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# Liquidity Risk Aversion, Debt Maturity, and Current Account Surpluses

## A Theory and Evidence from East Asia

Shin-ichi Fukuda and Yoshifumi Kon

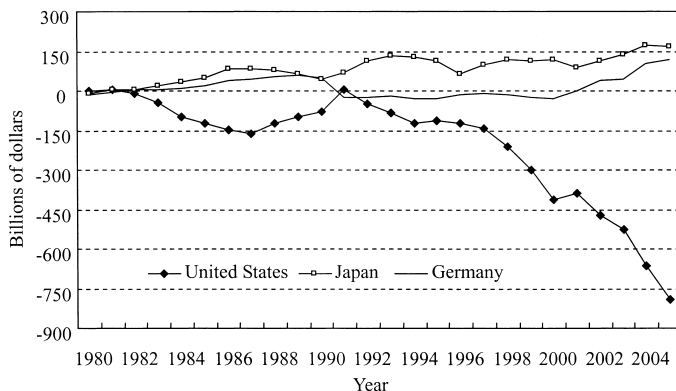
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### 2.1 Introduction

In recent literature, it has been widely discussed why the U.S. current account has deteriorated dramatically during the past decade (see, among others, Obstfeld and Rogoff, 2004; Roubini and Setser, 2004; Blanchard, Giavazzi, and Sa, 2005). Although the U.S. current account had been in deficit for most of the 1980s and 1990s, its deficits were almost balanced by Japan's current account surpluses until the mid-1990s. However, the U.S. current account started to show a dramatic deterioration after 1997 and is now far from balanced by surpluses of the other industrialized countries (see figure 2.1). The first strand of studies proposed that the recent deterioration in the U.S. current account primarily reflects a decline of the U.S. domestic saving and an increase in the U.S. demand for foreign goods. The second strand of studies, in contrast, pointed out that an increase in the global supply of saving, especially an increase in Asian and Middle Eastern savings, would help to explain the increase in the U.S. current account deficit. In particular, these studies stress a remarkable reversal in global capital flows that has transformed emerging-market economies from borrowers to large net lenders in international capital markets (see, for ex-

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**Fig. 2.1** Current account balances of the U.S., Japan, and Germany

Source: *International Financial Statistics*, IMF

ample, Bernanke, 2005; Dooley, Folkerts-Landau, and Garber 2005; and Caballero, Farhi, and Gourinchas, 2006).

When looking at the recent remarkable reversal in global capital flows, East Asian economies have been one of the major net lenders after the currency crisis in 1997. Table 2.1 reports total trade balances of eight East Asian economies from 1990 to 2004. It also reports their trade balances against the United States and the other trade partners. It shows that except for Hong Kong and the Philippines, the East Asian economies had trade balance surpluses in total after the crisis. In particular, except for the Philippines, they have had big trade balance surpluses against the United States since the crisis and the surpluses have widened in the 2000s. The trade balance surpluses have been one of the main sources of the U.S. current account deficits since the late 1990s, especially since the early 2000s.

In this paper, we explore some theoretical and empirical implications of the changed international capital flows in East Asian economies after the currency crisis. During the crisis, East Asian economies with smaller liquid foreign assets had a hard time 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 Asian economies took more seriously was raising foreign reserves (see, for example, Aizenman and Lee 2005 and Rodrik 2005). Foreign exchange reserves held by developing nations, especially East Asian economies, are now record-breaking and stand at levels that are a multiple of those held by advanced countries. The purpose of this paper is to show that

**Table 2.1 Trade balances of East Asian economies**

	China		Korea		Singapore		Hong Kong		Thailand		Indonesia		Malaysia		Philippines						
	Total	U.S. Non-U.S.	Total	U.S. Non-U.S.	Total	U.S. Non-U.S.	Total	U.S. Non-U.S.	Total	U.S. Non-U.S.	Total	U.S. Non-U.S.	Total	U.S. Non-U.S.	Total	U.S. Non-U.S.					
1995	16.8	8.6	-9.8	-6.2	-3.6	2.9	-6.2	-19.2	23.0	-42.2	-16.5	1.6	-18.1	3.8	1.9	1.9	-6.5	-10.9	1.0	-11.9	
1996	12.1	10.6	-19.8	-11.5	-8.3	1.5	-6.6	-18.0	22.7	-40.7	-17.6	0.8	-18.4	7.0	1.7	5.2	-2.3	-11.2	0.7	-11.9	
1997	40.8	16.5	-8.4	-8.4	0.0	-7.2	0.7	-20.8	24.7	-45.5	-5.4	2.5	-7.8	9.2	2.0	7.1	-2.9	-19.9	1.6	-21.6	
1998	43.4	21.0	22.4	39.3	2.7	36.7	8.3	3.1	5.2	-10.9	26.9	-37.8	11.4	6.1	5.3	21.5	3.5	18.0	15.2	4.4	10.7
1999	29.2	22.5	6.7	23.9	4.7	19.3	3.7	3.0	0.6	-5.9	28.8	-34.6	8.1	6.2	1.9	24.7	4.1	20.6	19.1	7.1	11.9
2000	24.0	29.8	-5.8	11.3	8.5	2.8	3.3	3.6	-0.3	-11.3	32.6	-43.9	7.0	7.4	-0.4	28.6	5.1	23.5	16.0	6.5	9.5
2001	23.1	28.2	-5.0	8.7	8.9	-0.2	5.7	-0.4	6.1	-11.6	28.9	-40.6	3.1	6.0	-3.0	25.3	4.6	20.8	14.8	6.0	8.9
2002	30.3	42.8	-12.5	9.4	9.8	-0.5	8.6	2.5	6.1	-7.8	31.1	-38.8	4.1	7.3	-3.2	25.9	4.9	20.9	13.9	5.7	8.2
2003	25.4	58.7	-33.3	13.9	9.4	4.5	16.1	2.6	13.6	-8.7	29.0	-37.7	4.5	6.5	-2.0	28.5	4.7	23.8	22.2	7.7	14.6
2004	31.8	80.4	-48.6	28.7	14.1	14.6	16.5	2.5	14.0	-12.1	29.5	-41.6	2.1	8.2	-6.2	25.0	5.6	19.5	22.2	8.5	13.7

Source: IMF, *Direction of Trade Statistics Yearbook*, various issues.

Note: Units in billions of U.S. dollars.

macroeconomic impacts will be very different depending on which strategy developing countries take for self-protection.

In the first part of this paper, we investigate what impacts an increased aversion to liquidity risk can have on current account and the other macroeconomic variables in a simple open economy model. In the model, each representative agent maximizes the utility function over time. Since Obstfeld and Rogoff (1997), usefulness of utility-based models has been widely recognized. A key feature in our model is that relative size of net foreign liquid debt to foreign reserve reduces the utility. This is one of the simplest forms that capture costs from holding liquid foreign debts. At period  $\tau$ , there is an unanticipated shock that increases aversion to liquidity risk. When the government keeps the amount of foreign reserves constant, the increased aversion among private individuals reduces liquid debt and increases illiquid debt. However, because the sum of liquid and illiquid debts does not change much, the macroeconomic impacts are not large, causing only small current account surpluses. In contrast, when both private individuals and the government respond to an unanticipated increase of liquidity risk aversion, the increased aversion increases foreign reserves and may lead to a rise of liquid debt. In particular, under some reasonable parameter set, it causes large macroeconomic impacts, including current account surpluses accompanied by depreciation of the real exchange rate.

In the second part of the paper, we provide some empirical evidence in East Asia that supports to the theoretical implications. In particular, we focus on the changes of foreign debt maturity structures and their implications in East Asian economies. We find that many East Asian economies temporarily reduced short-term borrowings soon after the crisis, but increased short-term borrowings in the early 2000s. Since short-term debt is liquid debt, the former change after the crisis is consistent with the case where only private agents respond to the increased aversion to liquidity risk. However, the latter change is consistent with the case where the government also started to respond and accumulated substantial foreign exchange reserves.

Since macroeconomic impacts of the increased liquidity risk aversion depend on which strategy the East Asian economies take, our results have several important implications. In particular, by accumulating foreign exchange reserves, the U.S. dollar is the dominant reserve currency in the currency compositions. This suggests that substantial rises in foreign exchange reserves will increase capital inflows into the United States. We point out that trade account surpluses have been widening against the United States, but not against non-U.S. countries in several Asian economies in the 2000s. Finally, we find that there were substantial depreciations of East Asian real exchange rates against the U.S. dollar even after the economies recovered from the crisis. We point out that the result is also consistent with the model.

There are several previous studies that address determinants of debt maturity structure. For example, Rodrik and Velasco (1999) argue that international investors with informational disadvantages may choose to lend short-term to better monitor and discipline borrowers (see also Fukuda 2001 and Jeanne, 2004). Broner, Lorenzoni, and Schmukler (2004) argue that emerging economies borrow short term due to the high risk premium charged by international capital markets on long-term debt (see also Schmukler and Vesperoni, 2006). However, unlike ours, none of them discussed interactions between debt maturity and foreign reserves that prevailed in emerging markets in the late 1990s and the early 2000s.

The paper proceeds as follows. Section 2.2 sets up our small open economy model and section 2.3 discusses its implications under constant foreign reserves. Section 2.4 discusses macroeconomic consequences when the government chooses foreign reserves so as to minimize its loss function, and section 2.5 presents the simulation results. Section 2.6 shows some supporting evidence in East Asia, and section 2.7 considers an implication for the U.S. current account deficits. Section 2.8 discusses implications for real exchange rates. Section 2.9 summarizes our main results and refers to their implications.

