Capital Account and Exchange Rate Management in a Surplus Economy: The Case of Singapore

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EXECUTIVE SUMMARY

1 In contrast to countries which import capital to finance their current account deficits, Singapore has had a growing current account surplus, and has been exporting capital abroad. As a result, the domestic interest rate has been generally lower than international interest rates. This paper analyses the relationship between the openness of Singapore's financial markets, its position as a net capital exporter, and the structure of its capital account, and draws implications for the conduct of exchange rate policy and the exercise of monetary autonomy.

2 Underpinned by the absence of formal trade barriers and exchange controls, Singapore is highly open to trade and investment, and is also an international financial centre. In the absence of exchange restrictions, covered interest arbitrage eliminates risk-free differences between the returns on Singapore Dollar and foreign currency assets. Indeed, if we allow for transaction costs, covered interest parity is found to hold on average during the period from December 1988 to September 1998.

3 To determine the structure of Singapore's capital account, we examine each of its components, and categorise them into 'hot' (volatile and easily reversible) or 'cold' flows. In the fifth edition of the IMF's Balance of Payments Manual, the overall capital account is labelled the capital and financial account balance. Under this are the capital and financial accounts. The capital account balance is the net sum of capital transfers and the acquisition and disposal of non-produced and non-financial assets, while the financial account balance is the net sum of net foreign direct investment, net portfolio investment and net other investment flows.

4 To categorise capital flows into 'hot' or 'cold', we examine their persistence and reversability characteristics by calculating autocorrelations for quarterly flows between 1986Q1 and 1998Q2. Large and positive autocorrelations for several quarterly lags indicate that capital account and net portfolio flows show signs of persistence. One reason for the

persistence of portfolio flows is that a substantial proportion of these flows represent long-term investments by both public and private entities abroad. The autocorrelations for net foreign direct investment flows suggest a transitory series, contradicting the notion that direct investment is not easily reversible. However, in Singapore, where the volume of outward direct investment is also large, the timing of the outward flows may tend to offset the relatively stable inward flows such that, on a net basis, the overall series appears to lack persistence. Alternating autocorrelations for other investment flows point to the quick reversal of fund flows in and out of the banking system.

5 The coexistence of excess domestic saving over investment, net capital outflow and lower domestic interest rates relative to international rates in Singapore contrasts with the situation in the majority of East Asian and Latin American countries in the first half of the 1990s. The gap between the domestic interbank rate and the US$ SIBOR rate widened substantially since 1994 until the onset of the Asian currency crisis in July 1997. This coincided with the acceleration in efforts to increase portfolio and direct investments abroad since 1993.

6 The differential between the domestic interbank rate and the US$ SIBOR rate may be thought of as due to two factors – an exchange rate risk premium and expected appreciation of the Singapore Dollar. Through formal testing, we find that the data suggests the presence of a time-varying risk premium on foreign currency-denominated assets. This implies that the expected returns on foreign currency-denominated assets must be higher than those on Singapore Dollar-denominated assets in order to encourage residents to channel their savings into an increasing stock of net foreign assets.

7 The other source of the relatively low domestic interest rates is the expected appreciation of the Singapore Dollar. The trend appreciation of the currency stems from the high savings by both the public and private sectors. Much of the public sector surplus is held by the MAS, while a

substantial proportion of private sector savings is held in the form of CPF contributions, over 90% of which is typically placed as advanced deposits with the MAS for the purchase of future issues of government bonds. This causes a contraction in the monetary base, thus providing a basis for the appreciation of the Singapore Dollar. The MAS offsets the contractionary effect of the public sector deposit placement by intervening in the foreign exchange market to sell the Singapore Dollar for the US Dollar. The extent to which this is done is determined by the targeted level of the trade-weighted nominal effective exchange rate.

8 The expected appreciation of the Singapore dollar dominates the exchange rate risk premium in explaining the interest rate differential between nominal Singapore and US Dollar interbank offer rates. We find that, on average, the mean and variance of the expected change in the spot exchange rate were larger than the mean and variance of the exchange rate risk premium.

9 Finally, we analyse the extent to which the MAS can influence domestic liquidity conditions without compromising its exchange rate target. This is thought to be virtually impossible. We find that capital flows move to *entirely* offset any changes in net domestic assets of the MAS within one quarter. This is consistent with earlier findings of perfect capital mobility and a relatively small risk premium underlying the interest rate differential. A relatively small risk premium implies that domestic and foreign currency assets are fairly close substitutes.

1 INTRODUCTION

1.1 The Mexican Peso crisis of 1994-95, as well as the recent East Asian financial crises, have highlighted the vulnerability of the recipient countries to the volatility and sharp reversal of international portfolio flows. Most of the capital-importing countries have used the capital inflows to finance their current account deficit. The inflows of these portfolio capital flows have also complicated the management of monetary policy in these countries.

1.2 The case of Singapore is somewhat different. The Singapore economy has experienced a growing current account surplus, and has been exporting capital abroad; and the domestic interest rate is generally lower than international interest rates. In this paper, we analyse the relationship between the openness of the Singapore financial market, its position as a net capital exporter, and the structure of the capital account of the balance of payments. The implications of these features of the economy on the conduct of exchange rate policy and the exercise of monetary autonomy are also evaluated.

II OPENNESS OF THE SINGAPORE ECONOMY

2.1 Singapore has an economy that is highly open to trade and investment. The total value of international trade, exports plus imports, is almost three times the size of the nominal GDP. Investment in the manufacturing sector, which constitutes around 27% of the economic value-added, is dominated by foreign investors. Foreign investment commitment accounts for about 75% of the total investment commitment in the sector.

2.2 Singapore is also an international financial centre which has an active offshore Asian Dollar Market and an Asian Dollar Bond Market. In the former, financial institutions are engaged in non-Singapore Dollar intermediation of deposits and loans, mainly at the shorter end of the maturity structure. The Asian Dollar Bond Market is centred around the raising of medium- to long-term non-Singapore Dollar funds.

2.3 Underpinning the openness to international trade and investment is the absence of formal trade barriers and exchange controls. With the exception of a few items, no import duties are levied; and there is no import licensing. Similarly, export licences are required only for a handful of items, and there are no restrictions on the utilisation of export proceeds.

2.4 Residents are allowed to borrow, lend and invest freely in foreign currencies. Banks in Singapore that are licensed to deal in Asian Currency Units can freely accept deposits in foreign currencies. Residents may deal freely in spot and forward foreign exchange transactions. Non-residents are freely allowed to make direct and portfolio investments in the country.

2.5 There are, however, restrictions placed on banks in providing Singapore Dollar credit facilities to non-residents for purposes of financing economic activities outside of Singapore. The Monetary Authority of Singapore (MAS), however, would consider an application if the credit facility is for the purpose of funding overseas projects where there is substantive

Singapore equity interest or where there is management control by Singaporeans. There is no restriction on the provision of credit facilities up to S$5 million to non-residents for the purposes of acquiring financial assets and investing in Singapore. For residents, there is no restriction in securing Singapore Dollar credit facilities for the purposes of financing economic activities within or outside Singapore.

