MONEY DEMAND, STERILIZATION, AND THE ADJUSTMENT OF BALANCE OF PAYMENTS: AN EMPIRICAL STUDY OF TAIWAN*

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摘　要

由於出口快速擴張，台灣享有長期、持續的貿易順差。本文試圖由貨幣面來發掘台灣長期、持續貿易順差的原因。實證研究結果顯示，在國際收支順差時期，貨幣需求所得彈性提高與沖銷大部分增加的國外資產，是阻絕國際收支自動調整機能運行的兩個可能原因。

以向量自我迴歸分析進一步檢定台灣的國際收支沖銷，結果顯示台灣國外資產變動導致台灣國內資產的變動，兩者干擾之間存在高度相關性。衝擊反應分析與變異分解分析顯示，台灣貨幣當局主要以沖銷政策來抵銷國外資產的變動。

Abstract

Due to the rapid expansion of exports relative to imports, Taiwan has enjoyed a persistent trade surpluses for a long time. In this paper, we attempt to find out why Taiwan could enjoy persistent trade surpluses for such prolonged period of time. The analysis will be based on the monetary side. The empirical results show that the higher income elasticity of demand for money and sterilization of most increased foreign assets in the period of trade surpluses are two possible reasons to break the automatic adjustment mechanism of Taiwan's trade imbalance.

The VAR analysis is used further to test the sterilization of the balance of payments, it shows that change in Taiwan's foreign assets Granger-causes change in Taiwan's domestic assets. There exists a high correlation between innovations of change in Taiwan's foreign assets and change in Taiwan's domestic assets. Both impulse response analysis and variance decomposition analysis indicate that the sterilization policies adopted by Taiwan's monetary authorities are major means to offset the change in foreign assets.

1. Introduction

Assuming there is no capital mobility between countries and exchange rates

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are fixed, trade disequilibrium between countries could be corrected through the so-called "specie-flow-mechanism" which was made famous by David Hume.

The automatic adjustment mechanism rests on the linkage between country's balance of payments and its money supply. For a country under the fixed exchange rates, the balance of payments surplus would increase the domestic money supply and lead to inflation. As a result, the competitiveness of domestic goods in the world market would deteriorate and thus eliminate the balance of payments surplus. On the other hand, the balance of payments deficit would reduce the domestic money supply and lead to deflation. This event would strengthen the competitiveness of domestic goods in the world market and hence improve or eliminate the balance of payments deficit. In other words, the disequilibrium of balance of payments (or trade balance) would be corrected automatically.

If the home country is a small open economy facing fixed world prices, a balance of payments surplus or deficit would change its money supply but exerts no influence on its domestic price level.[1] But, change in domestic money supply could change the aggregate demand in the economy, hence change the volume of exports and imports and correct disequilibrium of balance of payments (or trade balance).

The necessary condition for the automatic adjustment mechanism to work is the link between the balance of payments and money supply. As a matter of fact, monetary authorities frequently engaged in active monetary policy to sterilize the effect of balance of payments on the money supply. By sterilization operations, a long-term and persistent disequilibrium of trade balance between countries would exist.

But, no sterilization is not a sufficient condition for the quick adjustment of any trade imbalance. For a country with rapid economic growth and high income elasticity of demand for money, the increased money supply could easily be absorbed by expanding the economy and the balance of payments surplus might produce no pressure on the price level, the trade imbalance therefore could exist for prolonged period of time.

The data show that before 1970's Taiwan was always in unfavor trade balance and the balance of payments. Since then Taiwan's total trade balance and foreign exchange settlements shift from deficit to surplus. From 1970 to 1988, with the

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[1] For Armington model [3], the small country is a price-taker in the world markets for its imports, but it is specialized enough that it can exert an influence on the world price of its exports. Under the circumstances, the balance of payments surplus or deficit would exert influence on the small country's price level.

exception of 1973, 1974 and 1980, all of Taiwan's foreign exchange settlements were surpluses. From 1971 to 1988, with the exception of 1974 and 1975, all of Taiwan's total trade balances were surpluses. How can Taiwan's balance of payments surplus (or trade surplus) last such a long time? Why doesn't the automatic adjustment mechanism work to correct Taiwan's trade imbalance. In this paper, we try from the monetary side to identify the possible reasons of Taiwan's long-term, persistent trade imbalance.

2. Change of Demand for Money

Table 1 lists Taiwan's annual growth rates of money supply, real *GNP*, consumer prices, ratio of gross savings to *GNP*, and discount rate of the central bank from 1962 to 1987. The table shows that in this period Taiwan had high growth rates of money supply and real *GNP*, but low inflation rate (except the years of oil crises-- 1974, 1980, and 1981). During the period from 1962 to 1969, while Taiwan had suffered persistent international payments deficit, its annual growth rates of money supply, real *GNP*, and inflation rate on average were 18.73%, 9.77%, and 2.83% respectively. Those corresponding figures changed to 24.01%, 9.1%, and 7.06% when the country's international payments turned to surplus in the period from 1970 to 1987. If 1974 and 1979 to 1981 are excluded (the inflation caused by the worldwide oil crises), the inflation rate is on average 3.10%.

Table 1 shows an exceptional rapid growth rate of money supply, this may in part be considered to be an indicator of the continuing process of monetization of Taiwan. The evidence of monetization is further highlighted by comparing the growth rate of money supply with the growth rate of *GNP* (see Table 1, column (3)). The strong expansion of the money supply did not have a corresponding impact on Taiwan's inflation rate, this may imply that rapid expansion of money supply is largely determined by a strong increase in the demand for money.

Why has Taiwan's demand for money increased so much? The rapid development of the financial system and the high savings ratio may be the two most important factors to explain this phenomenon. The increasing numbers and assets of financial institutions implied an increasing rate of monetization. In the period from 1962 to 1986, the numbers of Taiwan's domestic banks increased from 260 to 617, medium business banks increased from 84 to 220, investment and trust companies increased from 1 to 35 (all included head office and branch offices); postal savings system increased from 1,295 to 1,578 (it ever increased to 2,438

Table 1: Growth Rates of Money Supply, GNP, and Consumer Prices of Taiwan (Unit: %)