## 2.2 A Small Open Economy Model

The main purpose of our theoretical model is to investigate macroeconomic consequences when the economy suddenly increased its aversion to liquidity risk. We consider a small open economy that produces two composite goods, tradables and nontradables. For analytical simplicity, we assume that outputs of tradables and nontradables,  $y^T$  and  $y^N$  respectively, are fixed and constant over time. Each representative agent in the economy maximizes the following utility function:

$$(1) \quad \sum_{j=0}^{\infty} \beta^j [U(c_{t+j}^T, c_{t+j}^N) - C(\lambda b_{t+j}^A, R_{t+j})], \quad 0 < \lambda,$$

where  $c_t^T$  = consumption of tradable good,  $c_t^N$  = consumption of nontradable good,  $b_t^A$  = net liquid debt,  $b_t^B$  = net illiquid debt, and  $R_t$  = foreign reserve. The parameter  $\beta$  is a discount factor such that  $0 < \beta < 1$ . Subscript  $t$  denotes time period. The utility function  $U(c_{t+j}^T, c_{t+j}^N)$  is increasing and strictly concave in  $c_{t+j}^T$  and  $c_{t+j}^N$ , while the disutility function  $C(\lambda b_{t+j}^A, R_{t+j})$  is strictly increasing and strictly convex in  $b_{t+j}^A$ .

The budget constraint of the representative agent is:

$$(2) \quad b_{t+1}^A + b_{t+1}^B = (1 + r_A)b_t^A + (1 + r_B)b_t^B - y^T - p_t^N y^N + c_t^T + p_t^N c_t^N + T_t$$

where  $T_t$  is lump-sum tax,  $p_t^N$  is the price of nontradable goods,  $r_A$  is real interest rate of liquid debt, and  $r_B$  is real interest rate of illiquid debt. For simplicity, we assume that  $r_A < r_B = (1/\beta) - 1$ . The assumption that  $r_A < r_B$  reflects a liquidity premium that makes real interest rate of liquid debt

lower than that of illiquid debt. Since the numeraire is the traded good, the real interest rates and the price of nontradable goods are defined in terms of tradables.

A key feature in equation (1) is that net liquid debt and foreign reserve are in the utility function. In our model, net supply of domestic debt is always zero, so that  $b_t^A$  denotes net liquid foreign debt. We assume that the relative size of net liquid foreign debt to foreign reserve reduces the utility. This is one of the simplest forms that capture potential costs from holding liquid foreign debts. Panics in financial markets and sudden reversals in capital flows 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 reserves. To the extent that  $\partial C(\lambda b_{t+j}^A, R_{t+j})/\partial(\lambda b_{t+j}^A) > 0$  and  $\partial C(\lambda b_{t+j}^A, R_{t+j})/\partial R_{t+j} < 0$ , the function  $C(\lambda b_{t+j}^A, R_{t+j})$  is a reduced form that captures the disutility from such potential costs.

One may interpret the function  $C(\lambda b_{t+j}^A, R_{t+j})$  as a shopping time model where either a decline of  $b_t^A$  or a rise of  $R_t$  saves labor time for reducing liquidity risk. In a closed economy, fiat money provides such liquidity services in the money-in-the-utility function model. In a small open economy that has a potential liquidity risk, either a decrease of liquid foreign debt or an increase of foreign reserve provides a similar service. In the following analysis, we assume that  $\partial^2 C(\lambda b_{t+j}^A, R_{t+j})/\partial(\lambda b_{t+j}^A)\partial R_{t+j} < 0$ . The assumption reflects the fact that a foreign reserve accumulation relieves the marginal disutility from increased liquid foreign debt. The parameter  $\lambda$  represents the degree of risk aversion to potential liquidity shocks. An increased aversion to liquidity risk generally increases the marginal disutility from the increased liquid foreign debt.

The first-order conditions are derived by maximizing the following Lagrangian:

$$(3) \quad L = \sum_{j=0}^{\infty} \beta^j [U(c_{t+j}^T, c_{t+j}^N) - C(\lambda b_{t+j}^A, R_{t+j})] \\ + \sum_{j=0}^{\infty} \beta^j \mu_{t+j} [b_{t+1+j}^A + b_{t+1+j}^B - (1 + r_A) b_{t+j}^A - (1 + r_B) b_{t+j}^B \\ + y^T + p_{t+j}^N y^N - c_{t+j}^T - p_{t+j}^N c_{t+j}^N - T_{t+j}].$$

It holds that  $c_t^N = y^N$  in equilibrium. Assuming interior solutions, the first-order conditions thus lead to:

$$(4a) \quad \partial U(c_t^T, y^N)/\partial y^N = \mu_t p_t^N,$$

$$(4b) \quad \partial U(c_t^T, y^N)/\partial c_t^T = \mu_t,$$

$$(4c) \quad \lambda \partial C(\lambda b_{t+1}^A, R_{t+1})/\partial(\lambda b_{t+1}^A) = (r_B - r_A) \mu_{t+1}.$$

Since the numeraire is the traded good, the price of nontradable good  $p_t^N$  denotes the real exchange rate of this small open economy at time  $t$ , where

a decline of  $p_t^N$  means depreciation of the real exchange rate. Equation (4a) thus implies that the real exchange rate depreciates when  $y^N$  increases. Equation (4b) determines the amount of consumption of tradable good. Equation (4c) implies that the amount of liquid foreign debt  $b_t^A$  is inversely related with the amount of foreign reserves  $R_t$ . This is because foreign reserves, which reduce liquidity risk, allow the representative agent to hold more liquid foreign debt.

Under the assumption that  $r_B = (1/\beta) - 1$  where the real interest rate of illiquid debt is equal to the rate of time preference, Lagrangian multiplier  $\mu_t$  is constant over time and equals to  $\mu > 0$ . This implies that all of the macro variables  $c_t^T$ ,  $p_t^N$ ,  $b_t^A$ , and  $b_t^A + b_t^B$  are constant over time without unanticipated external shocks.<sup>1</sup> However, an unanticipated change of the parameter  $\lambda$  affects the equilibrium values of these variables. In particular, the parameter  $\lambda$  affects the choice between liquid and illiquid foreign debts because of potential costs from holding liquid foreign debt, and may affect the current account of the economy.

### 2.3 The Macroeconomic Impacts under Constant Foreign Reserves

The main purpose of the following analysis is to explore the impacts when the economy suddenly increased its aversion to liquidity risk. To achieve this goal, we explore what impacts an unanticipated change of  $\lambda$  has on various macroeconomic variables. This section first considers the case where the amounts of foreign reserves  $R_t$  and lump-sum tax  $T_t$  are exogenously given and remain constant over time. Under the balanced budget, the government issues no bond to finance its activity. This corresponds to the case where only private individuals respond to an unanticipated increase of disutility from liquidity risk.

Suppose that there was an unanticipated increase of  $\lambda$  at period  $\tau$ . Then, both  $c_t^T$  and  $p_t^N$  instantaneously jump to the new steady state at period  $\tau$ , while both  $b_t^A$  and  $b_t^A + b_t^B$  move to the new steady state at period  $\tau + 1$ . Since  $c_t^N = y^N$ , the budget constraint thus leads to:

$$(5a) \quad 0 = r_B(b_0^A + b_0^B) - (r_B - r_A)b_0^A - y^T + c_0^T + T,$$

$$(5b) \quad b_1^A + b_1^B = (1 + r_B)(b_0^A + b_0^B) - (r_B - r_A)b_0^A - y^T + c_1^T + T,$$

$$(5c) \quad 0 = r_B(b_1^A + b_1^B) - (r_B - r_A)b_1^A - y^T + c_1^T + T,$$

where the variables with subscript 0 are those in the old steady state and the variables with subscript 1 are those in the new steady state. Denoting the change of the variable  $x$ 's steady state value by  $\Delta x$ , it therefore holds that:

1. When  $r_B \neq (1/\beta) - 1$ , Lagrangian multiplier  $\mu_t$  changes over time and consequently some macrovariables such as  $c_t^T$  have a time trend. However, even when  $r_B \neq (1/\beta) - 1$ , a basic message in the following analysis is essentially the same.



$$(6) \quad \Delta(b^A + b^B) = \frac{(r_B - r_A)}{(1 + r_B)} \Delta b^A = \Delta c^T.$$

Since equations (4b) and (4c) respectively imply that:

$$(7a) \quad \Delta \mu = \frac{\partial^2 U(c^T, y^N)}{\partial c^{T2}} \Delta c^T,$$

$$(7b) \quad \lambda^2 \frac{\partial^2 C}{\partial (\lambda b_{t+1}^A)^2} \Delta b^A + \left[ \frac{\partial C}{\partial (\lambda b_{t+1}^A)} + \lambda b^A \frac{\partial^2 C}{\partial (\lambda b_{t+1}^A)^2} \right] \Delta \lambda = (r_B - r_A) \Delta \mu,$$

we also obtain:

$$(8a) \quad \frac{\Delta b^A}{\Delta \lambda} = -\frac{1}{\Omega} \left[ \frac{\partial C}{\partial (\lambda b^A)} + \lambda b^A \frac{\partial^2 C}{\partial (\lambda b^A)^2} \right] < 0,$$

$$(8b) \quad \frac{\Delta(b^A + b^B)}{\Delta \lambda} = \frac{\Delta c^T}{\Delta \lambda} = \frac{r_B - r_A}{1 + r_B} \frac{\Delta b^A}{\Delta \lambda} < 0,$$

$$(8c) \quad \frac{\Delta \mu}{\Delta \lambda} = \frac{\partial^2 U(c^T, y^N)}{\partial c^{T2}} \frac{\Delta c^T}{\Delta \lambda} > 0,$$

where  $\Omega \equiv \lambda^2 [\partial^2 C / \partial (\lambda b_{t+1}^A)^2] - [(r_B - r_A)^2 / (1 + r_B)] [\partial^2 U(c^T, y^N) / \partial c^{T2}] > 0$ .

