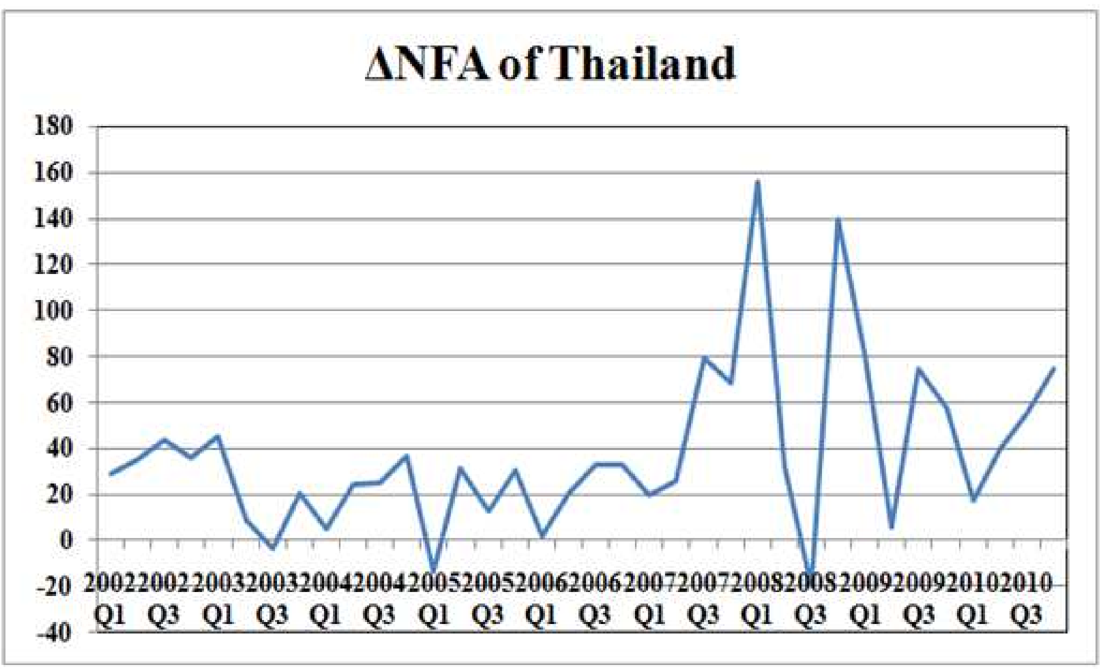


Figure T3 reports that net foreign assets increase when net capital inflows decrease.

Figure T3





Korea

Table K1 reports the results of the co-integration equation in the long run, while Table K1A reports the results of short-run dynamic equations.

1. The results of ECM for sterilization coefficient and offset coefficient in the long run

Korea	Main Variable (Significant)	Significant Endogenous Variables	Significant Dummy Variables	Error Term
NDAt	-0.766 NFAt	C +1227613LM2t	Dummy variables and seasonal dummy variables are not significant.	Error cooerction term is stationary.
NFAt	-0.773 NDAt	C +850133.4 LM2t	Dummy variables are not significant; Seasonal dummy variables are not significant.	Error correction term is stationary.

1A. The results of ECM for sterilization coefficient and offset coefficient in the short run

Korea	Main Variable (Significant)	Significant Endogenous Variables	Significant Dummy Variables	Error Term
ΔNDA_t with one lags	$-0.981\ \Delta NFA_t$ Sterilization Coefficient	$1170210\ \Delta LM2_t$ $+842.2\ \Delta CPI_t$ $+110708.9\ \Delta LEX_{t-1}$ $-7721.05\ \Delta R_t$ $-75.67\ \Delta FR_{t-1}$ $-0.237\ ECNDA_{t-1}$	DUMDNDA, DUMDNFA, DLM2; Seasonal dummies (D1, D2, D3, and D8) are partially significant	Error term is white noise
ΔNFA_t with three lags	$-0.902\ \Delta NDA_t$ Offset Coefficient	$964514\ \Delta LM2_t$ $+31009.6\ \Delta R_t$ $-207888\ \Delta R_{t-2}$ $+0.36 ECNFA_{t-1}$ $-0.36 ECNFA_{t-2}$	DUM, DUMDNDA, DUMDNFA, DUMDR ; Seasonal dummy (D7) is significant	Error term is white noise

The structural break analysis indicates a significant break point in December 2003. Thus, the new sample data has been selected from between January 2004 and December 2010. The results of co-integration equations (long-run equilibrium) and short-run dynamic equations do not support each other. The results of the short-run dynamic equations demonstrate that more system variables affected net domestic assets and net foreign assets than the results of the co-integration equation did. The error correction terms affected net domestic assets and net foreign assets significantly. Monetary policies responded to the previous exchange rate, foreign interest rate, foreign reserves, and error correction terms significantly. Thus, there was disequilibrium in the short run. The error correction terms of the co-integration equations are stationary and the error terms of the short-run dynamic equations are white noise, so the models are well-specified. An increase in the foreign interest rate would cause capital outflows.

The results of the ECM show the sterilization coefficient is -0.981 and the offset coefficient is -0.902.Korea had almost perfect sterilization and high capital mobility. Since the seasonal dummy variables are partially significant, sterilization would have seasonal effects in specific months. The significance of the additive dummy variable indicates the exogenous disturbances that would affect capital mobility. The significance of the multiplicative dummy variables indicates the shocks induced by the monetary policies for net domestic assets, net foreign assets and money supply would affect sterilization and the shocks induced by the policies for net domestic assets, net foreign assets and foreign interest rates would affect capital mobility. In addition, the significance of the multiplicative dummy variables demonstrates the interaction between exogenous disturbances and system variables for capital mobility. Most of seasonal dummies are insignificant in the model of capital mobility so there should be no significant seasonal effects on the activities of capital mobility.

Table K2 demonstrates the results of the OLS methodology.

2. The results of single equation of OLS methodology for sterilization coefficient and offset coefficient

Korea The single equation of OLS methodology	Main Variable (Significant)	Significant Endogenous Variables	Significant Dummy Variables	Error Term
ΔNDA_t	-0.906 ΔNFA_t Sterilization Coefficient	1195323 $\Delta LM2t$	Seasonal dummy (D1) is significant	Error term is stationary but not white noise
ΔNFA_t	-0.9998 ΔNDA_t Offset Coefficient	1195060 $\Delta LM2t$	Seasonal dummies (D1, D8 and D11) are significant	Error term is stationary but not white noise

Error terms are stationary but not white noise. Thus, the single equations of OLS are mis-specified. Because of the highly co-integrated relationship between system variables, the first differences of the system variables are also highly co-integrated. Thus, the results of the OLS methodology are similar to the results of the ECM. However, the OLS methodology could not accommodate disequilibrium in the short-run dynamics, so the results of the OLS methodology are not as good as the results of the ECM.

Table K3 demonstrates the results of the co-integration equation in the long run.

3. The following results of ECM are for relationship between Q and M2 in the long run

Korea	Main Variable (Significant)	Significant Endogenous Variables	Significant Dummy Variables	Error Term
LQt	0.122 LM2t	C (constant term is significant in the long run)	DUMLQ ; Seasonal dummy variables are most likely significant.	Error correction term is stationary.

Table K3A demonstrates the results of short-run dynamic equations.

Q: money multiplier of M2

M2: broad money supply

3A. The following results of ECM are for relationship between Q and M2 in the short run

Korea	Main Variable (Significant)	Significant Endogenous Variables	Significant Dummy Variables	Error Term
ΔLQ_t (with two lags)	0.408 $\Delta LM2_t$	1.761 $\Delta LM2_{t-2}$ -0.758 $ECLQ_t$	D11 is significant; DUMDLQ	Error term is white noise.

The error correction term is stationary and the error term of the short-run dynamic equation is white noise so the model is well-specified. The money supply is co-integrated with the money multiplier in the long run. The increase of money supply would raise the money multiplier in the short-run dynamics. The monetary policy responded to the previous money supply. The significance of the money multiplier indicates that the shocks induced by monetary policy affect the money multiplier. The error correction term also affects the money multiplier significantly. That indicates the system will correct the previous disequilibrium. Most of the seasonal dummies are insignificant. As the above results indicate, the money multiplier increases with capital inflows. The results show that the money multiplier increases when the money supply increases. When the money supply increases one percent, the money multiplier increases 0.408 percent. The effects of the error correction term on the money multiplier are significant and the money multiplier would respond to the previous money supply. Thus, the money market of Korea should have transitional dynamics in the sample period.

Table K4 demonstrates the results of the co-integration equation in the long run.

4. The following results of ECM are for relationship between credit multiplier and capital inflows in the long run

Korea	Main Variable (Significant)	Significant Endogenous Variables	Significant Dummy Variables	Error Term
LCQ_t	$-0.202\ LM2_t$	C $-0.826\ LNDA_t$ $+ 1.03\ LCD_t$	DUM DUMLCQ, DUMLNFA,DUMLNDA, DUMLDC; Seasonal variable D3 and D5 are significant	Error term is white noise.

Table K4A demonstrates the results of the short-run dynamic equation.

CQ: credit multiplier

LCQ: logarithm of credit multiplier

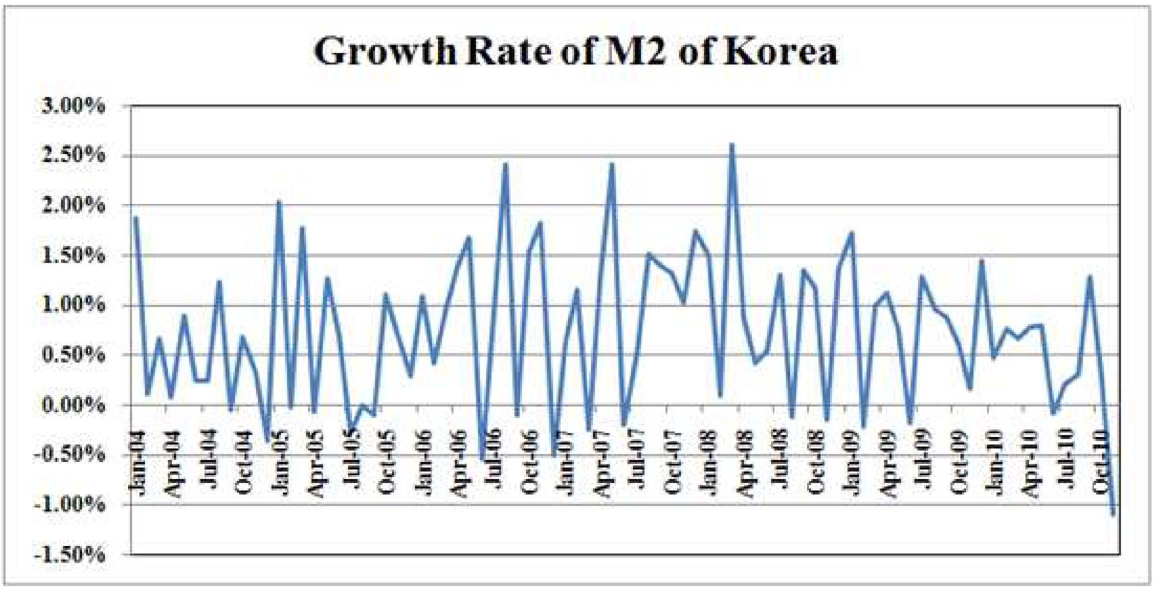
4A. The following results of ECM are for relationship between credit multiplier and capital inflows in the short run

Korea	Main Variable (Significant)	Significant Endogenous Variables	Significant Dummy Variables	Error Term
ΔLCQ_t (with two lags)	-0.202 $\Delta LNFA_t$	-0.81 $\Delta LNDA_t$ + 1.01 ΔLCD_t -0.586 $ECCQ_t$	D5 is significant. DUMDLCQ, DUMDLNFA, DUMDLNDA, DUMDLDC	Error term is white noise.

