Trade Patterns and Exchange Rate Regimes: Testing the Asian Currency Basket Using an International Input-Output System*

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Abstract

The Asian currency crises occurred in the year 1997. We focused on exchange rates of the Asian countries/regions among several causes and examined how they were determined with a currency basket peg framework. We also constructed an international input-output model linked with macroeconometric models. Using the model, we have analyzed trade pattern changes in relation to the yen-dollar rate. Estimation results of the Asian currency baskets show that the weight of the yen was low, indicating that the Asian exchange rate policy led to the de-facto dollar peg. Simulation results indicate that the effects of the yen-dollar rate on trade patterns depend on industrial structures. When a country/region's industrial structure is similar to that of Japan's and the yen is weak, the increase of the yen's weight proves to hold its competitiveness. As for the complementary structure, the weak yen will improve its current account. If the Asian countries/regions had had international capital inflows control, their current account deficits might not have spread as widely.

1 Introduction

In July 1997, the adoption of a free float exchange rate policy in Thailand triggered off the Asian currency crises. The contemporary world economy is based on the interdependence between different countries/regions. Hence, the currency crises in Asia spread over Russia and Brazil.

There are so many studies on the causes and policy considerations of the Asian currency crises. In this paper, we will focus on the Asian exchange rate policies and investment booms which set forth the main causes of the Asian currency crises. The Asian countries/regions' monetary authorities had employed the de-facto US dollar peg policy. The de-facto US dollar peg system had three benefits: a control of imported inflation, smooth access to the US market and acceptance of foreign investments; however, it effected the Asian real exchange rates to be overvalued in the process of the devaluation of the Chinese yuan in 1994 and the strong US dollar tendency against the Japanese yen from the year 1995. The moral hazard problem of the Asian financial institutions' loans of large amounts of foreign capital also occurred because the currency peg system lowered exchange rate risks. Thus, we can find that inflexibilities of the Asian currencies were one of the important factors to the Asian currency crises. In retrospect, what kind of exchange rate regime is appropriate for the Asian countries/regions? The Asian countries/regions are small

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open economies which are very dependent on trade. As a result, exchange rate stability equals domestic price stability. Under a free float system, the exchange rate will be volatile to where it leads to price instability. Hence, a basket peg policy that is easy to control and will not allow the real exchange rate to be overvalued is one of the alternative exchange rate policies for the Asian countries/regions.

In this paper, we will investigate how the Asian currencies are determined in relation to the movements of major currencies using the US dollar, the Japanese yen and the deutschemark as main examples. Then, we will analyze how trade patterns are affected when the Asian monetary authorities increase the weight of the Japanese yen in their currency baskets.[1] We will also examine the effects of investments to trade patterns.

To analyze these issues, we have constructed an international input-out put model that is linked with macroeconometric models. We use the Institute of Developing Economies' the Asian International Input-Output Table, 1990 that has 78 industrial sectors[2] and covers 10 countries/regions (Indonesia, Malaysia, the Philippines, Singapore, Thailand, China, Taiwan, Korea, Japan and the United States).

This paper is structured as follows:

The summarization of the literature on the Asian currency crises in Section 2.

The explanation of the model structure in Section 3.

Simulation results presented in Section 4.

Finally, the conclusions in Section 5.

2 Controversies on the Asian Currency Crises

There are two kinds of theoretical models have been developed for currency crises in general. One is the first generation model formulated by Krugman [16], and Flood and Garber [06]. The first generation models suppose that a small open economy adopts the fixed exchange rate system and that the monetary authority finances the government bonds issued by the fiscal authority. Monetizing the debt increases the money supply which in turn causes the inflation and decrease of interest rates. As a result of this process, currency value decreases. In this situation, the monetary authority moves to sustain the fixed rate, however, investors attack its currency before foreign reserve exhaustion, creating a currency crisis. The

[1] As for simulation analyses on the Asian currency devaluations, there are few experiments. Fair [04] uses a multi-country macroeconometric model to evaluate the effects of devaluations of Thai, Malaysian, Philippine and Korean currencies. McKibbin [20], and Noland, Liu, Robinson and Wang [21] examine the economic impact of the productivity shocks or changes of risk premium using computable general equilibrium models. Our approach differs from their analyses in the aspects of introducing and estimating currency baskets in addition to using an international input-output system.

[2] As for the sector classification, see Table 1.

other is the second generation model developed by Obstfeld [22, 23]. As in the first generation model, the second generation model also supposes that a small open economy operates its exchange rate policy under the fixed system. An exchange rate policy is conducted along the lines of a certain loss function. We assume that a government must endure the cost and the loss of trust in the fixed rate to adjust its currency. Thus, a government will evaluate the costs and benefits of a currency adjustment, and when the benefits are larger than the costs, a government will abandon the fixed exchange rate system and vice versa. Whether or not a government withdraws the fixed exchange rate depends on the expectations of the private sector; hence, when people expect a currency adjustment, costs of maintaining the fixed rate increase, resulting in a currency crisis. The market expectation actually triggers a currency crisis and the possibility of that crisis depends on the expectation. From this logic, we also call this model a self-fulfilling model with multi-equilibriums. The self-fulfilling model does not have any limitations to the international reserves or any consideration on macro-fundamentals concluding that the lack of exchange reserves or poor macroeconomic conditions will not give rise to a currency crisis.

Causes and policy implications on the Asian currency crises differ between these models, however, both of them implicate that the direct cause of the Asian currency crises is the rapid inflow and outflow of the international capital. As for the rapid capital inflow, financial liberalization with insufficient supervision in addition to low interest rates in the U.S. and Japan generated lending booms in Asia. This is not the same regarding the causes of the international capital outflows. Those who are based on the first generation model, e.g. Corsetti, Pesenti and Roubini [02], Feldstein [05], Goldstein [09], and Noland, Liu, Robinson and Wang [21], focus on current account deficits. They point out that the following two problems are the main causes of the deficits, one of the causes being the Asian exchange rate policies.[3] The Asian exchange rate policies were the de-facto dollar peg policy. We consider that there were three reasons for conducting that policy. First, most Asian countries/regions import their daily products, e.g. foods and energy. The prices of the primary products are determined at international markets in the US dollar. The Asian governments tried to control imported inflations by linking the national currencies to the US dollar. Second, the US market is vital to the Asian countries who have adopted the export-oriented development policy. Third, tremendous amount of foreign capital has been invested in Asia since the Plaza agreement in the year 1985 which has played an important role in Asia’s development. To attract foreign investors to Asia, the stability of home currencies against the US dollar was necessary. Though the de-facto dollar peg system was working well, the Asian real exchange rate had begun to be overvalued by the devaluation of the Chinese yuan in 1994 along with stronger dollar/weaker yen from the year 1995.

[3] Kohsaka [13] considers that the exchange rate policy is not a serious factor of the Asian currency crisis based on the real effective exchange rate stability in Indonesia, Korea, Malaysia, Thailand and Taiwan from the latter half of the 80’s.

Asia's export competitiveness was damaged by the real exchange rate appreciation causing a negative effect on exports themselves, which were one of the main engines of the Asian economic growth. Another cause of current account deficits was over-investment.[4] Due to the closely fixed exchange rate, the Asian financial institutions could borrow foreign capitals without any exchange rate risks. Furthermore, the Asian countries/regions liberalized their financial systems ignoring the use of supervision systems generating the increase of easy borrowing of the foreign capitals and easy investments in real estates or non-performing matters. Along this line, moral hazard problems in banking arose. These over-borrowings and over-investments increased both investments and imports. In another opinion, Goldstein [09] questioned the continuation of the current account deficits based on the over-production of export goods, the over-competitions in the export market and the protectionism of the United States.

Meanwhile, those who interpreted the Asian currency crises by the second generation model, e.g. Furman and Stiglitz [08], Kohsaka [13][5], and Radelet and Sachs [25][6], considered that though the vulnerability of the Asian economy created panic, the macro-imbalances were not solely the reasons of the Asian currency crises. In their opinion, it was the errors in the choice of policies which made the crises worse.

There is yet another opinion on the Asian currency crises. Krugman [18] argues that the Asian currency crises are not consistent with either the first generation model or the second generation model. There were not problems in fiscal sectors that the first generation model supposes, and the Asian countries/regions did not have any incentives to devalue their currencies as the second generation model shows. He focuses on the rise and fall of the asset prices, and stresses that the Asian currency crises are caused by the emergence and collapse of the asset bubbles. Though he holds a different stance, he also points out that the moral hazard problems in the banking system played a principle role in the crises.