Period	Money Supply (1)	Real GNP (2)	(3)=(1)−(2)	Consumer Prices (4)	Savings Ratio (5)	Discount Rate (6)
1962	8.70	7.85	.85	2.35	12.4	12.96
1963	26.50	9.37	17.13	2.22	17.1	12.24
1964	30.00	12.30	17.70	−.19	19.6	11.52
1965	13.90	11.02	2.88	−.08	19.6	11.52
1966	15.30	9.00	6.30	2.02	21.5	11.52
1967	27.90	10.56	17.34	3.35	22.5	11.04
1968	13.20	9.07	4.13	7.91	22.1	11.25
1969	14.30	9.00	5.30	5.05	23.8	11.16
1970	13.60	11.27	2.33	3.57	25.5	10.77
1971	27.20	12.89	14.31	2.82	28.8	9.48
1972	33.50	13.31	20.19	2.99	32.1	8.88
1973	45.40	12.82	32.58	8.17	34.6	9.17
1974	11.80	1.12	10.68	47.48	31.7	13.33
1975	24.70	4.27	20.43	5.23	26.9	11.06
1976	21.90	13.49	8.41	2.50	32.5	10.59
1977	34.40	10.05	24.35	7.04	32.9	8.66
1978	35.30	13.90	21.40	5.77	34.9	8.25
1979	10.20	8.46	1.74	9.76	34.5	9.58
1980	19.10	7.13	11.97	10.01	33.0	11.00
1981	13.80	5.71	8.09	16.33	32.0	12.45
1982	16.40	3.30	13.10	2.96	30.4	9.93
1983	17.50	7.88	9.62	1.36	32.1	7.30
1984	9.57	10.52	−.95	−.02	33.7	7.04
1985	11.93	5.08	6.85	−.17	33.5	6.17
1986	47.67	11.64	36.03	.70	37.7	4.69
1987	38.25	11.04	27.21	.52	38.5	4.50

Source: *Taiwan Statistical Data Book 1987* (Taipei: Council for Economic Planning and Development, the Republic of China, 1987).

Note: Savings ratio is gross savings to *GNP*, discount rate is average rate per annum.

(in 1978) then decreased), local branches of foreign banks increased from 1 to 32. In the same period, the assets (loans and investments) of financial institutions increased from N. T. $24,903 million to N. T. $2,097,570 million.[2] The rapid development of financial institutions not only promoted the growth and diversification of financial assets (included money), it also helped Taiwan transform its savings into capital formation, thus had the long-term effects on Taiwan's economic growth and structural change.

It is reasonable to infer that Taiwan's increased demand for money is to satisfy the rising demand for holding cash and deposits. In the process of economic development, Taiwan had experienced a rapidly increasing savings ratio. This very rapid growth of savings is evidently connected with a high ratio of gross savings to *GNP* (see Table 1). Accompanying by the rapid growth of financial institutions (or monetization) and high level of interest rate, the increased savings were mobilized to give rise to a tremendous savings deposit. The statistical data show that from 1961 onward, annual growth rate of savings deposits on average is 24.6%.[3] In the early stage of economic development, Taiwan adopted a high interest rate policy to stimulate savings and restrain effective demand (see Table 1, the discount rate of the central bank in the period from 1951 to 1961 on average was 23.58%). This policy had great contributions to Taiwan's money demand and price stabilization. Lundberg ever said that:[4]

> It is plausible that this growth demand for money should be determined to a considerable extent by the high nominal (and real) interest rates on deposits maintained in Taiwan most of the time. Taiwan was a pioneer among LDCs in setting interest rates at very high nominal levels in the beginning of the period and keeping them high enough above the rate of inflation,..., the Taiwanese monetary policy, with high and flexible interest rate, contributed to the result of restraining effective demand for goods and services in boom periods, thus preventing the enonomy from attaining positions of excess demand and overheating.

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[2] See *Taiwan Statistical Data Book 1987* (Taipei: Council for Economic Planning and Development, 1987), pp. 147-150.

[3] See *History of Economic Modernization Taiwan Area, the Republic of China* (Taipei: Council for Economic Planning and Development, 1986), p. 91.

[4] See Lundberg [10], p. 275.

In order to realize Taiwan's money demand function, we estimate the standard empirical money demand equation

$$m_t = \alpha + \beta Y_t + \gamma r_t + \lambda m_{t-1}, \tag{1}$$

where m_t is real money balance, y_t is real output (or income), r_t is interest rate,[5] m_{t-1} is lag one real money balance, all variables are in logs.

Equation (1) is commonly known as the partial adjustment model of money demand (or the Goldfeld equation) [6], which is an equation combined the transaction demand with the speculative demand for money, and it includes the lagged real money variable in the demand for money function, so the demand for money function is a partial adjustment mechanism or adaptive expectation mechanism. In equation (1), β is a measure of short-run income elasticity of money demand, $\frac{1}{\beta}$ is a measure of economy of scale for money demand, γ is a measure of interest rate elasticity of money demand, $1 - \lambda$ is coefficient of speed of adjustment for actural money balance adjusts toward long-run desired money demand, $\frac{\beta}{1-\lambda}$ is a measure of long-run income elasticity of money demand.

We estimate two regression equations, one covers Taiwan's foreign exchage settlements persistent deficit period (1961:4 to 1969:4), the other covers Taiwan's foreign exchange settlements persistent surplus period (1970:1 to 1987:4).[6] Because the regression included the lagged dependent variable, the equation is estimated by *OLS* using the Hildreth-Lu rather than the Cochrane-Orcutt method to adjust for the first-order serial autocorrelation.[7] The estimate of demand for money in Taiwan's foreign exchange settlements persistent deficit period is

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[5] Kohn and Manchester [9] argue that equation (1) is misspecified, the true money demand equation should be $m_t = \alpha + \beta Y_t + \gamma^*(E_t r_{t+1} - r_t) + \lambda m_{t-1}$, where $E_t r_{t+1}$ is the rational expectation of interest rate r_{t+1}, conditional on information available at the current period. That is the rational expected change in the current interest rate rather than the current interest rate level affects the speculative demand for money. In Taiwan, the interest rate is under control of monetary authorities, the discount rate of the central bank seldom changed, therefore expectations of interest rate change may not play an important role in Taiwan's money demand function.

[6] The persistent surplus of Taiwan's foreign exchange settlements was from 1970, the persistent surplus of Taiwan's trade balance was from 1971. But, it is foreign exchange settlements rather than trade balance has direct influence on money balance. Therefore, the sample period is divided by the change of position of foreign exchange settlements instead of trade balance.

[7] Goldfeld [6] estimated the money demand equation by the Cochrane-Orcutt technique.

$$m_t = \underset{(2.7)}{1.64} + \underset{(2.3)}{.217}y_t - \underset{(6.0)}{.651}r_t + \underset{(12.2)}{.768}m_{t-1}, \tag{2}$$

$$R^2 = .9928,\ \rho = -.51,\ \text{DW} = 2.11,$$

where m_t is the log of the real money balance which is nominal money balance (narrowly defined M_1, or sum of currency and demand deposit) divided by *GNP* deflator, y_t is log real *GNP*, r_t is log discount rate of the central bank, m_{t-1} is lag one log real money stock, all of data are seasonally adjusted. The numbers in parentheses are *t*-statistics, R^2 is the coefficient of determination, ρ is first-order autocorrelation coefficient of residual, which is significant at 10% level, *DW* is the Durbin—Watson statistic.[8]

Due to the restriction of data, in equation (2) the discount rate of the central bank is used as a proxy for the market interest rate.[9] In order to prove that such substitution is appropriate, we regress Taiwan's money market interest rate on Taiwan's discount rate of the central bank from 1973:4 to 1987:4 by *OLS* using the Cochrane-Orcutt method to adjust for first order serial correlation of residual (both data are seasonally adjusted), the result is

$$r_{mt} = \underset{(1.5)}{3.69} + \underset{(2.4)}{.481}r_{dt}, \tag{3}$$

$$R^2 = .903,\ DW = 1.57,$$

where r_{mt} is Taiwan's money market interest rate, r_{dt} is Taiwan's discount rate of the central bank. The significant positive relationship between r_{mt} and r_{dt}, and

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[8] When one or more lagged endogenous variables are present in the regreshion which have estimated using ordinary least squares, the Durbin h statistic not Durbin-Watson statistic should be used to test for first order serial correlation. But, if the regression is computed with correction for first order autocorrelated errors (such as Hildreth-Lu procedure), DW is appropriate for the test of first order serial correlation.

