Macroeconomic Impacts of Foreign Exchange Reserve Accumulation: A Theory and Some International Evidence [*]

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Abstract

Recently, a dramatic accumulation of foreign exchange reserves has been widely observed among developing countries. The purpose of this paper is to explore what long-run impacts accumulated foreign exchange reserves have on macro variables in developing countries. In the first part, we analyze a simple open economy model where increased foreign exchange reserves reduce costs of liquidity risk. Given the amount of foreign exchange reserves, the utility-maximizing representative agents decide consumption, capital stock, and labor input as well as the amounts of liquid and illiquid external debts. The equilibrium values of these macro variables depend on the amount of foreign exchange reserves. When the government increases its foreign exchange reserves, not only liquid debt but also total debt increases, while the debt maturity becomes shorter. To the extent that interest rates of foreign exchange reserve are low, the increased foreign reserves also lead to permanent decline of consumption. However, when the tradable sector is capital intensive, the increased foreign exchange reserves may enhance investment and economic growth. In the second part, we show several empirical supports to the theoretical implications. We provide several supportive evidences by using the panel data of the Penn World Table. The cross-country evidence shows that increased foreign exchange reserves make external debt outstanding larger and debt maturity shorter. It also implies that increased foreign exchange reserves lead to a decline of consumption but can enhance investment and economic growth. The positive impact on economic growth, however, disappears when we control the impact through investment.

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1. Introduction

Recently, a dramatic accumulation of foreign exchange reserves has been widely observed among developing countries. Some developing countries had accumulated significant amount of foreign exchange reserves even before the late 1990s. However, foreign exchange reserves started to show a dramatic increase after the late 1990s and are now record-breaking in many developing countries, especially in Asian and Middle Eastern countries (Figure 1). During the Asian crisis, less developed economies with smaller liquid foreign assets had hard time in preventing panics in financial markets and sudden reversals in capital flows (see, for example, Corsetti, Pesenti, and Roubini [1999] and Sachs and Radelet [1998]). Many developing countries thus came to recognize that increased liquidity is an important self-protection against crises. Among the strategies for the self-protection, replacing liquid short-term debt by illiquid long-term debt was initially one popular advice that many economists suggested. However, what most developing economies have taken more seriously was raising foreign reserves. The recent rapid rises in reserves were accelerated by policymakers' desire to prevent the appreciation of their currencies and maintain the competitiveness of their tradable sectors. However, to the extent that the government's decision is exogenous, the foreign exchange reserve accumulation results in the changes of the private agents' behavior. And the changed behavior may have various macroeconomic consequences. The consequences are particularly important in the long-run where temporary impacts of the foreign exchange reserve accumulation disappear.

In this paper, we explore what long-run impacts the accumulated foreign reserves had on macro variables in developing countries. In the first part, we analyze a simple open economy model where increased foreign reserves reduce costs of liquidity risk. In the model, each representative agent maximizes the utility function from consumption of tradable goods and non-tradable goods over time. A key feature in the model is that relative size of net foreign liquid debt to foreign exchange reserve reduces the costs of liquidity risk and makes liquidity premium lower. Given the amount of foreign exchange reserves, the utility-maximizing representative agents decide consumption, capital stock, and labor input as well as the amounts of liquid and illiquid foreign debts. The equilibrium values of these macro variables, thus, depend on the amount of foreign exchange reserves. When the government increases its foreign exchange reserves, not only liquid debt but also total debt increases, while the debt maturity becomes shorter. To the extent that interest rates of foreign exchange reserve are low, the increased foreign reserves also lead to permanent decline of consumption and move labor from non-tradable sector to tradable sector. However, when the tradable sector is capital intensive, the increased foreign exchange reserves may enhance investment and economic growth.

In the second part, we provide several supportive evidences by using the panel data of the Penn World Table. The data is unbalanced panel data of 135 countries and the sample period is 1980 to 2004. To allow a structural break after the crisis, we include the post-crisis dummy in some regressions. The evidence on external debt shows that increased foreign reserves make total external debt outstanding larger and debt maturity shorter. It also implies that increased foreign exchange reserves lead to a decline of consumption but can enhance investment and economic growth. The evidence is consistent with out theory when interest rates of foreign exchange reserve are low and when the tradable sector is capital intensive. The positive impact on economic

growth, however, disappears when we control the impact through investment.

One may argue that an increase of foreign exchange reserves improves the current account and consequently has a positive impact on aggregate output. In the short-run, the aggressive intervention could maintain competitiveness of their tradable sectors and manifest itself in the massive accumulation of foreign exchange reserves by central banks. The argument may be particularly relevant in explaining China's reserve accumulation, where *de facto* dollar peg had been maintained. However, this is a Keynesian type demand side story that will not be relevant in the long-run. Even though the intervention is effective in changing nominal exchange rates, the current account needs to be balanced in the long-run where real exchange rates are fully adjusted to the equilibrium values. Our analysis is thus by itself worthwhile in exploring what long-run impacts the exogenous accumulation of foreign exchange reserves has on various macro variables.

In previous literature, Aizenman and Lee (2005) compared relative importance of precautionary and mercantilist motives in accounting for the hoarding of international reserves by developing countries. Their empirical results suggested that precautionary motives played a more prominent role behind reserve accumulation by developing countries. Rodrik (2005) noted that a very rapid rise since the early 1990s in foreign reserves held by developing countries had climbed to almost 30 percent of developing countries' GDP. He then pointed out that reasonable spreads between the yield on reserve assets and the cost of foreign borrowing caused the income loss amounts to close to 1 percent of GDP in these developing countries. In contrast, Levy Yeyati (2006) pointed out that the costs of foreign exchange reserves may have been considerably overstated in previous studies. He argues that to the extent that reserves lower the probability of a run-induced default, they reduce the spread paid on the stock of sovereign debt.

Our question is motivated by these previous studies. However, macroeconomic effects of exogenous foreign exchange reserve accumulation have not been well discussed in literature. In particular, we distinguish liquid debt from illiquid debt and investigate how maturity structure of external debts changes when foreign exchange reserves are accumulated. The model allows costs and benefits from foreign exchange reserve accumulation in literature. It also incorporates both tradable and non-tradable sectors with different capital intensities. The different capital intensities between two sectors are crucial in determining the long-run effects of foreign exchange reserve accumulation on capital accumulation and economic growth.

The paper proceeds as follows. Section 2 sets up our small open economy model and section 3 discusses the impacts of increased foreign exchange reserves. Section 4 provides supportive evidences by using the panel data of the Penn World Table and section 6 provides its robustness check. Section 7 summarizes our main results and refers to their implications.

2. A Small Open Economy Model

The main purpose of our theoretical model is to investigate what long-run impacts accumulated foreign exchange reserves had on macroeconomic variables in developing countries. We consider a small open economy that produces two composite goods, tradables and nontradables, relying on external debts. Each

representative agent in the economy maximizes the following utility function:

$$(1)\quad \sum_{j=0}^{\infty} \beta^{j}\, U(c^{T}_{t+j}, c^{N}_{t+j}),$$

where c^{T}_{t} = consumption of tradable good, and c^{N}_{t} = consumption of nontradable good. The parameter β is a discount factor such that $0 < \beta < 1$. Subscript t denotes time period. The utility function $U(c^{T}_{t+j}, c^{N}_{t+j})$ is increasing and strictly concave in c^{T}_{t+j} and c^{N}_{t+j}.