The results show that models are well-specified to explain the economic activities between the credit multiplier and capital inflows. The results of the co-integration equation and the short-run dynamic equation support each other. However, the error correction term affected the credit multiplier significantly in the short-run dynamics. Thus, the short-run dynamic equation deviated from the long-run equilibrium. The results of short-run dynamics show that the credit multiplier decreases when net foreign assets (or capital inflows) increase. The credit multiplier decreases when net domestic assets increase. Thus, an increase in domestic credit would cause an increase in the credit multiplier. The seasonal dummies are most likely insignificant. The significance of multiplicative dummies indicates the shocks induced by the monetary policies. When the net foreign assets increase one percent, the credit multiplier decreases 0.202 percent. In the face of capital inflows, the effects of net foreign assets and net domestic assets on the credit multiplier are negative, but the effects of domestic credit and the error correction terms on the credit multiplier are positive. Because the error correction term and most of the multiplicative dummy variables affects the credit multiplier significantly, the credit market of Korea should have transitional dynamics within the sample period.

Figure K1 reports that the money supply and money multiplier are highly co-integrated. The money multiplier increases when the growth of money supply increases. The money multiplier decreases when the growth of money supply decreases. The money multiplier for Korea is much more volatile than for other countries.

Figure K1



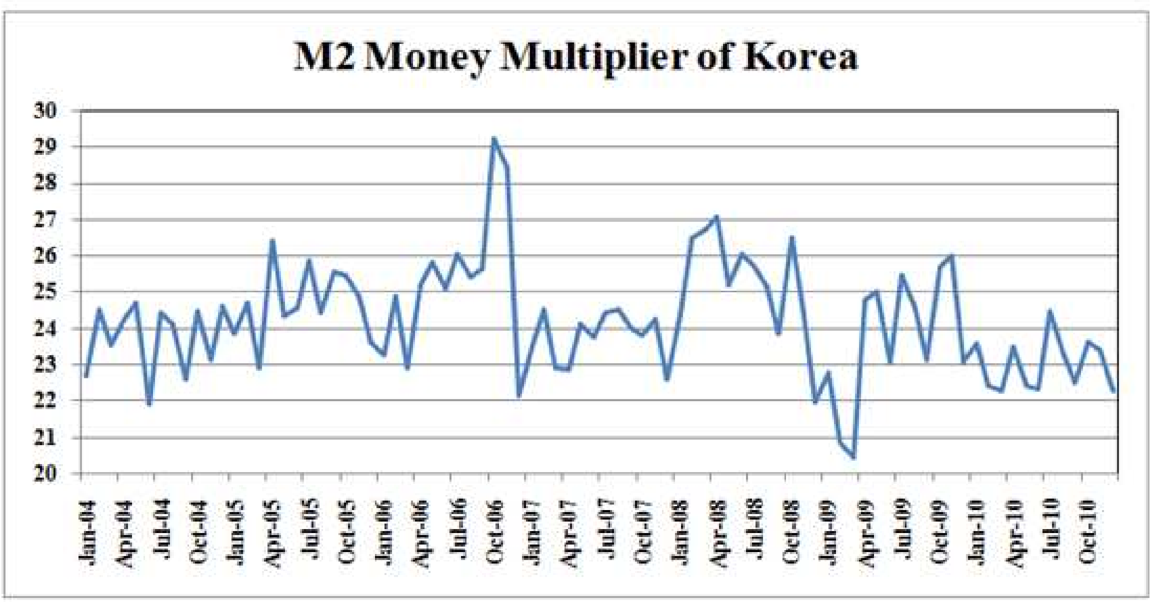


Figure K2 reports that the credit multiplier increases when the growth of the domestic credit increases.

Figure K2

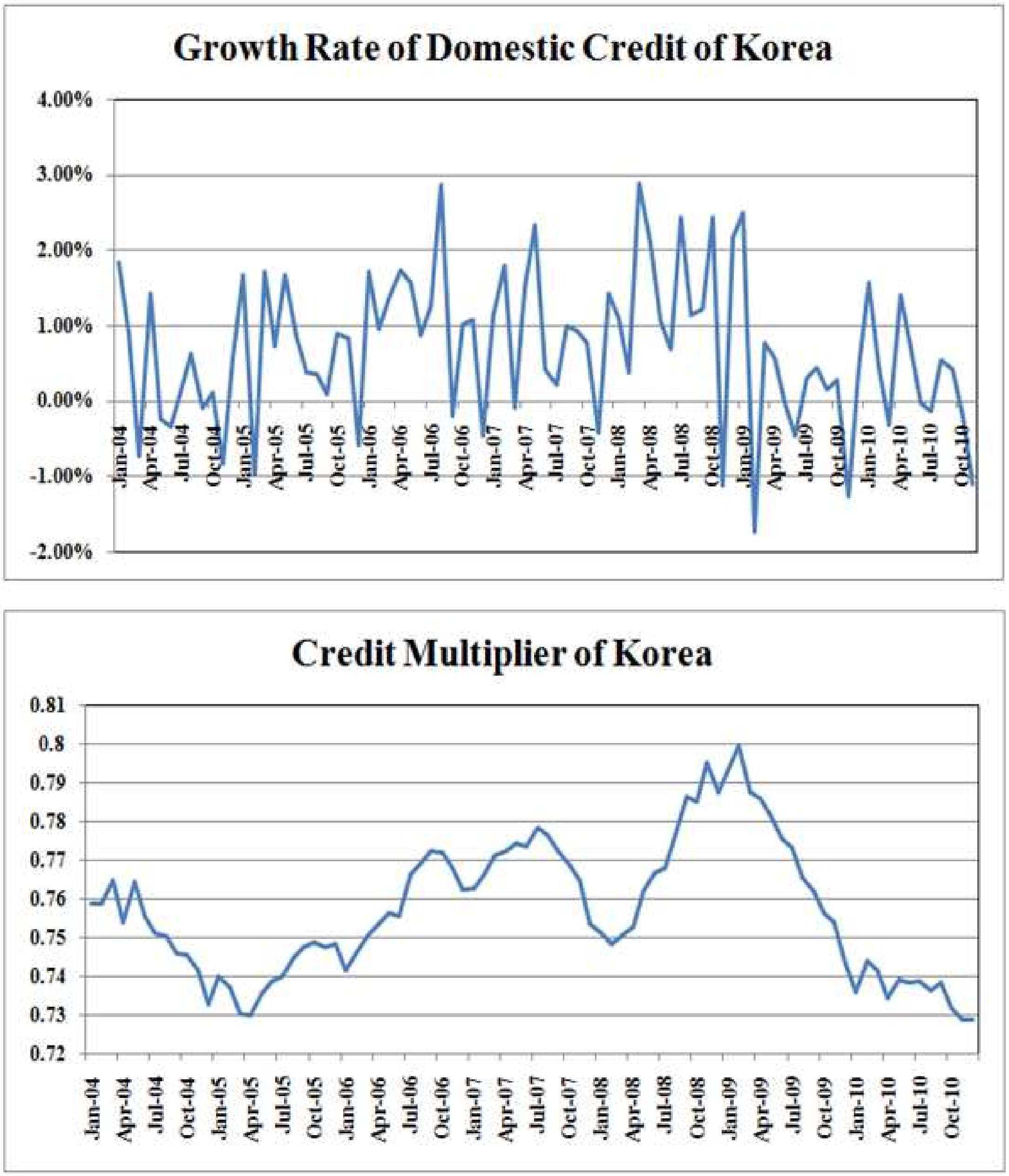
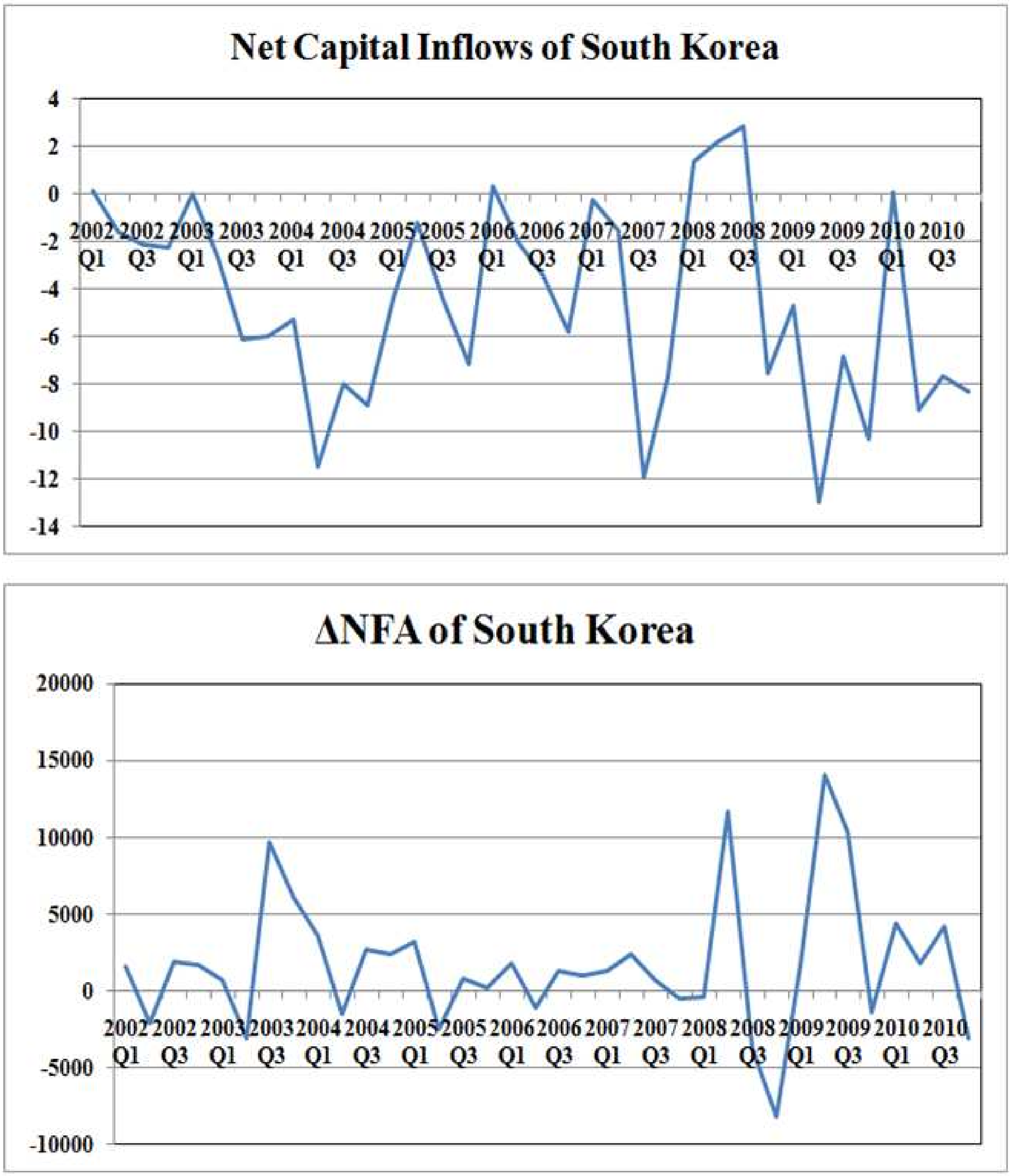


Figure K3 reports that net capital inflows are highly co-integrated with the change in net foreign assets and that they keep the same movement. Net foreign assets increase when net capital inflows decrease.

Figure K3



Indonesia

Table I1 reports the results of the co-integration equation in the long run.