[9] Taiwan established money market in 1976 (but the earliest official money market interest rate data was from 1973:4), until 1988 the interest rate was still under monetary authorities strict control. Therefore, the discount rate of the central bank is the only available and reliable data to represent Taiwan's interest rate for our research. The discount rate of the central bank had been used as a proxy for the interest rate variable in the money demand function (see Fan and Liu [5]).

high R^2 indicate that Taiwan's discount rate of the central bank is a good proxy variable for its money market interest rate.[10]

In equation (2), all t-statistics are significant, signs of coefficients are consistent with the theoretical hypotheses, the model is well specified. The short-run income elasticity is .217, the money demand has economy of scale; interest rate elasticity is —.651; adjustment speed is .232 and long-run income elasticity is .935.

The estimate of the demand for money in Taiwan's foreign exchange settlements persistent surplus period is

$$\begin{array}{lllll} m_t = & -1.62 & + .622y_t & - .246r_t & + .546m_{t-1}, \\ & (2.1) & (5.5) & (4.5) & (7.6) \end{array} \tag{4}$$

$$R^2 = .9975,\ \rho = .75,\ \mathrm{DW} = 2.32.$$

In equation (4), all (included ρ) t-statistics are significatnt, signs of coefficients are consistent with the theoretical hypotheses, the model is well specified. The short-run income elasticity is .622, the money demand had economy of scale; interest rate elasticity is —.246; adjustment speed is .454 and long-run income elasticity is 1.37.

In both equations (2) and (4), the signs of coefficients are consistent with the theoretical hypotheses. That is, real money demand is a positive function of the real income and a negative function of the interest rate. The estimated speeds of adjustment are not too low (actually, it is high relative to the speeds of adjustment of the industrial countries' demand for money function), both models' specifications are acceptable.[11]

In order to measure the soundness of our partial adjustment model of money demand, we fit equation (1) for the sample 1961:4 to 1984:4. The fitted regression is then used to do the dynamic simulation (or forecasting) for the period from 1985:1

[10] A good proxy variable is one that is uncorrelated with the residual and highly correlated with the variable to be substituted, Taiwan's discount rate of the central bank has these characteristics.

[11] Many empirical studies reported very slow speeds of adjustment for short-run money demand function (see Judd and Scadding [8]). Sweeney [14] argues that estimated slow adjustment speeds may be due to too low estimates of the serial autocorrelation parameter of residual. This is very possible to happen if the Cochrane-Orcutt method is used to estimate the regression including a lagged dependent variable (the global optimal may not be found and converge to the wrong root). Under the circumstances, the Hildreth-Lu method may be appropriate to find global optimum (see Betancourt and Kelejian [4]).

to 1987:4.[12] The smaller the variance of the dynamic forecasting error, the better is the model. The actual log money demand, the fitted log money demand, the dynamic forecasting of log money demand, the variance of regression residual, and the variance of dynamic forecasting error are listed in Table 2. The table shows that there is not much difference between the variance of dynamic forecasting error and the variance of regression residual. Therefore, we can conclude that our partial adjustment model of money demand is appropriate to represent Taiwan's money demand function in the period from 1961:4 to 1987:4.

Comparing equation (2) with equation (4), we find that Taiwan had higher income elasticity and adjustment speed but lower interest rate elasticity of demand

Table 2: Test of Goodness of Taiwan's Partial Adjustment Model of Money Demand (Unit: ln)

Period	Actual Value	Fitted Value	Forecasting Value	Variance of Fitted Residual	Variance of Forecasting Error
1985:1	13.3588	13.3884	13.3684	.0006	.0001
1985:2	13.3503	13.4188	13.4202	.0042	.0049
1985:3	13.4048	13.4366	13.5179	.0006	.0128
1985:4	13.4453	13.4890	13.5885	.0016	.0205
1986:1	13.5134	13.5493	13.6990	.0010	.0344
1986:2	13.5760	13.6110	13.7723	.0010	.0385
1986:3	13.7027	13.6801	13.8601	.0007	.0248
1986:4	13.8157	13.7868	13.9140	.0007	.0097
1987:1	13.9004	13.8841	13.9572	.0002	.0032
1987:2	13.9755	13.9594	13.9979	.0002	.0005
1987:3	14.0615	14.0407	14.0747	.0004	.0002
1987:4	14.1411	14.0957	14.0716	.0018	.0048

[12] The dynamic forecasting is $\tilde{m}_t = \alpha + \beta y_t + \gamma r_t + \lambda \hat{m}_{t-1}$, where $\tilde{m}_t$ is the dynamic simulation (or forecasting) value at time t, $\hat{m}_{t-1}$ is the fitted value at time $t-1$, $\hat{m}_t = \alpha + \beta y_t + \gamma r_t + \lambda m_{t-1}$. By continuous substitution of the fitted money demand into the dynamic forecasting equation, we can get $\tilde{m}_t = (\alpha + \lambda\alpha + \cdots + \lambda^n\alpha) + (\beta y_t + \lambda\beta y_{t-1} + \cdots + \lambda^n\beta y_{t-n}) + (\gamma r_t + \lambda\gamma r_{t-1} + \cdots + \lambda^n\gamma r_{t-n}) + \lambda^n m_{t-n}$. $0<\lambda<1$, thus $\lambda^n \approx 0$, the dynamic forecasting of m_t therefore is a function of current and lagged y and r only.

for money in the foreign exchange settlements persistent surplus period than in the foreign exchange settlements persistent deficit period.[13]

In order to examine whether Taiwan's demand for money function is different before and after its foreign exchange settlements position changed, we use the Chow test to check the stability of estimated parameters. Two subperiods are 1961:4 to 1969:4 and 1970:1 to 1987:4, the former is the persistent deficit period, the latter is the persistent surplus period of Taiwan's foreign exchange settlements position. The result is $F_{(4,95)} = 7.64$, the null hypothesis (the estimated parameters are the same in two sample periods) is rejected at both 1% and 5% significance level. This shows that Taiwan's money demand function had changed before and after its foreign exchange settlements position changed from persistent deficit to persistent surplus.

Comparing the short-run income elasticity of demand for money of persistent surplus period with persistent deficit period, we find that the former is almost three times of the latter. In addition, in the foreign exchange settlements persistent surplus period, the long-run income elasticity of Taiwan's demand for money is greater than one and the adjustment speed is about two times the adjustment speed in the foreign exchange settlements persistent deficit period. All these evidences imply that in the foreign exchange settlements persistent surplus period, Taiwan's residents were willing to hold more money balance. This may be attributed to Taiwan's price stabilization and therefore makes Taiwan's trade surplus persist.