2.6 The absence of exchange controls has enabled the onshore financial market to be fully integrated with the international market. Free movement of financial capital, through covered interest arbitrage, has eliminated any risk-free differences between the expected returns on Singapore Dollar-denominated assets and nominal foreign currency assets.

2.7 Covered interest parity (CIP) holds when the nominal domestic interest rate equals the foreign interest rate on an asset of similar default risk and identical maturity structure plus the forward discount:

$$i_t = i_t^* + fd_t \qquad (1)$$

where i and i^* are the domestic and foreign nominal interest rate respectively. fd_t is the forward discount, expressed as a percentage of the spot rate, i.e. $\frac{f_t - e_t}{e_t}$, where e is the spot exchange rate, defined as the number of units of local currency per unit of foreign currency, and f is the forward exchange rate.

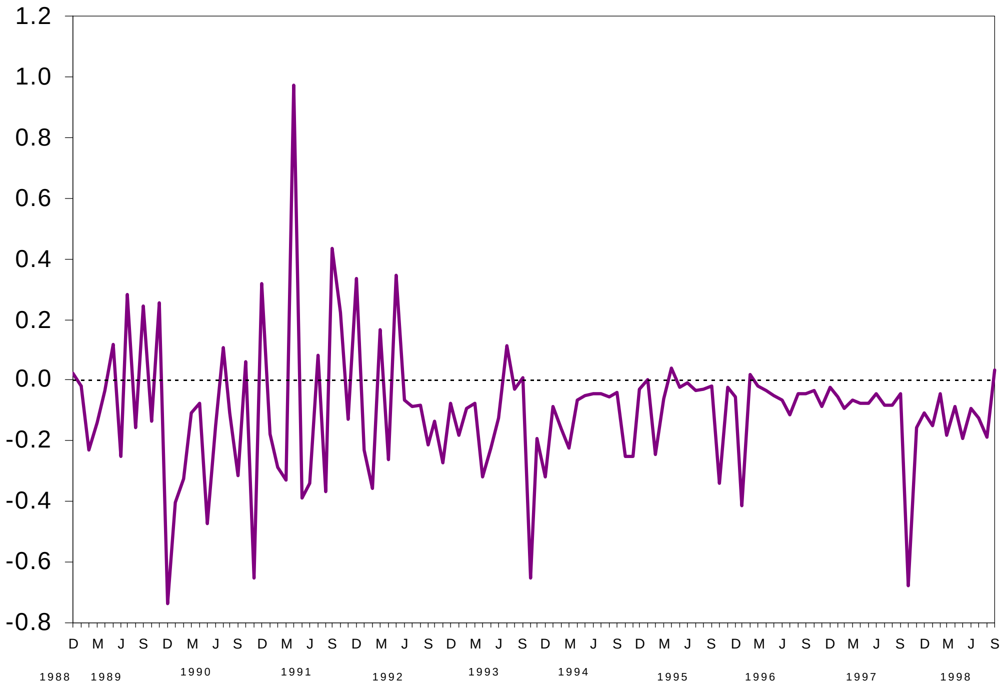
2.8 We define the deviation from CIP as:

$$h_t = i_t - i_t^* - fd_t \qquad (2)$$

Figure 1 shows the plot of the monthly deviations from CIP, which is calculated from the one-month Singapore Dollar domestic interbank rate and the US Dollar SIBOR rate. The observations are end-of-month quotations. The sample begins at December 1988 and ends at September 1998.

2.9 Figure 1 indicates that the deviations from CIP are generally negative, with a mean monthly deviation of -0.1010 of a percent. We therefore reject the null hypothesis of a zero mean at the marginal significance level of 0.00. As later analysis will show, this deviation from CIP is attributed mainly to the fact that we have not taken into consideration the presence of transaction costs. It should be noted that the deviations narrowed over time from the early 1990s until the onset of the East Asian currency crises in July 1997. The greater volatility of the exchange rate following the East Asian currency crises has given rise to wider bid-ask spreads, consequently causing larger deviations from CIP. It has also been widely observed in the past that periods of turbulence in the currency markets, by raising the transaction costs of arbitraging, had given rise to larger deviations [Frenkel and Levich (1977); Taylor (1988)].

Figure1
Deviations from Covered Interest Parity, Dec 88 – Sep 98



2.10 We formally tested the hypothesis that, subject to the cost of arbitraging, CIP holds on average, by estimating the equation:

$$fd_t = a + b(i_t - i_t^*) + u_t \qquad (3)$$

and testing that β = 1. Equation (3) is estimated by OLS using the Newey-West (1987) procedure to obtain consistent estimates of the standard error in the presence of serial correlation in the residuals:

$$fd_t = \underset{(5.111)}{0.1290} + \underset{(10.214)}{1.1720}(i_t - i_t^*)$$

$$\bar{R}^2 = 0.279, \qquad \text{LM}(2) = 6.032$$

The significance of the constant term indicates the presence of transaction costs. The test of the null hypothesis that the coefficient of the interest rate differential is not significantly different from one can be rejected at the marginal significance level of 0.1338.

2.11 Our analysis therefore suggests that the existing regulatory framework with regard to capital movements has allowed arbitrage activities to take place to the extent that CIP holds, after allowing for transaction costs.

III STRUCTURE OF CAPITAL ACCOUNT AND PERSISTENCE OF CAPITAL FLOWS

3.1 In an economy with a persistent current account surplus, net capital outflows reflect the acquisition of foreign currency-denominated assets abroad by residents. In line with the position of the country as a net exporter of capital, the capital account of Singapore (including errors and omissions between 1988 and 1992) has largely been in deficit since 1988. Underpinning the export of capital was the growing current account surplus, which rose from an average of 9% of nominal GDP during 1988-93 to an average of 16% of nominal GDP for the period 1994-97 (see Table 1).

Table 1
Selected Components of the Balance of Payments, 1988-1997
(Millions of S$)

	Current Account Balance	Capital Account (net)	Direct Investment (net)	Portfolio Investment (net)	Other Investment (net)	Change in Net Official Reserves
1988	3,898.8	-110.6	7,118.5	-589.6	-4,541.3	-3,343.6
1989	5,779.9	-79.7	3,909.1	-147.4	-1,323.2	-5,334.2
1990	5,652.5	-39.6	6,418.1	-1,880.4	2,617.1	-9,892.5
1991	8,495.5	-58.5	7,534.3	-1,566.9	-1,915.5	-7,262.8
1992	9,704.8	-61.8	1,445.5	4,055.8	-2,580.4	-9,959.0
1993	6,902.8	-115.3	4,095.1	-8,023.9	1,970.5	-12,153.7
1994	17,493.2	-128.5	6,659.3	-15,269.4	-9,245.5	-7,301.7
1995	20,335.2	-101.0	4,179.2	-11,630.9	6,525.4	-12,173.9
1996	20,760.2	-195.6	4,650.9	-12,144.8	4,056.3	-10,406.6
1997	21,979.5	-257.1	6,921.0	-16,138.9	2,483.1	-11,855.7

Source: Department of Statistics, "Implementation of IMF Balance of Payments Manual, Fifth Edition in Singapore Balance of Payments" (April 1998)

3.2 In the official Balance of Payments recording, the overall capital account is labelled as "Capital and Financial Account Balance" (CFAB), which consists of the Capital Account Balance (CAB) and the Financial Account Balance (FAB). The CAB consists of capital transfers (which include migrants' transfers, debt forgiveness, etc.) and the acquisition and disposal of non-produced and non-financial assets (e.g. patents and copyrights). Under the FAB are the net direct foreign investment (FDI), net portfolio investment (PI), as well as net other investment (OTHI), which represents financial flows intermediated through the banking system (e.g. trade credit, loans and advances, currency and deposits).