1. The results of ECM for sterilization coefficient and offset coefficient in the long run

Indonesia	Main Variable	Significant Endogenous Variables	Significant Dummy Variables	Error Term
NDAt	-0.181 NFAt (not significant)	C + 729035 LM2t +0.228 DCt – 209254.3 Rt -3.439 FRt	Additive and multiplicative dummy variables are not significant; Seasonal dummies are partially (D3 and D4) significant	Error correction term is stationary.
NFAt	-0.152 NDAt (not significant)	C + 605629 LM2t + 316159.1LEXt -0.262 DCt + 9.236 FRt	DUMFR; Seasonal dummies are not significant.	Error correction term is stationary.

Table I1A reports the results of short-run dynamic equations.

1A. The results of ECM for sterilization coefficient and offset coefficient in the short run

Indonesia	Main Variable (Significant)	Significant Endogenous Variables	Significant Dummy Variables	Error Term
ΔNDA_t (with two lags)	$-0.691\ \Delta NFA_t$ Sterilization Coefficient	$1375751\ \Delta LM2_t + 0.197\ \Delta DC_t - 66576.17\ \Delta R_t$	DUM, DUMDNDA, DUMDNFA, DUMDLM2; Seasonal dummies are partially (D4 and D5) significant	Error term is white noise
ΔNFA_t (with two lags)	$-0.532\ \Delta NDA_t$ Offset Coefficient	$841295.8\ \Delta LM2_t + 3.294\ \Delta FR_t$	DUMDNFA; Seasonal dummies are partially (D4 and D11) significant	Error term is white noise

The results show the models are well-specified. The results of the co-integration equation and short-run dynamic equation support each other. However, foreign reserves would affect net domestic assets in the long run, and the exchange rate and domestic credit would affect net foreign assets in the long run. The monetary policies did not respond to the previous endogenous variables and the error correction term did not affect net domestic assets and net foreign assets significantly. Thus, the short-run dynamic did not deviate from the long-run equilibrium. The sterilization coefficient was -0.691, and the offset coefficient was -0.532.

Indonesia had a medium degree of sterilization and capital mobility within the sample period. The capital mobility of Indonesia is not as high as other Asian countries. Net domestic assets decreased when foreign assets increased and increased when money supply and domestic credit increased. Net foreign assets increased when money supply and foreign assets increased. Most of the seasonal dummy variables in both models are insignificant. The significance of additive dummy variables in the sterilization equation indicates that the exogenous disturbances affect net domestic assets significantly. The significance of the multiplicative dummy variables indicates that the shocks induced by monetary policies for net domestic assets, net foreign assets, and money supply affects sterilization significantly. The significance of multiplicative of net foreign assets indicates that the shocks induced by monetary policies for net foreign assets would affect capital mobility significantly. In addition, the significance of multiplicative dummy variables demonstrates the interaction between exogenous disturbances and system variables for capital mobility. Most seasonal dummies were insignificant.

Table I2 demonstrates the results of the OLS methodology.

2. The results of single equation of OLS methodology for sterilization coefficient and offset coefficient

Indonesia The single equation of OLS methodology	Main Variable (Significant)	Significant Endogenous Variables	Significant Dummy Variables	Error Term
ΔNDA_t	$-0.869\ \Delta NFA_t$ Sterilization Coefficent	$1680402\ \Delta LM2$ $+0.353\ \Delta DC_t$ $-187421\ \Delta LEX_t$	Seasonal dummies are significant	Error term is stationary but not white noise
ΔNFA_t	$-0.454\ \Delta NDA_t$ Offset Coefficent	$814493.1\ \Delta LM2$ $+0.154\ \Delta DC_t$ $+4.045\ \Delta FR_t$	Seasonal dummies are most likely significant	Error term is stationary but not white noise

The error term is stationary but not white noise. Thus, the model is mis-specified. The results of the single equation of OLS are not similar to the ECM results, in that the results of the single OLS equation show a higher degree of sterilization and lower degree of capital mobility than the ECM results. This is the first case in which the estimates differ substantially. However, the results of the ECM show a medium degree of sterilization. Both results demonstrate a medium degree of capital mobility for Indonesia. The results of the single OLS equation show increased domestic credit would increase net domestic assets and net foreign assets. In fact, increased domestic credit is capable of increasing net domestic assets but not necessarily increasing net foreign assets. Thus, the results of the ECM are more reliable than the results of the OLS methodology.

Table I3 reports the results of the co-integration equation in the long run.

3. The following results of ECM are for relationship between Q and M2 in the long run

Indonesia	Main Variable (Significant)	Significant Endogenous Variables	Significant Dummy Variables	Error Term
LQt	-0.449 LM2t	C (constant term is significant in the long run)	DUM, DUMLQ, DUMLM2; Seasonal dummies are significant	Error correction term is stationary.

Table I3A reports the results of the short-run dynamic equation.

Q: money multiplier of M2

3A.The following results of ECM are for relationship between Q and M2 in the short run

Indonesia	Main Variable (Significant)	Significant Endogenous Variables	Significant Dummy Variables	Error Term
ΔLQt (with two lags)	-1.601 ΔLM2t	-0.558 ΔECLQt	DUM, DUMDLM2, DUMDLQ; Seasonal dummies are significant	Error term is white noise.

The models are well-specified. When the money supply increases one percent, the money multiplier decreases 1.601 percent. The ECM is a variant of the partial adjustment model. The error correction term guides the model to correct disequilibrium. The coefficient of the error correction term in the impulse response function is significant and negative (-0.558), which means the model deviates from the long-run equilibrium and the system corrects its previous period's disequilibrium. The seasonal dummies are significant. The significant effects of the additive dummy indicate that exogenous disturbances would affect the model. The significant effects of multiplicative dummies indicate that the multiplicative dummy variables should be present simultaneously in the model to respond to the shocks from exogenous disturbances and the shocks induced by monetary policies. The money multiplier decreases when the money supply increases. The error correction term and multiplicative dummy variables have significant impacts on the money multiplier. The impacts of capital inflows would cause the money market of Indonesia to approach transitional dynamics, and the error correction term would guide the model to correct the disequilibrium.

Table I4 reports the results of the co-integration equation in the long run and Table I4A demonstrates the results of short-run dynamic equation.

CQ: credit multiplier

4. The following results of ECM are for relationship between credit multiplier and capital inflows in the long run.

Indonesia	Main Variable (Significant)	Significant Endogenous Variables	Significant Dummy Variables	Error Term
LCQ_t	-0.257 $LNFA_t$	-0.802 $LNDA_t$ + 1.022 LDC_t	Additive and multiplicative dummy variables are not significant; Seasonal dummies are significant	Error corerction term is stationary.

4A. The following results of ECM are for relationship between credit multiplier and capital inflows in the short run.

Indonesia	Main Variable (Significant)	Significant Endogenous Variables	Significant Dummy Variables	Error Term
ΔLCQ_t (with two lags)	-0.225 $\Delta LNFA_t$	-0.731 $\Delta LNDA_t$ + 0.982 ΔLDC_t	DUMDLCQ, DUMDLNFA, DUMDLDC; Seasonal dummies are significant	Error term is white noise.

The models are well-specified to explain the economic activities, and the results of the co-integration equation and of short-run dynamics support each other. The short-run dynamic equation did not deviate from the long-run equilibrium. Net foreign assets, net domestic assets, and domestic credit affect the credit multiplier in the short-run dynamics as well as in the long-run co-integration equation. The results of short-run dynamics show the credit multiplier would decrease in the face of capital inflows. The capital inflows should increase the growth of domestic credit. The results show the increase of domestic credit cause an increase in the credit multiplier and that a decrease of net domestic assets reduces the credit multiplier. The seasonal dummies are significant. The significant effects of multiplicative dummies indicate that the multiplicative dummy variables should be present simultaneously in the model to respond to the shocks from exogenous disturbances and the shocks induced by monetary policies. When the net foreign assets increase one percent, the credit multiplier decreases 0.225 percent. The effects of net foreign assets and net domestic assets on the credit multiplier are negative, but the effects of domestic credit on the credit multiplier are positive. The credit multiplier would not increase with capital inflows.

Figure I1 reports that the money multiplier does not increase when the growth rate of the money supply increases, which is consistent with the ECM results.

Figure I1

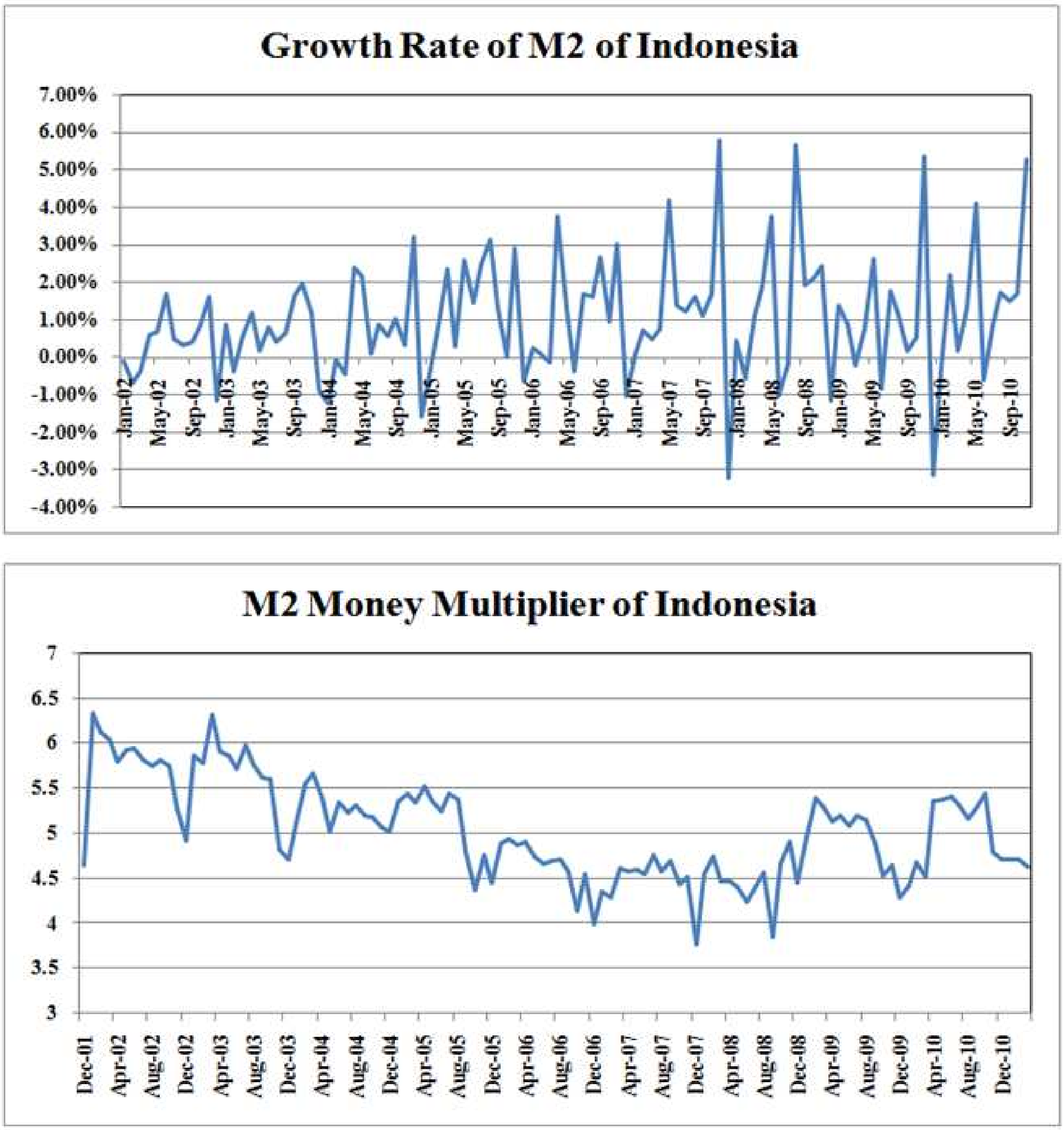


Figure I2 reports that credit multiplier increases when the growth of domestic credit increases in the face of capital inflows, which is consistent with the ECM results.