3. Sterilization of the Balance of Payments

Sterilization (or neutralization) of the impact of the balance of payments on a country's money supply is a form of monetary policy in which the monetary authorities offset all or part of the changes in reserve (base or high-powered) money resulting from foreign exchange reserves flows by countervailing changes with its non-reserve assets. That is, the monetary authorities are absorbing foreign exchange in return for domestic currency and in engaging in open market operation at the same time. By this way, changes in the official foreign exchange reserves are not allowed to

[13] Both estimated money demand equations have economy of scale of demand for money, but equation (4) has higher speed of adjustment and higher coefficient of first order autocorrelation of residual, this implies that the specification of equation (4) may be better than equation (2) [14].

affect a country's money supply. This general break down of the automatic adjustment mechanism of the balance of payments by the monetary authorities in the world economy is called the "international disequilibrium system" by Mundell [12], or "quasi-equilibrium" by Swoboda [15].[14]

The purpose of sterilization operations by the monetary authorities is to keep the economy from adjusting to an external balance of payments disequilibrium and to pursue an independent monetary policy. There are two alternative hypotheses regarding the controllability of money supply for an open economy with fixed exchange rates.

The key point to the alternative hypotheses is the interest rate elasticity of capital flows. One hypothesis (for example the Keynesian approach) proposes that the interest rate elasticity of capital flows is not so high that countries can sterilize the balance of payments and control over their money supply. The other hypothesis (for example the monetary approach) proposes that the interest rate elasticity of capital flow is too high so sterilization operation leading to differences in interest rates between countries will result in capital flow to offset the effort of sterilization operation. Therefore, the balance of payments cannot be neutralized, the monetary authorities lose control over money supply.

Until July 1987, because Taiwan adopted a strict control of its capital flow, the interest rate elasticity of capital flow is not a problem for Taiwan's central bank to sterilize the balance of payments deficit or surplus. The problem is to what extent did Taiwan's central bank sterilize the effect of fluctuations in foreign exchange reserves on its reserve money in order to pursue the internal equilibrium (or stabilization)?

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[14] Swoboda defines the quasi-equilibrium position as

> A disequilibrium in (at least) one market is consistently prevented from spreading to other markets and from returning the system (assumed to be stable) to equilibrium.

For an open economy, the quasi-equilibrium is

> One where an excess demand or supply of foreign exchange is prevented from affecting other markets by the neutralization operations of the central bank or exchange stabilization fund. In the absence of such operations an excess demand (supply) for foreign exchange would lead to a money supply decrease (increase), setting into motion a return to equilibrium.

See Swoboda [15], p. 164.

3.1 Implication of Sterilization

According to the balance sheet identity of the central bank, we can present the following highly simplified equation

$$\triangle RM = \triangle FA + \triangle DA, \tag{5}$$

where $\triangle RM$ is change in reserve money, $\triangle FA$ is change in net foreign assets, and $\triangle DA$ is change in net domestic assets of the central bank.

In equation (5), the change in reserve money is broken down into the foreign component ($\triangle FA$) and the domestic component ($\triangle DA$). Sterilization operations of the central bank are offsetting movements in domestic assets designed to neutralize changes in the international reserves induced by the balance of payments deficit or surplus. The central bank can use the monetary instruments such as open market operation, changes in the discount rate or reserve requirements, to accomplish this target.

The evidence of sterilization can be identified by the size and direction of change in the foreign and domestic components of the change in reserve money. Mathematically, the sterilization operations are described by the rule

$$\triangle DA = -\lambda \triangle FA, \ 0 \leq \lambda \leq 1, \tag{6}$$

where λ stands for the sterilization coefficient, it indicates the fraction of change in foreign assets that the central bank offsets by varying domestic assets. $\lambda = 0$ is no sterilization, $\lambda = 1$ is complete sterilization.

The relationship between changes in the reserve money and changes in the money supply is $\triangle M = m \triangle RM$, where m is the money multiplier. Equation (5) can be rewritten as

$$\frac{1}{m} \triangle M = \triangle FA - \lambda \triangle FA, \tag{7}$$

$$\triangle FA = \frac{\triangle M}{m(1-\lambda)}. \tag{8}$$

From equation (8) we know that if the initial divergence between the long-run equilibrium level of money demand and the actual money supply is $\triangle M$, then the cumulative change in foreign exchange reserves in the process of convergence to the long-run equilibrium level of money demand is $\triangle FA$. If

$\lambda=0$, then $\triangle FA=\frac{\triangle M}{m}$ immediately; if $0<\lambda<1$, then $\triangle FA>\frac{\triangle M}{m}$ when the long-run equilibrium achieved. This implies that sterilization operationsdo not affect the long-run equilibrium level of money demand, but it does slow down the speed of convergence of money supply to the long-run equilibrium level at the expense of a larger cumulative change in foreign exchange reserves.

Equation (8) also shows that complete sterilization is unfeasible. If the central bank attempts to set $\lambda=1$, then any small divergence between the long-run equilibrium level of money demand and the actual money supply (i.e., $\triangle M\neq 0$) will ultimately lead either to an infinite cumulative or infinite loss of foreign exchange reserves. Even if complete sterilization is impossible, sterilization policies are adopted by many countries, where they are feasible, to reduce the volatility of domestic economy at the expense of greater volatility in foreign exchange reserves.

3.2 Evidences of Sterilization

For an open economy, the controllability of reserve money (thus the money supply) has close relations with the sterilization policies of monetary authorities with respect to changes in foreign exchange reserves. If change in foreign exchange reserves is considered to be the variable to which the monetary authorities adjust the domestic component of reserve money to offset, the regression coefficient of change in foreign assets should be negative and statistically significant. Therefore, a simply way to examine the extent of Taiwan's sterilization of balance of payments deficit or surplus is to regress the change in net domestic assets on the change in net foreign assets of Taiwan's central bank. The result is[15]

$$\begin{aligned}\triangle DA_t &= \underset{(2.7)}{6451.7} - \underset{(32.2)}{.88}\triangle FA_t, \\ R^2 &= .94,\ DW = 2.06.\end{aligned} \tag{9}$$

Equation (9) shows that there exists a significant and close relationship between changes in domestic assets and changes in foreign assets of Taiwan's central bank.

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[15] The estimation based on quarterly data in *Financial Statistical Monthly, Taiwan District, the Republic of China* (Taipei: Economic Research Department, the Central Bank of China). The estimated periods is from 1970:4 to 1987:4, it is coincident with Taiwan's foreign exchange settlements persistent surplus period.

The estimated sterilization coefficient is —.88, it means that Taiwan's monetary authorities neutralized on average 88% of foreign exchange flows through opposite change in the domestic component of the reserve money during 1970:4 to 1987:4. Such a high degree of sterilization indicates that Taiwan's money supply was under almost complete control of the monetary authorities.[16] That is, changes in Taiwan's foreign assets would have no big effect on changes in Taiwan's reserve money and hence on changes in Taiwan's money supply.