The representative agent is net debtor in the international market. The budget constraint is

$$(2)\quad b^{A}_{t+1} + b^{B}_{t+1} - k_{t+1} = (1+r)\, b^{A}_{t} + (1+r+\rho(b^{A}_{t}/R_{t}))\, b^{B}_{t} - k_{t} - [y^{T}_{t} + p^{N}_{t} y^{N}_{t} - \phi(b^{A}_{t}/R_{t}) - c^{T}_{t} - p^{N}_{t} c^{N}_{t} - T_{t}].$$

where b^{A}_{t} = net liquid debt outstandings, b^{B}_{t} = net illiquid debt outstandings, k_{t} = domestic capital stock, T_{t} = lump-sum tax, p^{N}_{t} = the price of nontradable good, r = real interest rate of liquid debt, and R_{t} = foreign exchange reserves. For simplicity, we assume that capital stock is tradable and that there is no capital depreciation. We also assume that $1+r < 1/\beta$ to assure the existence of the steady state. Since the numeraire is the traded good, the real interest rate and the price of nontradable good are defined in terms of tradables.

Our model has two salient features that were not commonly used in previous studies. One is a liquidity premium $\rho(b^{A}_{t}/R_{t})$ that makes real interest rates of illiquid debt higher than that of liquid debt. In developing countries, sudden reversals in capital flows are less likely to happen when the borrower shifts its external debt from liquid debt to illiquid debt. The lender thus requires extra interest rates when issuing illiquid debt. The liquidity premium $\rho(b^{A}_{t}/R_{t})$ in the budget constraint reflects the premium. The other is an insurance premium $\phi(b^{A}_{t}/R_{t})$ that increases as potential liquidity risk increases. Unlike the liquidity premium $\rho(b^{A}_{t}/R_{t})$, the insurance premium $\phi(b^{A}_{t}/R_{t})$ is included as an independent cost in the budget constraint because it is a direct cost from holding liquid foreign debts. In our model, net supply of domestic debt is always zero, so that b^{A}_{t} denotes net liquid foreign debt. As b^{A}_{t} becomes relatively larger to R_{t}, the borrowing agent needs to pay larger costs to prevent the potential liquidity crisis. We assume that both of the premiums are increasing and convex in b^{A}_{t}/R_{t}, that is, $\rho'(b^{A}_{t}/R_{t}) > 0$, $\rho''(b^{A}_{t}/R_{t}) > 0$, $\phi'(b^{A}_{t}/R_{t}) > 0$, and $\phi''(b^{A}_{t}/R_{t}) > 0$. This reflects the fact that panics in financial markets are more likely to happen when the country has higher (net) levels of liquid foreign debts but are less likely when it has higher levels of foreign exchange reserves. The relative size of net liquid foreign debt to foreign exchange reserve is thus a good proxy for the premiums.

In the following analysis, we assume that each production function is constant returns to scale in capital stock and labor input. Denoting labor input for tradable good by n_{t} and total constant labor supply by N, our production functions are written as

$$(3)\quad y^{T}_{t} = f(k^{T}_{t}/n_{t})n_{t} \quad \text{and} \quad y^{N}_{t} = g(k^{N}_{t}/(N-n_{t}))(N-n_{t}),$$

where $f' > 0$, $g' > 0$, $f'' < 0$, and $g'' < 0$. We defined capital stock held in the tradable sector and held in the nontradable sector by k^T_t and k^N_t respectively. By definition, the total domestic capital stock is the sum of two capital stocks, that is, $k_t = k^T_t + k^N_t$.

The amounts of foreign exchange reserves R_t and lump-sum tax T_t are exogenously given for the representative agent. The first-order conditions are thus derived by maximizing the following Lagrangian:

$$(4)\quad L = \sum_{j=0}^{\infty} \beta^j U(c^T_{t+j}, c^N_{t+j})$$
$$+ \sum_{j=0}^{\infty} \beta^j \mu_{t+j} [\, b^A_{t+1+j} + b^B_{t+1+j} - (k^T_{t+1+j} + k^N_{t+1+j}) - (1+r)\, b^A_{t+j} - (1+r+\rho(b^A_{t+j}/R_{t+j}))\, b^B_{t+j} + (k^T_{t+j} + k^N_{t+j})$$
$$+ f(k^T_{t+j}/n_{t+j}) n_{t+j} + p^N_{t+j}\, g(k^N_t/(N - n_t))(N - n_{t+j}) - \phi(b^A_{t+j}/R_{t+j}) - c^T_{t+j} - p^N_{t+j}\, c^N_{t+j} - T_{t+j}].$$

Assuming interior solutions, the first-order conditions thus lead to

$$(5a)\quad U_2 \equiv \partial U(c^T_t, c^N_t)/\partial c^N_t = \mu_t p^N_t,$$
$$(5b)\quad U_1 \equiv \partial U(c^T_t, c^N_t)/\partial c^T_t = \mu_t,$$
$$(5c)\quad f(k^T_t/n_t) - f'(k^T_t/n_t)(k^T_t/n_t) = p^N_t\, [g(k^N_t/(N - n_t)) - g'(k^N_t/(N - n_t))\, k^N_t/(N - n_{t+j})],$$
$$(5d)\quad \mu_t = \beta \{(1+r) + \rho'(b^A_{t+1}/R_{t+1})(b^B_{t+1}/R_{t+1}) + \phi'(b^A_{t+1}/R_{t+1})/R_{t+1}\} \mu_{t+1},$$
$$(5e)\quad \mu_t = \beta \{(1+r) + \rho(b^A_{t+1}/R_{t+1})\} \mu_{t+1},$$
$$(5f)\quad \mu_t = \beta \{1 + f'(k^T_{t+1}/n_{t+1})\} \mu_{t+1},$$
$$(5g)\quad \mu_t = \beta \{1 + p^N_{t+1}\, g'(k^N_t/(N - n_t))\} \mu_{t+1}.$$

Under the assumption of perishable goods, it holds that $c^N_t = y^N_t$ in equilibrium. Since the numeraire is the traded good, the price of nontradable good p^N_t denotes the real exchange rate of this small open economy at time t, where a decline of p^N_t means depreciation of the real exchange rate. Equation (5a) implies that the real exchange rate is determined by U_2/U_1. Given the Lagrange multiplier, equation (5b) determines the amount of consumption of tradable good. Equation (5c) shows that the amount of liquid foreign debt b^A_t is positively related with the amount of foreign exchange reserves R_t. This is because foreign reserves, which reduce liquidity risk, allow the representative agent to hold more liquid foreign debt.

At the steady state, the Lagrange multiplier μ_t is constant and equals to $\mu > 0$. This implies that all of the macro variables c^T_t, p^N_t, b^A_t, and $b^A_t + b^B_t$ are constant over time without unanticipated external shocks. An unanticipated change of foreign exchange reserves affects the equilibrium values of these variables. However, at the steady state, it holds that $\mu_t = \mu_{t+1}$, so that equations (5d), (5e), (5f), and (5g) lead to

$$(6)\quad \rho(b^A/R) = \rho'(b^A/R)(b^B/R) + \phi'(b^A/R)/R = (1/\beta) - (1+r),$$
$$(7)\quad f'(k^T/n) = p^N g'(k^N/(N - n)) = (1/\beta) - 1.$$

Equations (5c), (6), and (7) imply that b^A/R, k^T/n, $k^N/(N- n)$, and p^N remain unchanged at the steady state for alternative values of foreign exchange reserves.