Figure I2

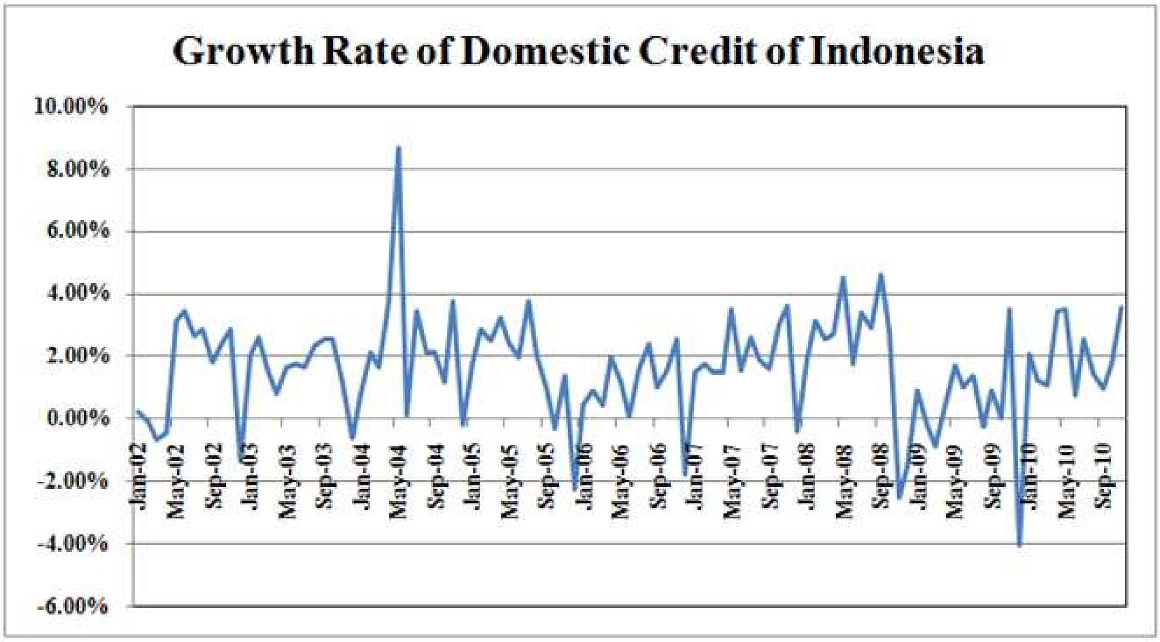
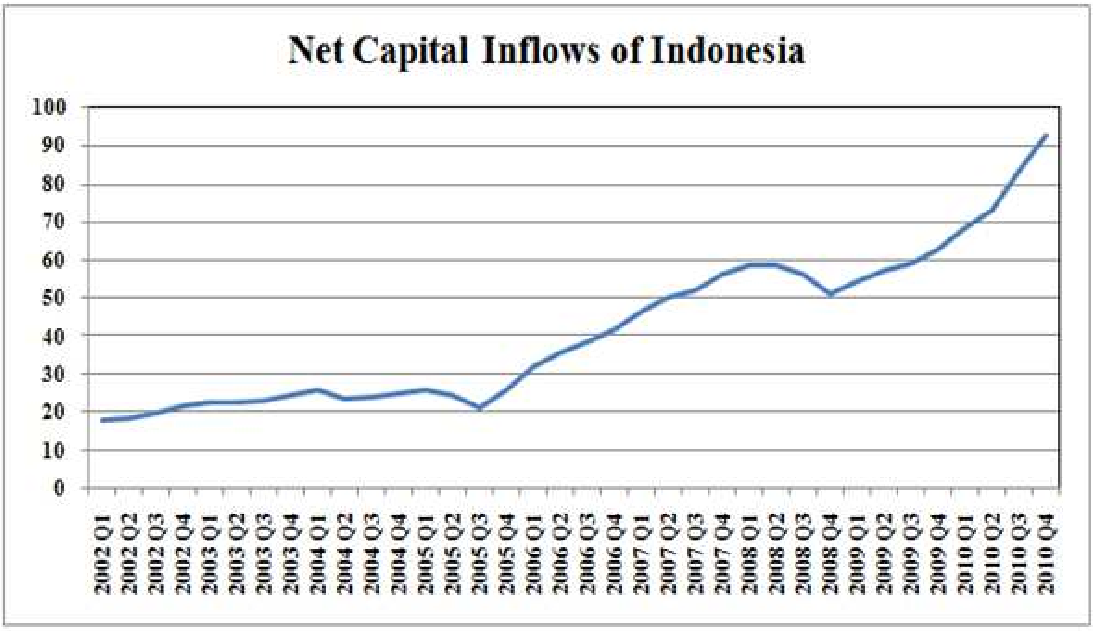
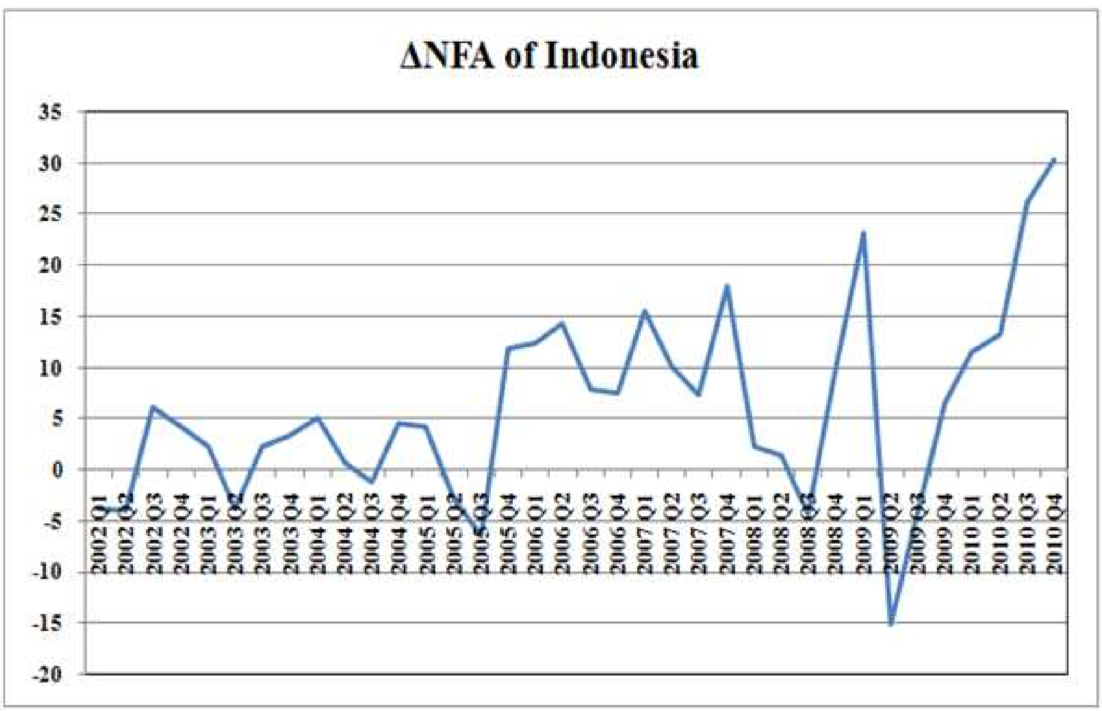


Figure I3 reports that net foreign assets increase when net capital inflows increase.

Figure I3





Malaysia

Table M1 demonstrates the results of co-integration equations in the long run.

1. The ECM results for the sterilization coefficient and offset coefficient in the long run

Malaysia 2002-2010	Main Variable (Significant)	Significant Endogenous Variables	Significant Dummy Variables	Error Term
NDAt	-1.45 NFAt	C +447043.4LM2t +59084.96 LQ2t +5068.86CPIt -261792.4LEXt -0.157DCt +1.18FRt	DUMLEX; Seasonal dummies are most likely not significant	Error correction term is stationary
NFAt	-0.482 NDAt	C +259341.4 LM2t +35873.39 LQt +2423.93CPIt - 0.15DCt +1.27FRt	DUMFR; Seasonal dummies are most likely not significant	Error correction term is stationary

Table M1A demonstrates the results of short-run dynamic equations.

1A. The results of ECM for sterilization coefficient and offset coefficient in the short run

Malaysia 2002-2010	Main Variable (Significant)	Significant Endogenous Variables	Significant Dummy Variables	Error Term
ΔNDA_t (with three lags)	$-1.032\ \Delta NFA_t$ Sterilization Coefficient	$575906.2\ \Delta LM2_t$ $-157242.1\ \Delta LM2_{t-1}$ $+19751.26\ \Delta LQ_{t-1}$ $+1621.65\ \Delta CPI_{t-1}$ $+1667.27\ \Delta CPI_{t-3}$	DUMDLEX; Seasonal dummies are partially (D2, D3 and D9) significant	Error term is white noise
ΔNFA_t (with three lags)	$-0.775\ \Delta NDA_t$ Offset Coefficient	$437979.8\ \Delta LM2_t$ $+18425.5\ \Delta LQ_{t-1}$ $+14649.66\ \Delta LQ_{t-3}$ $+1612.6\ \Delta CPI_{t-1}$ $+1836.49\ \Delta CPI_{t-3}$ $+295775.5\ \Delta LEX_{t-1}$ $-280225\ \Delta R_{t-2}$	DUMDLEX; Seasonal dummies are Partially (D2, D3 and D4) significant	Error term is white noise

The sample data is from between January 2002 and December 2010. The error correction terms of the co-integration equations are stationary and the error terms of the short-run dynamics are white noise, so the models are well-specified. The results of co-integration equations in the long run and the results of short-run dynamics do not support each other. The monetary policies respond to the previous money supply, money multiplier, inflation, exchange rate and foreign interest rate. Thus, the short-run dynamics deviate from the long-run equilibrium. The sterilization coefficient is -1.032and the offset coefficient is -0.775. Malaysia had perfect sterilization but a high degree of capital mobility within the sample period. The increase in money supply increases net domestic assets and net foreign assets in the face of capital inflows. The results showed seasonal dummies to be partially significant. The significant effects of multiplicative dummies indicate that the multiplicative dummy variables should be present simultaneously in the model to respond to the shocks from exogenous disturbances and the shocks induced by monetary policies. The effects of the foreign exchange rate on net domestic assets and net foreign assets were different across regimes.

Table M2 demonstrates the results of the OLS methodology.

2. The results of single equation of OLS methodology for sterilization coefficient and offset coefficient

Malaysia The single equation of OLS methodology	Main Variable (Significant)	Significant Endogenous Variables	Significant Dummy Variables	Error Term
ΔNDA_t	-1.022 ΔNFA_t Sterilization Coefficent	610657.1 $\Delta LM2_t$ +0.244 ΔDC_t	Seasonal dummy (D9) is significant	Error term is stationary but not white noise
ΔNFA_t	-0.759 ΔNDA_t Offset Coefficent	475990.6 $\Delta LM2_t$ +0.424 ΔFR_t	Seasonal dummies are partially (D3 and D9) significant	Error term is stationary but not white noise

The error term is stationary but is not white noise. Thus, the model is mis-specified. Although the results of the sterilization coefficient and offset coefficient show no significant difference from the results of ECM, the single OLS equation is not capable of accommodating the impacts of disequilibrium. Thus, the OLS methodology is capable of explaining overall economic activities in detail. The results of the OLS methodology are not as reliable as the results of the

ECM. For this reason, we do not adopt the results of the single OLS equation. Table M3 demonstrates the results of the co-integration equation in the long run.

3. The following results of ECM are for relationship between Q and M2 in the short run

Malaysia	Main Variable (Significant)	Significant Endogenous Variables	Significant Dummy Variables	Error Term
LQt	0.479 LM2t	C (constant term is significant)	DUMLQ, DUMLM2; Seasonal dummies are most likely not significant	Error correction term is stationary

Table M3A demonstrates the results of the short-run dynamic equation.