In order to examine the effect of a change in Taiwan's foreign assets on a change in Taiwan's reserve money, we regress the latter on the former. The result is

$$\triangle RM_t = \underset{(2.7)}{6451.7} + \underset{(4.3)}{.12}\triangle FA_t, \qquad (10)$$

$$R^2 = .22,\ DW = 2.06.$$

Equation (10) shows the effect of a change in Taiwan's foreign assets on a change in Taiwan's reserve money is significant but the relationship between the two variables is low. One unit increase in Taiwan's foreign assets only causes Taiwan's reserve money to increase .12 unit. This confirms that Taiwan's monetary authorities were able to sterilize most of change in foreign assets in the sample period.[17]

Sterilization can just reduce but not totally eliminate the influence of increases in foreign assets on a country's money supply. In spite of the fact that Taiwan's monetary authorities sterilized about 90% of increased foreign assets, if Taiwan's money multiplier is large, a change in foreign assets will still have a close relationship with Taiwan's money supply. We regress a change in Taiwan's money supply on a change in Taiwan's foreign assets, the result is

$$\triangle M_t = \underset{(3.8)}{6608.8} + \underset{(18.1)}{.36}\triangle FA_t, \qquad (11)$$

$$R^2 = .83,\ DW = 2.41.$$

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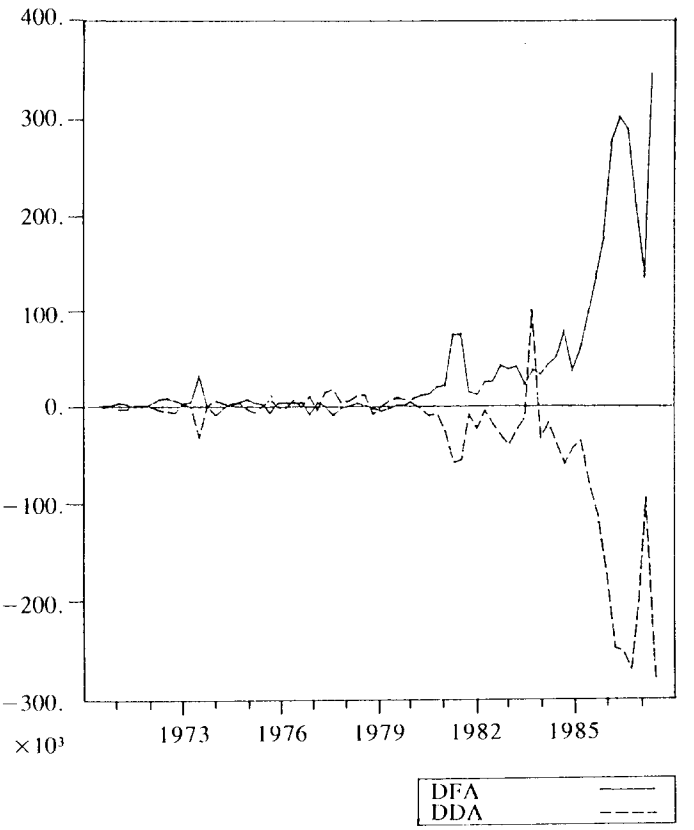
[16] Hickman and Schleicher [7] also find that many small European countries and Australia have high Sterilization coefficient (close to -1).

[17] Equation (10) is a counterpart of equation (9). According to equation of change in reserve money: $\triangle RM = \triangle FA + \triangle DA$, and we have estimated that $\triangle DA = 6451.7 - .88\triangle FA$, hence $\triangle RM = \triangle FA + (6451.7 - 88\triangle FA) = 6451.7 + .12\triangle FA$.

Equation (11) indicates that changes in Taiwan's foreign assets had a high correlation with changes in Taiwan's money supply. This implies that even most of the increased foreign assets had been sterilized by Taiwan's monetary authorities, changes in foreign assets still have a significant and close relationship with Taiwan's money supply.

The offsetting behavior of Taiwan's monetary authorities with respect to changes in foreign assets also becomes obvious in Figure 1. Changes in foreign assets and changes in domestic assets are plotted for the period 1970:3 to 1987:4. The figure shows that the variations of the two variables are more or less mirror images of each other. This indicates that Taiwan's monetary authorities responded strongly to the change in foreign assets.

Figure 1: Changes in Taiwan's Foreign Assets and Domestic Assets



Note: DFA stands for change in Taiwan's foreign assets.
DDA stands for change in Taiwan's domestic assets.

4. Reaction Function of the Central Bank

In an open economy, the goals of the central bank is to achieve both internal equilibrium (such as low inflation, high level of employment, and rapid economic growth) and external equilibrium (such as zero on the balance of payments).[18] But under the fixed exchange rates, the monetary policies alone cannot achieve the internal equilibrium and external equilibrium simultaneously. The monetary authorities face a tradeoff between internal equilibrium and external equilibrium in the short run. Of course, a certain degree of compromised combination between the two goals is possible.

The existence of an interdependence of internal and external targets makes it reasonable to specify a policy reaction function for the monetary authorities [2]. A simple reaction function can be expressed as

$$\triangle DA = \alpha \triangle FA + \sum_{i=1}^{n} ß_i DT_i, \tag{12}$$

where $\triangle DA$ is the change in net domestic assets of the central bank (it represents the monetary policies), and $\triangle FA$ is the change in net foreign assets of the central bank (it represents the external (or foreign) target of the central bank), α is sterilization coefficient, DT_i is the internal (or domestic) targets of the central bank.

Assuming that Taiwan's monetary authorities desire to reduce the impact of a change in foreign assets on the money supply, a change in foreign assets and the corresponding sterilization coefficient should be appropriate to represent the external policy target. We further assume that the major goal of Taiwan's monetary authorities is to pursue rapid economic growth, to curb inflation, and to lower unemployment rate. The variables representing the domestic monetary policy targets in the reaction function of Taiwan's monetary authorities include: growth rate of real *GNP*, increase rate of consumer prices, and unemployment rate. The following is the estimated reaction function of Taiwan's monetary authorities based in quarterly time series data:[19]

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[18] Many economists (such as the Monetarists) argue that monetary authorities' capabilities and responsibilities cover only nominal variables. But, Tobin [16] argues that monetary authorities should not escape responsibility for real macroeconomic variables.

[19] All of data, with the exception of change in foreign assets and change in domestic assets, are quarterly and seasonally adjusted. The estimated period is from 1970:4 to 1987:4.

$$\begin{aligned}\triangle DA_t = \underset{(.07)}{623.6} - \underset{(29.7)}{.89}\triangle FA_t + \underset{(.54)}{50386.8}\triangle LY_t - \underset{(.25)}{19515.3}\triangle LP_t + \\ \underset{(.71)}{2969.3}UR_t,\end{aligned}$$

$$R^2 = .94,\ DW = 2.05, \tag{13}$$

where $\triangle LY_t$ is growth rate of real *GNP*, $\triangle LP_t$ is increase rate of consumer prices, both are calculated as logarithmic first difference, UR_t is unemployment rate.