As Krugman [18] mentioned, neither the first nor the second generation models necessarily fit the circumstances of the Asian currency crises. When we take a look at economic fundamentals of the Asian countries/regions, e.g. the Thai current account deficits, it is difficult to conclude that there were not any problems in macro-fundamentals. Even if market expectations had triggered the crises, those expectations should have depended on the Asian macro economies. As many studies show, it is a fact that macro-imbalances emerged in Asia. In the Asian case, it is appropriate for us to consider that macro-imbalances,

[4] Kohsaka [13] pointed out that there were not only investment booms but also consumption booms in Asia.
[5] We categorize Kohsaka [13] into the group that is based on the second generation model because though he recognizes that macro-imbalances were one of the causes of the crises, he stresses the importance of the market participants' expectations for devaluations and policy errors.
[6] Radelet and Sachs [25] indicates that if the Thai government/monetary authority had adopted the free float system and tightened its macroeconomic policy when the asset prices decreased in 1997, the Asian currency crises would not have occurred.

e.g. current account deficits, are the main causes of the crises as the first generation model indicates.[7]

Based on the first generation model, the main causes of the Asian currency crises are the exchange rate policies and over-investments as we mentioned above. The de-facto dollar peg system generated the moral hazard problems of the financial institutions, hence, the exchange rate policy is the root of the crises. The Asian nations/regions had adopted the de-facto dollar peg policy in favor of price stability, smooth access to the US market and international capital inflows. Though this aided Asia to develop at high speed, the fixed rate could not adjust to the variations of the external environments (e.g. the yen-dollar rate movements). To solve this problem, the Asian countries/regions must possess exchange rate flexibility. However, it is difficult for a small and trade dependent country, like that of in Asia, to adopt the free float policy because the exchange rates are much too volatile under that system. Thus, we propose the currency basket system that enables certain flexibility and is less volatile than that of the free float policy for Asian countries/regions to conduct their exchange rate policies.[8] In the case of Thailand and Korea, however, they had in fact adopted the currency basket systems but the weights of the US dollar were very high. We conclude that a currency basket peg policy with much higher weight on the Japanese yen will be more appropriate than the de-facto dollar peg policy or a free float system for the Asian countries/regions.

3 The Structure of the Model

3.1 Macroeconometric Models

There are several differences in the economic structures between developed and developing countries/regions. Of course, we can apply the same model to both developed and developing countries/regions, yet it is not an accurate approach in analyzing their economies. To acquire more precise output to each country/region's differences, we have constructed two kinds of macroeconometric models.

3.1.1 Macroeconometric Model for Developed Countries/Regions

The macroeconomic block is constructed by the Keynesian framework. Our benchmark model is the demand-determined system developed by Klein [12] and that is called the skeleton model. The summation

[7] Krugman [17] criticizes that the second generation model ignores the trend of fundamentals, and indicates that when the fundamentals get worse, the possibility of multiple equilibrium is limited.

[8] Hamada [10] analyzes the exchange rate policy of a small country whose initial exchange rate policy is the fixed one by applying the framework of the three-countries' (two large countries and one small country) monetary policy games. His analysis shows that the free float system or the currency basket policy is better than the fixed rate, and that the currency basket policy is more appropriate than the free float policy under the strong wage demand pressure.

of each final demand components equals gross national products (GNP) and determines national production outputs.

Endogenous Variables

C_t = Private final consumption (Real)

π_t = Corporate profits (Nominal)

I_t = Gross fixed capital formation (Real)

Z_t = GNP (Real)

T_{1t} = Indirect tax (Nominal)

EX_t = Exports (Real)

IM_t = Imports (Real)

Y_t = Disposable income (Nominal)

P_t = Prices

D_t = Depreciation (Real)

r_t = Interest rate (Nominal)

K_t = Capital stock (Real)

T_{2t} = Personal tax (Nominal)

L_t = Employment

T_{3t} = Corporate tax (Nominal)

LF_t = Labor force

w_t = Wage rate

T_{rt} = Transfer payments (Nominal)

Exogenous Variables

G_t = Government spending (Real)

N_t = Population

PM_t = Import price

WT_t = World trade transactions (Real)

PW_t = World trade price

MS_t = Money supply (Nominal)

Definitional Equations

Real GNP

(3.1) $$C_t + I_t + G_t + EX_t - IM_t = Z_t$$

The real GNP is explained by this definitional equation. From the principle of effective demand, the left side of the gross national expenditure components determines the production output of a country.

Nominal GNP

(3.2) $$P_t Z_t - T_{1t} - P_t D_t = Y_t + T_{2t} + T_{3t} - T_{rt}$$

This equation defines the nominal GNP. By transforming this equation we explain the nominal disposable personal income.

National Income

(3.3) $$w_t L_t + \pi_t = Y_t + T_{2t} + T_{3t} - T_{rt}$$

Though this is the definitional equation of the national income, the nominal corporate profits are accounted for by this equation.

Capital Stock

(3.4) $$K_t = K_{t-1} + I_t - D_t$$

The increase of the capital stock for this period equals the gross fixed capital formation minus the depreciation. The end of last period's capital stock plus the increase of this period become the capital stock of this period.

Behavior and Technological Equations

Consumption

(3.5) $C_t = a_0 + a_1(Y_t / P_t) + a_2 C_{t\text{-}1}$

We adopt the Brown-type consumption function whose dependent variables are the real disposable income and the lagged consumption expenditure.

Investment

(3.6) $I_t = b_0 + b_1 Z_t + b_2 r_t + b_3 K_{t\text{-}1}$

The end period's capital stock and the real GNP explain investments. In this function the interest rate is added as one of the explanatory variables because most companies invest by borrowing.

Export

(3.7) $EX_t = c_0 + c_1 WT_t + c_2 (PW_t / P_t) + c_3 EX_{t\text{-}1}$

Fluctuations of trade transactions depend on changes of income and relative prices. The more trade partners' income increase, the more exports increase. If export prices are lower than importer's prices, exports increase. World trade transactions represent importers' income and the world trade prices stand for the other countries' prices.

Import

(3.8) $IM_t = d_0 + d_1 Z_t + d_2 (P_t / PM_t) + d_3 IM_{t\text{-}1}$

The real GNP, the ratio of prices and import prices explain imports.

Employment

(3.9) $\ln L_t = e_0 + e_1 \ln Z_t + e_2 \ln K_{t\text{-}1} + e_3 \ln L_{t\text{-}1}$

In this model, employment is determined by using the production function.

Prices

(3.10) $P_t = f_0 + f_1(w_t L_t / Z_t) + f_2 PM_t$

Prices depend on the unit labor cost (markup pricing) and import prices (cost-push inflation).

Wages

(3.11) $\Delta \ln w_t = g_0 + g_1[LF_t / (LF_t - L_t)] + g_2 \Delta \ln P_t$

The Phillips curve, which explains the relation between the unemployment rate and inflation, determines wages.

Labor Force

(3.12) $LF_t / N_t = h_0 + h_1[(LF_t - L_t)/LF_t] + h_2(w_t / P_t)$

The unemployment rate and the real wages explain the labor force.

Velocity of Circulation of Money

(3.13) $\ln(P_t Z_t / MS_t) = i_0 + i_1 r_t + i_2 \Delta \ln P_t$

The interest rate and inflation explain the velocity of money circulation. From this function, the interest rate is determined.

Depreciation

(3.14) $D_t = j_0 K_{t-1}$

The depreciation is estimated at a certain rate of the last period's capital stock.

Institutional Equations

Indirect Tax

(3.15) $T_{1t} = k_0 + k_1(P_t Z_t)$

Indirect taxes are explained by the nominal GNP.

Personal Tax

(3.16) $T_{2t} = l_0 + l_1 Y_t$

Personal taxes depend on the nominal disposable personal income.

Corporate Tax

(3.17) $T_{3t} = m_0 + m_1 \pi_t$

Corporate profits explain corporate taxes.

Transfer Payments

(3.18) $T_{rt} = n_0 + n_1(LF_t\text{-}L_t) + n_2 w_t$

In reference to the unemployment insurance, transfer payments depend on unemployment and wages.

The exchange rate function is not in the Klein's skeleton model. In this study we use the Filatov-Klein exchange rate function.[9] This function is written as:

(3.19) $\ln e_t = o_0 + o_1 \ln(P_t / P_{US,t}) + o_2(r_t - r_{US,t}) + o_3(Bal_t / P_t Z_t)$

where $P_{US,t}$ is the prices of the US, $r_{US,t}$ is the nominal US interest rate and Bal_t is the current account.