Since there is no net supply of domestic debt,  $b_t^A$  and  $b_t^B$  denote net liquid foreign debt and net illiquid foreign debt respectively. Equations (8a) and (8b) thus imply that the unanticipated decline of  $\lambda$  decreases not only the amount of net foreign liquidity debt, but also the sum of net foreign liquidity and illiquidity debts. Since the economy's current account balance over period  $t$  is defined by:

$$(9) \quad CA_t \equiv [(b_t^A + b_t^B) - (b_{t+1}^A + b_{t+1}^B)] + (R_{t+1} - R_t),$$

they also indicate that an unanticipated decline of  $\lambda$  improves the current account at period  $t$  because  $R_t$  is constant over time. However, since  $\Delta(b^A + b^B) = [(r_B - r_A) / (1 + r_B)] \Delta b^A$ , the change of  $b^A + b^B$  is much smaller than the change of  $b^A$  because  $(r_B - r_A) / (1 + r_B)$  is small. This implies that the increased aversion may have a limited impact on the sum of net foreign debts, although it changes the component of net foreign debts substantially through decreasing liquid foreign debt and increasing illiquid debt when private individuals increase disutility from liquidity risk.

The inequality (8c) implies that  $\Delta c^T / \Delta \lambda < 0$ . Therefore, equations (4a) and (4b) lead that  $\Delta p^N / \Delta \lambda < 0$ . These inequalities imply that an unanticipated increase in the aversion decreases consumption of tradable good and leads to the depreciation of the real exchange rate. Since  $r_B > r_A$ , the shift from liquidity debt to illiquid debt increases the burden of total interest payments. Given consumption of nontradable goods, this decreases both

$c^T$  and  $p^N$ . However, to the extent that the sum of liquid and illiquid debts does not change much, the macroeconomic impacts are not large, causing only small current account surpluses.

## 2.4 The Government Loss Minimization Problem

In the last section, we assumed that the amount of foreign reserves is exogenously given. This exercise is useful to see macroeconomic consequences when only private individuals respond to an unanticipated increase in the aversion to liquidity risk. It is, however, natural that the government also chooses the amount of foreign reserves so as to minimize the social costs. The purpose of this section is to explore what impacts an unanticipated change of liquidity risk aversion has on various macroeconomic variables, especially the current account balance, when both private individuals and the government respond to an unanticipated increase in the disutility from liquidity risk. In the analysis, we assume that the government minimizes the following loss function:

$$(10) \quad \text{Loss}_t = \sum_{j=0}^{\infty} \beta^j C^G(\lambda^G b_{t+j}^A, R_{t+j}).$$

In equation (10), the government losses arise solely from disutility from liquidity risk. The government's loss function,  $C^G(\lambda^G b_{t+j}^A, R_{t+j})$ , is strictly decreasing and strictly convex in  $R_{t+j}$ . This reflects the fact that foreign reserves relieve the country's liquidity risk. The parameter  $\lambda^G$  represents the degree of the government's aversion to the potential liquidity risk, where  $\partial C^G(\lambda^G b_{t+j}^A, R_{t+j}) / \partial (\lambda^G b_{t+j}^A) > 0$ . An increased aversion to the risk generally increases the marginal loss from decreased foreign reserves because  $\partial^2 C^G(\lambda^G b_{t+j}^A, R_{t+j}) / \partial (\lambda^G b_{t+j}^A) \partial R_{t+j} < 0$ . We allow that the government's disutility function  $C^G(\lambda^G b_{t+j}^A, R_{t+j})$  is generally different from that of the representative private agent  $C(\lambda b_{t+j}^A, R_{t+j})$ .

When increasing the amount of foreign 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 reserves are solely financed by lump-sum tax increases. In this case, the government budget constraint at period  $t$  is written as:

$$(11) \quad T_t = G^* + R_{t+1} - (1+r)R_t,$$

where  $G^*$  is exogenous government expenditure and  $r$  is real interest rate of the foreign reserves. We assume that the rate of returns from foreign reserves is very low in international capital market, so that  $r < r_A < r_B$ .

Assuming interior solution, the government's first-order conditions that minimize (10) lead to:

$$(12) \quad \frac{\partial C^G(\lambda^G b_{t+1}^A, R_{t+1})}{\partial R_{t+1}} = 0.$$

Equation (12) means that the government changes the amount of foreign reserves up to the satiation point. Equations (11) and (12), together with equations (4a)–(4c) and (5a)–(5c), determine the equilibrium allocation when the government chooses the amount of foreign reserves so as to minimize the loss function.

Since there is no net supply of domestic debt, both  $b_t^A$  and  $b_t^B$  are net foreign debts, the sum of which is still constant without external shocks even when the government chooses the amount of foreign reserves endogenously. However, unanticipated changes of  $\lambda$  and  $\lambda^G$  affect the equilibrium allocation. Suppose that there were unanticipated increases of  $\lambda$  and  $\lambda^G$  at period  $\tau$ . Then, both  $c_t^T$  and  $p_t^N$  instantaneously jump to the new steady state at period  $\tau$ , while three stock variables  $b_t^A$ ,  $b_t^A + b_t^B$ , and  $R_t$  move to the new steady state at period  $\tau + 1$ . Since  $c_t^N = y^N$ , the budget constraints in periods  $\tau - 1$ ,  $\tau$ , and  $\tau + 1$  respectively lead to:

$$(13a) \quad 0 = r_B(b_0^A + b_0^B) - (r_B - r_A)b_0^A - y^T + c_0^T + G^* - rR_0,$$

$$(13b) \quad b_1^A + b_1^B = (1 + r_B)(b_0^A + b_0^B) - (r_B - r_A)b_0^A - y^T + c_1^T + G^* + R_1 - (1 + r)R_0,$$

$$(13c) \quad 0 = r_B(b_1^A + b_1^B) - (r_B - r_A)b_1^A - y^T + c_1^T + G^* - rR_1,$$

where the variables with subscript 0 are those in the old steady state, and the variables with subscript 1 are those in the new steady state. It therefore holds that:

$$(14) \quad \Delta(b^A + b^B) - \Delta R = \Delta c^T = \left[ \frac{(r_B - r_A)}{(1 + r_B)} \right] \Delta b^A - \left[ \frac{(r_B - r)}{(1 + r_B)} \right] \Delta R.$$

The condition (14) degenerates into the condition (6) when  $\Delta R = 0$ . However, since  $\Delta R \neq 0$  when the government optimally chooses  $R$ , the following results become very different from those in the last section.

When the government chooses the amount of foreign reserves endogenously, equation (4c) implies:

$$(15) \quad \lambda^2 \left[ \frac{\partial^2 C}{\partial (\lambda b^A)^2} \right] \Delta b^A + \left[ \frac{\partial C}{\partial (\lambda b^A)} + \lambda b^A \frac{\partial^2 C}{\partial (\lambda b^A)^2} \right] \Delta \lambda + \lambda \left[ \frac{\partial^2 C}{\partial (\lambda b^A) \partial R} \right] \Delta R = (r_B - r_A) \Delta \mu,$$

while equation (4b) still leads to (7a). Since equation (12) leads to:

$$(16) \quad \lambda^G \left[ \frac{\partial^2 C^G}{\partial (\lambda^G b^A) \partial R} \right] \Delta b^A + b^A \left[ \frac{\partial^2 C^G}{\partial (\lambda^G b^A) \partial R} \right] \Delta \lambda^G + \left( \frac{\partial^2 C^G}{\partial R^2} \right) \Delta R = 0,$$

we therefore obtain that:

$$(17a) \frac{\Delta R}{\Delta \lambda} = \frac{-\frac{\partial^2 C^G}{\partial(\lambda^G b^A) \partial R} \left\{ b^A \Omega \left( \frac{\Delta \lambda^G}{\Delta \lambda} \right) - \lambda^G \left[ \frac{\partial C}{\partial(\lambda b^A)} + \lambda b^A \frac{\partial^2 C}{\partial(\lambda b^A)^2} \right] \right\}}{\frac{\partial^2 C^G}{\partial R^2} \Omega - \lambda \lambda^G \frac{\partial^2 C}{\partial(\lambda b^A) \partial R} \frac{\partial^2 C^G}{\partial(\lambda^G b^A) \partial R}},$$

$$(17b) \frac{\Delta b^A}{\Delta \lambda} = -\frac{1}{\Omega} \left[ \frac{\partial C}{\partial(\lambda b^A)} + \lambda b^A \frac{\partial^2 C}{\partial(\lambda b^A)^2} + \lambda \frac{\partial^2 C}{\partial(\lambda b^A) \partial R} \frac{\Delta R}{\Delta \lambda} \right],$$

$$(17c) \frac{\Delta(b^A + b^B - R)}{\Delta \lambda} = \frac{\Delta c^T}{\Delta \lambda} = \frac{r_B - r_A}{1 + r_B} \frac{\Delta b^A}{\Delta \lambda} - \frac{r_B - r}{1 + r_B} \frac{\Delta R}{\Delta \lambda},$$

$$(17d) \frac{\Delta \mu}{\Delta \lambda} = \frac{\partial^2 U(c^T, y^N)}{\partial c^{T2}} \frac{\Delta c^T}{\Delta \lambda}$$

where  $\Omega$ , which is positive, was defined following equations (8a)–(8c).

As you see in (17a),  $\Delta R/\Delta \lambda$  depends on various derivatives and parameters. Therefore, we cannot conclude that  $\Delta R/\Delta \lambda$  is positive in general. However, to the extent that the government chooses the amount of foreign reserves to minimize the liquidity risk, it is natural to suppose that the government increases  $R$  when aversion to liquidity risk increases. We thus focus on the case where  $\Delta R/\Delta \lambda > 0$  in the following analysis. When  $\Delta R/\Delta \lambda > 0$ , equation (17b) implies that  $\Delta b^A/\Delta \lambda$  depends on two opposite effects. One is  $(-1/\Omega)[\partial C/\partial(\lambda b^A) + \lambda b^A \partial^2 C/\partial(\lambda b^A)^2]$  that is negative, reflecting the private agent's responses to the increased aversion to liquidity risk. The other is  $(-\lambda/\Omega)[\partial^2 C^G/\partial(\lambda b^A) \partial R](\Delta R/\Delta \lambda)$  that is positive, reflecting the government's responses to the increased aversion to liquidity risk. The sign of  $\Delta b^A/\Delta \lambda$  generally depends on which effect is bigger.