3.3 CAB has consistently registered a negative balance, and its contribution to the overall capital account is rather small, averaging around 4.2% of the transactions in the period 1986Q1 to 1998Q2. The deficit in the overall CFAB has been mainly attributed to the large outflows of net portfolio investment. Portfolio investment has consistently registered a net outflow (with the exception of 1992), with the size of the outflows rising substantially since 1993. The dominant form of portfolio outflows was net purchases by residents, including the government, of overseas equities and to a smaller extent, debt securities. FDI, on the other hand, has continued to remain positive despite the surge in outward direct investment by Singapore-based companies since 1993. Between 1988-97, the inflow of FDI rose from S$7.4 billion to S$12.8 billion, while outward direct investment increased from S$0.2 billion to S$5.9 billion.[1]

3.4 OTHI balances, while much more volatile, have since 1995 recorded a net inflow. The net inflow of funds into the domestic banking sector can be attributed to the onshore banks borrowing from the Asian Dollar Market to fund their lending activities. In addition, foreign banks operating in the domestic banking sector have been bringing in funds to meet the enhanced net head office capital requirement.

3.5 As a first step in determining how far each of these capital flows can be considered ‘hot’ or ‘cold’ on the basis of its time series properties, we present in Table 2 the summary statistics of the quarterly capital account flows. From the computed coefficient of variation, CAB and

[1] Department of Statistics, “Implementation of IMF Balance of Payments Manual, Fifth Edition in Singapore’s Balance of Payments” (April 1988)

FDI flows are less volatile than PI and OTHI flows. This observation is consistent with the expectation that capital transfers and direct foreign investment flows show a more stable pattern than transactions in the capital market and banking system.

Table 2
Summary Statistics on Components of
Capital and Financial Account Balance, 1986Q1 - 1998Q2

	Mean (millions of S$)	Standard Deviation (millions of S$)	Coefficient of Variation (%)	Average Share in Capital and Financial Account (%)
Capital and Financial Account (net)	-752.0	3861.7	513	100.0
Capital Account	-31.3	21.6	69	4.2
Direct Foreign Investment	1283.1	598.8	47	-170.6
Portfolio Investment	-1394.3	1719.3	123	185.4
Other Investment	-609.6	3317.2	544	81.1

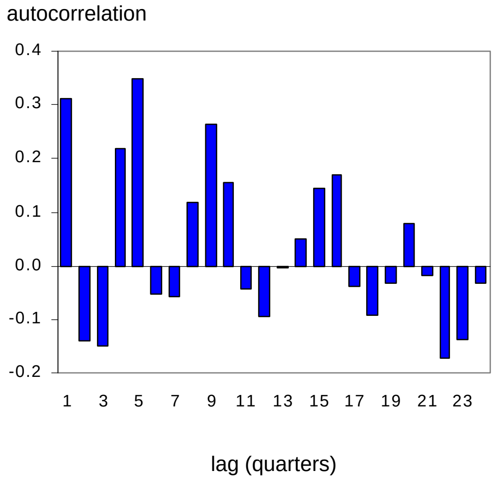
3.6 However, a closer characterisation of capital flows into 'hot' or 'cold' would require an examination of the persistence and reversability characteristics of the flow [Claessens, Dooley and Warner (1995)]. For this purpose, we calculated the autocorrelations for each type of capital account transaction. A 'cold' capital flow would be characterised by a series of large and positive autocorrelations. On the other hand, a 'hot' money flow is one that is subject to quick reversability, and therefore, its autocorrelations would show alternating signs.

3.7 Figure 2 displays the quarterly autocorrelations for each type of capital flows calculated over the entire sample 1986Q1 to 1998Q2. The autocorrelations for the overall capital and financial account balance (CFAB) indicate that quarterly flows have a high transitory and mean-reverting component, where significant positive autocorrelations are followed by negative autocorrelations. The autocorrelations of the individual components indicate that CAB and PI flows show signs of persistence. In each of these flows, the initial large positive autocorrelation is followed by subsequent positive autocorrelations for several quarterly lags. In fact, the Augmented Dickey-Fuller test indicates the presence of unit roots in these series. The persistence in the autocorrelations for the portfolio investment series seems to contradict the general notion that portfolio capital flows are essentially 'hot' money. One reason for the persistence of portfolio capital outflows is that a substantial amount of these flows actually represent long-term investment by private as well as government entities in companies abroad. Under the Fifth Edition of the Balance of Payments Manual, any acquisition of equity interest in overseas companies that is less than 10% of the share capital is regarded as foreign portfolio investment.

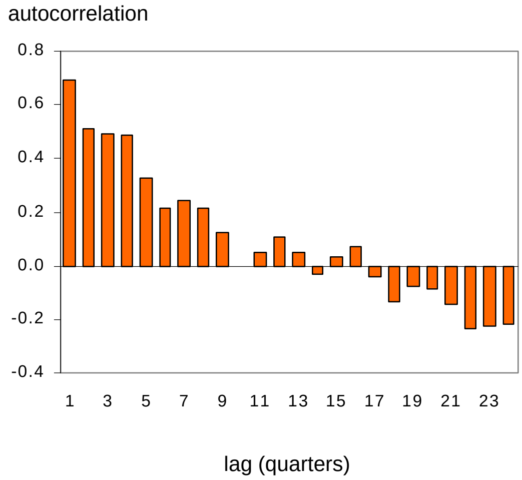
3.8 The autocorrelations of the net FDI flows, on the other hand, suggest a transitory series. The lack of persistence in the series appears to contradict the notion that direct investment is not easily reversible. However, in the context of the Singapore economy, where the volume of outward direct investment is also large, the timing of the outward flows may tend to offset the relatively stable inward direct investment flows such that, on a net basis, the overall series appears to lack persistence. The alternating sign of the autocorrelations of the OTHI flows indicate the quick reversal of fund flows in and out of the banking system. As will be shown in Section V, this form of financial flows are sensitive to changes in interest rates and exchange rate expectations.