The Filatov-Klein model explains the exchange rate by relative prices between the home country and the

US, the interest rate differences and the nominal current account per the nominal GNP. The exchange rate is basically determined by the purchasing power parity. Its short-term fluctuation depends on the interest rate differences and the current account.

3.1.2 Macroeconometric Model for Developing Countries/Regions

Developing countries basically have labor surplus-capital shortage economies. They are excess demand economies. Hence, we analyze macroeconomic structures of developing countries by the supply-determined system. We use the UNCTAD's macroeconometric model as the proto-type model that is in Ball [01]. This model does not have an exchange rate function, as in the Klein's skeleton model. Thus, we use the Filatov-Klein exchange rate function to determine it endogenously.

Endogenous Variables

C_t = Private consumption (Real)

I_t = Investment (Real)

J_t = Inventory

$Z_{a,t}$ = Agricultural production

$Z_{na,t}$ = Non-agricultural production

$Z^P_{na,t}$ = Non-agricultural production potential

X_t = Export (Real)

P_t = Prices

PE_t = Export prices (US dollar)

$PE_{d,t}$ = Export prices

$P_{a,t}$ = Agricultural prices

$P_{na,t}$ = Non-agricultural prices

R_t = International reserve

$D_{f,t}$ = External indebtedness (Nominal)

M_t = Import (Real)

$Z_{n,t}$ = GNP (Real)

K_t = Capital stock (Real)

$Z_{d,t}$ = GDP (Real)

$Z_{f,t}$ = Net factor payments abroad (Real, US dollar)

$Z^*_{f,t}$ = Net factor payments abroad (Nominal, US dollar)

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[9] See De Grauwe and Peeters [03]

Exogenous Variables

N_t = Population

PM_t = Import prices

TW_t = World export volume index

F_t = Net capital inflow

MS_t = Money supply

t = Time

PW_t = World export price index (US dollar)

E_t = Exchange rate (US dollar per Home currency)

Definitional Equations

Real GDP

(3.20) $$Z_{d,t} = Z_{a,t} + Z_{na,t}$$

Agricultural production plus non-agricultural production determine the real GDP because this is the supply determined model.

Real GNP

(3.21) $$Z_{n,t} = Z_{d,t} - Z_{f,t}$$

By definition, the real GNP equals the real GDP minus net factor payments abroad.

Inventory

(3.22) $$J_t = Z_{d,t} + M_t - C_t - I_t - X_{\mathrm{t}}$$

By the definition of the gross domestic expenditure, we determine inventory as the residual.

Capital Stock

(3.23) $$K_t = \sum I_{t-i}$$

It is difficult for econometricians to collect capital stock data of developing countries. Hence, we use the summation of past investments as its proxy.

Nominal External Indebtedness

(3.24) $$D_{f,t} = \sum \left[\left(PM_t M_t \right) - \left(PE_t X_t \right) + Z^*_{f,t} \right]$$

Net import plus net factor payments abroad equal the flow of the external indebtedness. Hence, the stock of the external indebtedness is the summation with respect to time.

International Reserve

(3.25) $$R_t = R_{t-1} + F_t + \left(PE_t X_t \right) - \left(PM_t M_t \right) - Z^*_{f,t}$$

Changes of international reserves will be explained as net capital inflow plus net export minus net factor payments abroad. International reserves are equal to its flow plus the lagged international reserves.

Export Prices in US Dollar

(3.26) $$PE_t = PE_{dt} E_t$$

Export prices in the US dollar can be defined as export prices in the home currency by the exchange rate (the US dollar per the home currency).

Net factor payments abroad in US dollar (Real)

(3.27) $$Z_{f,t} = \left(Z^*_{f,t} / PM_t \right)$$

Nominal net factor payments abroad is deflated by import prices.

Behavior Equations

Agricultural Production

(3.28) $$Z_{a,t} = a_0 + a_1 t$$

We assume that agricultural production depends on time.

Consumption

(3.29) $$C_t / N_t = b_0 + b_1 \left(Z_{n,t} / N_t \right) + b_2 \left(C_{t-1} / N_{t-1} \right)$$

We explain per capita real consumption by per capita GNP and the lagged value of per capita real consumption.

Investment

(3.30) $$I_t = c_0 + c_1 Z_{d,t} + c_2 Z_{d,t-1}$$

Investments are explained by the real GDP and the lagged real GDP.

Export

(3.31) $$X_t = d_0 + d_1 TW_t + d_2 \left(PE_t / PW_t \right)$$

Exports are determined by the world trade volume index and the export prices relative to the world export prices.

Import

(3.32) $$M_t = e_0 + e_1 Z_{d,t} + e_2 \left(R_{t-1} / PM_{t-1} \right) + e_3 \left(PM_t / P_t E_t \right)$$

Imports are explained by explanatory variables; the real GDP, the import prices relative to the domestic prices in the US dollar and the international reserves deflated by the import prices.

Non-agricultural Production Potential

(3.33) $Z^{P}_{na,t} = f_0 + f_1 K_{t-1}$

Most developing countries have the capital shortage economies. Hence, non-agricultural production potential depends on the capital stocks.

Non-agricultural Production - Type I

(3.34) $Z_{na,t} \big/ Z^{P}_{na,t} = g_0 + g_1 M_t + g_2 Z_{a,t}$

This non-agricultural production function focuses on the supply side. The non-agricultural production potential and the real imports explain the non-agricultural production. Most developing countries import capital goods and intermediate inputs, therefore we assume that the real imports also determine the non-agricultural production.

Non-agricultural Production - Type II

(3.35) $Z_{na,t} = g_0 + g_1 C_t + g_2 I_t + g_3 X_t$

We can also formulate the non-agricultural production by the effective demands. In this case, explanatory variables are the real consumptions, the real investments and the real exports.

Agricultural Prices

(3.36) $P_{a,t} = h_0 + h_1 Z_{a,t} + h_2 Z_{a,t-1} + h_3 Z_{na,t}$

Agricultural prices are determined by the agricultural production and non-agricultural production. Non-agricultural production is a proxy variable of the demand for the agricultural products.

Non-agricultural Prices - Type I

$$P_{na,t} = i_0 + i_1\left(Z_{na,t} / Z^{P}_{na,t}\right) + i_2\left(MS_t / Z_{d,t}\right) + i_3 P_{a,t} + i_4 PM_t \qquad (3.37)$$

In one of the formulations of non-agricultural prices, it can be explained by the capacity utilization ratio, the ratio of the money supply to the real GDP, and the agricultural prices plus the import prices as production costs.

Non-agricultural Prices - Type II

$$P_{na,t} = i_0 + i_1 Z_{na,t} + i_2 Z_{na,t-1} + i_3\left(MS_t / Z_{d,t}\right) \qquad (3.38)$$

In another formulation of the non-agricultural prices, we assume that there is a non-agricultural production limitation. In this case, it will depend on the non-agricultural production, the lagged non-agricultural production and the ration of the money supply to the real GDP.

Prices

$$P_t = j_0 + j_1 P_{a,t} + j_2 P_{na,t} \qquad (3.39)$$

This model is the two-sector supply-determined system. Hence, Agricultural prices and non-agricultural prices determine the general prices.

Export Prices in the Home Currency

$$PE_{dt} = k_0 + k_1 P_t + k_2 X_t + k_3 PE_{d,t-1} \qquad (3.40)$$

Export prices are determined by the general prices, exports and the lagged dependent variable.

Nominal Net Factor Payments Abroad in the US Dollar

$$Z^{*}_{f,t} = l_0 + l_1 D_{f,t-1} + l_2\left(PE_t X_t\right) \qquad (3.41)$$

Nominal net factor payments abroad is explained by the interest payments of the external indebtedness as the payment factor and exports as the receivable factor.

3.1.3 Estimation Results

Structural equations of the ten countries/regions are estimated by time-series data.[10] Table 2 shows several features of our macroeconometric models. Though we provide only exchange rate function results that are most important in this analysis, we note that all macroeconometric models passed the final tests with good results. General notations on estimate results of exchange rates are as follows: the upper parenthesis = t-statistic, the lower bracket = p-value, Adj. R^2 = the adjusted R-squared, S. E. = the standard error, D. W. = the Durbin-Watson statistic, OLS = the ordinary least squares, NLS = the nonlinear least squares. A subscript is a degree of lags. Abbreviations of a country/region are as follows: IDN = Indonesia, MLS = Malaysia, PHL = the Philippines, SGP = Singapore, THA = Thailand, CHN = China, TWN = Taiwan, KOR = Korea, JPN = Japan, USA = the United States.