3. The Impacts of Increased Foreign Exchange Reserves

The main purpose of the following analysis is to explore the long-run impacts on macro variables when the government increased its foreign exchange reserves. To achieve this goal, we explore what impacts an unanticipated change of R_t has on various macroeconomic variables at the steady state. When increasing the amount of foreign exchange reserves, the government has alternative methods to finance it. However, because of the Ricardian equivalence, the government method of finance does not affect resource allocation. We thus focus on the case where the increases of the foreign exchange reserves are solely financed by lump-sum tax T_t increases. In this case, the government budget constraint at period t is written as

$$(8) \quad T_t = G^* + R_{t+1} - (1+r_R) R_t,$$

where G^* is exogenous government expenditure and r_R is real interest rate of the foreign exchange reserves. It is natural to suppose that the rate of returns from foreign exchange reserves is very low in international capital market.

Assuming that there is an unanticipated increase of foreign reserves, we first consider what impacts the increased foreign exchange reserves have on external debts and their component at the steady state. Denote the steady-state value of a variable x_t by x and its change by Δx. Then, since equation (6) holds at the steady state for any R_t, we obtain

$$(9a) \quad \Delta b^A / \Delta R = b^A/R > 0,$$
$$(9b) \quad \Delta b^B / \Delta R = \mathrm{r}(b^A/R)/\mathrm{r}'(b^A/R) > 0,$$

Since there is no net supply of domestic debt, two types of debts b^A_t and b^B_t denote net liquid foreign debt and net illiquid foreign debt respectively. Equations (9a) and (9b) imply that an unexpected rise of foreign exchange reserves increases not only liquid foreign debt but also the sum of liquid and illiquid foreign debts. Equations (9a) and (9b) also lead to

$$(10) \quad \frac{\Delta\left(b^A - b^B\right)}{\Delta R} = \frac{b^A / R}{\mathrm{r}'(b^A / R)} \left\{ \mathrm{r}'(b^A / R) - \frac{\mathrm{r}(b^A / R)}{b^A / R} \right\}.$$

Equation (10) indicates that an unexpected rise of foreign exchange reserves always increases the share of liquid foreign debt to total foreign debts. This happens because foreign exchange reserves reduce liquidity risk, so that

the value of holding illiquid debt declines. An unexpected rise of foreign exchange reserves not only has an income effect that increases total foreign debt but also has a substitution effect that replaces illiquid foreign debt by liquid debt.

We next consider what impacts the increased foreign exchange reserves have on several macro variables. Recall that each of p^N, k^T/n, and $k^N/(N-n)$ relies solely on the rate of time preference, that is, $1/\beta$, and is independent of the amount of foreign exchange reserves at the steady state. This indicates that an unanticipated increase in the foreign reserve has no impact on the real exchange rate nor on capital-labor ratios of two sectors even in the long-run. However, the change of foreign reserves has impacts on the steady state values of other macro variables such as consumption, capital stock, labor, and total output.

At the steady state, all macro variables are constant over time. Since $y^T = f(k^T/n)n$, $T = G^* - r_R R$, and $c^N = y^N$, the budget constraint at the steady state implies that $rb^A + \{r + \rho(b^A/R)\}b^B = f(k^T/n)n - c^T - \phi'(b^A/R) - G^* + r_R R$.. Since b^A/R, k^T/n, and $k^N/(N-n)$ remain unchanged, we thus obtain

$$(11)\quad r\Delta b^A + \{r + \rho(b^A/R)\}\Delta b^B = r_R \Delta R + f(k^T/n)\Delta n - \Delta c^T.$$

In addition, noting that $c^N = y^N = g(k^N/(N-n))(N-n)$, equations (5a), (5b), and (7) imply that

$$(12a)\quad \Delta c^T = B\,\Delta c^N,$$
$$(12b)\quad \Delta c^N = -g(k^N/(N-n))\,\Delta n,$$
$$(12c)\quad p^N = U_2/U_1 = f'(k^T/n)/g'(k^N/(N-n)),$$

where $B \equiv \{(U_2/U_1)U_{12} - U_{22}\}/\{U_{12} - (U_2/U_1)U_{11}\}$. Since $B > 0$, equations (12a) and (12b) imply that consumption declines in both tradable and non-tradable sectors when labor input increases in the tradable sector. Equation (12c) indicates that the real exchange rate equals not only to the substitution rate of marginal utility but also to the substitution rate of marginal transformation between two sectors. The latter is the supply side determinant of the real exchange rate in our model.

Since $(1/\beta) - 1 = \rho(b^A/R) + r$, combining (12a) and (12b) with (9a), (9b), and (11) leads to

$$(13a)\quad \frac{\Delta(c^T + c^N)}{\Delta R} = -(1+B)g(k^N/(N-n))]\frac{\Delta n}{\Delta R},$$

$$(13b)\quad \frac{\Delta n}{\Delta R} = -\frac{\{(1/\beta)-1\}\dfrac{\rho(b^A/R)}{\rho'(b^A/R)} + \left\{(b^A/R)r - r_R\right\}}{f(k^T/n) + Bg(k^N/(N-n))}$$

Equations (13a) and (13b) determine the impacts of increased foreign reserves on total consumption and labor input in the tradable sector respectively. In general, we cannot see whether the derivatives are positive or negative in these equations. This is because while low rate of return of foreign exchange reserve and the

increased total foreign debt reduce permanent income, a shift from illiquid debt to liquid debt may relieve interest rate burden of foreign debt. However, we can show that $\Delta(c^T + c^N)/\Delta R < 0$ and $\Delta n/\Delta R > 0$ if and only if

(14) $r_R < [(1/\beta)-1][\mathsf{r}(b^A/R)/\mathsf{r}'(b^A/R)] + (b^A/R)\, r.$

The right-had side of (14) is increasing in b^A/R. This implies that when b^A/R is large enough, an increase in foreign exchange reserve has a positive impact on consumption and shifts labor from the tradable sector to the non-tradable sector. This happens because increasing foreign exchange reserves is beneficial in reducing risk premiums when liquidity risk is high enough. In contrast, the left-hand side of (14) is increasing in r_R. Therefore, when the interest rate of foreign exchange reserves r_R is low enough, an unanticipated increase in foreign exchange reserve has a negative impact on consumption and shifts labor from the non-tradable sector to the tradable sector. When the interest rate of foreign exchange reserves is low, holding foreign reserves is costly and leads to a decline of permanent income in terms of tradable goods. Consequently, while the tradable sector expands to supplement a decline of permanent income in terms of tradable goods, consumption declines in both sectors at the same time.

It is also worthwhile to note that $\Delta k^T/\Delta R > 0$ and $\Delta k^N/\Delta R < 0$ when (14) holds. This happens because capital-labor ratios k^T/n and $k^N/(N-n)$ are independent of the amount of foreign reserves at the steady state. Shifting labor from the non-tradable to the tradable increases capital stock in the tradable but decreases the non-tradable. We also obtain

$$\text{(15a)} \quad \frac{\Delta k}{\Delta R} = \frac{\Delta k^T}{\Delta R} + \frac{\Delta k^N}{\Delta R} = \left(\frac{k^T}{n} - \frac{k^N}{N-n} \right) \frac{\Delta n}{\Delta R},$$

$$\text{(15b)} \quad \frac{\Delta y}{\Delta R} = \frac{\Delta y^T}{\Delta R} + p^N \frac{\Delta y^N}{\Delta R}$$

$$= [f(k^T/n) - p^N g(k^N/(N-n))] \frac{\Delta n}{\Delta R},$$

$$= f'(k^T/n)\,[\{f(k^T/n)/f'(k^T/n)\} - \{g(k^N/(N-n))/g'(k^N/(N-n))\}] \frac{\Delta n}{\Delta R}.$$

Equations (15a) and (15b) determine the impacts of increased foreign exchange reserves on total capital stock and total output respectively. The impacts depend not only on the sign of $\Delta n/\Delta R$ but also on relative capital intensity of each sector. This is because when $\Delta n/\Delta R > 0$, increased foreign exchange reserves lead to expansion of tradable sector but contraction of non-tradable sector. Consequently, when $\Delta n/\Delta R > 0$, total capital stock increases as foreign exchange reserves increase if and only if tradable sector is more capital intensive than non-tradable sector, that is, $(k^T/n) > (k^N/(N-n))$. When $\Delta n/\Delta R > 0$, total output also increases as foreign exchange reserves increase if and only if tradable sector is more capital intensive than non-tradable sector, that is, $f(k^T/n)/f'$

$(k^T/n) > g(k^N/(N-n))/g'(k^N/(N-n))$. The relative capital intensities between two sectors are crucial in determining what impacts the increased foreign reserves have on aggregate capital stock and aggregate output.