Given  $\Delta b^A/\Delta \lambda$  and  $\Delta R/\Delta \lambda$ , equations (17c) and (17d) determine  $\Delta(b^A + b^B - R)/\Delta \lambda$ ,  $\Delta c^T/\Delta \lambda$ , and  $\Delta \mu/\Delta \lambda$ . The signs of  $\Delta(b^A + b^B - R)/\Delta \lambda$ ,  $\Delta c^T/\Delta \lambda$ , and  $\Delta \mu/\Delta \lambda$  in general depend on whether  $(r_B - r)\Delta R$  is bigger than  $(r_B - r_A)\Delta b^A$  or not. Since the current account balance over period  $t$  is still defined by (9), this indicates that the effect on the current account is not clear. However, when  $\Delta b^A/\Delta \lambda < 0$ , we can pin down the signs of  $\Delta(b^A + b^B - R)/\Delta \lambda$ ,  $\Delta c^T/\Delta \lambda$ , and  $\Delta \mu/\Delta \lambda$ . In this case, the macroeconomic impacts of an unanticipated change of  $\lambda$  work in the same directions as those in the last section, even if both the government and private individuals increase disutility from liquidity risk.

Moreover, to the extent that  $(r_B - r)\Delta R > (r_B - r_A)\Delta b^A$ , the conditions (17c) and (17d) imply that an unanticipated increase of  $\lambda$  leads to a temporal improvement of the current account when the economy moves from the old steady state to the new steady state, and that the increase of  $\lambda$  reduces the amount of tradable consumption and leads to the depreciation of the real exchange rate. When the government increases foreign reserves substantially, the representative private agent may not need to increase costly illiquid foreign debt. However, since the rate of returns from foreign reserves is

very low, the private agent's disposal income declines through increasing lump-sum tax. Given consumption of nontradable goods, this may decrease both  $c^T$  and  $p^N$  and derive a temporal improvement of the current account.

It is noteworthy that in terms of the magnitude, an unanticipated change of  $\lambda$  generally has different macroeconomic impacts when both the government and private individuals increase liquidity risk aversion as opposed to when only private individuals do. For example, suppose that two types of economies initially have a common value of  $\Omega$ . This happens when two types of economies initially have common values of  $b^A$ ,  $R$ , and  $c^T$ . In this case, it is easy to see that the absolute value of  $\Delta b^A/\Delta\lambda$  is larger when only private individuals increase liquidity risk aversion. However, even in this case,  $\Delta(b^A + b^B - R)/\Delta\lambda$  and  $\Delta c^T/\Delta\lambda$  can be larger when both the government and private individuals increase liquidity risk aversion because of the effect of  $\Delta R/\Delta\lambda$ . In other words, an increased aversion to liquidity risk may lead to larger current account surplus in the short-run, and may lower social welfare when the government minimizes the costs from liquidity risk and increases the amount of foreign reserves. The next section will investigate this possibility by specifying the functional forms in the model.

## 2.5 Some Numerical Examples

In the last section, we explored what impacts an increased aversion to liquidity risk have on current account and other macro variables when the government minimizes the costs from liquidity risk. However, the magnitude is not necessarily clear without using specific functional forms. The purpose of this section is to explore the quantitative impacts by specifying the functional forms in the model.

In the experiment, we use the following functional forms:

$$(18a) \quad U(c_t^T, c_t^N) \equiv \gamma \ln[(c_t^T)^\alpha (c_t^N)^{1-\alpha}]$$

$$(18b) \quad C(b_t^A, R_t) \equiv \frac{1}{2R_t} \left( \lambda \frac{b_t^A}{R_t} - D \right)^2, \text{ when } \frac{b_t^A}{R_t} \geq \frac{D}{\lambda},$$

$$\equiv 0, \quad \text{otherwise,}$$

$$(18c) \quad C^G(b_t^A, R_t) \equiv \frac{1}{2R_t} \left( \lambda^G \frac{b_t^A}{R_t} - D^G \right)^2, \text{ when } \frac{b_t^A}{R_t} \geq \frac{D^G}{\lambda^G},$$

$$\equiv 0, \quad \text{otherwise,}$$

In (18a), the utility from consumption represents the case where an elasticity of substitution in consumption between the tradable good and the nontradable good equals to one. The disutility functions (18b) and (18c) imply that the satiation ratio of  $b_t^A/R_t$  is  $D/\lambda$  for the private agent and  $D^G/\lambda^G$  for the government.

To explore the impacts of unanticipated changes of  $\lambda$  and  $\lambda^G$ , we set the structural parameters as  $\alpha = 0.7$ ,  $\beta = 0.9$ ,  $\gamma = 10$ ,  $r_B - r_A = 0.05$ ,  $r = 0.01$ ,  $G^* = 1.5$ ,  $D = 1.05$ , and  $D^G = 1$  and domestic outputs as  $y^T = y^N = 10$ . We also set that  $R = 15$  when the government does not choose  $R$  endogenously. These parameters and variables remain constant throughout the period. However, at period  $\tau$ , there was an unanticipated preference shock in holding liquid foreign debt, and the value of  $\lambda$  and  $\lambda^G$  increased from 1 to 1.1 permanently. Then, when  $b_t^A + b_t^B = c_t^T$  before period  $\tau$ , the equilibrium values of macro variables are summarized in tables 2.2–2.4.

Table 2.2 reports the case where the government does not respond to the shock, while table 2.3 reports the case where the government responds to the shock. The change of  $\lambda$  has very small impacts on  $c_t^T$ ,  $p_t^N$ , and  $b_t^A + b_t^B$  in table 2.2. In contrast, in table 2.3, the changes of  $\lambda$  and  $\lambda^G$  increase  $R_t$  substantially and cause large declines of  $c_t^T$ ,  $p_t^N$ , and  $b_t^A + b_t^B - R_t$ . As we discussed in the last section, it is not clear in general what impacts the changes of  $\lambda$  and  $\lambda^G$  have when both private individuals and the government respond to the shock. However, table 2.3 indicates that under the parameter set and exogenous variables specified above, rises of  $\lambda$  and  $\lambda^G$  increase  $R_t$ ,  $b_t^A$ ,  $b_t^B$ , and  $b_t^A + b_t^B$  at period  $\tau + 1$ , decrease  $c_t^T$  and  $p_t^N$  at period  $\tau$ , and lead to a temporal current account surplus at period  $\tau$ . We can also see that the changes of these macrovariables are substantial in table 2.3. For example, tradable good consumption declines at period  $\tau$  only by less than 1 percent in table 2.2 but nearly 10 percent in table 2.3. A large decline of  $b_t^A + b_t^B - R_t$  in table 2.3 implies that the economy runs larger substantial current account surplus when the government also responds to the shock than when only the private individuals respond.

However, each of  $b_t^A$  and  $b_t^B$  shows a dramatic change even when only private individuals respond to the shock. That is,  $b_t^A$  declined by about 10

**Table 2.2** The impacts of an increase in  $\lambda$ : Numerical examples when  $R$  is always constant.

	$R$	$b^A$	$b^B$	$b^A + b^B$	$CA$	$c^T$	$p^N (x10)$
period $\tau - 1$	15.00	16.38	7.01	23.39	0.00	8.39	1.80
period $\tau$	15.00	16.38	7.01	23.39	0.07	8.32	1.78
period $\tau + 1$	15.00	14.84	8.48	23.32	0.00	8.32	1.78

**Table 2.3** The impacts of an increase in  $\lambda$ : Numerical examples when  $R$  is always endogenously chosen.

	$R$	$b^A$	$b^B$	$b^A + b^B$	$CA$	$c^T$	$p^N (x10)$
period $\tau - 1$	14.86	15.60	6.26	21.86	0.00	7.00	9.85
period $\tau$	14.86	15.60	6.26	21.86	0.64	6.36	9.55
period $\tau + 1$	26.77	15.56	7.58	33.14	0.00	6.36	9.55

percent and  $b_t^B$  increased by about 20 percent in table 2.2. This reflects the fact that the increased aversion to liquidity risk causes a shift from liquid debt to illiquid debt when private individuals try to reduce the risk. When the government responds to the shock,  $b_t^A$  and  $b_t^B$  also show significant changes in the table. However, both  $b_t^A$  and  $b_t^B$  increase in table 2.3. It is not clear in general whether the increased liquidity aversion increases  $b_t^A$  or not when both private individuals and the government respond to the shock. But if the government increased  $R_t$  and reduced the liquidity risk, the private individuals would have less incentive to shift their debts from liquid ones to illiquid ones. Table 2.3 shows that this effect can dominate the other under some reasonable parameter set.

The different responses of  $b_t^A$  and  $b_t^B$  may have interesting implications when the private individuals respond to the shock first and then the government follows it. In this case, the increased liquidity aversion would have very different impacts before or after the government responds. Table 2.4 summarizes the changes of macro variables under the circumstance. In table 2.4, we still assume the parameter set and exogenous variables specified above. But we suppose that before period 1, the economy was in the steady state where only private individuals maximized. At period 1, there was an unanticipated shock and the value of  $\lambda$  increased from 1 to 1.1 permanently. At period 1, only private individuals respond to the shock, while the government keeps foreign reserves constant. The changes of the variables from period 0 to period 1 are thus exactly the same as those in table 2.2. However, after period 2,  $\lambda^G$  increased from 1 to 1.1 permanently and the government also starts to respond to the shock so as to minimize the loss function. The steady state values are thus adjusted to those in table 2.3.

It is noteworthy that the introduction of the government's minimization reduces the amount of tradable good consumption from 8.32 to 6.36 in table 2.4. This implies that the welfare of the representative agent is not necessarily enhanced by the government's optimization. In fact, when  $\lambda = \lambda^G = 1$  permanently, we can confirm that the introduction of the government's optimization reduces the lifetime utility of the representative agent from 10.4 to 9.9. This is partly because the government's loss function is different from that of the private agent. However, low real interest of for-

**Table 2.4** The impacts of an increase in  $\lambda$ : Numerical examples when the government responds only after period 2.