Indonesia

The Indonesian exchange rate function is as follows:

(3.42) EIDN = 2234.925 + 2.406*(D86LATER*E) + 972.969*LOG(PEX738393IDN/PEX92USA)

(13.108) (3.477) (5.216)

[0.0000] [0.0046] [0.0002]

- 3555.360*(($EXIDN_{-1}$-$IMIDN_{-1}$)/$GDPIDN_{-1}$) - 3019.846*D78 - 3617.243*D79_82

(-2.239) (-11.641) (-9.728)

[0.0448] [0.0000] [0.0000]

- 1298.339*D83_87 - 383.6732*D88_96

(-8.671) (-2.432)

[0.0000] [0.0316]

Adj. R^2 = 0.971 S. E. = 121.025 D. W. = 1.22 Sample: 1978-1997 Method: OLS

where EIDN is the Indonesian exchange rate, E is the Japanese exchange rate, PEX738393IDN is the export deflator of Indonesia (1973, 1983, 1993 = 100), PEX92USA is the export deflator of the United States (1992 = 100), ($EXIDN_{-1}$-$IMIDN_{-1}$)/$GDPIDN_{-1}$ is the lagged ratio of the nominal current account against the nominal GDP in Rupiah, D86LATER is a dummy variable (1986-the end of the simulation period = 1; otherwise 0), D78 is a dummy variable (1978 = 1; otherwise 0), D79_82 is a dummy variable (1979-1982 = 1; otherwise 0), D83_87 is a dummy variable (1983-1987 = 1; otherwise 0) and D88_96 is a dummy variable (1988-1996 = 1; otherwise 0). The Indonesian Rupiah is determined by the Japanese yen

(1986-), the home export deflator relative to the US export deflator and the ratio of current account against the nominal GDP. All statistics perform well except for the Durbin-Watson statistic. Based on the Durbin-Watson statistic, we can recognize the positive autoregressive process.

Malaysia

The Malaysian exchange rate function is estimated as follows:

(3.43) EMLS = 2.228 + 0.00066*(D85LATER*E) + 0.177*(D86LATER*EGER)
(64.271) (3.310) (9.515)
[0.0000] [0.0048] [0.0000]
+ 0.249*LOG(PEX7078MLS/PEX92USA) - 0.159*D79_80 - 0.165*D86_88
(4.859) (-4.446) (-4.823)
[0.0002] [0.0005] [0.0002]
- 0.133*D92_93 - 0.163*D95_96
(-3.648) (-4.549)
[0.0024] [0.0004]
Adj. R^2 = 0.935 S. E. = 0.044 D. W. = 2.522 Sample: 1975-1997 Method: OLS

where EMLS is the Malaysian ringgit per the US dollar, EGER is the deutschemark per the US dollar, D85LATER is a dummy variable (1985-the end of the simulation period = 1; otherwise 0), D79_80 is a dummy variable (1979-1980 = 1; otherwise 0), D79_80 is a dummy variable (1986-1988 = 1; otherwise 0), D92_93 is a dummy variable (1992-1993=1; otherwise 0) and D95_96 is a dummy variable (1995-1996 = 1; otherwise 0). The Malaysian ringgit depends on the Japanese yen (1985-), the deutschemark (1986-) and the relative prices of tradable goods. We can find that statistics provide sufficient results.

The Philippines

The estimation result of the Philippine exchange rate is as follows:

(3.44) EPHL = 17.647 + 0.0089*(D86LATER*E) + 11.608*LOG(PEX85PHL/PEX92USA)
(47.432) (1.969) (23.056)
[0.0000] [0.0706] [0.0000]
- 2.589*D79 + 2.452*D90_91 + 1.652*D93
(-3.098) (3.999) (2.032)

[10] As for data sources, see Appendix A.

[0.0085]   [0.0015]   [0.0631]

Adj. R^2 = 0.990 S. E. = 0.768 D. W. = 1.788 Sample: 1979-1997 Method: OLS

where EPHHL is the exchange rate of the Philippines, D79 is a dummy variable (1979 = 1; otherwise 0), D90_91 is a dummy variable (1990-1991 = 1; otherwise 0) and D93 is a dummy variable (1993 = 1; otherwise 0). The Philippine peso is determined by the Japanese yen (1986-) and the relative export deflators. The Japanese yen is not statistically significant at the 95 percent level but is at the 90 percent level. In exception to that, we can conclude that this function is well-estimated.

Singapore

The Singaporean exchange rate function is estimated as follows:

(3.45) ESGP = 1.458 + 0.00135*(D85LATER*E)

(19.738) (4.779)

[0.0000] [0.0004]

+ 1.0892*LOG($PGDP8590SGP_{-2}/PGDP92USA_{-2}$)

(4.251)

[0.0011]

- 1.299*($NEXSGP_{-1}/GDPSGP_{-1}$) + 0.190*D79_89 + 0.109*D84 - 0.152*D85

(-2.893)   (3.862)   (1.982)   (-2.108)

[0.0135]   [0.0023]   [0.0709]   [0.0567]

Adj. R^2 = 0.972 S. E. = 0.049 D. W. = 1.663 Sample: 1979-1997 Method: OLS

where ESGP is the Singaporean dollar per the US dollar, PGDP8590SGP is the GDP deflator of Singapore (1985, 1990 = 100), PGDP92USA is the US GDP deflator (1992 = 100), NEXSGP is the nominal net export of Singapore, D79_89 is a dummy variable (1979-1989 = 1; otherwise 0), D84 is a dummy variable (1984 = 1; otherwise 0) and D85 is a dummy variable (1985 = 1; otherwise 0). The Japanese yen (1985-), the relative GDP deflators and the current account determine the value of the Singaporean dollar. Though most statistics show good results, the Durbin-Watson statistic shows the positive autoregressive process.

Thailand

The estimated exchange rate function of Thailand is as follows:

(3.46) ETHA = 30.215 + 0.0108*E - 0.098*($RGBTHA_{-2}-RGBUSA_{-2}$)

(45.047) (2.544) (-2.112)

[0.0000] [0.0273] [0.0584]

$- 5.680*((EXTHA_{-3}-IMTHA_{-3})/GDPTHA_{-3}) - 12.300*D78\_80 - 10.333*D81\_83$

(-2.677) (-32.876) (-23.559)

[0.0215] [0.0000] [0.0000]

- 9.415*D84 - 5.728*D85 - 6.152*D86_96

(-20.875) (-12.587) (-29.624)

[0.0000] [0.0000] [0.0000]

Adj. R^2 = 0.995 S. E. = 0.180 D. W. = 2.244 Sample: 1978-1997 Method: OLS

where ETHA is the Thai exchange rate, RGBTHA is the government bond yield of Thailand, RGBUSA is the US government bond yield, EXTHA is the nominal export of Thailand, IMTHA is the nominal import of Thailand, GDPTHA is the Thai nominal GDP, D78_80 is a dummy variable (1978-1980 = 1; otherwise 0), D81_83 is a dummy variable (1981-1983 = 1; otherwise 0) and D86_96 is a dummy variable (1986-1996 = 1; otherwise 0). The Thai baht is determined by the interest rate difference and the current account. In the Thai case, the relative price is not statistically significant.

China

We estimate the Chinese exchange rate function as follows:

(3.47) ECHN = 8.228 + 0.004*(D85LATER*E) + 3.328*LOG(PGDP95CHN/PGDP92USA)

(22.279) (2.112) (1.970)

[0.0000] [0.0584] [0.0745]

- 3.496*D80_87 - 3.175*D88_89 - 1.973*D90_93 + [AR(1)=0.297]

(-3.169) (-3.703) (-2.911) (2.196)

[0.0089] [0.0035] [0.0142] [0.0504]

Adj. R^2 = 0.975 S. E. = 0.393 D. W. = 1.780 Sample: 1980-1997 Method: NLS

where ECHN is the Chinese exchange rate, PGDP95CHN is the Chinese GDP deflator (1995 = 100), D80_87 is a dummy variable (1980-1987 = 1; otherwise 0), D88_89 is a dummy variable (1988-1989 = 1; otherwise 0), D90_93 is a dummy variable (1990-1993 = 1; otherwise 0) and AR(1) is the first order autoregressive process. Though the Japanese yen (1985-) and the relative GDP deflators determine the Chinese yuan, the coefficient of the relative price is statistically significant at the 90 percent level.