Figure 2
Autocorrelations of Net Capital Flows, 1986Q1 - 1998Q4

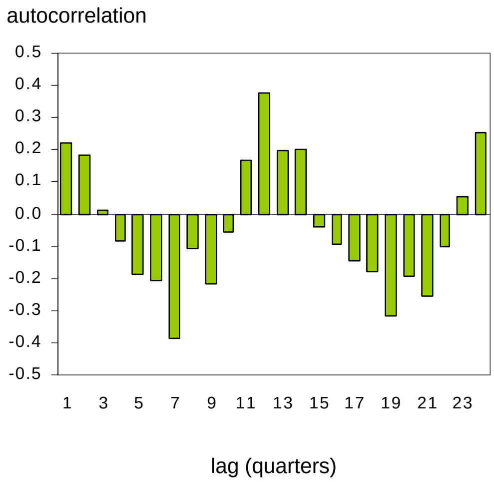
Capital and Financial Account (net)



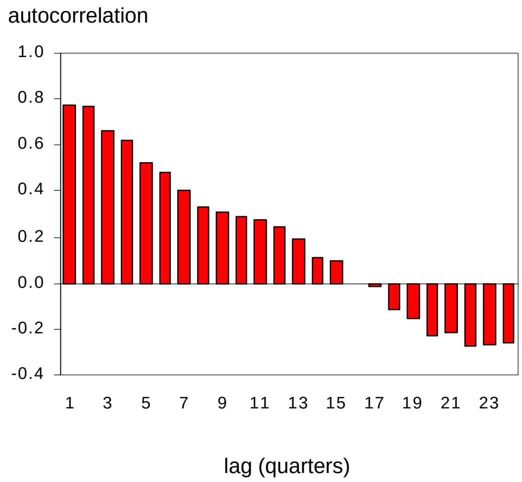
Capital Account



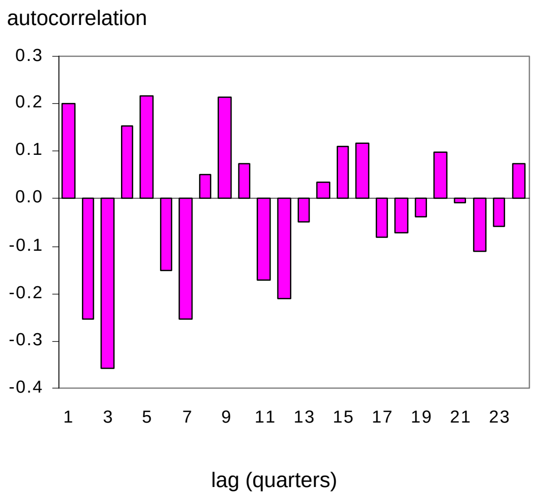
Direct Foreign Investment



Portfolio Investment



Other Investment



3.9 We employ the variance ratio test [Cochrane (1988); Campbell and Mankiw (1989)] to provide a summary measure on the degree of persistence as well as to estimate the contribution of the permanent (random walk) component to the variance of the changes in each of the capital flows series. The variance ratio is written as:

$$V^k = 1 + 2 \sum_{j=1}^{k} \left(1 - \frac{j}{k+1}\right) r_j \qquad (4)$$

where r_j is the j-th autocorrelation of the change in the variable. For a random walk series, V^k is unity for all k, while for a stationary series, the ratio approaches zero for large k. In our estimates of the variance ratios presented in Table 3, k is set to 24.

Table 3
Variance Ratios of Quarterly Capital Flows

	V^k	S.E.(V^k)
Capital and Financial Account Balance (net)	0.119	0.098
Capital Account	0.694	0.572
Direct Foreign Investment	0.067	0.055
Portfolio Investment	0.119	0.098
Other Investment	0.107	0.088

Note: *S.E.(V^k)* is the asymptotic standard error of the ratio, computed as $V^k / \sqrt{\frac{3}{4}(T/(k+1))}$.

3.10 The variance ratios presented in Table 3 indicate that the CAB shows the most persistence characteristics, with the random walk component accounting for around 70% of the variance of the series, although the large estimated asymptotic error makes it not possible to estimate the permanent component precisely. For the rest of the capital flows series, the permanent component is quite small. This is despite the fact that the PI series was found to have a unit root. However, the random walk component in the series may taper off after several lags and is likely to be offset by the stationary component.[2] Our findings on the lack of persistence, on the basis of the variance ratio statistics for both the 'hot' and 'cold' net capital flows, is consistent with the findings of Claessens, Dooley and Warner (1995) on the persistence characteristics of capital flows of several countries. They determined the degree of persistence on the basis of the half-lives of the estimated impulse response functions.[3]

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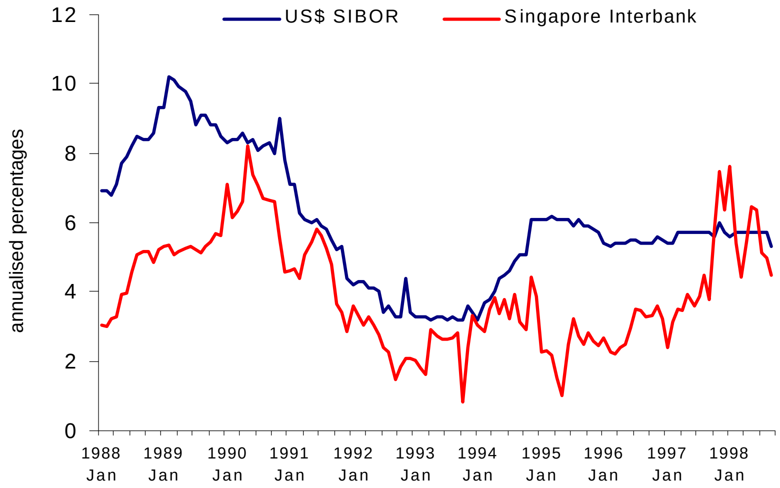
[2] The Dickey-Fuller unit root test has been found to have low power against the local alternatives (near unit roots), and as such it may not be able to distinguish between a small and a large random walk component. As Ardeni and Lubian (1989) have shown, when the first-order autocorrelation coefficient is 0.8, the power of the Dickey-Fuller and the Augmented Dickey-Fuller tests are 59.2% and 30.9% respectively. On the other hand, the variance ratio test rejects the unit root hypothesis 73.4% of the time.

[3] Campbell and Mankiw (1989) discussed the relationship between the impulse response function measure of persistence with that of the variance ratio.

IV SURPLUS SAVING, CAPITAL OUTFLOWS AND THE "INTEREST RATE ISLAND" PHENOMENON

4.1 In the previous section, we have seen that since 1988, there has been a net capital outflow from Singapore, representing efforts by resident entities to acquire foreign currency-denominated assets in the face of rising domestic savings surpluses. At the same time, as shown in Figure 3, the domestic interbank rate in Singapore remained largely below the US Dollar SIBOR rate until the onset of the East Asian currency crises in July 1997.