	$R$	$b^A$	$b^B$	$b^A + b^B$	$CA$	$c^T$	$p^N (x10)$
period 0	15.00	16.38	7.01	23.39	0.00	8.39	1.80
period 1	15.00	16.38	7.01	23.39	0.07	8.32	1.78
period 2	15.00	14.84	8.48	23.32	1.95	6.36	9.55
period 3	26.77	25.56	7.58	33.14	0.00	6.36	9.55

eign reserves is another crucial factor that reduces the welfare of the representative agent. The accumulation of foreign reserves is useful in reducing the liquidity risk for the representative agent. However, since the accumulation of foreign reserves reduces available resources, it may deteriorate the welfare of the representative agent through reducing consumption of tradable goods.

## 2.6 Some Evidence in East Asia

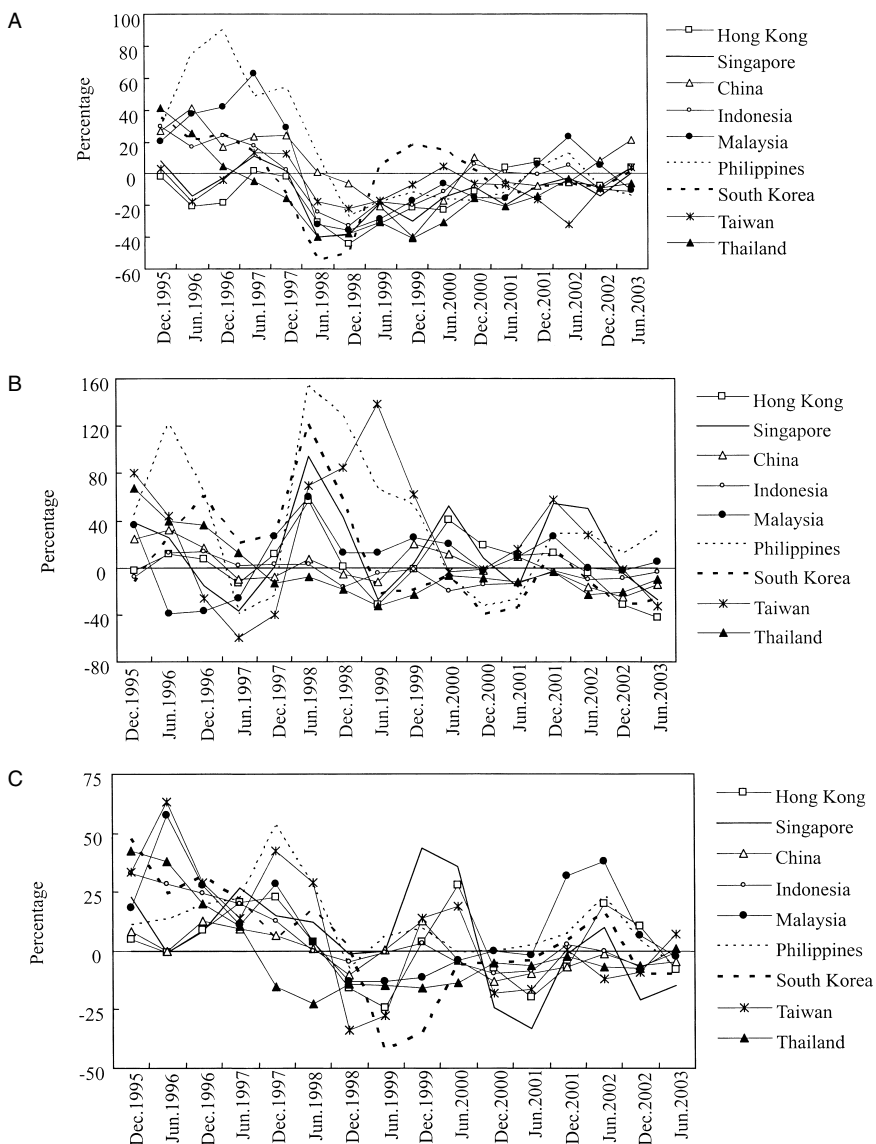
After the Asian crisis, most Asian economies came to recognize that economic growth that relies on liquid external borrowings is not desirable, given their vulnerability to a sudden reversal of capital flows. Soon after the crisis, they thus started to increase liquidity as an important self-protection against crises. Our theoretical model, however, implies that they had alternative strategies for the self-protection depending on whether the government cares about liquidity risk or not.

Based on the data in *BIS Quarterly Review*, figure 2.2 reports the changes of short-term, medium-term, and long-term borrowings in seven East Asian economies before and after the crisis. Reflecting dramatic capital inflows into East Asia before the crisis, we can observe large increases of all types of debts in 1995 and 1996. We can also observe that there were substantial declines of short-term borrowings not only during the crisis, but for some periods after the crisis. The declines of short-term borrowings during the crisis clearly happened because of capital flight under the panicking crisis. It is, however, noteworthy that the declines of short-term borrowings continued even in 1998, when East Asian economies started their economic recovery. At the same time, there were dramatic increases of medium-term borrowings and some increases of long-term borrowings in several East Asian economies after the crisis.

These results indicate that many East Asian economies shifted their borrowings from liquid short-term debt to illiquid long-term debts soon after the crisis. However, the shift from liquid debt to illiquid debt did not persist. Instead, liquid short-term debt increased again in the early 2000s. Korea was the only East Asian country that had significant increases of short-term borrowings since the late 1990s. But several East Asian economies also experienced increases of their short-term borrowings in the early 2000s. In contrast, in the East Asian economies, medium-term debt and long-term debt slowed in growth and sometimes declined during the same period. This indicates that many East Asian economies may have reversed their maturity structures, shifting their borrowings from illiquid long-term debt to liquid short-term debt.

An essentially similar result can be obtained from the alternative data set in *Global Development Finance* issued by the World Bank. Table 2.5 summarizes average maturity of private credits to six East Asian countries





**Fig. 2.2 Annual loan growth rates: A, Short-term; B, Medium-term; C, Long-term**

Source: Table 9A in *BIS Quarterly Review* (June 12, 2006).

Notes: The data are percent changes of international claims from a year earlier in average amounts outstanding. Short-term is up to and including one year, medium-term is 1 up to 2 years, and long-term is over 2 years.

**Table 2.5** Average maturity of new commitments in private credit to East Asia

	China	Indonesia	Korea	Malaysia	Philippines	Thailand
1995	7.3	11.0	5.8	16.9	10.9	8.9
1996	7.0	11.5	12.3	18.1	13.9	7.9
1997	6.4	16.1	6.6	12.7	14.4	10.9
1998	11.1	n.a.	6.4	13.7	6.3	6.8
1999	10.9	14.3	5.1	10.3	13.5	8.8
2000	10.5	6.9	4.6	7.6	11.4	7.3
2001	10.2	8.0	4.1	11.6	4.7	5.9
2002	10.1	9.4		10.2	9.4	4.3
2003	8.7	7.9		6.1	8.3	4.7
2004	9.0	8.2		8.3	8.5	5.0

Source: *Global Development Finance*, The World Bank.

Note: Units in years.

from 1995 to 2004. In the East Asian countries, the average maturity increased during the crisis and remained high until late 1999. This indicates significant shifts from liquid short-term debt to illiquid long-term debt soon after the crisis. However, as in figure 2.2, Korea reduced average maturity in the late 1990s. The other East Asian countries also gradually reduced maturity in the early 2000s. This alternative data set also supports the view that many East Asian economies may have reversed their maturity structures in the early 2000s.

Since short-term borrowing is liquid debt and medium-term and long-term borrowings are illiquid debts, shifting their debt from short-term to long-term is consistent with the case in our theoretical model where only private agents responded to the increased aversion to liquidity risk. In contrast, increasing their short-term borrowings and decreasing long-term borrowings are consistent with the case in the model where the government also responded. The above evidence suggests that in East Asia, the former case prevailed soon after the crisis but the latter became dominant in the early 2000s.

Among the strategies for self-protection, replacing liquid short-term debt by illiquid long-term debt was one of the most popular pieces of advice that many economists suggested for developing countries. However, what step most Asian economies eventually took was to raise foreign reserves. Table 2.6 reports the ratios of foreign exchange reserves to GDP for ten East Asian economies (Japan, China, Hong Kong, Indonesia, Korea, Malaysia, the Philippines, Singapore, Thailand, and Taiwan) from 1990 to 2004. It shows that the ratios went up substantially after the crisis and showed further increases in the early 2000s, except for Indonesia. The ratios are now over 10 percent in all East Asian economies and over 20 percent except for Japan, Indonesia, and the Philippines. It is highly possible

**Table 2.6 The ratios of foreign exchange reserves to GDP in East Asia**

	Japan	China	Hong Kong	Indonesia	Korea	Malaysia	Philippines	Singapore	Thailand	Taiwan
1990	2.7	9.7	32.8	7.0	5.8	22.8	2.1	76.0	15.6	45.2
1991	2.2	12.6	33.5	8.0	4.7	23.1	7.2	80.7	17.8	45.9
1992	2.0	5.6	35.0	8.3	5.6	29.9	8.3	82.2	18.3	38.8
1993	2.3	5.5	36.4	7.1	5.6	40.7	8.6	82.9	19.6	37.3
1994	2.6	9.8	37.0	6.9	6.1	34.1	9.4	82.4	20.3	37.8
1995	3.5	10.8	39.1	6.8	6.3	26.8	8.6	81.8	21.4	34.1
1996	4.6	13.0	40.8	8.0	6.1	26.8	12.1	83.4	20.7	31.5
1997	5.1	15.8	53.4	7.7	3.9	20.8	8.9	74.7	17.3	28.8
1998	5.5	15.6	54.2	23.8	15.0	35.4	14.2	91.3	25.8	33.8
1999	6.4	15.8	59.9	18.9	16.6	38.6	17.4	93.1	27.8	36.9
2000	7.5	15.6	65.1	17.3	18.8	32.7	17.2	86.6	26.1	34.4
2001	9.5	18.1	68.3	16.6	21.3	34.6	18.9	87.8	28.0	43.7
2002	11.6	22.3	69.9	15.5	22.2	36.0	17.7	92.7	30.0	57.4
2003	15.4	27.8	76.3	14.7	25.5	42.9	17.6	103.7	28.7	72.2
2004	17.9	37.3	75.8	13.6	29.3	56.4	15.5	105.1	29.8	79.2

Sources: Except for Taiwan, *International Financial Statistics*, IMF. For Taiwan, Key Indicators, ADB.

that the accumulated foreign reserves discouraged the private agents to replace liquid short-term debt by illiquid long-term debt in these economies.