Taiwan

The Taiwanese exchange rate function is estimated as follows:

(3.48) ETWN = 21.726 + 0.036*E + 39.565*LOG(PEX8691TWN/PEX92USA)
(20.390) (4.074) (9.948)
[0.0000] [0.0015] [0.0000]
- 0.314*($RSTWN_{-3}$-$RSUSA_{-3}$)
(-2.558)
[0.0251]
Adj. R^2 = 0.981 S. E. = 0.810 D. W. = 2.031 Sample: 1982-1997 Method: OLS

where ETWN is the exchange rate of Taiwan, PEX8691TWN is the export deflator of Taiwan (1986, 1991 = 100), RSTWN is the Taiwanese short-term interest rate and RSUSA is the US short-term interest rate. In the Taiwanese case, the Japanese yen, the relative export deflators and the interest rate difference explain the exchange rate. The current account does not affect the exchange rate. All statistics are acceptable.

Korea

The exchange rate function of Korea is estimated as follows:

(3.49) EKOR = 792.308 + 0.913*E + 1911.794*LOG(PEX95KOR/PEX92USA)
(19.445) (4.619) (7.307)
[0.0000] [0.0006] [0.0000]
- 7.938*(RSKOR-RSUSA) - 493.547*(($EXKOR_{-1}$-$IMKOR_{-1}$)/$GDPKOR_{-1}$)
(-1.851) (-2.714)
[0.0889] [0.0188]
+ [AR(1)=0.339]
(4.425)
[0.0008]
Adj. R^2 = 0.935 S. E. = 20.984 D. W. = 1.914 Sample: 1980-1997 Method: NLS

where EKOR is the Korean exchange rate, PEX95KOR is the export deflator of Korea (1995 = 100), RSKOR is the short-term interest rate of Korea, EXKOR is the Korean nominal export, IMKOR is the nominal import of Korea and GDPKOR is the Korean nominal GDP. In this estimation, we assume the first order autoregressive process. The Korean won is determined by the Japanese yen, the relative export deflators, the interest rate difference and the current account. The coefficient of the interest rate difference is not statistically significant at the 95 percent level, yet the Korean exchange rate function is estimated well.

Japan

The Japanese exchange rate function is estimated as follows:

(3.50) LOG(E) = 4.727 + 5.790*LOG(PGDP90/PGDP92USA) - 0.047*(RGB_{-2}-$RGBUSA_{-2}$)

(54.278) (4.926) (-1.806)

[0.0000] [0.0001] [0.0887]

- 10.512*((EX-IM)/GDP) - 0.130*D904 - 0.062*D932 - 0.105*D952

(-2.788) (-3.568) (-1.920) (-3.506)

[0.0126] [0.0024] [0.0717] [0.0027]

+ [AR(1)=0.608]

(4.670)

[0.0002]

Adj. R^2 = 0.958 S. E. = 0.033 D. W. = 2.017 Sample: 1990:1-1996:1 Method: NLS

where LOG(x) is the log of the variable x, PGDP90 is the Japanese GDP deflator (1990 = 100), RGB is the government bond yield of Japan, EX is the nominal export of Japan, IM is the Japanese nominal import, GDP is the nominal GDP of Japan, D904 is a dummy variable (the fourth quarter of the year 1990 = 1; otherwise 0), D932 is a dummy variable (the second quarter of the year 1993 = 1; otherwise 0), D952 is a dummy variable (the fourth quarter of the year 1995 = 1; otherwise 0). The relative GDP deflator, the long-term interest rate difference and the current account explain the Japanese yen - the US dollar rate. We estimate this function with the assumption of the first order autoregressive process. Although the interest rate difference is statistically significant at the 90 percent level, other statistics show good results.

3.1.4 Policy Reaction Functions

Policy variables, e.g. the short-term interest rate and the government expenditure, are exogenous ones in the general macroeconometric models. In this model, we estimate policy reaction functions to determine macroeconomic policy instruments endogenously. The monetary policy reaction function is estimated for both developed and developing countries/regions, and the fiscal one is estimated for only Japan and the United States. As for the monetary policy, we assume that the monetary policy instrument of the developed countries is the short-term interest rate and that of the developing countries/regions is the money supply. The general notations, subscripts and abbreviations on a country/region are the same as those in Section 3.1.3.

Indonesia

The monetary policy reaction function of Indonesia is estimated as follows:

(3.51) @PCH(M2IDN) = 0.644 - 0.228*(@PCH(PCP738393IDN$_{-1}$)) - 0.00013*EIDN$_{-1}$
(3.736) (-2.106) (-2.086)
[0.0028] [0.0570] [0.0590]
- 0.019*(@PCH((EXIDN-IMIDN)/GDPIDN)) - 0.007*RSIDN$_{-2}$
(-5.600) (-1.666)
[0.0001] [0.1215]
+ 0.179*D75_79 - 0.327*D75_82 + 0.400*D80 - 0.193*D83_87
(2.927) (-2.304) (3.974) (-2.511)
[0.0127] [0.0399] [0.0018] [0.0273]
+ [MA(1)=-0.990,BACKCAST=1977]
(-1593.123)
[0.0000]

Adj. R^2 = 0.760 S. E. = 0.058 D. W. = 2.516 Sample: 1977-1998 Method: NLS

where @PCH(x) is the one-period percentage change of the variable x, M2IDN is M2 of Indonesia, PCP738393IDN is the private consumption deflator of Indonesia (1973, 1983, 1993 =100), RSIDN is the short-term interest rate of Indonesia, D75_79 is a dummy variable (1975-1979 = 1; otherwise 0), D75_82 is a dummy variable (1975-1982 = 1; otherwise 0), D80 is a dummy variable (1980 = 1; otherwise 0), and MA(1) is the first order moving average term. The Indonesian monetary policy depends on the private consumption deflator change, the exchange rate, the current account and the short-term interest rate. They are statistically significant at the 90 percent, the 90 percent, the 99 percent and the 85 percent levels, respectively. Therefore, the Indonesian monetary authority focuses on the current account, in particular. This is because as Coresetti, Pesenti and Roubini [02, Table 23] shows, the ratio of foreign debts against the nominal GDP is relatively high in Indonesia, hence, the current account is the most important for repaying them. As for other statistics, results are acceptable in exception to the low adjusted R-squared.

Malaysia

The Malaysian monetary policy reaction function is estimated as follows:

(3.52) LOG(M2MLS) = 9.465 - 0.929*((EXMLS$_{-2}$-IMMLS$_{-2}$)/GDPMLS$_{-2}$)

(170.439) (-2.577)

[0.0000] [0.0180]

+ 0.131*(@TREND(1975)) + [MA(1)=0.953,BACKCAST=1975]

(33.884) (12.749)

[0.0000] [0.0000]

Adj. R^2 = 0.995 S. E. = 0.067 D. W. = 1.306 Sample: 1975-1998 Method: NLS

where M2MLS is M2 of Malaysia, EXMLS is the Malaysian nominal export, IMMLS is the nominal import of Malaysia, GDPMLS is the nominal GDP of Malaysia and @TREND(1975) is a time trend (1975 = 0). The Malaysian monetary policy is determined by its current account. The price level/change is not statistically significant. The Malaysian monetary authority also pays attention to balances between Malaysia and foreign countries/regions.

The Philippines

We estimate the Philippine monetary policy reaction function as follows:

(3.53) @PCH(M2PHL) = 0.216 - 0.137*(@PCH(PCP85PHL$_{-2}$)) - 0.003*EPHL

(3.754) (-1.390) (-2.199)

[0.0024] [0.1876] [0.0466]

- 1.309*((EXPHL-IMPHL)/GDPPHL) - 0.020*D75_92 - 0.103*D79

(-3.772) (-0.643) (-2.887)

[0.0023] [0.5317] [0.0127]

+ 0.290*D83 + 0.135*(D88_89)

(8.058) (4.479)

[0.0000] [0.0006]

Adj. R^2 = 0.900 S. E. = 0.032 D. W. = 1.627 Sample: 1978-1998 Method: OLS

where M2PHL is M2 of the Philippines, PCP85PHL is the private consumption deflator of the Philippines (1985 = 100), EXPHL is the nominal export of the Philippines, IMPHL is the nominal import of the Philippines, GDPPHL is the Philippine nominal GDP, D75_92 is a dummy variable (1975-1992 = 1; otherwise 0) and D83 is a dummy variable (1983 = 1; otherwise 0). The Philippine monetary policy is explained by the private consumption deflator, the exchange rate and the current account. Though the private consumption deflator is statistically significant at the 80 percent level, the exchange rate and the current account are statistically significant at the 95 percent and 99 percent levels, respectively. The Philippine monetary authority pays more attention to the current account than the domestic inflation. Though D75_92 is not statistically significant, we use it as an explanatory variable because the Philippine M2 data is not continuous before/after the year 1993.