4. Some International Evidence

(i) The Impacts on External Debts

The main implications of our theoretical analysis are that an increase in foreign reserves has significant impacts on several macroeconomic variables in developing countries. The impacts, however, depend on the parameter values as well as the interest rates. The purpose of this section is to test the long-run impacts of foreign exchange reserve accumulation by panel data of a large number of developing countries. We first examine what relationship foreign reserves have with total external debt outstandings and their average maturity. In terms of liquidity, short-term debt is more liquid than long-term debt because sudden reversals in capital flows are more likely when debt maturity is short. Smaller average maturity of foreign debts, thus, can be a proxy for the degree of liquidity of foreign debts. Our theoretical results suggest that a rise in foreign exchange reserves not only increase foreign debt but also causes a shift from illiquid debt and liquid debt. In the following estimation, we can therefore expect that foreign exchange reserves have a positive impact on. total external debt outstandings but has a negative impact on the average maturity.

We estimate the following two equations:

(16) $\Delta(Debt_{j,t}/\ GNI_{j,t}) = a_1 \cdot \Delta(Foreign\ Reserve_{j,t}/\ GNI_{j,t}) + a_2 \cdot log\ GNI_{j,t}$,

(17) $Maturity_{j,t} = b_1 \cdot Foreign\ Reserve_{j,t}/\ GNI_{j,t} + b_2 \cdot log\ GNI_{j,t}$,

where *Debt* = total external debt outstanding, *Maturity* = average maturity of new commitments (years), *GNI* = gross national income, and *Foreign Reserve* = the amount of foreign exchange reserve. Subscript j denotes country j, while subscript t denotes year. The variable $\Delta x_{j,t}$ denotes the first difference of $x_{j,t}$. To avoid heteroscedasticity problem, foreign exchange reserve is divided by *GNI* in equation (17). To allow income differences and scale effects, we include *log GNI* as an explanatory variable in both equations. We also include auxiliary variables such as import ratio, openness, and Asia dummy in (16).

The data of foreign exchange reserve is from International Financial Statistics issued by IMF, while total external debt outstanding, average maturity of new commitments, and *GNI* are from Global Development Finance issued by the World Bank. The data is unbalanced panel data of 134 countries all of which are developing countries in the World Bank's classification (see Appendix 1 for the names of individual countries). The sample period is 1980 to 2004. The method of estimation is OLS with constant term. To allow a structural break after the crisis, we include the post-crisis dummy in some regressions. The post-crisis dummy is a time dummy that takes one from 1998 to 2004 and zero otherwise.

Tables 1-(1) and 1-(2) report the estimation results of (16) and (17) with and without the post-crisis dummy. The total external debt outstandings have significantly positive correlation with foreign exchange reserves, while

they are negativetly correlated with log *GNI*. The increase in foreign exchange reserves is financed by issuing new external debt when income differences are adjusted. The results are robust even if we include auxiliary variables. This supports the view that an increased foreign exchange reserves makes external debt outstanding larger. The maturity is, in contrast, negatively correlated with foreign exchange reserves as well as with log *GNI*. The negative correlation with foreign exchange reserves implies that an increased foreign exchange reserve makes debt maturity shorter. Our theoretical analysis implies that foreign exchange reserves reduce liquidity risk, so that their increase will cause a shift from illiquid debt to liquid debt. To the extent that short-term debt is more liquid than long-term debt, the result supports this implication. The negative correlation with log *GNI* implies that debt maturity is shorter in smaller countries.

(ii) The Impacts on Macro Variables

We next examine what relationship foreign exchange reserves have with consumption, capital investment, export share, and GDP growth rate by using the panel data of developing countries. These variables are important variables to measure macro performances in the economy. Our theoretical model suggests that an increase in foreign exchange reserves has a negative impact on consumption and a positive impact on export share when interest rates on foreign exchange reserves are low. When interest rates on foreign exchange reserves are low, it also indicates that an increase in foreign reserves has a positive impact on capital investment and output if tradable sector is more capital intensive than non-tradable sector and vise versa.

We estimated the following three equations:

(18) $Consumption_{j,t}/GDP_{j,t} = c_1\,(Foreign\ Reserve_{j,t}/\ GNI_{j,t}) + c_2 \cdot log\ GNI_{j,t}$,

(19) $Export_{j,t}/GNI_{j,t} = d_1\,(Foreign\ Reserve_{j,t}/\ GNI_{j,t}) + d_2 \cdot log\ GNI_{j,t}$,

(20) $Investment_{j,t}/GDP_{j,t} = e_1\,(Foreign\ Reserve_{j,t}/\ GNI_{j,t}) + e_2 \cdot log\ GNI_{j,t}$,

(21) $\Delta GDP_{j,t}/GDP_{j,t} = f_1\,(Foreign\ Reserve_{j,t}/\ GNI_{j,t}) + f_2 \cdot log\ GNI_{j,t}$,

where *Consumption* = domestic consumption, *GDP* = gross domestic product, *Export* = the amount of export, and *Investment* = domestic capital investment. Subscript j denotes country j, while subscript t denotes year. To avoid heteroscedasticity problem, foreign exchange reserves and export are divided by *GNI*, while consumption and investment is divided by *GDP*.

Equations (18) and (19) explore the impacts of foreign exchange reserves on consumption and export ratio respectively, while equations (20) and (21) investigate the impacts on capital stock and aggregate output. In equations (20) and (21), we used investment rate and GDP growth rate as dependent variables. If we follow our theoretical discussions literally, we may use capital stock and the level of GDP as dependent variables in these equations. However, while consumption responds to a shock instantaneously, it usually takes a long time for capital stock to reach the steady state. In the estimations, we thus explore whether the investment and GDP growth are on the right transition path to the steady state which our theory predicts. To allow income differences and scale effects, we include *log GNI* in all equations. One may concern that the accumulation of foreign

exchange reserves might be endogenous. However, the accumulation is a consequence of repeated changes in previous years. Therefore, reverse causality from the dependent variables to the level of foreign exchange reserves is less likely in our estimations.

The data of consumption, investment, and *GDP* are from the Penn World Table (PWT 6.2). The data is unbalanced panel data of 134 countries and the sample period is 1980 to 2004. The method of estimation is OLS with constant term. To allow a structural break after the crisis, we include the post-crisis dummy in some regressions. The post-crisis dummy is a time dummy that takes one from 1998 to 2004 and zero otherwise.