One may argue that the rapid rise in reserves in recent years has little to do with the self-insurance motive, but is instead related to policymakers' desire to prevent the appreciation of their currencies and maintain the competitiveness of their tradable sectors. The aggressive intervention could maintain the competitiveness of their tradable sectors and manifest itself in the massive accumulation of foreign reserves by Asian central banks. This argument may be relevant in explaining China's reserve accumulation, where *de facto* dollar peg has been maintained for a long time. To some extent, it may also explain recent reserve accumulation in the other East Asian economies. However, it may not explain why the dramatic rise in foreign reserves started to happen after the crisis, because the policymakers had an incentive to maintain the trade competitiveness even before the crisis.

## 2.7 An Implication for the U.S. Current Account Deficits

In previous sections, we provided some theoretical and empirical analyses on the changes in international capital flows in East Asian economies after the currency crisis in 1997. The analyses were motivated by what happened in East Asia after the crisis. However, the changes of capital flows in East Asia will have a special implication for the U.S. current account when the government accumulates foreign reserves. This is because the U.S. dollar is the dominant reserve currency in international capital market, so that it became indispensable for developing countries to accumulate the U.S. government bonds that would make crises less likely.

Unfortunately, each government keeps the currency composition of the foreign exchange reserves a well-guarded secret. But IMF annual report provides average currency composition for industrialized countries and developing countries every year. In addition, Tavlas and Ozeki (1991) reported average currency composition for selected Asian countries in the 1980s.<sup>2</sup> Table 2.7 summarizes the reported currency compositions. The shares of the U.S. dollar have been high in both industrialized and developing countries. In particular, the shares of the U.S. dollar in developing countries were close to 70 percent from 1991 to 2001. Although updated data is not available for the selected Asian countries, more than half of these reserves are likely to have been invested in the United States, typically U.S. treasuries or other safe U.S. assets.

Some comparable data sets are also available from the U.S. side. The U.S. Treasury does have estimates of major foreign holders of treasury securi-

2. Tavlas and Ozeki (1991) did not clarify which countries they included in their selected Asian countries. China is likely to be excluded in their estimates.

**Table 2.7** Official holdings of foreign exchange (in percent)

	1980	1984	1989	1994	1999	2004
U.S. dollar						
Industrial countries	54.3	57.0	48.4	51.2	75.3	71.5
Developing countries	58.1	57.0	60.5	61.8	68.2	59.9
Selected Asian countries	48.6	58.2	56.4	n.a.	n.a.	n.a.
Japanese yen						
Industrial countries	2.1	5.3	7.5	8.3	6.7	3.6
Developing countries	4.9	4.1	6.9	8.2	6.0	4.3
Selected Asian countries	13.9	16.3	17.5	n.a.	n.a.	n.a.
Pound sterling						
Industrial countries	0.5	1.4	1.2	2.3	2.2	1.9
Developing countries	5.3	4.1	5.8	4.9	3.7	4.8
Selected Asian countries	3.0	3.5	6.4	n.a.	n.a.	n.a.
Deutsche mark						
Industrial countries	9.4	12.9	20.6	16.4	—	—
Developing countries	15.4	8.8	11.7	11.8	—	—
Selected Asian countries	20.6	14.6	15.2	n.a.	—	—
ECUs or Euro						
Industrial countries	29.0	20.6	15.0	14.1	16.1	20.9
Developing countries	0.0	0.0	0.0	0.0	19.9	29.2
Selected Asian countries	0.0	0.0	0.0	n.a.	n.a.	n.a.
Swiss franc						
Industrial countries	1.1	1.2	1.1	0.2	0.1	0.1
Developing countries	4.8	2.6	2.2	2.0	0.4	0.2
Selected Asian countries	10.6	4.9	3.0	n.a.	n.a.	n.a.
French franc						
Industrial countries	0.0	0.4	1.1	2.1	—	—
Developing countries	2.6	1.7	2.1	2.1	—	—
Selected Asian countries	0.6	0.6	0.5	n.a.	—	—
Netherlands guilder						
Industrial countries	0.4	0.6	1.1	0.2	—	—
Developing countries	1.3	0.9	1.0	0.9	—	—
Selected Asian countries	2.8	1.9	0.9	n.a.	—	—
Other currencies						
Industrial countries	3.2	0.7	4.0	5.3	1.4	2.0
Developing countries	7.6	20.8	9.9	8.3	1.7	1.6
Selected Asian countries	0.0	0.0	0.0	n.a.	n.a.	n.a.

Sources: Except for selected Asian countries, *IMF Annual Report*. For selected Asian countries, Tavlas and Ozeki (1991).

ties holdings from 2000 to 2005. Table 2.8 summarizes the estimates for Japan, China, Korea, Taiwan, Hong Kong, Singapore, and Thailand. The changes of treasury securities holdings were modest in Hong Kong, Singapore, and Thailand. However, there were dramatic increases of treasury securities holdings in China and Japan. In Korea and Taiwan, the amount of treasury securities holdings was more than doubled from 2000 to 2005. Although the data includes both official and private holdings, it is more likely

**Table 2.8** Major foreign holders of U.S. treasury securities

	2000	2001	2002	2003	2004	2005
Japan	317.7	317.9	378.1	550.8	689.9	671
China	60.3	78.6	118.4	159	222.9	310.9
Korea	29.6	32.8	38	63.1	55	68.9
Taiwan	33.4	35.3	37.4	50.9	67.9	68.1
Hong Kong	38.6	47.7	47.5	50	45.1	40.3
Singapore	27.9	20	17.8	21.2	30.4	33
Thailand	13.8	15.7	17.2	11.7	12.5	16.1

Source: <http://www.ustreas.gov/tic/mfhhis01.txt>.

Note: All data are those in the end of December. Units in billions of U.S. dollars.

that recent increases in central bank reserves account for a large share of those assets.<sup>3</sup> The reserves, which are typically held in the form of U.S. Treasury bills and agency bonds, pay a low rate of return. It is less likely that private investors accumulated such low interest assets.

The evidence supports the view that substantial rises in foreign exchange reserves increase capital inflows into the United States. It is, however, noteworthy that similar capital inflows from East Asia would not happen outside the United States when the East Asian economies adopt the strategy of replacing liquid short-term debt by illiquid long-term debt for self-protection. In fact, several East Asian economies came to run frequent trade balance *deficits* against other countries in the early 2000s. For example, Korea's trade balance against non-U.S. countries was in deficit in 2001 and 2002. China and Thailand have run deficit against non-U.S. countries since 2000. The change of the strategies from the late 1990s to the early 2000s may explain why the East Asian economies widened their trade account surpluses only against the United States in the 2000s.

Needless to say, our results do not necessarily deny alternative views in explaining recent increases in the U.S. current account deficits. One may argue that the recent deterioration in the U.S. current account primarily reflects economic policies and other economic developments within the United States itself. One popular argument for the "made in the U.S.A." explanation of the rising current account deficit focuses on the burgeoning U.S. federal budget deficit. That inadequate U.S. national saving is the source of declining national saving and the current account deficit must be true at some level. However, the so-called twin-deficits hypothesis, that government budget deficits cause current account deficits, does not account for the fact that the U.S. external deficit expanded by about \$300 billion between 1996 and 2000, a period during which the federal budget was

3. When Treasuries are resold, it is difficult to identify who holds what U.S. Treasury securities. Private custodial transactions on behalf of governments also cloud matters.

in surplus and projected to remain so. It seems unlikely, therefore, that changes in the U.S. government budget position can entirely explain the behavior of the U.S. current account over the past decade (see also Erceg, Guerrieri, and Gust 2005). The U.S. national saving is currently very low and falls considerably short of domestic capital investment. Of necessity, this shortfall is made up by net foreign borrowing. The increased capital flows from the East Asian economies to the U.S. economy may provide one of the promising answers to the question of why the United States has been borrowing so heavily in international capital markets.

## 2.8 Implications for Real Exchange Rates

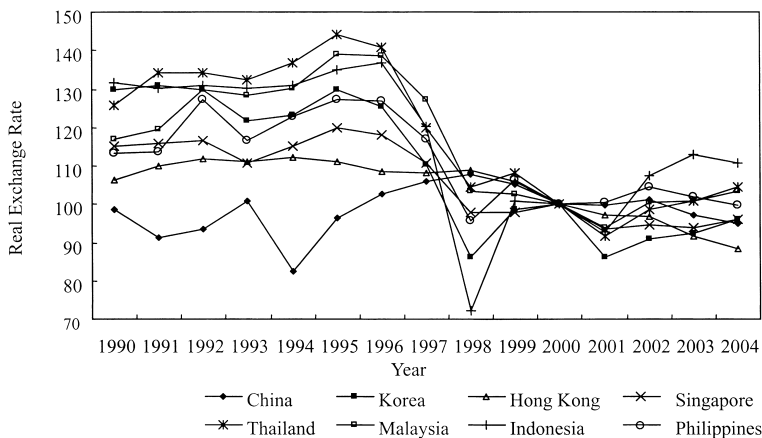
One of the byproducts of our theoretical analysis is the impacts of increased liquidity risk aversion on the real exchange rate. If recent current account surpluses in East Asia primarily reflect either an increase in the U.S. demand for East Asian products or increased productivity of East Asian exports, they would naturally lead to currency appreciation of East Asian currencies in a world of floating exchange rates. However, when the economy increases its liquidity risk aversion, large current account surpluses could persist for long years accompanied by the real exchange rate depreciation. This is particularly true for current account surplus against the United States, the currency of which has been widely held as an international reserve currency. The purpose of this section is to investigate these implications empirically. Figure 2.3 reports real exchange rates of eight East Asian economies from 1990 to 2004. In the figure, lower values mean depreciation. It shows that except for China, the real exchange rates depreciated substantially against the U.S. dollar after the crisis and remained low even after the economies recovered from the crisis. The rate of depreciation from 1996 to 2004 is more than 20 percent in Korea, Thailand, Malaysia, and the Philippines.