Singapore

The Singaporean monetary policy reaction function is estimated as follows:

(3.54) @PCH(M2SGP) = 0.124 - 0.957*(@PCH(PCP8590SGP)) - 0.010*(RTBUSA-RMMSGP)

(10.595) (-4.707) (-1.404)

[0.0000] [0.0011] [0.1938]

+ 0.102*D75_89 - 0.072*D84 - 0.185*D85 - 0.157*D86 + 0.083*D89

(8.449) (-3.103) (-7.382) (-5.911) (3.485)

[0.0000] [0.0127] [0.0000] [0.0002] [0.0069]

+ 0.076*D94 + 0.161*D98 + [AR(3)=-0.666]

(2.742) (6.397) (-6.392)

[0.0228] [0.0001] [0.0001]

Adj. R^2 = 0.897 S. E. = 0.022 D. W. = 1.658 Sample: 1979-1998 Method: NLS

where M2SGP is M2 of Singapore, PCP8590SGP is the private consumption deflator of Singapore (1985, 1990 = 100), RTBUSA is the US treasury bill rate, RMMSGP is the money market rate of Singapore, D75_89 is a dummy variable (1975-1989 = 1; otherwise 0), D86 is a dummy variable (1986 = 1; otherwise 0), D89 is a dummy variable (1989 = 1; otherwise 0), D94 is a dummy variable (1994 = 1; otherwise 0), D98 is a dummy variable (1998 = 1; otherwise 0) and AR(3) is the third order autoregressive term. The domestic private consumption deflator and the interest rates difference between Singapore and the United States explain the money supply of Singapore. The p-value of the private consumption deflator is only 0.0011, hence, this is statistically significant at the 99 percent level. The interest rate difference is statistically significant at the 80 percent level. The Singaporean monetary authority conducts its monetary policy to control the domestic inflation.

Thailand

The estimation result of the Thai monetary policy reaction function is as follows:

(3.55) @PCH(M2THA) = 0.165 - 0.059*(@PCH(PCP7288THA)) - 0.163*(@PCH(ETHA))

(22.069) (-1.683) (-3.187)

[0.0000] [0.1117] [0.0057]

+ 0.029*D75_79 + 0.088*(D82_83) + 0.121*(D89_90)

(6.088) (8.202) (8.809)

[0.0000] [0.0000] [0.0000]

+ [MA(1)=-0.989,BACKCAST=1976]

(-3.376)

[0.0038]

Adj. R^2 = 0.797 S. E. = 0.021 D. W. = 2.215 Sample: 1976-1998 Method: NLS

where M2THA is M2 of Thailand, PCP7288THA is the private consumption deflator of Thailand (1972, 1988 = 100), D82_83 is a dummy variable (1982-1983 = 1; otherwise 0) and D89_90 is a dummy variable (1989-1990 = 1; otherwise 0). In Thailand, the monetary policy is determined by the private consumption deflator and the exchange rate. The private consumption deflator is statistically significant at the 85 percent level and the exchange rate is at the 99 percent level. The main policy target of the Thai monetary authority is controlling the value of the Thai baht per the US dollar. The adjusted R-squared is less than 0.800, however, other statistics show good results.

China

We estimate the Chinese monetary policy reaction function as follows:

(3.56) @PCH(M2CHN) = 0.098 - 0.460*(@PCH($AGR95CHN_{-3}$)) - 0.056*$ECHN_{-2}$

(0.809) (-1.668) (-3.546)

[0.4450] [0.1392] [0.0094]

- 2.385*(NEXCHN/GDPCHN) + 0.091*D84 - 0.117*D88

(-3.618) (1.554) (-2.348)

[0.0085] [0.1640] [0.0512]

- 0.136*D89 + 0.031*(@TREND(1975))

(-2.936) (2.953)

[0.0218] [0.0213]

+ [MA(1)=-0.926,BACKCAST=1983]

(-9.561)

[0.0000]

Adj. R^2 = 0.794 S. E. = 0.033 D. W. = 2.496 Sample: 1983-1998 Method: NLS

where M2CHN is M2 of China, AGR95CHN is the real agricultural production of China (the base year = 1995), NEXCHN is the nominal net export of China, GDPCHN is the nominal GDP of China and D88 is a dummy variable (1988 = 1; otherwise 0). The Chinese monetary policy is explained by the agricultural output, the exchange rate and the current account. The exchange rate and the current account are more statistically significant than that of the agricultural production. The GDP deflator is not statistically significant. The Chinese monetary authority focuses on the exchange rate and the current account rather than the inflation.

Taiwan

The monetary policy reaction function of Taiwan is estimated as follows:

(3.57) @PCH(M2TWN) = 0.513 - 0.538*(@PCH(GDP8691TWN$_{-1}$)) - 0.193*(@PCH(ETWN))

(13.122) (-8.462) (-2.361)

[0.0000] [0.0000] [0.0322]

- 0.014*RTBUSA - 0.018*D75_77 - 0.036*D89_90

(-4.679) (-0.617) (-2.226)

[0.0003] [0.5465] [0.0418]

- 0.014*(@TREND(1975))

(-9.862)

[0.0000]

Adj. R^2 = 0.926 S. E. = 0.020 D. W. = 2.162 Sample: 1977-1998 Method: OLS

where M2TWN is M2 of Taiwan, GDP8691TWN is the real GDP of Taiwan (base year = 1986 and 1991) and D75_77 is a dummy variable (1975-1977 = 1; otherwise 0). The economic growth, the exchange rate and the US treasury bill rate explain the money supply of Taiwan. The Economic growth and the US treasury bill rate are statistically significant at the 99 percent level, hence, the Taiwanese monetary authority focuses on both the domestic stability and the US monetary policy.

Korea

The estimation result of the Korean monetary policy reaction function is as follows:

(3.58) @PCH(M2KOR) = 0.160 - 0.250*(@PCH(PCP95KOR$_{-3}$)) - 0.678*(@PCH(GDP95KOR))

(3.534) (-3.165) (-3.281)

[0.0033] [0.0069] [0.0055]

+ 0.678*(@PCH(M2KOR$_{-1}$)) - 0.002*(@TREND(1975))

(4.545) (-2.078)

[0.0005] [0.0566]

+ [MA(1)=-0.989,BACKCAST=1979]

(-992.275)

[0.0000]

Adj. R^2 = 0.615 S. E. = 0.032 D. W. = 1.756 Sample: 1979-1998 Method: NLS

where M2KOR is M2 of Korea, PCP95KOR is the private consumption deflator of Korea (1995 = 100), GDP95KOR is the real GDP of Korea (base year = 1995). The monetary policy of Korea is explained by the private consumption deflator and the economic growth. The Korean monetary authority targets the economic growth without the inflation. As for statistics, we must note that the adjusted R-squared is relatively low.

Japan

Monetary Policy

The Japanese monetary policy reaction function is estimated as follows:

(3.59) RMM = -8.625 + 0.076*PCP90 + 0.989*RMM$_{-1}$ + 18.858*GR_M2CD

(-3.506) (3.318) (28.606) (2.160)

+ 8.283*GR_M2CD$_{-1}$ + 8.669*GR_M2CD$_{-2}$ + 12.439*GR_M2CD$_{-3}$

(1.148) (1.608) (2.217)

+ 12.015*GR_M2CD$_{-4}$ - 0.180*GR_M2CD$_{-5}$ Sum of lags = 60.0842

(1.658) (0.020) (5.811)

Adj. R^2 = 0.978 S. E. = 0.312 D. W. = 1.558 Sample: 1986:3-1996:1 Method: OLS

where RMM is the overnight call rate of Japan, PCP90 is the private consumption deflator of Japan (1990 = 100) and GR_M2CD is the percentage change of M2 plus certificates of deposits of Japan. The private consumption deflator and the money growth explain the Japanese monetary policy. For the estimation, we apply the Almon polynomial lag to the money growth (five lags and the third degree of polynomials). The money growth can be recognized as one of the intermediate targets of the monetary policy. Therefore, the Japanese monetary authority focuses on the domestic inflation.