Tables 2-(1), 2-(2), 2-(3), and 2-(4) report the results of our regressions with and without the post-crisis dummy. The coefficients of foreign exchange reserves are statistically significant in all cases. Foreign exchange reserve is negatively correlated with consumption in table 2-(1) and positively correlated with export ratio in table 2-(2). The results imply that an increased foreign exchange reserve decreases consumption and expands the share of tradable sector. To the extent that interest rate revenues from foreign exchange reserves are low, this is consistent with our theoretical results. Foreign exchange reserves are positively correlated with investment rate and GDP growth rate in tables 2-(3) and 2-(4). This implies that the accumulation of foreign exchange reserves is beneficial in enhancing capital accumulation and sustainable growth in developing countries. Our theory suggests that this happens when tradable sector is more capital intensive than non-tradable sector,.

5. Robustness Checks I: Additional Explanatory Variables

(i) The impact of the change of foreign exchange reserves

The purpose of this sub-section is to estimate equations (18), (19), (20), and (21) including the change of foreign exchange reserves as an additional explanatory variable. The inclusion of the change of foreign exchange reserves is useful in distinguishing temporary impacts from persistent impacts of foreign exchange reserve accumulation. The impacts of a temporal change of foreign exchange reserves will be reflected in the coefficient of the change of foreign exchange reserves, while the impacts of a permanent change will be reflected in the coefficient of the level. Comparing the coefficients will reveal how different the temporary and the persistent impacts are.

Tables 3-(1), 3-(2), 3-(3), and 3-(4) report the results of our regressions with and without the post-crisis dummy. Even including the change of foreign exchange reserves, the coefficients of the level of foreign exchange reserves still take the same signs and remain statistically significant in all cases. However, the coefficients of the change of foreign exchange reserves either become statistically insignificant or take different signs.

The change of foreign exchange reserve is positively correlated with consumption in table 3-(1) and with export ratio in table 3-(2). However, neither of the correlations is statistically significant. The short-run impacts of increased foreign exchange reserve on consumption and export share are, if any, very small. In contrast, the change of foreign exchange reserve is negatively correlated with investment rate and with GDP growth rate in tables 3-(3) and 3-(4). The correlations are statistically significant but took opposite signs. This implies that increased foreign exchange reserves may reduce investment rate and GDP growth rate in the short-run, although

they increase them in the long-run.

When increased foreign reserves are persistent, consumption declines because permanent income declines. But when increased foreign reserves are temporary, consumption does not decline because of the permanent income hypothesis. Temporary increases of foreign exchange reserves therefore reduce domestic savings and have a negative impact on domestic investment and economic growth. Since the main purpose of our analysis is to explore what long-run impacts exogenous accumulation of foreign exchange reserves has on various macro variables, the impacts of temporary increases of foreign exchange reserves are not our main concerns. However, it is by itself noteworthy that the accumulation of foreign exchange reserves may have different impacts in the short-run.

It is also noteworthy that the inclusion of the change of foreign exchange reserves might be useful in avoiding possible simultaneous bias in the coefficient of the level of foreign exchange reserves. Foreign exchange reserves may respond endogenously to several macro shocks. However, the response will be reflected only in the change of foreign exchange reserves. Reverse causality from the dependent variables to the level of foreign exchange reserves will be less likely when we include not only the level of foreign exchange reserves but also the change of foreign exchange reserves in the estimations.

(ii) Impacts through current account surplus

Until now, our empirical studies have not taken into account the impacts through current account surplus. This is because we focus on the long-run where current account will be balanced. To the extent that the rate of time preference is equal to world interest rate, the current account needs to be balanced in the long-run where real exchange rates are fully adjusted. However, our sample period may not be long enough to smooth out short-run impacts. In the short-run, the aggressive intervention could maintain competitiveness of their tradable sectors and manifest itself in the massive accumulation of foreign exchange reserves by central banks. One may argue that an increase of foreign exchange reserves improves the current account and consequently has a positive impact on investment and aggregate output in our sample period.

The purpose of this sub-section is to estimate equations (18), (19), and (21) including current account surplus as an additional explanatory variable. The inclusion of current account surplus is useful in isolating the impacts of foreign exchange reserve accumulation through current account surplus in our regressions. Tables 4-(1), 4-(2), and 4-(3) report the results of our regressions with and without the post-crisis dummy. The current account surplus has significantly positive impacts on consumption but has significantly negative impacts on investment and economic growth. Current account surplus may benefit consumption but may not be beneficial in enhancing investment and economic growth in our long-run data.

More importantly, even including current account surplus, the coefficients of the level of foreign exchange reserves still take the same signs and remain statistically significant in all cases. Neglecting the impacts through current account surplus is not essential in discussing our main results in our long-run data set.

(iii) Neoclassical growth regression

In our basic regression, we found that foreign exchange reserve is positively correlated with GDP growth rate. The regression is, however, not standard in literature. Since seminal papers by Barro (1991) and Mankiw, Romer, and Weil (1992), a number of studies support that the rate of economic growth is well explained by initial income level, investment rate, and other auxiliary variables. The purpose of this sub-section is to examine how robust our results are when we follow the tradition in growth literature. We estimate the following equation.

(22) $\Delta GDP_{j,t}/GDP_{j,t} = g_1\,(initial\ GDP_{j,t}) + g_2\,(Investment_{j,t}/GDP_{j,t}) + g_3 \cdot (Foreign\ Reserve_{j,t}/\ GNI_{j,t})$.

We estimate equation (22) with and without investment rate as an explanatory variable. Table 5 summarizes the estimation results. When we estimate (22) without investment rate, foreign exchange reserve has still significantly positive correlation with GDP growth rate. However, foreign exchange reserve no more has a significantly positive impact on GDP growth when we add investment rate as an explanatory variable. This implies that once we add investment rate as an explanatory variable, foreign exchange reserve accumulation is irrelevant for economic growth rate. In other words, foreign exchange reserve accumulation can enhance economic growth rate but only through enhancing investment.

6. Concluding Remarks

Recent foreign exchange reserve accumulations are record-breaking in many developing countries. This paper investigated what long-run macroeconomic impacts the accumulated foreign exchange reserves have in developing countries. In the first part, we analyzed a simple open economy model where increased foreign exchange reserves reduce costs of liquidity risk. When the government increases its foreign exchange reserves, not only liquid debt but also total debt increases, while the debt maturity becomes shorter. The increased foreign exchange reserves also lead to a decline of consumption but enhance investment and economic growth when the tradable sector is capital intensive. In the second part, we showed several empirical supports to the theoretical implications.

During the last decade, financial globalization has been accompanied by frequent and painful financial crises. During the crises, countries with smaller liquid foreign assets had hard time in preventing panics in financial markets and sudden reversals in capital flows. Many developing countries thus came to recognize that increased liquidity is an important self-protection against crises. Raising foreign exchange reserves is a popular strategy that many economists advised. However, accumulation of foreign reserves is accompanied by social costs. It is important to reconsider what is the optimal accumulation of foreign reserves in developing countries.