Figure 3
Nominal Singapore and US Interest Rates (1-month)



4.2 The coexistence of excess domestic saving over investment, net capital outflow, and the lower domestic interest rate relative to international interest rates contrasts with the situation in the majority of the countries in East Asia and Latin America during the first-half of the 1990s [Glick (1998); Calvo, Leiderman, and Reinhart (1995)]. These countries experienced massive capital inflows which were used to finance the rising current account deficit. The excess capital inflows were channeled into the accumulation of foreign exchange reserves as monetary authorities in these countries tried to moderate the upward pressure on their currencies. In order to limit the monetary consequences of their exchange market intervention, the central banks resorted to considerable sterilisation operations [Frankel and Okongwu (1995); Kletzer and Spiegal (1998)]. As a result of the sterilisation efforts and rising currency risk premiums on the local currencies, the interest rates in some of these countries rose well above the international interest rate [Frankel and Okongwu (1995)].[4]

4.3 Part of the observed nominal interest rate differential can be explained by the risk premium on the foreign currency that is required in order to encourage residents to hold an increasing stock of net foreign assets. Overall, the sources of the lower nominal interest differentials that Singapore experienced can be seen from the following decomposition[5]:

$$i^s - i^{us} = (i^s - i^{us} - \frac{\Delta e^e}{e}) + \frac{\Delta e^e}{e} \qquad (5)$$

where i^s is the Singapore nominal interest rate and i^{us} is the US interest rate, and $\frac{\Delta e^e}{e}$ is the expected appreciation of the Singapore Dollar against the US Dollar.

4.4 The first term of equation (5) is the deviation from uncovered interest parity (UIP), which is attributed to the existence of an exchange rate risk premium. A lower domestic interest rate is associated with an exchange rate risk premium on foreign currency-denominated assets. In other words, for Singapore residents to have an incentive to channel their excess saving into holdings of foreign currency assets, the expected returns on these assets must be higher than the expected returns on Singapore Dollar-

4 Frankel (1995) argued that a rising currency risk premium in the face of large capital inflows could be taken to represent the market perception that the capital inflows are not sustainable.

5 Equation (5) assumes that CIP holds. This allows us to rewrite equation (5) as:

$$i^s - i^{us} = (i^s - i^{us} - fd) + (fd - \frac{\Delta e^e}{e}) + \frac{\Delta e^e}{e}$$

If CIP holds, $i^s - i^{us} = fd$. As indicated in the previous section, the deviations from CIP are minimal and on an average equal to zero.

denominated assets as implied by the UIP. Since the deviation from the UIP reflects exchange rate risk, it cannot be arbitraged away unless the risk-return preferences change. Figure 3 shows that the gap between the US interest rate and the local rate widened substantially since 1994 until the onset of the Asian currency crises in July 1997. Since 1993, there was an accelerated effort to increase portfolio as well as direct investments abroad, resulting in the net outflow of capital.

4.5 We next evaluate formally the presence of a currency risk premium using the orthogonality test methodology employed by Hansen and Hodrick (1980), Hodrick and Srivastava (1984), Cumby (1988) and others.[6] Under the conditions that the preference of investors is risk averse and the costs of transacting are zero, the *ex post* deviation from UIP, P_t, will be equal to the exchange rate risk premium and the forecast error:

$$\Pi_t = i_t - i_t^* - (\frac{\Delta e}{e})_t = R_t + e_t \qquad (6)$$

where $(\frac{\Delta e}{e})_t$ is the actual change in the nominal exchange rate over the holding period, R_t is the risk premium, and e_t is the exchange rate forecast error. Under the joint null hypotheses that UIP holds and that the market makes rational forecasts, P_t should be orthogonal with any elements of the known information set. Under rational expectations, e_t would have zero mean, be serially uncorrelated, and uncorrelated with known information. We test the null hypotheses by estimating:

$$P_t = X_t b + m_t \qquad (7)$$

where X_t is an n-dimension row vector consisting of variables in the information set at time t and b is the n-dimension column vector of parameters. The null hypotheses are evaluated by testing the restriction $b = 0$.

6 An alternative procedure of extracting the risk premium is to use data from currency forecast surveys. However, such survey data on a continuous basis was not available to us.

4.6 We employed monthly data from April 1988 to September 1998 to estimate the equation. The F-test of the null hypothesis that all the coefficients except the constant are zero is rejected at the marginal significance level of 0.032.[7] Hence the test result suggests the presence of a significant time-varying risk premium.

4.7 The second source of the low interest rate is the expectation of appreciation of the Singapore Dollar exchange rate. Figure 4 shows that the Singapore Dollar nominal effective exchange rate was appreciating since 1988. The underlying factor which provides the basis for the trend appreciation of the currency can again be found in the high savings by both the private and public sector, and the manner in which the savings resources are intermediated to acquire foreign currency assets. Between 1990 to 1997, the public sector budget surplus averaged 6.2% of nominal GDP (see Figure 5). A high level of private sector saving ensured a positive private sector saving-investment balance despite the high level of private investment. By 1997, the private sector savings rate had risen to 40% of GDP, from 14% in 1980.

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7 The variables we selected to be included in X_t are the three lagged *ex post* deviations from UIP, lagged changes in the exchange rate, and lagged nominal interest rate differentials. The estimated equation is:

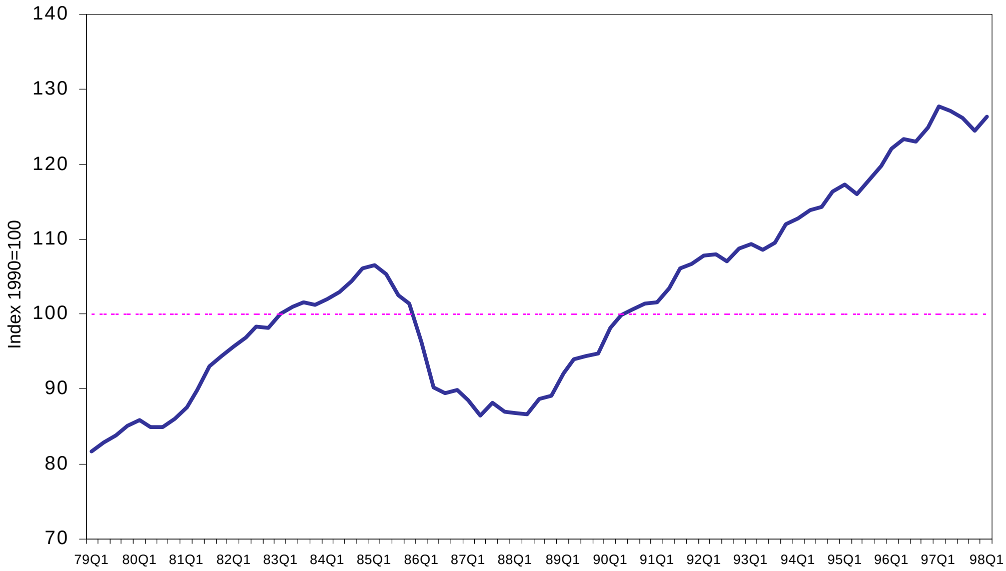
$$\underset{}{\Pi_t} = \underset{(0.999)}{-0.307} + \underset{(1.376)}{33456\,\Pi_{t-1}} - \underset{(-1.132)}{30808\,\Pi_{t-2}} + \underset{(1.177)}{26511\,\Pi_{t-3}} + \underset{(1.376)}{33456\,\Delta e_{t-1}} - \underset{(-1.132)}{30808\Delta e_{t-2}}$$

$$+ \underset{(1.177)}{26510\Delta e_{t-3}} - \underset{(-1.376)}{33453(i - i^*)_{t-1}} + \underset{(1.132)}{30797\,(i - i^*)_{t-2}} - \underset{(-1.176)}{26501(i - i^*)_{t-3}}$$