In equation (13), with the exception of the parameter of $\triangle FA_t$, all the t-statistics of other parameters are insignificant. The sterilization coefficient is almost the same as one obtained in equation (9). Our finding shows that the internal targets do not play a significant role in the formation of monetary policy. This finding is also consistent with the hypothesis that monetary policies are weakened to achieve the domestic targets when they are used to offset change in foreign assets.

It is reasonable to assume that the formation of monetary policy is based not only on the current economic conditions but also on the past and future economic conditions. In estimating the reaction function of Taiwan's central bank, we intend to include both the backward-looking and forward-looking variables.[20]

The backward-looking variables are represented by the lagged variables, while the forward-looking variables are created by using the Akaike Information Criterion [1] and the Schwarz Criterion [13] to determine the appropriate lag lengths of the variable, the fitted value of the distributed lag regression is used to represent the expected or forward-looking variable; or we may substitute the leading variables for the forward-looking variables and estimate the equation directly, then transform the fitted parameters of leading variables into the fitted parameters of forward-looking variables.[21]

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[20] In estimating the reaction function of U. S. federal funds rate, McNees [11] ever included the backward-looking and forward-looking variables in the model.

[21] The relationship between the fitted parameters of leading variables and the fitted parameters of forward-looking variables is as follows:

Suppose that one hypothesizes the regression

$$y_t = \beta_0 + \beta x^e_{t+1} + e_t, \tag{14}$$

where x^e_{t+1} is expected x_{t+1} conditional on the information available at time t, e_t is white noise, which is uncorrelated with x^e_{t+1}. The relationship between x^e_{t+1} and x_{t+1} (observed x at time $t+1$) is

$$x_{t+1} = x^e_{t+1} + v_{t+1}, \tag{15}$$

The estimate directly using the forward-looking (or expected) variables created by the Akaike Information Criterion and the Schwarz Criterion is[22]

$$\begin{aligned}\triangle DA_t = {} & \underset{(.57)}{6863.3} - \underset{(24.2)}{.93}\triangle FA_t + \underset{(.88)}{100023.9}\triangle LY_t - \\ & \underset{(.35)}{123436.4}\triangle LP_t + \underset{(1.2)}{26598.4}UR_t - \underset{(.65)}{71117.0}\triangle LY_{t-1} - \\ & \underset{(.21)}{19624.0}\triangle LP_{t-1} + \underset{(1.1)}{14389.0}UR_{t-1} - \underset{(.96)}{105706.1}\triangle LY^e_{t+1} \\ & + \underset{(.35)}{122187.8}\triangle LP^e_{t+1} - \underset{(1.3)}{38772.5}UR^e_{t+1},\end{aligned}$$

$$R^2 = .93,\ DW = 2.11, \tag{19}$$

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where v_{t+1} is the forecast error, it is a white noise, which is uncorrelated with x^e_{t+1}.

In practice, x^e_{t+1} is unobserved. Therefore, we substitute observed x_{t+1} for x^e_{t+1} and run the regression

$$y_t = \gamma_0 + \gamma x_{t+1} + u_t. \tag{16}$$

The estimated γ, denoted by $\hat{\gamma}$, is

$$\begin{aligned}\hat{\gamma} &= \frac{cov(x_{t+1}, y_t)}{var(x_{t+1})} = \frac{cov(x^e_{t+1}+v_{t+1}, y_t)}{var(x^e_{t+1}+v_{t+1})}, \\ &= \frac{cov(x^e_{t+1}, y_t)}{\mathrm{var}(x^e_{t+1})+var(v_{t+1})}, \\ &= \frac{cov(x^e_{t+1}, y_t)}{var(x^e_{t+1})}\left[\frac{var(x^e_{t+1})}{var(x^e_{t+1}) + var(v_{t+1})}\right].\end{aligned} \tag{17}$$

As the sample size increases, $\text{plim}\ \dfrac{cov(x^e_{t+1}, y_t)}{var(x^e_{t+1})} = ß$. Hence

$$\text{plim}\ \gamma = ß\left[\frac{1}{(1 + \frac{var(v_{t+1})}{var(x^e_{t+1})})}\right]. \tag{18}$$

According to equation (18), we can estimate the parameters of forward-looking variables by fitting the parameters of leading variables indirectly. The bias of estimation is $\dfrac{1}{(1 + \frac{var(v_{t+1})}{var(x^e_{t+1})})}$.

[22] By the Akaike Information Criterion and the Schwarz Criterion, the expected growth rate of real *GNP* is created by the first difference of the fitted value in the equation of logarithmic real *GNP* including constant, trend, and five lag lengths; the expected increase rate of consumer prices is created by the first difference of the fitted value in the equation of logarithmic consumer prices index including constant, trend, and one lag length; the expected unemployment rate is created by the fitted value in the equation of unemployment rate including constant and five lag lengths.

where $\triangle LY_{t-1}$, $\triangle LP_{t-1}$, and UR_{t-1} are lag one of growth rate of real *GNP*, increase rate of consumer prices, and unemployment rate respectively; $\triangle LY^{e}_{t+1}$, $\triangle LP^{e}_{t+1}$, and UR^{e}_{t+1} are one period ahead expected value of growth rate of real *GNP*, increase rate of consumer prices, and unemployment rate created by the Akaike Information Criterion and the Schwarz Criterion respectively.

The estimate directly using the leading variables is

$$\begin{aligned}\triangle DA_t = {} & \underset{(.53)}{6976.3} - \underset{(24.5)}{.93}\triangle FA_t + \underset{(.16)}{18631.7}\triangle LY_t - \\ & \underset{(.24)}{24532.7}\triangle LP_t + \underset{(.35)}{3810.4}UR_t - \underset{(.85)}{99224.6}\triangle LY_{t-1} - \\ & \underset{(.36)}{34338.6}\triangle LP_{t-1} + \underset{(.51)}{4627.4}UR_{t-1} - \underset{(1.4)}{162405.6}\triangle LY_{t+1} \\ & -\underset{(.24)}{21481.9}\triangle LP_{t+1} - \underset{(.49)}{4406.4}UR_{t+1},\end{aligned}$$

$$R^2 = .93,\ DW = 2.06, \tag{20}$$

where $\triangle LY_{t+1}$, $\triangle LP_{t+1}$, and UR_{t+1} are leading one of growth rate of real *GNP*, increase rate of consumer prices, and unemployment rate respectively. The biases of estimation are .41, .52, and .64 for $\triangle LY_{t+1}$, $\triangle LP_{t+1}$, and UR_{t+1} respectively.

In equations (19) and (20), with the exception of the sterilization coefficient, all of the t-statistics of other parameters are insignificant. This may imply that Taiwan's monetary authorities were only concerned with sterilizing the change in foreign assets and did not worry about other past, current, and future economic variables. One possible explanation for this result is that the pressure of persistent balance of payments surplus made Taiwan's monetary authorities simply wish to sterilize the current increase of foreign assets, other economic targets are therefore ignored.