Appendix : The Names of Sampled Countries

Africa	Asia	Europe	Middle East	Western Hemisphere
Algeria	Bangladesh	Albania	Egypt	Argentina
Angola	Bhutan	Armenia	Iran	Barbados
Benin	Cambodia	Azerbaijan	Jordan	Belize
Botswana	China	Belarus	Lebanon	Bolivia
Burkina Faso	Fiji	Bosnia and Herzegovina	Oman	Brazil
Burundi	India	Bulgaria	Syria	Chile
Cameroon	Indonesia	Croatia	Yemen	Colombia
Cape Verde	Laos	Czech Republic		Costa Rica
Central African Republi	Mongolia	Estonia		Dominica
Chad	Nepal	Georgia		Dominican Republic
Comoros	Pakistan	Hungary		Ecuador
Congo, Dem. Rep.	Papua New Guinea	Kazakhstan		El Salvador
Congo, Republic of	Philippines	Kyrgyzstan		Grenada
Cote d`Ivoire	Samoa	Latvia		Guatemala
Djibouti	Solomon Islands	Lithuania		Guyana
Equatorial Guinea	Sri Lanka	Macedonia		Haiti
Eritrea	Thailand	Malaysia		Honduras
Ethiopia	Tonga	Maldives		Jamaica
Gabon	Vanuatu	Moldova		Mexico
Gambia, The	Vietnam	Poland		Nicaragua
Ghana		Romania		Panama
Guinea		Russia		Paraguay
Guinea-Bissau		Serbia and Montenegro		Peru
Kenya		Slovak Republic		St. Kitts & Nevis
Lesotho		Tajikistan		St. Lucia
Liberia		Turkey		St. Vincent & Grenadines
Madagascar		Ukraine		Trinidad & Tobago
Malawi		Uzbekistan		Uruguay
Mali				Venezuela
Mauritania				
Mauritius				
Morocco				
Mozambique				
Niger				
Nigeria				
Rwanda				
Sao Tome and Principe				
Senegal				
Seychelles				
Sierra Leone				
Somalia				
South Africa				
Sudan				
Swaziland				
Tanzania				
Togo				
Tunisia				
Uganda				
Zambia				
Zimbabwe				

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Table 1 International Evidence on the Impacts on External Debt

(1) $\Delta Debt_{j,t}$ = constant term + $a_1 \cdot \Delta Foreign\ Reserve_{j,t} + a_2 \cdot log\ GNI_{j,t}$,

Regression	1	2	3	4	5
Constant	7.0888 **	7.6568 **	7.0881 **	7.0816 *	6.9725
	(2.47)	(2.54)	(2.47)	(1.68)	(1.64)
ΔR/GNI	0.8547 ***	0.8525 ***	0.8580 ***	0.8542 ***	0.8552 ***
	(5.10)	(5.09)	(5.12)	(5.11)	(5.11)
log(GNI)	-0.6975 **	-0.7755 **	-0.6770 **	-0.6225 *	-0.6082
	(-2.18)	(-2.25)	(-2.09)	(-1.67)	(-1.59)
Asia-dummy		1.7918			
		(0.63)			
After98-dummy			-0.6220		0.1053 **
			(-0.43)		(2.50)
Import/GNI				0.1049 **	-0.0758 ***
				(2.49)	(-2.99)
Openness				-0.0763 ***	-0.2429
				(-3.03)	(-0.16)
adj.R squared	0.0153	0.0150	0.0149	0.0192	0.0187

(2) $Maturity_{j,t}$ = constant term + $b_1 \cdot Foreign\ Reserve_{j,t}/\ GNI_{j,t} + b_2 \cdot log\ GNI_{j,t}$

Regression	1	2	3	4
Constant	44.6099 ***	44.8509 ***	44.7498 ***	45.1080 ***
	(41.25)	(39.60)	(41.46)	(39.86)
R/GNI	-0.0536 ***	-0.0549 ***	-0.0706 ***	-0.0729 ***
	(-2.90)	(-2.95)	(-3.72)	(-3.81)
log(GNI)	-2.4161 ***	-2.4472 ***	-2.4807 ***	-2.5280 ***
	(-20.43)	(-19.42)	(-20.81)	(-19.84)
Asia-dummy		0.8480		1.2485
		(0.72)		(1.05)
After98-dummy			1.9947 ***	2.0435 ***
			(3.78)	(3.86)
adj.R squared	0.1390	0.1388	0.1434	0.1434

Notes)

1) Number of observation. = 2411 (134 countries and 25 periods, unbalanced panel). The sample includes developing countries only.

2) The method of estimation is pooled-OLS. t-statistics are in parentheses.

3) Asia-dummy takes 1 for 5 Asian countries (China, Indonesia, Malaysia, Philippines, and Thailand).

Table 2 International Evidence on the Impacts on Macro Variables

(1) $Consumption_{j,t}/GNI_{j,t}$ = constant term + c_1 $Foreign\ Reserve_{j,t}/\ GNI_{j,t}$ + $c_2 \cdot\ log\ GNI_{j,t}$

Regression	1	2	3
Constant	95.6620 ***	82.7353 ***	82.7034 ***
	(62.26)	(50.04)	(49.90)
R/GNI	-0.2537 ***	-0.1965 ***	-0.1948 ***
	(-9.05)	(-7.34)	(-7.09)
log(GNI)	-2.2701 ***	-1.2512 ***	-1.2425 ***
	(-13.64)	(-7.26)	(-7.10)
Asia-dummy		-9.0239 ***	-9.0628 ***
		(-5.88)	(-5.88)
Africa-dummy		10.1350 ***	10.1254 ***
		(14.90)	(14.87)
After98-dummy			-0.2070
			(-0.28)
adj.R squared	0.0985	0.1944	0.1941

(2) $Export_{j,t}/GNI_{j,t} = d_1\ (Foreign\ Reserve_{j,t}/\ GNI_{j,t}) + d_2 \cdot\ log\ GNI_{j,t}$,

Regression	1	2	3	4
Constant	57.7109 ***	72.2412 ***	73.3367 ***	74.5535 ***
	(28.37)	(32.45)	(33.24)	(34.46)
R/GNI	0.6687 ***	0.6031 ***	0.5441 ***	0.4822 ***
	(18.02)	(16.72)	(14.89)	(13.28)
log(GNI)	-3.0394 ***	-4.2169 ***	-4.5163 ***	-4.5371 ***
	(-13.80)	(-18.17)	(-19.38)	(-19.89)
Asia-dummy		11.9238 ***	13.2619 ***	-17.0032 ***
		(5.77)	(6.47)	(-4.69)
Africa-dummy		-10.8637 ***	-10.5310 ***	-10.7252 ***
		(-11.86)	(-11.62)	(-12.08)
After98-dummy			7.1217 ***	6.3296 ***
			(7.33)	(6.63)
Asia*(R/GNI)				1.8677 ***
				(10.02)
adj.R squared	0.1928	0.2534	0.2702	0.3005

Table 2 International Evidence on the Impacts on Macro Variables (continued)

(3) $Investment_{j,t}/GDP_{j,t}$ = constant term + e_1 ($Foreign\ Reserve_{j,t}/ GNI_{j,t}$) + $e_2 \cdot log\ GNI_{j,t}$,

Regression	1	2	3	4
Constant	3.8187 ***	9.7789 ***	3.6617 ***	9.6381 ***
	(6.14)	(14.93)	(5.89)	(14.71)
R/GNI	0.1423 ***	0.1127 ***	0.1511 ***	0.1203 ***
	(12.55)	(10.63)	(13.04)	(11.09)
log(GNI)	0.7476 ***	0.2035 ***	0.7889 ***	0.2420 ***
	(11.11)	(2.98)	(11.57)	(3.50)
Asia-dummy		8.2814 ***		8.1094 ***
		(13.63)		(13.32)
Africa-dummy		-3.4497 ***		-3.4925 ***
		(-12.81)		(-12.97)
After98-dummy			-1.0852 ***	-0.9155 ***
			(-3.50)	(-3.17)
adj.R squared	0.1022	0.2307	0.1066	0.2337