$$R^2 = 0.142 \qquad F = 2.128 \qquad Q(12) = 19.318 \qquad LM(2) = 5.942$$

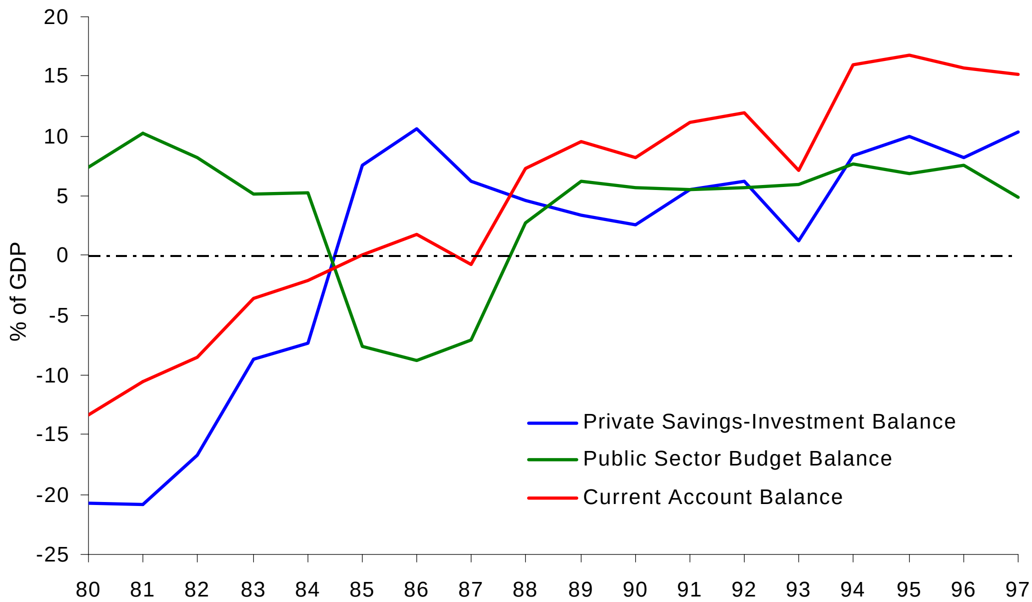
The equation was estimated by OLS with its standard error corrected for heteroscedasticity and serial correlation using the Newey-West procedure. The figures in parentheses are *t*-statistics.

Figure 4
Nominal Effective Exchange Rate of the Singapore Dollar



Source: IMF, International Financial Statistics

Figure 5
Public Sector Budget Balance and
Private Sector Savings-Investment Balance, 1980-1997



4.8 Most of the public sector surplus is placed directly with the MAS. A substantial portion of the private sector saving is held in the form of Central Provident Fund (CPF) contributions, which is managed by the MAS as a fiscal agent for the government. The CPF is a compulsory savings scheme which aims at providing old-age security for public and private sector employees. Employees make monthly contributions, at a certain percentage of their wage income, to the CPF. In addition, employers must also match the employees' monthly contributions. Currently the employees' and employers' contribution stand at 20% each of the employees' monthly salary, subject to a maximum contribution of S$1200 by both parties. Employees are allowed to withdraw from the Fund upon reaching the age of 55. However, limited withdrawals are allowed for specific purposes before the age of 55. Table 4 shows that the contributions, net of withdrawals, continued to increase over time. Typically, over 90% of CPF assets are held in government securities and in the form of advanced deposits to the MAS. The advanced deposits placed with the MAS are for the purchase of future issues of government bonds.

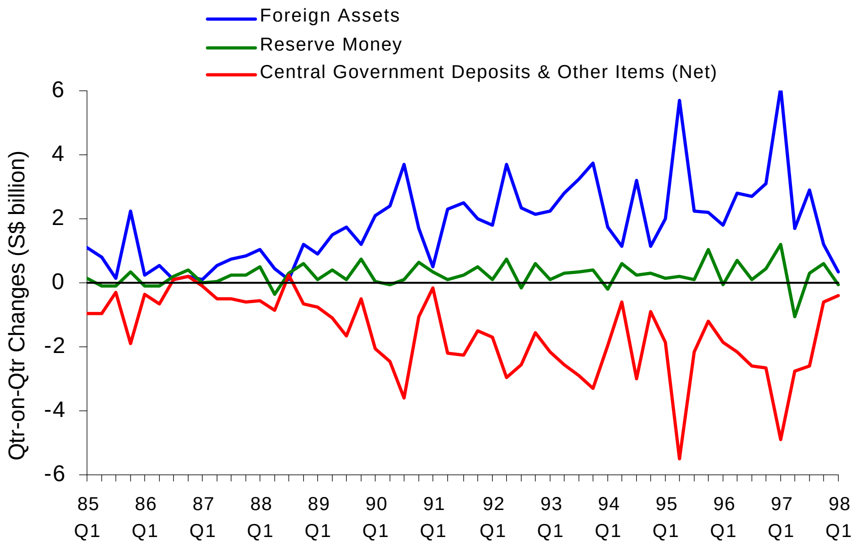
Table 4
Balances of the Central Provident Fund (Millions of S$)

	Members' Contributions	Withdrawals	Net Contributions	Advanced Deposits With MAS	Holdings of Government Bonds
1981	3,007.2	1,068.0	1,939.2	2,885.5	8,992.3
1982	3,901.1	1,241.3	2,659.8	5,394.8	9,852.1
1983	4,491.0	1,718.4	2,772.6	4,199.3	14,877.4
1984	5,385.2	3,510.7	1,874.5	7,459.5	14,455.3
1985	5,993.4	3,359.9	2,633.5	11,959.2	13,638.5
1986	4,777.8	3,824.3	953.5	13,455.8	13,638.5
1987	4,446.8	4,297.5	149.3	1,188.2	28,620.0
1988	4,985.1	4,010.5	974.6	2,244.0	30,120.0
1989	6,107.5	3,663.5	2,444.0	3,721.9	32,120.0
1990	7,174.2	4,003.5	3,170.7	8,226.8	32,120.0
1991	8,101.4	4,664.9	3,436.5	13,733.7	32,120.0
1992	9,028.2	5,418.3	3,609.9	5,829.3	45,620.0
1993	10,427.0	10,949.2	-522.2	7,737.1	44,620.0
1994	11,278.5	7,300.9	3,977.6	13,837.8	43,620.0
1995	13,536.1	7,266.1	6,270.0	20,537.2	45,120.0
1996	14,623.0	10,544.7	4,078.3	20,857.0	51,620.0
1997	15,873.8	11,475.5	4,398.3	22,101.5	57,120.0

Source: Central Provident Fund Board annual reports

4.9 The effect of the public sector placement of deposits with the MAS is to cause a contraction in the monetary base and money supply. As Figure 6 indicates, net deposits placed with the MAS constitutes a large contractionary influence on the monetary base, which in turn provides the basis for the appreciation of the Singapore Dollar. The MAS offsets the contractionary effect of the public sector deposit placement by undertaking foreign exchange market intervention, whereby it sells the Singapore Dollar for the US Dollar. Figure 6 shows the impact of the accumulation of foreign exchange on the monetary base. The extent of the foreign exchange market intervention is determined by the targeted level of the trade-weighted nominal effective exchange rate, which is bounded within an undisclosed band. The path of the appreciation of the effective exchange rate was determined by the need to contain the domestic inflationary pressure as the economy approached full employment by the 1980s [Teh and Shanmugaratnam (1992)].