The basic result still remains true even when we use absolute PPP data to evaluate the real exchange rates after the crisis. By using the balanced panel data of the Penn World Table (PWT 6.2) from 1990 to 2003, we estimated the simple following logarithmic equation over the 2000 observations:

$$(19) \quad \log P_j/P_{\text{US}} = \text{constant} + a \cdot \log Y_j/Y_{\text{US}},$$

where  $P_j/P_{\text{US}}$  is the price level of country  $j$  relative to the United States, and  $Y_j/Y_{\text{US}}$  is country  $j$ 's income level relative to the United States. We included  $\log Y_j/Y_{\text{US}}$  in the regression because Rogoff (1996) found that the Balassa-Samuelson effect leads to a clear positive association between relative price levels and real incomes.

To examine the real exchange rate depreciation in East Asia after the crisis, we include the post-crisis dummy and the post-crisis East Asian dummy. The post-crisis dummy is a time dummy that takes one from 1998 to 2003 and zero otherwise. The post-crisis East Asian dummy is an East Asian re-



**Fig. 2.3 Real exchange rates in East Asia**

Sources: *International Financial Statistics*, IMF.

Notes: All real exchange rates are normalized to be 100 in 2000. "Real Exchange Rate" of country  $c$  in year  $y = [p_{c,y} \times (e_y/e_{2000}) \times 100]/p_{USA,y}$  where  $e$  = nominal exchange rate (dollar per national currency),  $p$  = except for China, Producer Price Index (for China, Consumer Price Index). Lower values mean depreciation.

gional dummy times a post-crisis dummy that takes one from 1999 to 2003 only for eleven Asian economies (China, Hong Kong, Indonesia, Korea, Macao, Malaysia, the Philippines, Singapore, Taiwan, Thailand, and Vietnam) and zero otherwise. We started the post-crisis East Asian dummy from 1999 because the East Asian economies may have had a different strategy for the self-protection in 1998. Because China, former centrally planned countries, and post-crisis Indonesia can be outliers, we also include the China dummy, the East Europe dummy, and the post-crisis Indonesia dummy in some regressions. The China dummy or the East Europe dummy takes one from 1990 to 2003 for China or two East Europe countries (Romania and Russia) and zero otherwise. The post-crisis Indonesia dummy takes one from 1998 to 2003 for Indonesia and zero otherwise.

Table 2.9 reports the results of our regressions with and without the three extra dummies. Like Rogoff's result, the coefficient of the relative income level always takes significantly positive, showing a clear positive association between relative price levels and real incomes. However, the coefficients of the two time dummy variables are significantly negative. The negative coefficient of the post-crisis dummy implies that there was worldwide undervaluation of real exchange rates against the U.S. dollar after the crisis. The negative coefficient of the post-crisis East Asian dummy implies that the degree of the undervaluation of the real exchange rates was more conspicuous among the East Asian economies after the Asian crisis.

It is noteworthy that the negative coefficient of the post-crisis East Asian dummy is much larger than that of the post-crisis dummy in the absolute



**Table 2.9** The Balassa-Samuelson Regression

	dependent variable $\log P_j/P_{US}$		
constant	-0.0996 (-5.66)	-0.0881 (-5.07)	-0.0889 (-5.13)
$\log Y_j/Y_{US}$	0.3420 (46.69)	0.3428 (47.49)	0.3423 (47.50)
post-crisis dummy	-0.0991 (-5.60)	-0.1007 (-5.78)	-0.0976 (-5.60)
post-crisis East Asian dummy	-0.3112 (-5.37)	-0.2827 (-4.88)	-0.2268 (-4.06)
China dummy		-0.4125 (-3.70)	-0.4179 (-3.74)
East Europe dummy		-0.6340 (-8.14)	-0.6352 (-8.18)
post-crisis Indonesia dummy			-0.6101 (-3.48)
adj. <i>R</i> -squared	0.4898	0.5066	0.5102

Source: *The Penn World Table (PWT 6.2)*, where  $Y_j$  = nominal GDP per capita in country  $j$ , and  $P_j$  = price level of  $Y_j$ . The data was downloaded from <http://pwt.econ.upenn.edu/>.

Notes: Number of observations is 2,338 (14 periods for 168 countries) for each regression. Data period is from 1990 to 2003 (balanced panel). Eleven Asian countries are: China, Hong Kong, Indonesia, Korea, Macao, Malaysia, Philippines, Singapore, Taiwan, Thailand, and Vietnam. *t*-statistics are in parentheses.

value. The result is consistent with our theoretical model, where the East Asian economies that increased the liquidity risk aversion had current account surpluses accompanied by the real exchange rate depreciation. The result does not change even if we include the China dummy, the East Europe dummy, and the post-crisis Indonesia dummy. All of the three dummies had significantly negative coefficients.<sup>4</sup> However, both the post-crisis dummy and the post-crisis East Asian dummy kept having negative impacts, implying undervaluation outside the United States and larger undervaluation in East Asia after the crisis.

## 2.9 Concluding Remarks

During the last decade, financial globalization has been accompanied by frequent and painful financial crises. Some of the well-known crises include Mexico in 1995, East Asia in 1997, Russia in 1998, Brazil in 1999, and Argentina in 2002. During the crises, countries with smaller liquid foreign assets had a hard time preventing panics in financial markets and sudden

4. The negative coefficient of the China dummy implies that the Chinese Yuan had been undervalued throughout the 1990s. It reconfirms the conclusion of Frankel (2005) that China's prices have been well below the level that one would predict from the Balassa-Samuelson equation.

reversals in capital flows. Many developing countries thus came to recognize that increased liquidity is an important self-protection against crises. However, developing countries have alternative strategies for the self-protection. Replacing liquid short-term debt by illiquid long-term debt and raising foreign reserves are two popular strategies that many economists advised. The first strategy would be taken when private individuals respond to the shock, because an increased aversion to liquidity risk among private individuals reduces liquid debt and increases illiquid debt. We found that the East Asian economies may have taken this course soon after the crisis. However, we also found that what most Asian economies have taken seriously in the 2000s is the second strategy. Under a reasonable parameter set, it may lead to larger liquid debt, smaller illiquid debt, and larger current account surpluses, accompanied by depreciation of the real exchange rate when the government responds to an unanticipated increase in the liquidity risk aversion. Macroeconomic impacts of the increased liquidity risk aversion can be very different depending on which strategy developing countries will take.

When looking at remarkable recent reversals in global capital flows, East Asian economies have been one of the major net lenders after the currency crisis in 1997. Foreign exchange reserves held by East Asian economies are now record-breaking, and stand at levels that are a multiple of those held by advanced countries. In particular, because of the role of the U.S. dollar as an international currency, it became indispensable for developing countries to accumulate the U.S. government bonds that would make crises less likely. Consequently, after the crisis, the increased preference for international liquidity allowed a large proportion of the U.S. current account deficit to be financed by developing countries, especially East Asian economies. It is important to reconsider what impacts the increased liquidity risk aversion in East Asia had on international capital flows, including the U.S. current account deficit.

Needless to say, our model is too simple to describe a variety of macroeconomic phenomena in East Asia after the crisis. For example, our model neglected the role of capital stock investment, which showed dramatic fluctuations before and after the crisis. It also did not take into account risk premium for long-term debt that prevailed in emerging markets. Incorporating these factors is left for our future research.

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**Comment** Linda S. Goldberg

The main goal of this chapter is to explore the consequences of heightened demand for liquidity by Asian economies in the period following crises of 1997. The authors argue that this heightened demand led to appreciation of the key international currency of liquidity, the U.S. dollar. To make this point, the authors develop a model wherein a liquidity demand shock generates a period of persistent strength for the high liquidity asset and currency. The chapter is well-written and draws logical conclusions from its modelling exercise.

My main comments on the chapter will focus on the specific application of the chapter to the data since 1997. I then offer some suggestions for expanding the modeling to make this application conform more closely to recent experience. I will make suggestions pertaining to the following themes: (a) How can the authors supplement the model to provide richer dynamics? (b) Is liquidity demand for dollars really the key issue in the last decade, beyond perhaps the initial period of reserve accumulation in East Asia? (c) If liquidity demand is so important, can the authors motivate why there appears to have been such a bias towards dollars over, for example, euros?

**Supplementing the Model to Provide Richer Dynamics**

Within the model of the chapter, utility from consumption of goods is a substitute for utility from having liquid investments. Shocks to demand for liquidity therefore lead to persistent consumption collapse. Savings rise, consumption falls. The authors may consider providing more motivation for their specific way of introducing a useful concept. One alternative approach is to have more separability in utility from consumption and liquidity, with the relevant margin of substitution instead to be between liquid and illiquid investments.

Another aspect of the model that can be extended is the treatment of investment and production. Within the model, fixed endowments are assumed without any investment dynamics. It would be interesting to see a richer approach to investment choices. This richer approach is especially relevant since, with events in East Asia motivating the paper, we also observe a dynamics of real investment and output that have been an integral part of recent events.

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The views in this discussion are those of the author and do not necessarily reflect the position of the Federal Reserve Bank of New York or the Federal Reserve System.