(4) $D GDP_{j,t}/GDP_{j,t}$ = constant term + f_1 ($Foreign\ Reserve_{j,t}/ GNI_{j,t}$) + $f_2 \cdot log\ GNI_{j,t}$,

Regression	1	2	3	4
Constant	-0.8413	0.5695	-0.8428	0.5825
	(-1.41)	(0.84)	(-1.41)	(0.86)
R/GNI	0.0422 ***	0.0347 ***	0.0422 ***	0.0341 ***
	(3.83)	(3.13)	(3.76)	(3.01)
log(GNI)	0.1884 ***	0.0485	0.1888 ***	0.0455
	(2.91)	(0.68)	(2.87)	(0.63)
Asia-dummy	(0.00)	2.4535 ***		2.4632 ***
	(0.00)	(3.94)		(3.95)
Africa-dummy		-0.6193 **		-0.6194 **
		(-2.19)		(-2.19)
After98-dummy		(0.00)	-0.0118	0.0771
		(0.00)	(-0.04)	(0.24)
adj.R squared	0.0037	0.0057	0.0113	0.0132

Notes)

1) Number of observation. = 2411 (134 countries and 25 periods, unbalanced panel). The sample includes developing countries only.

2) The method of estimation is pooled-OLS. t-statistics are in parentheses.

3) Asia-dummy takes 1 for 5 Asian countries (China, Indonesia, Malaysia, Philippines, and Thailand).

Table 3 The Impacts when Including D*R* as an Independent Variable

(1) dependent variable = $Consumption_{j,t}/GNI_{j,t}$

Regression	1	2	3
Constant	95.6744 ***	82.7426 ***	82.7106 ***
	(62.23)	(50.02)	(49.87)
R/GNI	-0.2554 ***	-0.1974 ***	-0.1957 ***
	(-8.94)	(-7.24)	(-7.01)
ΔR/GNI	0.0282	0.0141	0.0148
	(0.32)	(0.17)	(0.17)
log(GNI)	-2.2704 ***	-1.2514 ***	-1.2425 ***
	(-13.64)	(-7.26)	(-7.10)
Asia-dummy		-9.0242 ***	-9.0638 ***
		(-5.88)	(-5.88)
Africa-dummy		10.1338 ***	10.1239 ***
		(14.90)	(14.86)
After98-dummy			-0.2107
			(-0.29)
adj.R squared	0.0981	0.1941	0.1937

(2) dependent variable = $Export_{j,t}/GNI_{j,t}$,

Regression	1	2	3	4
Constant	57.7797 ***	72.3313 ***	73.4087 ***	74.6030 ***
	(28.40)	(32.48)	(33.27)	(34.47)
R/GNI	0.6592 ***	0.5926 ***	0.5354 ***	0.4759 ***
	(17.44)	(16.14)	(14.41)	(12.91)
ΔR/GNI	0.1573	0.1724	0.1488	0.1109
	(1.33)	(1.51)	(1.32)	(1.01)
log(GNI)	-3.0409 ***	-4.2194 ***	-4.5169 ***	-4.5375 ***
	(-13.81)	(-18.19)	(-19.38)	(-19.89)
Asia-dummy		11.9202 ***	13.2518 ***	-16.9062 ***
		(5.77)	(6.46)	(-4.66)
Africa-dummy		-10.8793 ***	-10.5462 ***	-10.7359 ***
		(-11.88)	(-11.63)	(-12.09)
After98-dummy			7.0846 ***	6.3047 ***
			(7.29)	(6.60)
Asia*(R/GNI)				1.8612 ***
				(9.98)
adj.R squared	0.1930	0.2538	0.2704	0.3005

Table 3. The Impacts when Including D*R* as an Independent Variable (continued)

(3) dependent variable = $Investment_{j,t}/GDP_{j,t}$,

Regression	1	2	3	4
Constant	3.7253 ***	9.6699 ***	3.5771 ***	9.5385 ***
	(6.04)	(14.88)	(5.79)	(14.67)
R/GNI	0.1553 ***	0.1255 ***	0.1634 ***	0.1325 ***
	(13.54)	(11.71)	(13.97)	(12.11)
βR/GNI	-0.2134 ***	-0.2087 ***	-0.2100 ***	-0.2058 ***
	(-5.94)	(-6.28)	(-5.86)	(-6.20)
log(GNI)	0.7496 ***	0.2066 ***	0.7889 ***	0.2428 ***
	(11.22)	(3.05)	(11.66)	(3.54)
Asia-dummy		8.2858 ***		8.1234 ***
		(13.75)		(13.45)
Africa-dummy		-3.4308 ***		-3.4715 ***
		(-12.84)		(-13.00)
After98-dummy			-1.0344 ***	-0.8642 ***
			(-3.36)	(-3.02)
adj.R squared	0.1155	0.2434	0.1194	0.2460

(4) dependent variable = $D GDP_{j,t}/GDP_{j,t}$,

Regression	1	2	3	4
Constant	-0.8701	0.5297	-0.8698	0.5450
	(-1.46)	(0.78)	(-1.45)	(0.80)
R/GNI	0.0461 ***	0.0386 ***	0.0461 ***	0.0379 ***
	(4.12)	(3.43)	(4.04)	(3.30)
βR/GNI	-0.0695 *	-0.0687 *	-0.0695 *	-0.0689 *
	(-1.96)	(-1.95)	(-1.96)	(-1.95)
log(GNI)	0.1886 ***	0.0490	0.1885 ***	0.0455
	(2.91)	(0.69)	(2.87)	(0.63)
Asia-dummy		2.4694 ***		2.4810 ***
		(3.97)		(3.98)
Africa-dummy		-0.6031 **		-0.6032 **
		(-2.14)		(-2.14)
After98-dummy			0.0023	0.0916
			(0.01)	(0.29)
adj.R squared	0.0105	0.0201	0.0100	0.0197

Note) The sample and the estimation method are the same as those in Table 2.

Table 4. The Impacts through Current Account Surplus

(1) dependent variable = $Consumption_{j,t}/GNI_{j,t}$

Regression	1	2	3
Constant	93.4117 ***	80.5921 ***	81.0855 ***
	(42.51)	(34.21)	(34.04)
R/GNI	-0.1431 ***	-0.1266 ***	-0.1328 ***
	(-5.10)	(-4.66)	(-4.83)
β_jR/GNI	0.0013	-0.0065	-0.0099
	(0.02)	(-0.08)	(-0.13)
log(GNI)	-1.6558 ***	-0.6998 ***	-0.7628 ***
	(-8.39)	(-3.36)	(-3.58)
CA/GNI	0.8510 ***	0.7861 ***	0.7879 ***
	(12.56)	(11.92)	(11.94)
Export/GNI	-1.0001 ***	-0.9188 ***	-0.9204 ***
	(-17.98)	(-16.87)	(-16.90)
Import/GNI	0.8138 ***	0.7824 ***	0.7806 ***
	(14.06)	(13.89)	(13.85)
Asia-dummy		-8.3645 ***	-8.1390 ***
		(-5.80)	(-5.61)
Africa-dummy		7.1984 ***	7.2077 ***
		(10.98)	(11.00)
After98-dummy			0.9580
			(1.39)
adj.R squared	0.2552	0.3041	0.3044

Table 4. The Impacts through Current Account Surplus (continued)