However, even if Taiwan's monetary authorities were not concerned with other economic variables in the execution of sterilization policies, they may still care about the past and future changes in foreign assets. Because the sterilization operations can only delay (rather than change) the influence of a increase in foreign assets on the domestic economy, the longer a country engages in sterilization, the bigger the eventual accumulated effect of changes in foreign assets would and hence the greater the eventual effect upon the domestic economy. Therefore, the long-term and persistent sterilization operations are not the optimum policy for a country to solve the problem of the balance of payments surplus. It may be better to allow

the automatic adjustment mechanism to work in the long run (even if not in the short run). We run a regression of a change in Taiwan's domestic assets on the past, current, and future changes in Taiwan's foreign assets to try to understand the attitude of Taiwan's monetary authorities towards the operations of sterilization. The result is

$$\begin{aligned} \triangle DA_t = \underset{(2.7)}{6693.1} - \underset{(8.2)}{.88}\triangle FA_t - \underset{(.75)}{.07}\triangle FA_{t-1} + \underset{(.67)}{.04}\triangle FA_{t+1}, \\ R^2 = .93,\ DW = 2.09, \end{aligned} \tag{21}$$

where $\triangle FA_{t-1}$ and $\triangle FA_{t+1}$ are lag and leading one of changes in foreign assets respectively.

Equation (21) shows that t-statistics of the lagged and leading changes in foreign assets are insignificant. This may mean that Taiwan's monetary authorities were not concerned about the past and future situations of changes in foreign assets in sterilizing the current change in foreign assets. In other words, equation (21) implies that Taiwan's monetary authorities intend to offset the change in foreign assets for as long as possible.

5. VAR analysis of Sterilization

In the monetary approach, the change in net domestic asset of the central bank is regarded as an exogenous variable. This implies that the change in domestic assets Grange-causes the change in foreign assets of the central bank. But, in practice, both changes in domestic assets and changes in foreign assets of the central bank are determined simultaneously, and both are endogenous variables. Because monetary policy (or a change in domestic assets of the central bank) affects the balance of payments and at the same time it is used to sterilize changes in the foreign exchange reserves (i.e., past changes in domestic assets of the central bank were induced by changes in foreign reserve assets, and they had effects on the current position of balance of payments).

Many empirical researches show strong evidence that standard monetary approach which assumes domestic credit as exogenous is invalid. The problem of simultaneity of change in net domestic assets and change in foreign reserve assets of the central bank suggests that the appropriate economic models to test sterilization operation must be able to overcome the problem of the simultaneous determination of monetary

policy and the balance of payments under the fixed exchange rates. The VAR model can match this requirement. Therefore in this section, the VAR model is used to analyze the relationship between changes in net domestic assets and changes in net foreign assets of Taiwan's central bank.

By the two-variable VAR models,[23] the *F*-tests of block of coefficients show that at the 10% significance level, changes in foreign assets Grang-cause changes in domestic assets (see Table 3), and the contemporaneous correlation of innovations in Taiwan's change in foreign assets and change in domestic asets is —.81. This confirms the high proportion of sterilization found by the OLS.

Table 3: *F*-Tests of Block of Coefficients

Equation	Block of Coefficients	*F*-statistic	Significance Level
△DA	△DA	.91	.49
	△FA	4.64	.00
△FA	△DA	1.86	.11
	△FA	6.16	.00

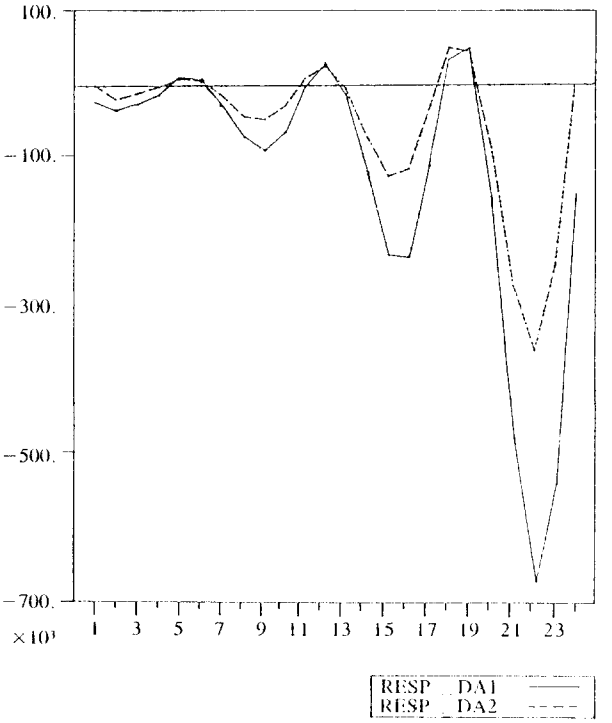
Note: △DA is change in domestic assets, △FA is change in foreign assets.

Figure 2 shows that a positive innovation in change in Taiwan's foreign assets causes Taiwan's domestic assets to decrease persistently at most time horizons shown. This indicates the existence of sterilization operation by Taiwan's monetary authorities. Figure 3 shows that a positive innovation in change in Taiwan's domestic assets causes Taiwan's foreign assets to decrease persistently at most time horizons shown. This is consistent with the hypothesis that an increase in domestic assets will deteriorate a country's balance of payments.

Table 4 shows that in the change in foreign assets-change in domestic assets VAR model, innovations in change in domestic assets at most account for 3.37% of the variation in change in foreign assets at all time horizons shown. But, innovations in change in foreign assets account for more than 90% of the variation in change in domestic assets for periods seven to twenty four, peaking at 99.12% in period twenty two.

[23] The modified likelihood ratio tests are: $x^2 = 18.6$, corresponding significance level = .02 for four lag lengths versus six lag lengths; $x^2 = 4.72$, corresponding significance level = .79 for six lag lengths versus eight lag lengths. Therefore, six lag lengths are appropriate to this model, hence the model is estimated with constant and six lag lengths. The sample period is from 1972:1 to 1987:4.

Figure 2: Impulse Responses of Change in Taiwan's Domestic Assets to a Positive Shock in Change in Taiwan's Foreign Assets

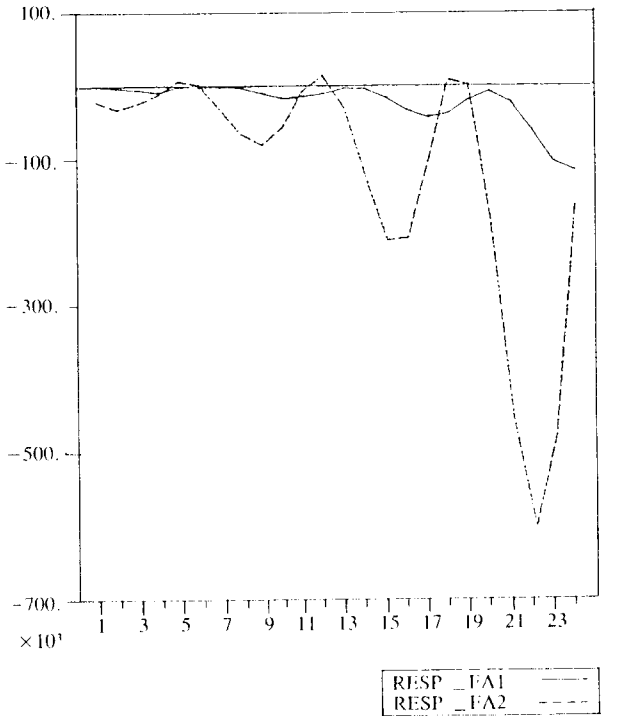


Note: RESP _DA1 stands for the impulse responses in the VAR model ordering change in foreign assets-change in domestic assets.
RESP _DA2 stands for the impulse responses in the VAR model ordering change in domestic assets-change in foreign assets.