Figure 6
Changes in Monetary Base and its Components



Source: IMF, International Financial Statistics

4.10 Finally, we assess the relative contribution of the mean and the variance of the exchange rate risk premium and the expected change in the spot rate to the first two moments of the nominal interest rate differential.

Since both the exchange rate risk premium and the expected change in the exchange rate are not observable, one of these variables would have to be estimated in order to determine the contribution of these variables to the mean of the nominal interest differential. We generate the risk premium from the estimated equation reported in footnote 7, which relates the *ex-post* deviations from UIP to the variables in the current information set. Under the assumption that expectations are rational, the predicted values from the regression would provide an estimate of the time-varying risk premium. The series of the expected change in the exchange rate can then be obtained by subtracting the nominal interest rate differential from the estimated risk premium. The mean of the nominal Singapore-US one-month interest rate differential, was -0.16% on a monthly basis for the period from January 1988 to September 1998. Among its components, the mean of the estimated exchange rate risk premium was only -0.04%, compared to the mean of -0.12% for the expected rate of appreciation of the Singapore Dollar.

4.11 Finally, to determine the relative contribution of the variance of the risk premium and the variance of the expected change in the spot rate to the overall variance of the nominal interest rate differential – which under CIP is equal to the forward discount – we employed the decomposition procedure attributed to Fama (1984). The procedure involves estimating the following pair of regressions:

$$\log f_t - \log e_{t+1} = a_1 + b_1 (\log f_t - \log e_t) + u_{1t} \qquad (8)$$

$$\log e_{t+1} - \log e_t = a_2 + b_2 (\log f_t - \log e_t) + u_{2t} \qquad (9)$$

Under the assumption that the market forms its forecast rationally, Fama has shown that the difference between the two estimated coefficients b_1 and b_2 is given by:

$$b_1 - b_2 = \frac{[\mathrm{var}(risk\ premium) - \mathrm{var}(expected\ change\ in\ spot\ rate)]}{\mathrm{var}(forward\ discount)} \qquad (10)$$

A positive value for $(b_1 - b_2)$ indicates that the variance of the risk premium is greater than the variance of the exchange rate expectation.

4.12 The results of the estimation are presented in Table 5. The sample is the same monthly data from January 1989 to September 1998. First, we note that the coefficient b_2 is positive and thus differs from the estimates obtained by Fama (1984), Marston (1995) and others who obtained mostly negative values for the coefficient. A positive b_2 implies that the covariance between the expected change in the exchange rate and the risk premium is positive. In other words, the estimates indicate that periods when the Singapore Dollar was expected to appreciate against the US Dollar coincided with periods when the required risk premium for holding US Dollar assets increased. As we have indicated earlier, the underlying factor driving these two variables was the growing surplus of saving over investment. The difference $(b_1 - b_2)$ is -0.157, indicating that, on average, the variance of the expected change in the exchange rate is larger than the variance of the risk premium.

Table 5
Decomposition of the Variance of the Nominal Interest Rate Differential

	Equation (8)	Equation (9)
a_1	0.0009 (0.5414)	
a_2		-0.0009 (-0.5414)
b_1	0.4215 (1.1220)	
b_2		0.5784 (1.5396)
DW	1.6005	1.6005
R^2	0.0049	0.0091

Note: The figures in parentheses are *t*-values which are computed from standard errors corrected according to the Newey-West procedure.

4.13 In summary, the high domestic saving has provided the impetus for substantial capital outflow and trend appreciation of the Singapore Dollar. The expectation of the appreciation of the Singapore Dollar and the foreign currency risk premium have resulted in generally lower local interest rates relative to international interest rates. Our analysis indicates that the exchange rate expectation factor tends to dominate the risk premium factor, on average, in explaining the mean and variance of the interest rate differential.

V CAPITAL FLOWS AND MONETARY AUTONOMY

5.1 Given that the MAS manages the exchange rate within a band, and that the mobility of financial capital is sufficiently high, the next issue that we would like to analyse is the extent to which the monetary authority can influence the domestic liquidity condition without compromising its exchange rate target. The consensus that has developed is that under the conditions of perfect capital mobility and perfect substitutability of domestic and foreign currency assets in the investor's portfolio (i.e. investors do not demand an additional currency risk premium for holding foreign currency-denominated assets), it is not possible to insulate the domestic money supply from the exchange market intervention without affecting the level of nominal exchange rates [Obstfeld (1990)].

5.2 We evaluate this proposition by estimating the offset coefficient from a reduced-form capital flow equation, which is derived from a portfolio balance model of a small open economy (see Appendix). When domestic and foreign securities are perfectly substitutable and where no capital controls exist to restrict the movement of funds, any changes in the monetary authority's net domestic assets can be completely offset by capital flows. In such a situation, the monetary authority cannot rely on sterilisation measures to limit the impact of changes in international reserves on domestic money supply.

5.3 The reduced-form capital flow equation that is used to estimate the offset equation is:

$$KAP_t = a_0 + b_1 DY_t + b_2 DNDA_t + b_3 [CA_t + EO_t + FDI_t + PI_t] + b_4 (i^* + \frac{\Delta e^e}{e})_t + x_t \qquad (11)$$

where *KAP* is the interest-sensitive component of capital flows (which we take to be net other investments, OTHI), *Y* is the nominal GDP, *NDA* is the monetary authority's net domestic assets, *CA* is the current account balance, *FDI* is the net direct foreign investments, PI is net portfolio investments, *EO* is the errors and omissions, i^* is the 3-month US Dollar SIBOR rate, and *e* is the Singapore Dollar-US Dollar nominal exchange rate, defined as the number of Singapore Dollars per US Dollar. Δe^e is the expected change in the exchange rate over the three-month holding period. b_2 is the offset coefficient and equals -1 when the offset is complete. The sample consists of quarterly observations from 1986Q2 to 1998Q1.

5.4 Two econometric issues arise from equation (11). First is the potential simultaneous equation bias in the offset coefficient b_2, which arises from the endogeneity of *DNDA* when the monetary authority systematically sterilises the impact of reserve flows. As Kouri and Porter (1974), Obstfeld (1982) and others have observed, systematic sterilisation results in b_2 being biased towards minus unity.

5.5 Second is the choice of the empirical proxy for the unobservable expected change in the exchange rate. In the analysis that follows, we employ, alternatively, the rational expectations and adaptive expectations schemes:

$$\Delta e_t^e = \Delta e_t + d_t \qquad \text{(rational expectations)}$$

$$\Delta e_t^e = \Delta e_{t-1} \qquad \text{(adaptive expectations)}$$

where d_t is the serially uncorrelated exchange rate forecast error with zero mean and constant variance, and is orthogonal to the elements of the information set. We employ the McCallum (1976) instrumental variable procedure to obtain a consistent estimate of b_4 under rational expectations.[8]

5.6 Table 6 presents the results of our estimates of equation (11) under alternative exchange rate expectation schemes. We first employ the

[8] The instruments are lagged changes in the monetary authority's net domestic assets, real GDP, CPI inflation, and the domestic interbank rate, as well as lagged levels of the exchange rate, the current account balance and net other investment flows.