Q: money multiplier of M2

3A. The following results of ECM are for relationship between Q and M2 in the short run

Malaysia	Main Variable (Significant)	Significant Endogenous Variables	Significant Dummy Variables	Error Term
ΔLQt (with two lags)	0.732 ΔLM2t	-0.584 ΔECLQt + 0.30ΔECLQt-1	DUMDLQ; Seasonal dummies are not significant	Error term is white noise.

The error correction term is stationary and the error term is white noise, so the model is well-specified. For the short-run dynamics, the significance of the multiplicative dummy variables indicates that the shocks induced by the money multiplier affect the money multiplier. The error correction terms also affect the money multiplier significantly in the short run. This means disequilibrium occurred in the short-run dynamics and the system restored its previous disequilibrium to the long-run equilibrium. There were no seasonal effects in the short-run dynamics. In the case of Malaysia, the money multiplier increased with capital inflows by 0.732 times the logarithm value of money supply. An increase in money supply would cause a significant increase in the money multiplier. When the money supply increases one percent, the money multiplier increases 0.479 percent. The money multiplier not only responds to the error correction term in the current period but also to the error correction term from the previous period. The money market of Malaysia should enter transitional dynamics and the error correction term should guide the model to correct disequilibrium.

Table M4 demonstrates the results of the co-integration equation in the long run.

4. The following results of ECM are for relationship between credit multiplier and capital inflows in the short run

Malaysia	Main Variable (Significant)	Significant Endogenous Variables	Significant Dummy Variables	Error Term
LCQt	-0.408LNFAt	C -0.607LNDAt + 1.048LDCt	DUM, DUMLNFA, DUMLDC; Seasonal dummies are not significant	Error correction term is stationary

Table M4A demonstrates the results of the short-run dynamic equation.

CQ: credit multiplier

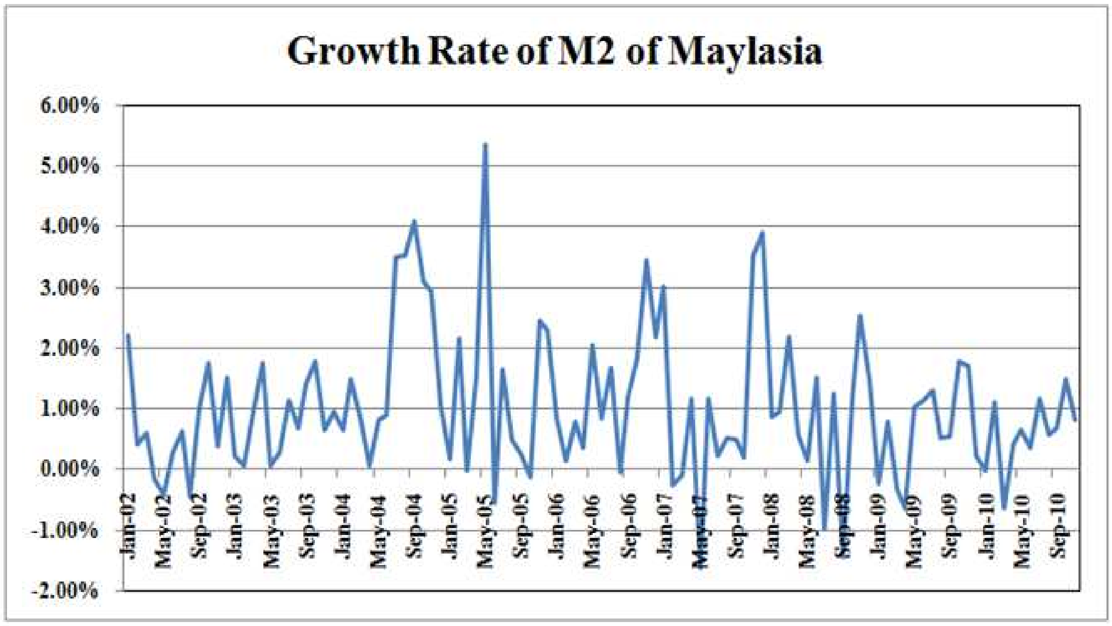
4A. The following results of ECM are for relationship between credit multiplier and capital inflows in the short run

Malaysia	Main Variable (Significant)	Significant Endogenous Variables	Significant Dummy Variables	Error Term
ΔLCQt (with two lags)	-0.375 ΔLNFAt	-0.572 ΔLNDAt + 1.04 ΔLDCt	DUMDLCQ, DUMDLNFA, DUMDLNDA, DUMDLDC; Seasonal dummies are not significant	Error term is white noise.

The error correction term of the co-integration equation is stationary and the error term of the short-run dynamics is white noise, so model is well-specified for explaining economic activities. The results of the co-integration equation and the results of the short-run dynamics support each other. The error correction term does not affect the short-run dynamics significantly. Thus, the short-run dynamics does not deviate from the long-run equilibrium. Seasonal dummies are not significant. In the short-run dynamics, the significance of the multiplicative dummy variables indicates the shocks induced by monetary policies. The significant effects of multiplicative dummies indicate that the multiplicative dummy variables should be present simultaneously in the model to respond to the shocks from exogenous disturbances and shocks induced by monetary policies. When the net foreign assets increase one percent, the credit multiplier decreases 0.375 percent. The effects of net foreign assets and net domestic assets on the credit multiplier are negative, but the effects of domestic credit on the credit multiplier are positive. Thus, the credit multiplier does not increase with capital inflows.

Figure M1 reports that the money multiplier increases when the growth rate of the money supply increases, which is consistent with the ECM results.

Figure M1



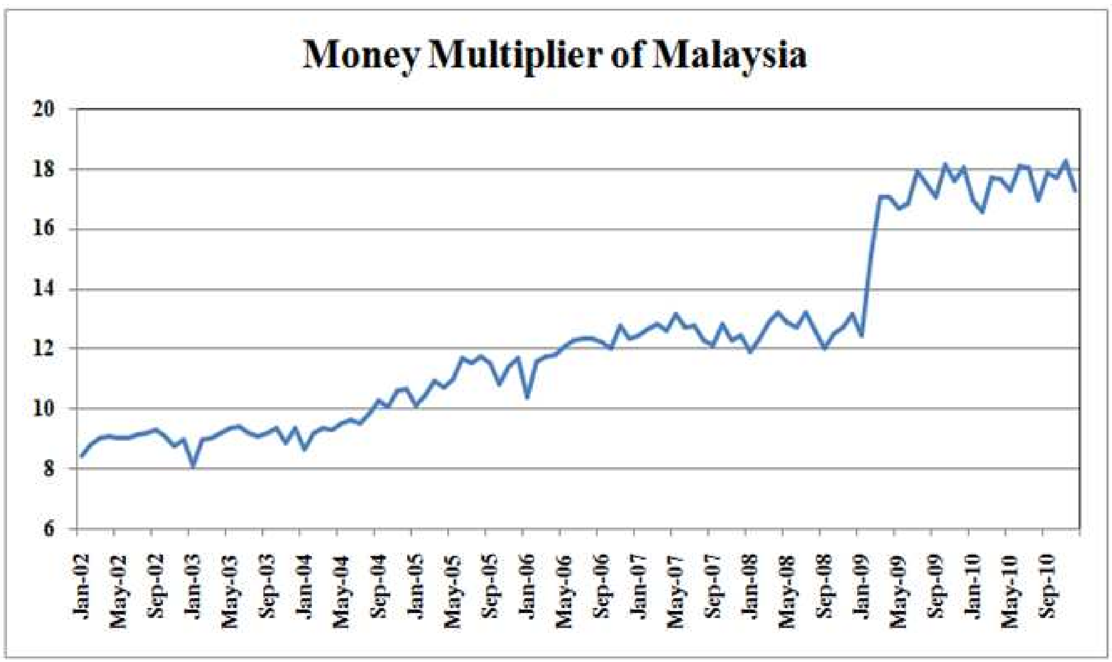


Figure M2 reports that the credit multiplier decreases when the growth of domestic credit increases, which is not consistent with the ECM results.