Fiscal Policy

The Japanese fiscal policy reaction function is estimated as follows:

(3.60) GR4_IG90 = 0.098 - 1.113*GR4_GDP90 + 0.0006*(@MOVSUM(DFBAL,5))
(1.307) (-3.328) (0.598)
[0.2045] [0.0031] [0.5557]
+ 0.752*GR4_IG90(-1) + 0.067*D902 - 0.059*D932 - 0.067*D941
(9.001) (2.382) (-1.980) (-2.279)
[0.0000] [0.0263] [0.0603] [0.0327]
- 0.097*D943 - 0.069*D944 - 0.103*D951 + 0.141*D961
(-3.291) (-2.322) (-3.435) (4.278)
[0.0033] [0.0299] [0.0024] [0.0003]

Adj. R^2 = 0.864 S. E. = 0.027 D. W. = 1.807 Sample: 1988:1-1996:1 Method: OLS

where GR4_IG90 is the four-period percentage change of the real public investments (the base year = 1990) of Japan, GR4_GDP90 is the four-period percentage change of the real GDP (the base year = 1990) of Japan, @MOVSUM(DFBAL,5) is the five-period backward moving summation of the Japanese fiscal deficits, D902 is a dummy variable (the second quarter of the year 1990 = 1; otherwise 0), D941 is a dummy variable (the first quarter of the year 1994 = 1; otherwise 0), D943 is a dummy variable (the third quarter of the year 1994 = 1; otherwise 0), D944 is a dummy variable (the fourth quarter of the year 1994 = 1; otherwise 0), D951 is a dummy variable (the first quarter of the year 1995 = 1; otherwise 0) and D961 is a dummy variable (the first quarter of the year 1996 = 1; otherwise 0). The Japanese fiscal policy is determined by the GDP growth and the fiscal deficit per the nominal GDP, however, the fiscal deficit term is not statistically significant. The Japanese government has conducted its fiscal policy without any consideration to the deficits. Although this is the case, we explain the fiscal policy by the fiscal deficits term to integrate the fiscal adjustment mechanism into our model.

USA

Monetary Policy

The estimation result of the US monetary policy reaction function is as follows:

(3.61) RFFUSA = 5.051 + 116.804*GR4_PCP92USA - 0.598*URUSA + 24.426*GR4_M2USA

(7.303) (15.739) (-4.872) (6.662)

[0.0000] [0.0000] [0.0000] [0.0000]

- 0.749*D90 - 0.964*D91 - 1.425*D92 - 1.126*D93 + 0.800*D95

(-2.448) (-3.059) (-3.857) (-3.093) (2.810)

[0.0187] [0.0039] [0.0004] [0.0036] [0.0076]

Adj. R^2 = 0.925 S. E. = 0.495 D. W. = 0.836 Sample: 1986:1-1998:2 Method: OLS

where RFFUSA is the federal funds rate, GR4_PCP92USA is the four-period percentage change of the private consumption deflator of the United States (base year = 1992), URUSA is the US unemployment rate, GR4_M2USA is the four-period percentage change of the US money supply (M2), D90 is a dummy variable (4 quarters of the year 1990 = 1; otherwise 0), D91 is a dummy variable (four quarters of the year 1991 = 1; otherwise 0), D92 is a dummy variable (four quarters of the year 1992 = 1; otherwise 0), D93 is a dummy variable (four quarters of the year 1993 = 1; otherwise 0) and D95 is a dummy variable (four quarters of the year 1995 = 1; otherwise 0). The US monetary policy is determined by the domestic inflation, the unemployment rate and the money growth. In the case of the United States, rather than the GDP growth, the unemployment rate is statistically more suitable. The unemployment rate represents both the economic growth and the wage movements. Thus, the US Federal Reserve targets both the price stability and the GDP growth.

Fiscal Policy

The US fiscal policy reaction function is estimated as follows:

(3.62) LOG(IG92USA) = 2.451 + 0.026*(URUSA-$URUSA_{-4}$) - 0.474*LOG(GDP92USA)

(5.479) (10.568) (-2.722)

[0.0000] [0.0000] [0.0098]

+ 0.535*LOG(GRUSA/PCG92USA*100) + 0.559*LOG($IG92USA_{-1}$)

(3.899) (16.192)

[0.0004] [0.0000]

- 0.062*D911 - 0.049*D913 - 0.038*D941 + 0.033*D943

(-4.622) (-3.431) (-3.330) (2.741)

[0.0000] [0.0015] [0.0020] [0.0094]

+ [MA(1)=-0.989,BACKCAST=1986:1]

(-7.815)
[0.0000]
Adj. R^2 = 0.939 S. E. = 0.012 D. W. = 1.946 Sample: 1986:1-1997:3 Method: NLS

where IG92USA is the real public investments of the United States (1992 prices), GDP92USA is the real US GDP (1992 prices), GRUSA is the government revenue of the United States, PCG92USA is the US government consumption deflator (1992 = 100), D911 is a dummy variable (the first quarter of the year 1991 = 1; otherwise 0) and D913 is a dummy variable (the third quarter of the year 1991 = 1; otherwise 0). The unemployment, the GDP growth and the real government revenue explain the US fiscal policy. Due to the huge deficits, the US fiscal policy has not played an important role as one of the macroeconomic policies, however, we find that the US fiscal authority conducts its policy with consideration to the GDP growth and the level of the government revenue.

3.2 International Input-Output Model[11]

An international input-output model is formulated as below.[12]

Variables

a_{ij}^{k} = Input coefficient of the *i*th sector in the *j*th sector of the *k*th country/region

X_{j}^{k} = Total output in the *j*th sector of the *k*th country/region

$X_{ij(h)}^{k}$ = Imports of the *i*th commodity from the *h*th country/region in the *j*th sector of the *k*th country/region

$s_{(ijk)}$ = Each country/region's elasticity of substitution of the *i*th commodity in the *j*th sector of the *k*th country/region

$m_{ij(h)}^{k*}$ = Initial share coefficient of the *i*th commodity of the *h*th country/region in the *j*th sector of the *k*th country/region

$PX_{ij(h)}^{k}$ = Export prices of the *i*th commodity of the *h*th country/region in the *j*th sector of the *k*th country/region

[11] This international input-output model was originally developed by Kosaka [14, 15].
[12] For another formulation of an international input-output model, see Torii and Akiyama [28].

t_i^k = Tariff rate of the *i*th commodity of the *k*th country/region (=Tariff on the *i*th commodity of the *k*th country/region / import of the *i*th commodity of the *k*th country/region)

$F_{i(h)}$ = Final demand in the *i*th sector of the *h*th country/region

$X_{i(h)}$ = Total output in the *i*th sector of the *h*th country/region

C_{j1}^k = Tariff on the import of the *i*th commodity in the *j*th sector of the *k*th country/region

C_{j0}^k = International freight and insurance, and others. in the *j*th sector of the *k*th country (= Total cost of the international freight and insurance, tariff and others. - tariff)

c_{jo}^k = Initial ratio of international freight and insurance, and others. to the total output in the *j*th sector of the *k*th country/region

F^k = Final demand of the *k*th country/region

F^o = Final demand of the rest of the world

H^k = Converter matrix of the final demand of the *k*th country/region (= f_{ig}^k)

g^k = Final demand of the *k*th country/region transferred from its macroeconometric model

P_i^q = Prices in the *i*th sector of the *q*th country/region (the base year = 1)

$sf_{(igk)}$ = Elasticities of substitution of the final demands of the *k*th country/region

f_{ig}^{k*} = Initial shares of final demands of the *k*th country/region

P_j^k = Prices in the *j*th sector of the *k*th country/region (the base year = 1)

v_j^k = Value added coefficient in the *j*th sector of the *k*th country/region

W_j^k = Wage in the *j*th sector of the *k*th country/region

V_{j0}^k = Value added minus wage in the *j*th sector of the *k*th country/region

w_j^k = Wage rate in the *j*th sector of the *k*th country/region

L_j^k = Employment in the *j*th sector of the *k*th country/region

b_j^k = Elasticity of labor input in the *j*th sector of the *k*th country/region

w^k = Wage rate of the *k*th country/region

v_{j0}^k = Ratio of value added minus wage to the total output in the *j*th sector of the *k*th country/region

τ_i^h = Export subsidy of the ith exported commodity of the hth country/region

Intermediate Input and Technical Coefficient

(3.63) $$X_{ij}^k = a_{ij}^k X_j^k$$

(3.64) $$a_{ij}^k = \sum_h X_{ij(h)}^k \Big/ X_j^k$$

i, j: sector k, h: country/region

Intermediate inputs for the unit production of the jth sector in the kth country/region, in other words, the technical coefficients, are defined in the same manner as those of a domestic input-output model.