Hausman (1978) specification test to test for the existence of a simultaneous equation bias in the coefficient b_2. The results of the specification test are reported in equations (1a) and (2a) of Table 6, which indicate that the null hypothesis of no sterilisation bias cannot be rejected, as the coefficient of the predicted NDA is not statistically different from zero.

Table 6
Estimates of Capital Flow Equation

Independent Variables	Rational Expectations		Adaptive Expectations	
	(1a)	(1b)	(2a)	(2b)
DY	0.046 (0.992)	0.051 (1.082)	0.046 (1.013)	0.055 (1.202)
DNDA	-0.991 (-17.269)	-1.020 (-33.602)	-0.993 (-18.557)	-1.017 (-33.819)
(P DNDA)	-0.046 (-0.620)		-0.048 (-0.655)	
(CA + FDI + PI + EO)	-0.934 (-37.899)	-0.929 (-49.336)	-0.936 (-37.988)	-0.928 (-49.265)
$\Delta(i^* + \frac{\Delta e^e}{e})$	-48.147 (-1.658)	-53.450 (-2.236)	-31.367 (-1.192)	-37.209 (-1.801)
$\bar{R}^2$	0.987	0.988	0.987	0.987

Note: *PDNDA* is the predicted value of *DNDA* which is entered into the regression to implement the Hausman test. The hypothesis of no sterilisation bias is equivalent to testing the hypothesis that the coefficient of *PDNDA* is zero. Figures in parentheses are *t*-statistics.

5.7 Preliminary analysis of the residuals of the estimated equations indicates that they are heteroscedastic and serially correlated. Subsequently we employ the Newey-West (1987) procedure to obtain consistent estimates of the covariance matrices of the equations.

5.8 Equations (1b) and (2b) in Table 6 estimate the coefficient b_2 to be -1, indicating that capital flow moves in the direction to offset any changes in the net domestic assets of the monetary authority within a quarter. The estimate is consistent with the earlier findings of perfect capital mobility and the relatively small risk premium underlying the interest rate differential. The latter would imply that domestic and foreign currency assets are fairly close substitutes.

5.9 The estimates also indicate that the capital flows are sensitive to changes in the interest rate and the expectation of exchange rate changes. An increase in the US interest rate and/or an expectation of a depreciation of the local currency leads to a capital outflow. Further, an increase in the current account surplus or an increase in the inflow of FDI, holding other variables constant, gives rise to an outflow of capital. An increase in the current account surplus or FDI increases the supply of reserve money in excess of its demand, thereby lowering the domestic interest rate relative to the expected return on holding foreign assets. The resultant portfolio substitution leads to capital outflow. The coefficient of the change in nominal income, while positive, is not statistically significant. A positive coefficient would indicate that any increase in demand for reserve money resulting from rising income would be partially fulfilled by capital inflows. Overall, the estimated model explained the capital flow well, with a reasonably high $\overline{R}^2$.

VI SUMMARY AND CONCLUSION

6.1 This paper set out to analyse the structure of the capital account and the persistence characteristics of the individual capital flow components in an economy which has a highly open financial market and which exports capital abroad. Our time series analysis indicates that the individual net capital flows, including FDI, show little evidence of persistence. One reason for the small permanent component in net FDI flow is the large outward direct investment, which tends to offset the steady inward investment.

6.2 The risk premium on foreign currency-denominated assets, together with the expectation of appreciation of the local currency have resulted in the domestic rate being generally lower than international interest rates. We have shown that the proximate cause of the interest rate differential is the excess of domestic saving over investment. In the face of perfect capital mobility and the relatively small currency risk premium, it is almost impossible for the monetary authority to pursue a monetary policy stance that is independent of its exchange rate objective.

Appendix

A Portfolio Balance Model of Capital Flows

In this Appendix, we develop a simple open-economy portfolio balance model, from which we derived the capital flow equation. The model is in the spirit of the well-known Kouri-Porter (1974) paper. In the model, investors can hold three types of financial assets, namely base money (M), domestic currency-denominated interest-bearing assets (B), and foreign currency-denominated interest-bearing assets (F). Portfolio allocation decisions among these assets depends upon domestic and foreign interest rates, exchange rates and income, subject to the wealth constraint.

The demand for domestic reserve money is determined by the level of the nominal domestic interest rate and the level of income:

$$M_t^d = a + b_1 i_t + b_2 Y_t \quad (1)$$

where i_t is the nominal domestic interest rate and Y_t is the income. We have left out the wealth variable as an argument in the demand function as no satisfactory empirical proxy for the variable is available.

The supply of base money is given as:

$$M_t^s = NDA_t + NFA_t \quad (2)$$

where NDA_t and NFA_t refer to the monetary authority's net domestic assets and net foreign assets respectively.

Taking the first difference in (1) and (2), equating the change in demand for base money with the change in supply, and solving for the domestic interest rate gives:

$$Di_t = \frac{1}{b_1}(DNDA + DNFA)_t - \frac{b_2}{b_1} DY_t \qquad (3)$$

The interest-sensitive capital flow (KAP, which we take to be OTHI) is the change in the foreign demand for domestic assets less the change in the domestic demand for foreign assets:

$$KAP_t = g_1 + g_2 D[i - i^* - \frac{\Delta e^e}{e}]_t + g_3 DY_t \qquad (4)$$

where i^* is the foreign interest rate and $\frac{\Delta e^e}{e}$ is the expected change in the exchange rate. Here, we drop the wealth and foreign income variables.

Substituting (3) into (4):

$$KAP_t = g_1 + \frac{g_2}{b_1}(DNDA + DNFA)_t + \frac{b_1 g_3 - b_2 g_2}{b_1} DY_t$$

$$- g_2 (i^* + \frac{\Delta e^e}{e})_t \qquad (5)$$

using the balance of payments identity:

$$DNFA \equiv CA + KAP + FDI + PI + EO \qquad (6)$$

where *CA* is the current account balance, *FDI* is the flow of foreign direct investment, and *EO* is the errors and omissions term.

Substituting (6) into (5) and rearranging:

$$KAP_t = l_0 + l_1 DY_t + l_2 DNDA_t + l_3 CA_t + l_4 EO_t$$

$$+ l_5 FDI_t + l_6 PI_t + l_7 (i^* + \frac{\Delta e^e}{e})_t \qquad (7)$$

where $l_0 = \frac{g_1 b_1}{b_1 - g_2}$, $l_1 = \frac{b_1 g_3 - b_2 g_2}{b_1 - g_2}$,

$$\lambda_2 = \lambda_3 = \lambda_4 = \lambda_5 = \lambda_6 = \frac{g_2}{b_1 - g_2}, \; \lambda_7 = -\frac{g_2 b_1}{b_1 - g_2}.$$

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