Table 5 shows that in the change in domestic assets-change in foreign assets VAR model, innovations in change in foreign assets account for 21% to 30.64% of the variation in change in domestic assets in the period from seven to twenty four. Innovations in domestic assets account for about 70% of the variation in domestic assets at all time horizons shown. Table 4 and 5 together show that innovations in change in foreign assets have bigger effect on the fluctuations of change in domestic assets than the effects of innovations in change in domestic assets on the fluctuations of change in foreign assets.[24]

[24] The high correlation between innovations in change in foreign assets and change in domestic assets make the impulse response analysis and the variance decomposition analysis be sensitive to the ordering of variables in the VAR model. Therefore, we report two results of different orderings of variables.

Figure 3: Impulse Responses of Change in Taiwan's Foreign Assets to a Positive Shock in Change in Taiwan's Domestic Assets



Note: RESP _FA1 stands for the impulse responses in the VAR model ordering change in foreign assets-change in domestic assets.
RESP _FA2 stands for the impulse responses in the VAR model ordering change in domestic assets-change in foreign assets.

6. Conclusion

The persistent trade surplus of Taiwan make it worthwhile examine why the automatic adjustment mechanism failed to work effectively. According to our analysis, we find that income elasticity of demand for money tends to increase as trade continues to move in favor of Taiwan. Higher income elasticity of demand for money in the period of trade surplus might help to absorb some of the increased money supply created by trade surplus, hence contribute to the stabilization of the price level.

Our estimated reaction function of Taiwan's monetary authorities indicates that about 90% of the change in Taiwan's foreign assets is sterilized by countervailing change in domestic assets. Sterilization operation seems to be considered as the most important policy target by Taiwan's monetary authorities. We cannot find any past

Table 4: Decomposition of Variances in Changes in Foreign and Domestic Assets (Unit: %)

Quarter	Stand. Devi. (N. T. $ Million) (1)	△FA by △FA	△FA by △DA	Stand. Devi. (N. T. $ Million) (2)	△DA by △FA	△DA by △DA
1	25875.	100.00	.00	27763.	65.04	34.96
2	45471.	99.77	.23	43788.	85.85	14.15
3	52543.	99.12	.88	51116.	88.53	11.47
4	53819.	96.80	3.20	53247.	87.64	12.36
5	54657.	96.83	3.17	54453.	87.92	12.08
6	54848.	96.63	3.37	55222.	88.19	11.81
7	66412.	97.67	2.33	62047.	90.45	9.55
8	104773.	99.03	.97	94169.	95.85	4.15
9	141261.	99.05	.95	131270.	97.37	2.63
10	153947.	98.17	1.83	146949.	97.11	2.89
11	154564.	97.39	2.61	147621.	96.26	3.74
12	156856.	97.06	2.94	151010.	95.97	4.03
13	160564.	97.17	2.83	151599.	95.96	4.04
14	222231.	98.50	1.50	196008.	97.59	2.41
15	335168.	99.14	.86	302624.	98.83	1.17
16	409556.	98.80	1.20	383489.	98.77	1.23
17	423233.	97.89	2.11	401627.	97.91	2.09
18	426519.	97.17	2.83	404734.	97.12	2.88
19	427193.	97.00	3.00	408152.	96.96	3.04
20	482927.	97.63	2.37	436396.	97.33	2.67
21	733615.	98.89	1.11	646821.	98.74	1.26
22	1019120.	99.07	.93	932786.	99.12	.88
23	1147800.	98.45	1.55	1080630.	98.61	1.39
24	1159390.	97.48	2.52	1096370.	97.63	2.37

Note (a): Stand. Devi. (1) is the standard deviation of forecasting error of change in foreign assets; Stand. Devi. (2) is the standard deviation of forecasting error of change in domestic assets. The order of variables in the VAR model is change in foreign assets-change in domestic assets.

Note (b): △FA is change in foreign assets, △DA is change in domestic assets.

Table 5: Decomposition of Variances in Changes in Domestic and Foreign Assets (Unit: %)

Quarter	Stand. Devi. (N. T. $ Million) (1)	△DA by △DA	△DA by △FA	Stand. Devi. (N. T. $ Million) (2)	△FA by △DA	△FA by △FA
1	27763.	100.00	.00	25875.	65.04	34.96
2	43788.	81.38	18.62	45471.	68.75	31.25
3	51116.	81.71	18.29	52544.	71.56	28.44
4	53247.	83.01	16.99	53819.	72.77	27.23
5	54453.	81.15	18.85	54657.	72.09	27.91
6	55222.	80.30	19.70	54848.	71.66	28.34
7	62047.	79.00	21.00	66412.	70.41	29.59
8	94169.	70.70	29.30	104773.	68.53	31.47
9	131270.	72.46	27.54	141261.	70.93	29.07
10	146949.	74.46	25.54	153947.	73.42	26.58
11	147621.	74.27	25.73	154564.	73.04	26.96
12	151010.	72.44	27.56	156846.	71.72	28.28
13	151599.	72.53	27.47	160564.	71.75	28.25
14	196008.	69.63	30.37	222231.	69.43	30.57
15	302624.	69.80	30.20	335168.	70.11	29.89
16	383489.	71.96	28.04	409556.	72.52	27.48
17	401627.	73.69	26.31	423233.	73.95	26.05
18	404734.	72.59	27.41	426519.	72.85	27.15
19	408152.	71.86	28.14	427193.	72.63	27.37
20	436396.	71.35	28.65	482927.	71.61	28.39
21	646821.	69.36	30.64	733615.	69.91	30.09
22	932786.	70.62	29.38	1019120.	71.41	28.59
23	1080630.	73.05	26.95	1147800.	73.70	26.30
24	1096370.	73.82	26.18	1159390.	74.18	25.82

Note (a): Stand. Devi. (1) is the standard deviation of forecasting error of change in domestic assets; Stand. Devi. (2) is the standard deviation of forecasting error of change in foreign assets. The order of variables in the VAR model is change in domestic assets-change in foreign assets.

Note (b): △DA is change in domestic assets, △FA is change in foreign assets.

or future variables which play a significant role in the formation of Taiwan's monetary policy. It appears that Taiwan's monetary authorities intend to break the automatic adjustment mechanism for long as possible.

The VAR analysis shows that changes in Taiwan's foreign assets Granger-cause changes in Taiwan's domestic assets. There exists a high correlation (—.81) between innovations in both variables. Both impulse response analysis and variance decomposition analysis indicate the adoption of sterilization operations by Taiwan's monetary authorities and the importance of innovations in change in Taiwan's foreign assets in the fluctuations of change in Taiwan's domestic assets.

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