(2) dependent variable = $Investment_{j,t}/GDP_{j,t}$,

Regression	1	2	3	4
Constant	-5.5362 ***	1.6163 *	-6.2786 ***	0.8956
	(-6.08)	(1.71)	(-6.89)	(0.94)
R/GNI	0.1402 ***	0.1293 ***	0.1513 ***	0.1384 ***
	(12.07)	(11.85)	(12.97)	(12.58)
β_jR/GNI	-0.1707 ***	-0.1668 ***	-0.1644 ***	-0.1618 ***
	(-5.03)	(-5.24)	(-4.88)	(-5.11)
log(GNI)	1.3842 ***	0.7912 ***	1.4819 ***	0.8833 ***
	(16.93)	(9.45)	(17.92)	(10.37)
CA/GNI	-0.1835 ***	-0.1651 ***	-0.1878 ***	-0.1677 ***
	(-6.54)	(-6.23)	(-6.75)	(-6.36)
Export/GNI	0.0218	-0.0059	0.0255	-0.0036
	(0.95)	(-0.27)	(1.12)	(-0.17)
Import/GNI	0.0440 *	0.0447 **	0.0460 *	0.0473 **
	(1.84)	(1.97)	(1.93)	(2.10)
Asia-dummy		7.5720 ***		7.2426 ***
		(13.07)		(12.49)
Africa-dummy		-2.9392 ***		-2.9529 ***
		(-11.16)		(-11.27)
After98-dummy			-1.7735 ***	-1.3993 ***
			(-6.10)	(-5.08)
adj.R squared	0.2227	0.3163	0.2348	0.3237

Table 4 The Impacts through Current Account Surplus (continued)

(3) dependent variable = $D GDP_{j,t}/GDP_{j,t}$,

Regression	1	2	3	4
Constant	-3.5278 ***	-1.9842 *	-3.5896 ***	-2.0269 *
	(-3.70)	(-1.88)	(-3.75)	(-1.90)
R/GNI	0.0366 ***	0.0341 ***	0.0379 ***	0.0348 ***
	(3.06)	(2.85)	(3.12)	(2.86)
β_jR/GNI	-0.0578	-0.0578	-0.0571	-0.0574
	(-1.63)	(-1.63)	(-1.61)	(-1.62)
log(GNI)	0.3592 ***	0.2170 **	0.3684 ***	0.2226 **
	(4.20)	(2.31)	(4.25)	(2.33)
CA/GNI	-0.0640 **	-0.0651 **	-0.0649 **	-0.0656 **
	(-2.19)	(-2.22)	(-2.22)	(-2.23)
Export/GNI	0.0339	0.0326	0.0346	0.0330
	(1.41)	(1.34)	(1.44)	(1.36)
Import/GNI	-0.0069	-0.0116	-0.0072	-0.0117
	(-0.28)	(-0.46)	(-0.29)	(-0.47)
Asia-dummy		2.1291 ***		2.1120 ***
		(3.38)		(3.34)
Africa-dummy		-0.3510		-0.3478
		(-1.21)		(-1.20)
After98-dummy			-0.2131	-0.1030
			(-0.66)	(-0.32)
adj.R squared	0.0231	0.0285	0.0228	0.0281

Note) The sample and the estimation method are the same as those in Table 2.

Table 5. The Impacts in Neoclassical Growth Regressions

$\Delta GDP_{j,t}/GDP_{j,t}$ = constant term + f_1 ($Foreign\ Reserve_{j,t}/\ GNI_{j,t}$) + $f_2 \cdot\ log\ GNI_{j,t}$,

Regression	1	2	3	4	3	4
Constant	0.6187 ***	0.9849 ***	0.9035 ***	-0.2345	0.2774	0.1704
	(2.62)	(3.11)	(2.79)	(-0.78)	(0.70)	(0.42)
R/GNI	0.0244 **	0.0222 *	0.0192 *	0.0136	0.0153	0.0118
	(2.14)	(1.96)	(1.65)	(1.18)	(1.32)	(0.99)
ΔR/GNI	-0.0495	-0.0522	-0.0528	-0.0346	-0.0409	-0.0413
	(-1.40)	(-1.49)	(-1.50)	(-0.98)	(-1.16)	(-1.17)
GDP per capita	0.1864 ***	0.1662 ***	0.1706 ***	0.1612 ***	0.1546 ***	0.1592 ***
	(7.33)	(6.46)	(6.58)	(6.22)	(5.95)	(6.08)
Initial GDP per capita	-0.1380 ***	-0.1304 ***	-0.1335 ***	-0.1266 ***	-0.1248 ***	-0.1280 ***
	(-6.92)	(-6.43)	(-6.54)	(-6.34)	(-6.14)	(-6.26)
Investment share				0.0972 ***	0.0682 ***	0.0698 ***
				(4.58)	(2.91)	(2.98)
Asia-dummy		1.9815 ***	1.9749 ***		1.3815 **	1.3602 **
		(3.33)	(3.32)		(2.20)	(2.16)
Africa-dummy		-0.6740 **	-0.6568 **		-0.4730	-0.4492
		(-2.23)	(-2.17)		(-1.53)	(-1.45)
After98-dummy			0.4010			0.4455
			(1.28)			(1.42)
adj.R squared	0.0311	0.0397	0.0400	0.0402	0.0431	0.0436

Figure 1. Total reserve minus gold

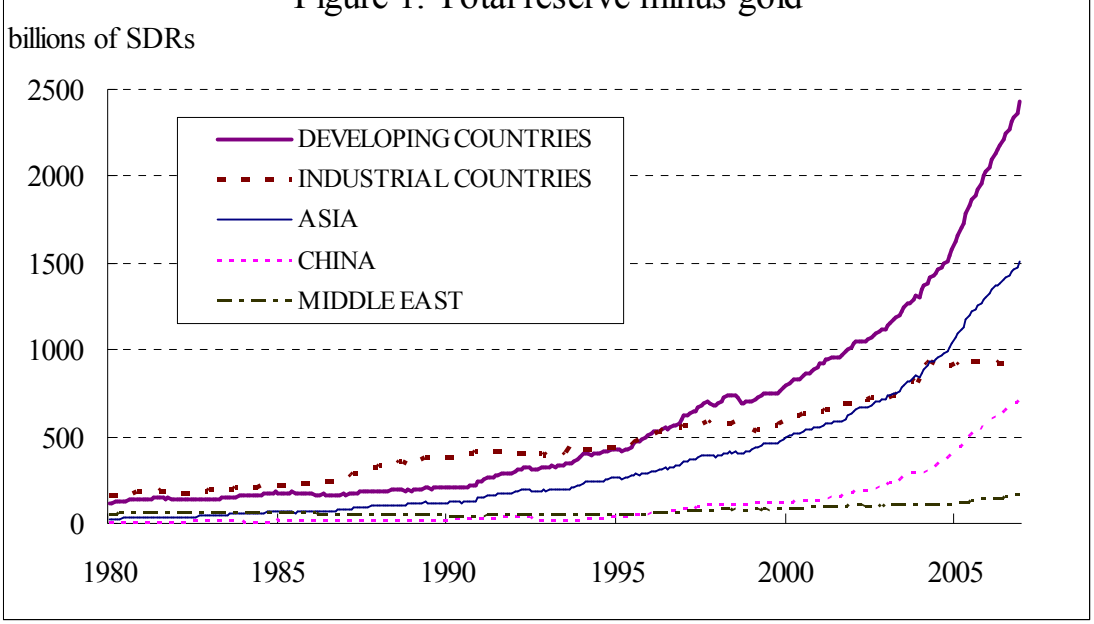

Figure 2. Histogram of R/GNI