Figure M2

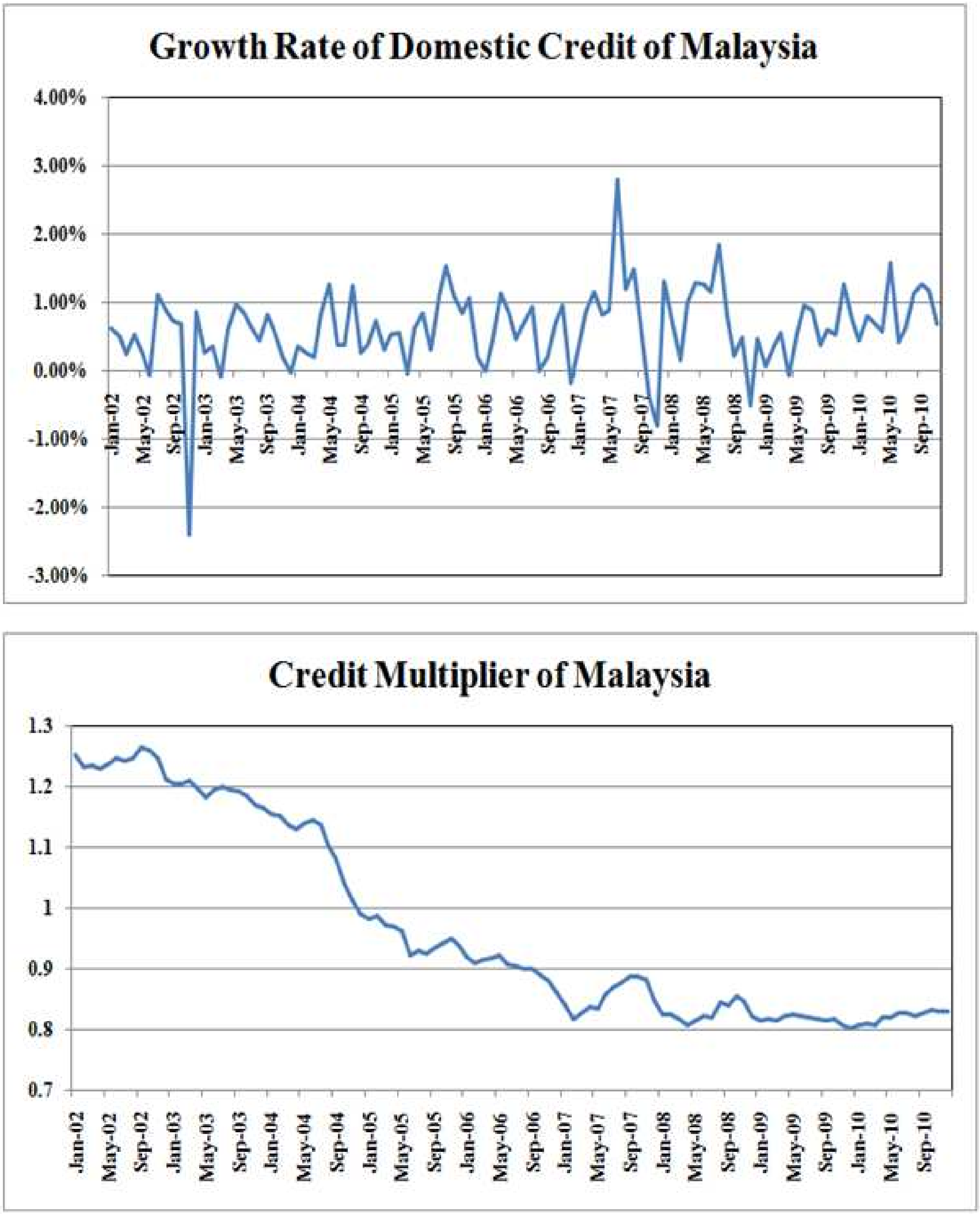
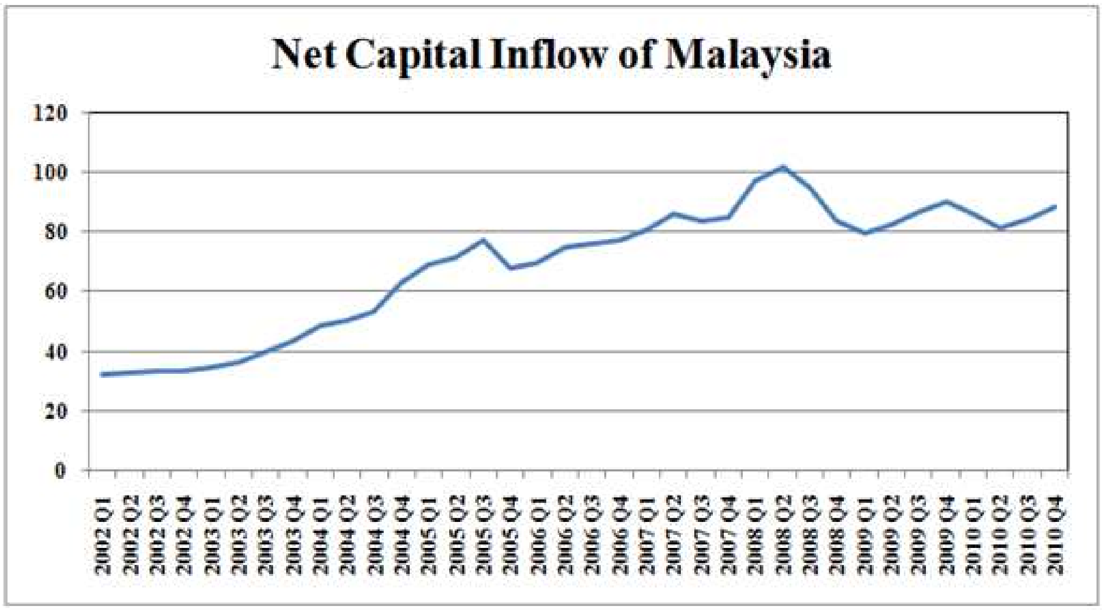
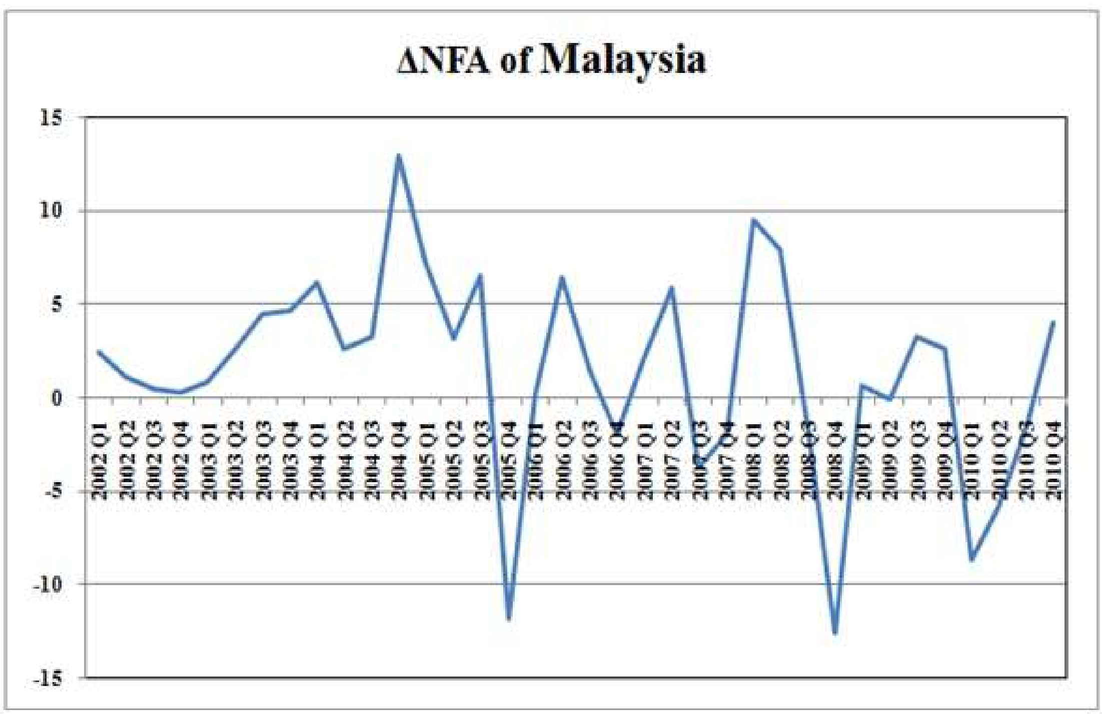


Figure M3 reports that net capital inflows increase dynamically but the change of net foreign assets accords with the seasonal cycle.

Figure M3





Chapter 7: Conclusion

This dissertation applies the error correction model (ECM) to estimate the monetary response functions for sterilization and capital mobility. In addition, this dissertation applies a dummy variable approach to capture the structural change of the models in transitional dynamics. The results demonstrate that the ECM provides better analysis with which to construct the monetary response functions for measuring the sterilization and offset coefficients.

The structural break analysis ensures the coefficient consistency for the sterilization coefficient and offset coefficient. The dynamic methodology of this dissertation demonstrates the instability and transitional dynamics of the models when shocks caused by capital inflows affect the models. The significance of dummy variables demonstrates the structural changes in the economy caused by the shocks. These changes indicate the instability of the models. The results show that, when the monetary response functions respond to the previous monetary policies, the economic state approaches transitional dynamics. Consequently, the lag impacts in the dynamic models become significant. The error correction terms should guide the models to correct the disequilibrium.

From the perspective of econometrics, the OLS models are mis-specified, because the error terms of the models are not white noise. This means serial correlation is present in the errors and the model is spurious. When we plan to apply the OLS for model specification, we should ensure that the data of all variables are normally distributed and the error term of the model is white noise. The OLS results for the sterilization coefficient and offset coefficient for Thailand and Korea do not significantly differ from the ECM results. This could result from the high co-integration of system variables. However, the OLS results could not provide a macroeconomic relationship among variables as well as the ECM could. Ultimately, we adopt the results of the ECM, because they can demonstrate how the system corrects previous disequilibrium in the short-run dynamics.

The results of this dissertation show that Thailand has perfect sterilization with high capital mobility, Korea has a high degree of sterilization with a high degree of capital mobility, Indonesia has a medium degree of sterilization with a medium degree of capital mobility, and Malaysia has perfect sterilization with high capital mobility (Table A3 in the Appendix). Exogenous disturbances affect Korea and Indonesia. The significance of the multiplicative dummy variables induced by domestic policies affect all four countries. This dissertation also demonstrates the impacts of all dummy variables on sterilization and capital mobility (Table A4 in the Appendix). Korea and Malaysia experienced the transitional dynamics in the process of sterilization. The ECM corrects the previous disequilibrium significantly for Korea and Malaysia. Thus, the short-run dynamics provide a more detailed explanation of how monetary policies respond significantly to the previous exchange rate, foreign interest rate, and foreign reserves in cases of sterilization and capital mobility (Table A5 in the Appendix).

The monetary response functions of this dissertation demonstrate how to implement sterilization efficiently. Under conditions of efficient sterilization, there is no consistent relationship of increase or decrease between the money supply and money multiplier. In the cases of Thailand, Korea, and Malaysia, the money multiplier increases when the money supply increases (Table A6 in the Appendix). In Indonesia, the money multiplier decreases when the money supply increases. Moreover, the money multiplier does not consistently increase or decrease. The results indicate that the credit multiplier does not increase for any of countries. In the short run dynamics, the money markets of all four East Asian countries in question enter transitional dynamics, but only the credit market of Korea is in a state of transitional dynamics. In Korea, the system corrected the previous disequilibrium in the credit market within the sample period (Table A7 in the Appendix). After the Asian financial crisis (1997), most Asian countries improved their financial regulations in order to prevent credit booms in the face of large capital inflows.

Appendix

Figure A1 demonstrates that a capital inflow surge will bring about macroeconomic concerns and financial stability risks.

Figure A1

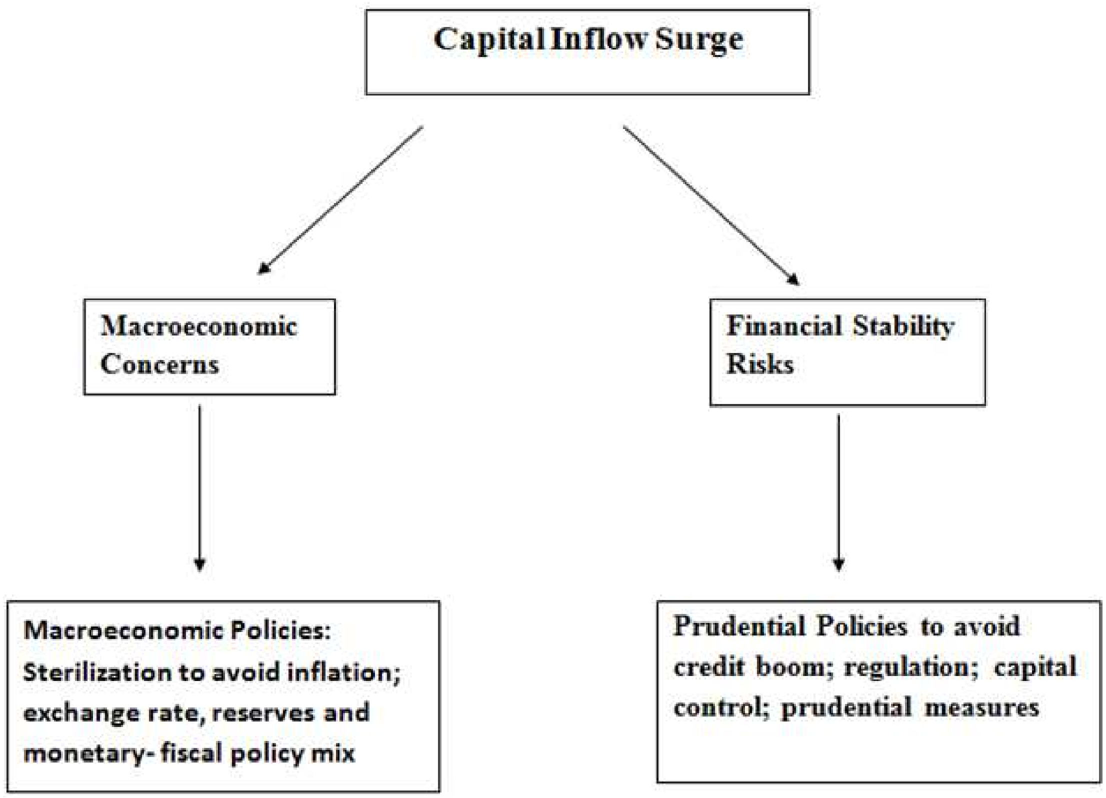


Figure A2 demonstrates that capital inflows will increase reserves, the monetary base, and broad money supply, which leads to an increase in domestic demand and domestic credit.