Two recent papers present a nice treatment of investment and can suggest useful ways to have more fully dynamic modelling of investment and exchange rates. Within a dynamic stochastic general equilibrium approach (DSGE), the paper by Erceg, Guerrieri, and Gust (2006) is useful. If you want a model with rudimentary portfolio choice and exogenous risk premiums, which like the Fukuda and Kon chapter doesn't capture reasons for a sudden change in appetite for risk, the work by Faruquee, Laxton, Muir and Pesenti (2005) is carefully specified.

### Interpreting the Empirics

Within the Fukuda and Kon chapter, increased liquidity demand shows up in growth of foreign exchange reserves relative to GDP across East Asia. This growth in foreign exchange reserves probably played a substantial role during the first year or two after the crisis. Yet, how do the authors explain the continued accumulation of reserves by the same countries? The liquidity argument has a substantially different emphasis than arguments focused on the "global savings glut."

The authors present some regression analysis. This section could be expanded, with more discussion of both the testing methodology and interpretation of the results. One point that could be addressed is why and if the authors view the demand for liquidity exclusively as a post-Asia crisis phenomenon? Why would this demand not arise for larger groups of countries and across other crises?

Overall, in thinking about the emphasis of the paper, it is important to determine the importance of *liquidity demand* in recent imbalances and the duration of its effects. According to the International Monetary Fund's WEO Report for 2005, a key feature of the East Asia events instead involves a focus on *investment rates*.

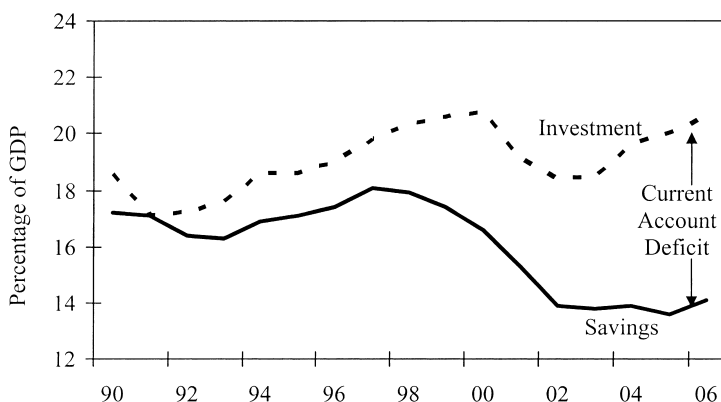
Investment rates have fallen across virtually all industrial country regions, although this has been most noticeable in Japan and the euro area countries, where they reached historic lows in 2002. . . . In volume terms, the fall in average investment rates in industrial countries has been more modest.

Investment rates differ substantially across emerging market economies . . . With the exception of China and a handful of other countries, however, investment rates have fallen in emerging market economies since the Asian financial crisis. Indeed, investment rates in East Asia have declined by more than 10 percentage points of GDP since their peak in the mid-1990s and have not rebounded. WEO 2005, Ch. 2.

These observations support the suggestion made earlier in these comments that the authors should provide a richer modeling of investment in the paper. For example, when we examine data for the United States in fig-

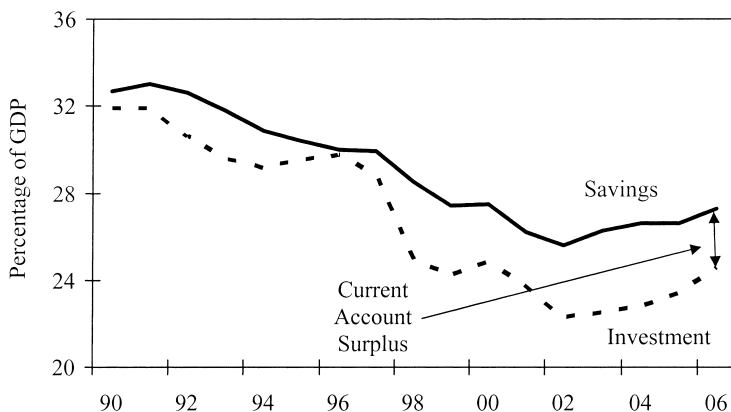
ure 2C.1, the growth in the current account deficit, defined as the difference between national savings and investment, is dominated by low national savings since 2000.

Figure 2C.2 shows the savings and investment by Asia, outside of China since 1990. Observe the interesting dynamics of savings and investment in this region in the period from 1997 to 2006. The model of the paper predicts substitution between consumption and liquidity, while investment is stable. Yet in the data we observe a reduction in savings and an even larger collapse in investment spending.



**Fig. 2C.1 United States: Savings and Investment**

Source: IMF April 2006 *World Economic Outlook*, OECD, authors' calculations. 2006 values are based on IMF *WEO* and OECD forecasts.



**Fig. 2C.2 Asia outside China: Savings and investment**

Source: IMF April 2006 *World Economic Outlook*, OECD, authors' calculations. 2006 values are based on IMF *WEO* and OECD forecasts.

**Table 2C.1** Global current account balances

	2002	2005	Change
Surpluses			
Oil Exporters <sup>a</sup>	88	398	310
Emerging Asia	128	241	113
Japan	113	164	51
Western Europe <sup>b</sup>	52	23	-29
Others + Errors	95	-20	-116
Deficit			
United States	-475	-805	-330

Sources: IMF September 2005 *World Economic Outlook*, national sources.

Note: Figures in billions of U.S. dollars.

<sup>a</sup>IMF WEO fuel exporters plus Norway.

<sup>b</sup>EMU plus Denmark, the United Kingdom, Sweden, and Switzerland.

If the dollar strength post-1997 is a focal point of the modeling exercise, and liquidity demand from Asia is emphasized, it is useful to provide context on the extent to which global current account balances are dominated by particular regions. As shown in table 2C.1 in the early 2000s (for example 2002) the surpluses of Emerging Asia and Japan accounted for more than half of the current account deficit of the United States. This situation changed by the mid-2000s, when the surpluses of oil exporters basically matched those of emerging Asia and Japan. Could it still be that the strength of dollar was attributable to liquidity demand at this time? The authors of the paper could elaborate more on the timing and strength of the liquidity motive behind a demand for dollars in the period well after 1997.

### **Why is liquidity demand biased towards dollars over, for example, euros?**

The arguments of the paper lead Asian economies to purchase dollars, and generate an associated dollar appreciation in the wake of strong liquidity demands. It would be useful to have more exposition of why this liquidity demand is so strongly biased toward dollars, instead of euros, for example. Evidence on bid-ask spreads in foreign exchange markets may be informative, as would information on the depth of dollar versus euro bond markets.

Is it because of the low transaction costs of operating in dollar markets, and the prevalence of the dollar in trade invoicing? Goldberg and Tille (2006) argue that the special role of the dollar in international markets makes for asymmetric effects of exchange rates across the U.S. and its trading partners. Models need to recognize such asymmetry, when consequences for dollars, rather than alternative currencies, are postdated.

## Conclusions

This well-written and thought-provoking paper focuses our attention on the special position of and effects on countries with highly liquid assets. The demand for liquidity appears to have been especially important in the immediate aftermath of the Asian crises of 1997. The challenge for the authors is to make the paper both more specific and more general at the same time. More specific to this event means that we could have richer modelling of investment decisions—the liquidity versus consumption trade-offs. It could be more general in the sense that we would like to see whether this liquidity demand phenomenon was present in other crises and observe how it was manifested. If not, the model and empirical application may be able to tell us why.

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## Comment      Andrew K. Rose

This is an interesting paper on an important set of related issues that has been much discussed in the literature of late. The authors are interested in whether the American current account deficit is fundamentally sustainable. Linked to this is the question of how special the United States is since it happens to be the country that issues the world's favored reserve currency (at least the current favorite). Alternatively expressed, are the fundamental causes of "global imbalances" mostly American or foreign? Mostly permanent or transitory? I congratulate the authors for a stimulating piece of work on such a relevant and topical set of issues.

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While praise is appropriate, the role of the discussant is intrinsically critical. I want to begin by pointing out three strategic choices the authors made that I would have made differently.

The first place where I diverge from the authors is in the approach they take to modeling the exogenous parameter shock that starts the ball rolling. Why exactly does the taste for foreign liquidity suddenly rise? Why is the taste limited to Asian countries? And why does it take place when it does? To me, if the fundamental source of the shock was the Asian crisis (as seems perfectly reasonable), then this should be modeled more directly. As it is, assuming that there is a shock to preferences for net foreign assets of a specific currency seems perilously close to assuming the solution to the problem of interest. It is also restrictive, since it doesn't allow one to really address the question of what's special about the United States other than by assumption.

A separate issue is the implicit linkage in the paper between bilateral and multilateral balances—or, more precisely, between trade and financial imbalances. In the paper, a country that develops a taste for the assets of, for example, the United States runs a current account surplus vis-à-vis the United States. That seems natural—but only at first. Usually we model bilateral trade flows independently of the aggregate trade balance; a country may have a deficit vis-à-vis a particular country and still run an aggregate surplus. More importantly, we also usually model trade in goods (and services) independently of trade in assets. I can obtain euros by running a surplus vis-à-vis Japan and then trading the yen for euros. So the setup here is restrictive and at odds with the literature. That's not necessarily bad, of course, it's simply worth pointing out (and defending).

The final and most important issue, at least to me, is whether we really believe that agents get utility from holding net foreign assets. I am not wholly convinced that this is intrinsically plausible. It seems hard for me to believe that net foreign assets (NFA) deliver welfare in a way similar to the satisfaction I get from consuming goods and services. Do I really benefit from NFA per se, that is assets that *aren't* converted into goods and services? Even if I do, isn't there satiation in NFA? Do the net foreign assets of different countries really yield substantially different utility? Do Asians have different tastes for NFA than say Europeans, and does this really vary a lot over time? Could the size of this effect be comparable to that from goods? After all,  $\rho$  and  $\lambda$  are big in the paper (as recognized by the authors). Finally, if NFA holdings are inherently valuable, why do so few countries seek to increase them by reducing liabilities (as opposed to increasing reserves)? All this strikes me as a set of issues worthy of discussion in future work.