Figure A2

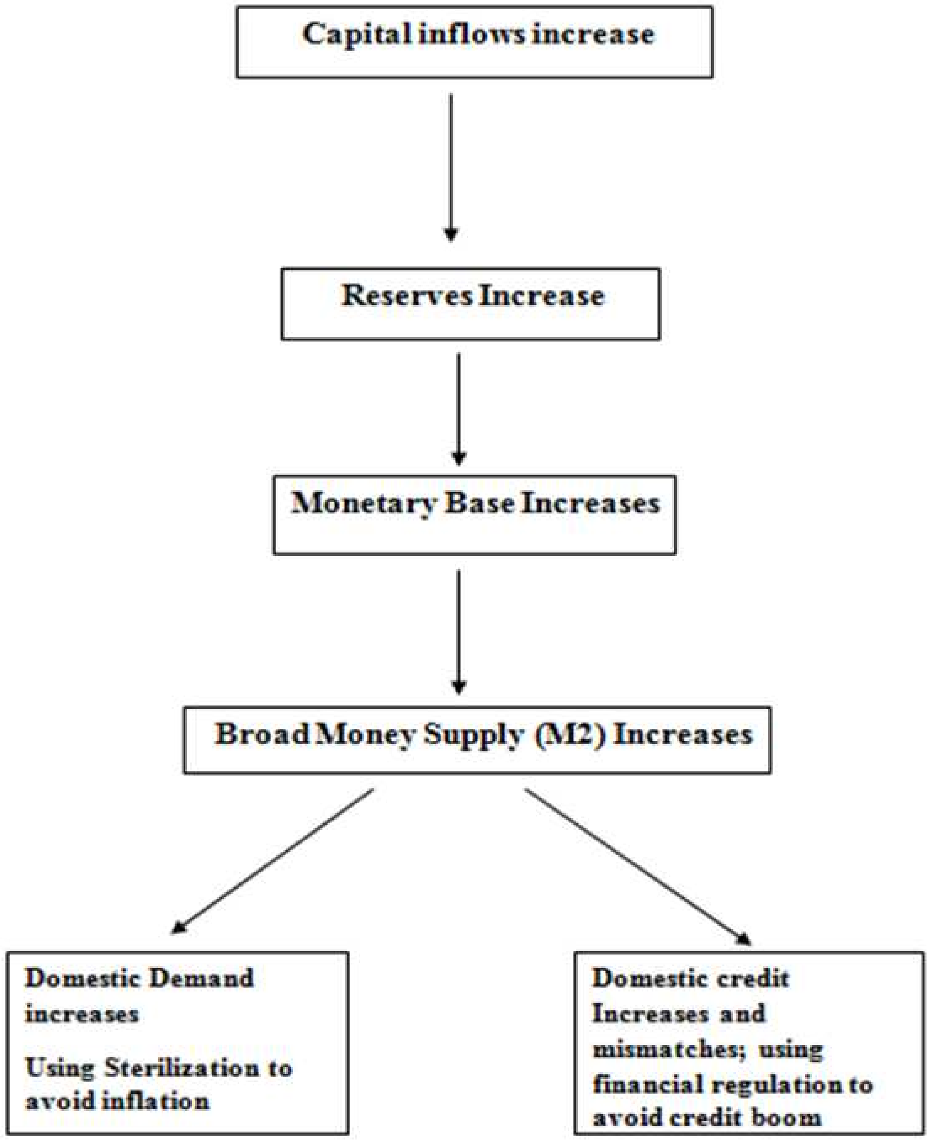

Capital inflows increase
Reserves Increase
Monetary Base Increases
Broad Money Supply (M2) Increases
Domestic Demand increases
Using Sterilization to avoid inflation
Domestic credit Increases and mismatches; using financial regulation to avoid credit boom

Figure A3 demonstrates the GDP of four East Asian countries. South Korea obtains higher GDP than other countries, but Indonesia achieves stronger economic growth than Thailand and Malaysia.

Figure A3

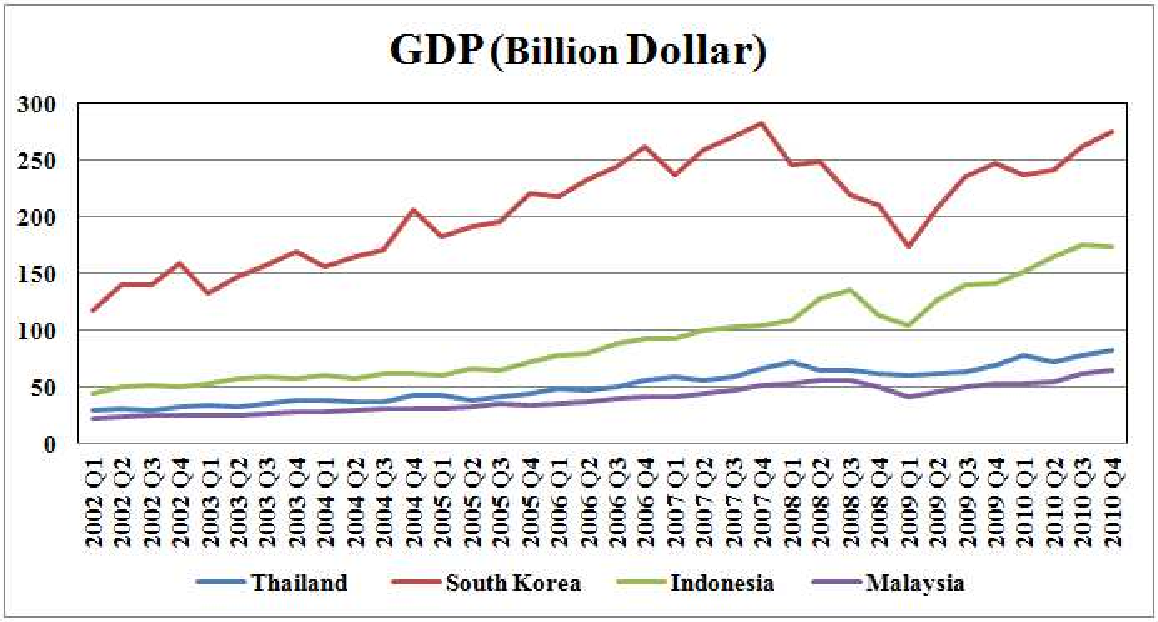


Figure A4 demonstrates that the credit multiplier does not increase within the sample period.

Figure A4

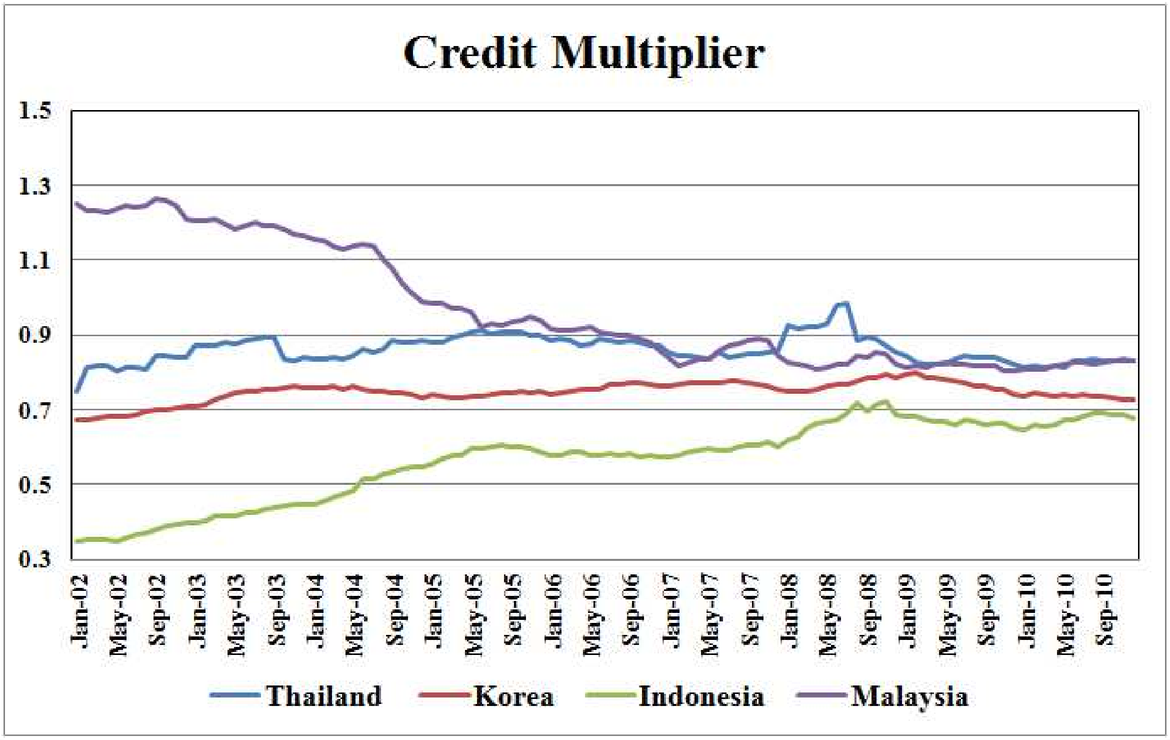


Table A1: Definitions and Measurement of the Variables used in Empirical Study

variables	Definitions	Measured as	Data (Source)
NFAt	Foreign reserves denominated in domestic currency minus foreign liability	Reserves($) * EXt - Foreign Liabilities	IFS
EXt	Exchange Rate	Yuan/$	IFS
ΔNFAt	The change on NFA	NFAt -NFAt-1	IFS
NDAt	Net domestic assets	MBt - NFAt	IFS
ΔNDAt	The change on NDA	NDAt -NDAt-1	IFS
M2t	Money Supply		IFS
MB	Monetary Base		
Qt	Money Multiplier for M2	M2/ Monetary Base	IFS
LM2t	Logrithm of M2	Log(M2t)	IFS
Δ LM2t	First difference of LM2t	Log(M2t)- Log(M2t-1)	IFS
LQt	Logrithm of Qt	Log(Qt)	IFS
Δ LQt	First difference of LQt	Log(Qt)- Log(Qt-1)	IFS
CPIt	Consumer price index		IFS
Δ CPIt	First difference of CPIt	CPIt - CPIt-1	IFS
CQt	Credit Multiplier		IFS
LCQt	Logrithm of CQt		IFS
Δ LCQt	First difference of LCQt	Log(CQt)- Log(CQt-1)	IFS

Table A2: ADF Unit Root Test For Data (2002: M1 - 2010M12)

variables	Types of Test	ADF test Statistic (P-value) H0 :Variable has a unit root
ΔNFA_t	Intercept	Reject H0
ΔNDA_t	Intercept	Reject H0
$\Delta LM2_t$	Intercept	Reject H0
ΔLQ_t	Intercept	Reject H0
ΔCPI_t	Intercept	Reject H0

Note: significant at more than 5 percent.

Table A3 reports the degree of sterilization and the degree of capital mobility.

Table A3

The results of sterilization coefficients and offset coefficients are as follows:

	Thailand 2004-2010	Korea 2004-2010	Indonesia 2002-2010	Malaysia 2002-2010
Sterilization	Perfect Sterilization (-1.06)	High Degree Sterilization (-0.98)	Medium Degree Sterilization (-0.69)	Perfect Sterilization (-1.03)
Capital Mobility	High Capital Mobility (-0.91)	High Capital Mobility (-0.90)	Medium Degree Capital Mobility (-0.53)	High Capital Mobility (-0.78)

Table A4 reports the effective dummy variables for the sterilization equation and capital mobility equation for the short-run dynamics.

Table A4

The impacts of dummy variables are as follows:

	Thailand 2004-2010		Korea 2004-2010		Indonesia 2002-2010		Malaysia 2002-2010	
	ST	CM	ST	CM	ST	CM	ST	CM
Additive Dummy and Variables with multiplicative dummy	DNDA, DNFA DLM2 DFR	DNDA, DNFA, DLM2, DFR	DNDA, DNFA, DLM2	DUM, DNDA, DNFA, DR	DUM, DNDA, DNFA, DLM2	DNFA	DLEX	DLEX
Seasonal Dummy	NS	NS	PS	NS	PS	PS	PS	PS

ST: Sterilization Equation; CM: Capital Mobility Equation

PS: Partially Significant; NS: Not Significant

Table A5 reports the relationship between variables of the monetary reaction functions of sterilization and capital mobility.

Table A5

The results of ECM for four East Asian countries are as follows:

	Thailand Jan 2004 to Dec 2010		Korea Jan 2004 to Dec 2010		Indonesia Jan 2002 to Dec 2010		Malaysia Jan 2002 to Dec 2010	
	ΔNDA PS	ΔNFA HCM	ΔNDA HS	ΔNFA HCM	ΔNDA MS	ΔNFA MCM	ΔNDA PS	ΔNFA HCM
ΔR	–	–	–	+ - (lag)	–	NS	NS	-(lag)
ΔM2	+	+	+	+	+	+	+ -(lag)	+
ΔCPI	NS	NS	+	NS	NS	NS	+(lag)	+(lag)
ΔEX	NS	NS	+ (lag)	NS	NS	NS	NS	+(lag)
ΔFR	+	+	-(lag)	NS	NS	+	NS	NS
ΔDC	NS	NS	NS	NS	+	NS	NS	NS
ΔQ	NS	NS	NS	NS	NS	NS	+(lag)	+(lag)
SR Disequilibrium	NS	NS	S	S	NS	NS	S	S

PS: Perfect Sterilization, HCM: High Capital Mobility, HS: High Degree of Sterilization

MS: Medium Degree of Sterilization, MCM: Medium Degree of Sterilization

R: foreign interest rate, M2: broad money supply, CPI: consumer price index

EX: exchange rate, FR: foreign reserves, DC: domestic credit, Q: money multiplier of M2

+: positively significant, + (lag): positively significant lag impacts,

-: negatively significant, - (lag): negatively significant lag impacts, NS: Not significant

Table A6 reports the relationships between the money supply and money multiplier.

Table A6

The relationship of money multiplier, money supply and other variables are as follows:

	Main Variable (Significant)	Significant Endogenous Variables	Significant Dummy Variables	Error Term
Thailand ΔLQt (with two lags)	1.04ΔLM2t	0.64ΔLM2t-1	DUMDLQ;	Error term is white noise
Korea ΔLQt (with two lags)	0.40 ΔLM2t	1.76 ΔLM2t-2 -0.758ECLQt	D11; DUMDLQ	Error term is white noise
Indonesia ΔLQt (with two lags)	-1.60 ΔLM2t	-0.56ΔECLQt	Seasonal Dummies are significant; DUM, DUMDLM2, DUMDLQ, DUMDLQ	Error term is white noise
Malaysia ΔLQt (with two lags)	0.73ΔLM2t	-0.58ΔECLQt +0.30ΔECLQt-1	DUMDLQ	Error term is white noise

Table A7 reports the credit multiplier did not increase in the face of capital inflows and shows the relationships among variables within the sample period.

Table A7

The relationship of credit multiplier, net foreign assets and other system variables are as follows:

	Main Variable (Significant)	Significant Endogenous Variables	Significant Dummy Variables	Error Term
Thailand ΔLCQ_t (with two lags)	$-0.26\Delta LNFA_t$	$-0.62\Delta LNDA_t$ $+0.95\Delta LCD_t$	D5 and D7 (Seasonal Dummies)	Error term is white noise
Korea ΔLCQ_t (with two lags)	$-0.20\Delta LNFA_t$	$-0.81\Delta LNDA_t$ $+1.01\Delta LCD_t$ $-0.586ECCQ_t$	D5; DUMDLCQ, DUMDLNFA, DUMDLNDA, DUMDLDC	Error term is white noise
Indonesia ΔLCQ_t (with two lags)	$-0.23\ \Delta LNFA_t$	$-0.73\ \Delta LNDA_t$ $+0.98\Delta LDC_t$	Seasonal Dummies are significant; DUMDLCQ, DUMDLNFA, DUMDLDC	Error term is white noise
Malaysia ΔLCQ_t (wth two lags)	$-0.38\ \Delta LNFA_t$	$-0.57\Delta LNDA_t$ $+1.04\Delta LDC_t$	DUMDLCQ, DUMLNFA, DUMLNDA, DUMDLDC	Error term is white noise

CQ: credit multiplier; LCQ: logarithm of credit multiplier; LNFA: logarithm of net foreign assets;LDC: logritham of domestic credit; ECCQ: error correction term; DUMDLCQ: multiplicative dummy variable of credit multiplier; DUMDLNFA: multiplicative dummy variable of net foreign assets; DUMDLNDA: dumtiplicative dummy variable of net domestic assets; DUMDLDC: multiplicative dummy variable of domestic credit

References

Bai, J. "Estimation of a Change Point in Multiple Regression Models."*Review of Economics and Statistics* 79 (1997): 551-63.

Balke, Nathan S., and Thomas B. Fomby."Threshold Cointegration."*International Economic Review* 38 (1997): 627-45.

Bernanke, Ben A., and Alan S. Blinder."Credit, Money, and Aggregate Demand."*The American Economic Review* 78 (June 1987): 435-39.

Bernanke, B.S. "Nonmonetary Effects of the Financial Crisis in the Propagation of the Great Depression."*The American Economic Review* 73 (June 1983): 257-76.

Calvo, G.A., L. Leiderman, and C. Reinhart."Capital Inflows to Latin America: The 1970s and the 1990s."IMF Working Paper 92/85, October 1992.

Calvo, G.A. and E.G. Mendoza, 1996. "Mexico's balance-of-payments crisis: A Chronicle of a Death Foretold."*Journal of International Economics*41 (1996):235-246.

Chow, G. "Tests of Equality between Sets of Coefficients in Two Linear Regressions."*Econometrica* 28 (1960): 591-605.

Celasum, O., C. Denizer and D.He."Capital Flows, Macroeconomic management, and the Financial System: Turkey, 1989-97." Policy Research Working Paper No.2141, The World Bank,1999.

Christensen, J. "Capital Inflows, Sterilization, and Commercial Bank Speculation: The case of Czech Republic in the Mid-1990s."Working Paper No. 04/218,IMF, 2004.

Dickey, D.A., and W.A. Fuller."Distribution of the Estimation for Autoregressive Time Series with a Unit Root."*Journal of the American Statistical Association* 74 (1979): 427-31.

Dasgupta, D., and D. Ratha."What Factors Appear to Drive Private Capital Flows to Developing Countries ? And How Does Official Lending Respond ?" Policy Research Working Paper 2392, The World Bank, 2000.

Edwards, S."Capital Flows, Real Exchange Rates, and Capital Controls: Some Latin American Experiences."Working Paper 6800,National Bureau of Economic Research,November1998.

Engle, R.F., and C.W.J. Granger. "Cointegration and Error Correction: Representation, Estimation and Testing." *Econometrica* 55 (1987): 251-76.

Esaka, T. and S. Takagi."Sterilization and the Capital Inflow Problem in East Asia, 1987-1997."In*Regional and Global Capital Flows: Macroeconomic Causes and Consequences*,edited by T. Ito and A.O.Krueger.Chicago: University of Chicago Press, 2001, 197-226.

Frankel, J.A."Sterilization of Money Inflows: Difficult (Calvo) or Easy (Reisen)?"Working Paper 94/159, IMF, 1994.

Frankel, J. and A.K. Kose."Currency Crashes in Emerging Markets: an Empirical Treatment."*Journal of International Economics*41(1996):351-366.

Haque, N. and P.J. Montiel. "Long-Run Real Exchange Rate Changes is Developing Countries: Simulations from an Econometric Model"(1999).In *Exchange Rate Misalignment: Concepts and Measurement for Developing Countries,* edited byL. Hinkle and P. Montiel.New York: Oxford University Press, Forthcoming.

Krugman, P. "A Model of Balance of Payments Crises."*Journal of Money, Credit and Banking*11 (1979):345-407.

Kwack, S.Y. "An Empirical Assessment of Monetary Policy Responses to Capital Inflows in Asia before the Financial Crisis."*International Economic Journal* 15 (2001):95-113.

Laban, R. and F.B. Larrain."Can a Liberalization of Capital Outflows Increase Net Capital Inflows ?"Working Paper 155, Instituto de Economia, Pontificia Universidad Catoloca de Chile,May 1993.

Lee, J.Y."Implication of a Surge in Capital Inflows: Available Tools and Consequences for the Conduct of Monetary Policy."IMF, Working Paper 96/53 (May 1996).

Moreno, R. "Intervention, Sterilization, and Monetary Control in Korea and Taiwan*. "Federal Reserve Bank of San Francisco*(*FRBSF) Economic Review*3 (1996): 23-33.

Montiel, P.J."Managing Economic Policy in the Face of Large Capital Inflows: What Have We Learned ?"Presented at Private Capital Flows to Emerging Markets after the Mexican Crisis, Institute for International Economics, Osterreichische, National Bank, Viena, September 7-9, 1995.

Montiel, P.J."Determinants of the Long-Run Equilibrium Real Exchange Rate: An Analytical Model"(1999b).In *Exchange Rate Misalignment: Concepts and Measurement for Developing Countries*, edited by L. Hinkle and P.J. Montiel. London: Oxford University Press, Forthcoming.

Montiel, P.J., and C.M. Reinhart. "Nominal Exchange Rate Regimes and the Behavior of Real Exchange Rates: Evidence and Implications." In *Real Business Cycles, Real Exchange Rates, and Actual Policies*, edited by K. Brunner and A. Meltzer. Amsterdam: North Holland, 1999.

Montiel,P.J."Policy Responses to Volatile Capital Flows."Presented at Capital Flows, Financial Crisis, and Policies, World Bank, Washington, DC, April 15-16, 1999.

Mundell, R.A."Capital Mobility and Sterilization Policy under Fixed and Flexible Exchange Rates."*The Canadian Journal of Economics and Political Science* 29, no.4 (November 1963):475-485.

Nasution, A., S. Griffith-Jones, and M.F. Montes(Eds).*Short-Term Capital Flows and Economic Crisis*. New York: Oxford University Press, 2001, 3-28.

Obstfeld, M."The Logic of Currency Crisis."Working Paper 4640, National Bureau of Economic Research, September 1994.

Obstfeld, M."Models of Currency Crises with Self-Fulfilling Features."*European Economic Review* 40, no. 3(April 1996):1037-1047.

Ouyang, Y. A., R.S. Rajan, and T.D.Willett.*From Bust to Boom in Emerging Asia: Monetary Management in the Face of Capital Inflow Surges*. Mimeo, 2009.

Ouyang, Y. A., R.S. Rajan, and T.D.Willett. "China as a Reserve Sink:The Evidence from Offset and Sterilization Coefficients." 2006.

Radelet,S. and J. Sachs. "Lessons from the Asian Financial Crisis."*Global Financial Crises and Reforms; Cases and Caveats*. London: Routledge, 2001.

Sachs, J.,A. Tornell, and A. Velasco. "Financial Crises in Emerging Markets: The Lessons from 1995." Brookings Papers on Economic Activity 1, 1996, 147-215.

Shiller, R. and National Bureau of Economic Research."Consumption, Asset Markets and Macroeconomic Fluctuations." Carnegie-Rochester Conference Series on Public Policy 17,1982, 203-238.

Spiegel, M.M. "Sterilization of Capital Inflows through the Banking Sector: Evidence from Asia."*Federal Reserve Bank of San Francisco Economics Review*3(1995):17-34.

Schadler, Susan."Surges in Capital Inflows: Boom or Curse?"*Finance and Development*, March 1994, 20-23.

Takagi, S. and T. Esaka."Sterilization and the Capital Inflow Problem in East Asia."Discussion Paper 86, Economic Planning Agency, Tokyo, Japan, 1999.

Tang, M. and J. Villafuerte."Capital Flows to Asia and Pacific Developing Countries: Recent Trends and Future Prospects."Statistical Report Series 18, Economics and Developing Resource Center, Asian Development Bank, November 1995.

World Bank. *Private Capital Flows to Developing Countries. The Road to Financial Integration, A World Bank Policy Research Report*. New York: Oxford University Press, 1997.

World Bank. *East Asia: The Road to Recovery*. Washington, DC: World Bank, 1998