International Transaction of Intermediate Input

(3.65) $$X_{ij(h)}^k \Big/ X_{ij}^k = m_{ij(h)}^{k*} \left\{ \left(1 + t_i^k\right) PX_{ij(h)}^k \Big/ \left[\sum_{q \neq h} m_{ij(q)}^{k*} \left(1 + t_i^k\right) PX_{ij(q)}^k \right] \right\}^{-s_{(ijk)}}$$

q: competitors

Hickman-Lau [11] developed a trade linkage system for the Project LINK, hence, we can use their model to explain international transactions of intermediate inputs. The ratio of the ith commodity of the hth country/region in the jth sector of the kth country/region to the ith commodity in the jth sector of the kth country/region is determined by the initial trade share, the export prices of the hth country/region relative to that of the qth country/region and the elasticity of substitution.

Total Output

(3.66) $$\sum_j \sum_k X_{ij(h)}^k + F_{i(h)} = X_{i(h)}$$

$$i = 1, \cdots, M; h = 1, \cdots, N$$

The hth country/region's output of the ith sector equals its intermediate inputs plus its final demands.

Final Demand

$$(3.67)\qquad \begin{aligned} F &= \sum_k F^k + F^o \\ &= \sum_k H^k g^k + F^o \end{aligned}$$

where $H^k = \left(f_{ig}^k\right) = \left(\sum_{q \neq k} P_i^q \Big/ P_i^k\right)^{sf_{(igk)}} f_{ig}^{k*}$.

In our model, macroeconometric models are linked to an international input-output model enabling the use to treat final demands as endogenous variables. Final demands derived from macroeconometric models will be allocated to each sector by shares. Shares are explained by the initial shares, the competitors' prices relative to the home country's prices and elasticities of substitution.

International Freight and Insurance, Tariff and others

We can divide the international freight and insurance, tariffs and others into two components: tariffs and the others.

Tariff

$$(3.68)\qquad C_{j1}^k = \sum_{h \neq k} \sum_i t_i^k PX_{ij(h)}^k X_{ij(h)}^k$$

Tariffs equal imports by the tariff rate in the *j*th sector of the *k*th country/region.

International Freight and Insurance, and others

$$(3.69)\qquad C_{j0}^k = c_{jo}^k X_j^k$$

International freight and others can be defined by international freight and insurance, tariff and others minus tariff. We suppose a ratio of the initial international freight and insurance, and others to the initial output as fixed over the periods.

Prices

(3.70) $$P_j^k X_j^k = V_j^k + \sum_i \sum_h PX_{ij(h)}^k X_{ij(h)}^k + \left(C_{j1}^k + C_{j0}^k\right)$$

Dividing equation (3.70) by X_j^k yields

(3.71) $$\begin{aligned} P_j^k &= V_j^k \big/ X_j^k + \sum_i \sum_h PX_{ij(h)}^k X_{ij(h)}^k \Big/ X_j^k + \left(C_{j1}^k + C_{j0}^k\right) \Big/ X_j^k \\ &= v_j^k + \sum_i \sum_h PX_{ij(h)}^k X_{ij(h)}^k \Big/ X_j^k + \left(C_{j1}^k \big/ X_j^k + c_{j0}^k\right) \end{aligned}$$

In our system, the cost structure can be written as equation (3.70). Prices in the *j*th sector of the *k*th country/region are set as the numeraire. Hence, we can rewrite equation (3.70) as equation (3.71) and it determines prices.

Value Added

(3.72) $$V_j^k = W_j^k + V_{j0}^k = w_j^k L_j^k + V_{j0}^k$$

(3.73) $$w_j^k = f\left(w^k\right)$$

(3.74) $$L_j^k = a_j^k \left(X_j^k\right)^{b_j^k} \qquad b_j^k < 1$$

We divide value added into two categories; wages and the others. Furthermore, wages can be divided into the wage rate and employment of each sector. The wage rate of each sector is explained by that of a country/region derived from its macroeconometric model. The employment of each sector is determined by Ozaki [24]'s employment function.

(3.75) $$v_j^k = V_j^k \big/ X_j^k = w_j^k L_j^k \big/ X_j^k + V_{j0}^k \big/ X_j^k = w_j^k L_j^k \big/ X_j^k + v_{j0}^k$$

Value added coefficients are described as equation (3.75) and linked to the prices determination equation.

Export Prices

(3.76) $PX_{ij(h)}^{k} = P_i^h$

(3.77) $PX_{ij(h)}^{k} = \left(1 - \tau_i^h\right)P_i^h$

There are two methods to formulate export prices. When there are not any export subsidies, export prices can be explained as equation (3.76). If the *h*th country/region puts export subsidies in the *i*th commodity, export prices are determined as equation (3.77).

4 Simulation Analyses on the Asian Currency Crises

4.1 Formulation of a Currency Basket

4.1.1 Theoretical Methodologies

A currency basket system is one of the exchange rate policies, which pegs a home currency to a basket of currencies. There are two main methods to determine a currency basket; the harmonic average one and the arithmetic average one.

The Harmonic Average Method

In the case of the harmonic average formulation, we can write a currency basket as follows:

(4.1) $\left(1/R_t\right) = \sum_i x_i \left(1/R_{it}\right)$

where R_t is an exchange rate of the home country at time t, x_i is the unit of the *i*th currency and R_{it} is the *i*th currency at time t. The unit of the *i*th currency depends on the assigned share to it. In this method, the inverse of the *i*th currency multiplied by its unit should equal its share. In equations, this rule can be written as:

(4.2) $\rho_i = x_i R^* / R_i^*$

where ρ_i is the share of the *i*th currency, R^* is the initial home currency , R_i^* is the initial *i*th currency. Hence, the *i*th currency's unit can be expressed as:

(4.3) $$x_i = \rho_i R_i^* / R^* .$$

By using this unit, a currency basket with a harmonic average method can be obtained as:

(4.4) $$(1/R_t) = \sum_i (\rho_i R_i^* / R^*)(1/R_{it}).$$

The Arithmetic Average Method

A currency basket in the arithmetic average manner can be written as:s

(4.5) $$R_t = \sum_i x_i R_{it} .$$

As in the harmonic average method, an initial exchange rate multiplied by its unit is equal to its weight. In an equation, we can write this rule as:

(4.6) $$\rho_i = x_i R_i^* / R^* .$$

The unit of the *i*th currency can be written as:

(4.7) $$x_i = \rho_i R^* / R_i^* .$$

Inserting equation (4.7) into equation (4.5), a currency basket in the arithmetic average rule can be re-formulated as:

(4.8) $$R_t = \sum_i (\rho_i R^* / R_i^*) R_{it} .$$

4.1.2 Estimating the Shares of Composite Currencies

4.1.2.1 The Method

Though Thailand (the origin of the Asian currency crises) was under a currency basket peg policy, it is said that the Thai exchange rate policy was the de-facto dollar peg because the share of the US dollar was extremely high.[13] Governments/monetary authorities do not announce their compositions of currency baskets in most cases, hence, we must estimate them using an appropriate method. Frankel-Wei [07][14] and Kwan [19] estimate implicit currency shares by regression analyses with changes of composite currencies. Those studies are summarized in Takagi [27]. In this study, we will use the arithmetic average method to estimate currency shares instead of using changes of composite currencies like Frankel-Wei [07] and Kwan [19].

Equation (4.8) shows a currency basket in the arithmetic average rule. The summation of currency shares should be equal to 100.0 percent (or 1.00). Under this condition, equation (4.8) can be rewritten as:

$$(4.9) \qquad R_t = \sum_i \rho_i \left(R^* / R_i^*\right) R_{it} \ , \qquad \sum_i \rho_i = 1 \, .$$

All exchange rates can be given in the manner of the home currency per the US dollar, hence, we can re-formulate equation (4.9) as:

$$(4.10) \qquad R_t = \left(1 - \sum_{i=2} \rho_i \right) R^* + \sum_{i=2} \rho_i \left(R^* / R_i^*\right) R_{it} \, , \qquad \rho_1 = 1 - \sum_{i=2} \rho_i$$

where ρ_1 is the share of the US dollar. We can estimate this econometrically and suppose that the constant term is the part of the currency basket pegged to the US dollar.[15] Estimation results are provided in Table 3.

4.1.2.2 Estimation Results

Indonesian Rupiah

In Indonesia, the currency basket peg policy had been adopted since the year 1978. As a result of the Asian currency crises, the Indonesian exchange rate policy was changed to the free-floating system. Our analysis shows that the Indonesian monetary authority composed its currency basket with the US dollar

[13] According to Frankel-Wei [07], shares of the US dollar and the Japanese yen were estimated at 91 and 5 percents, respectively, for the sample period from 1979 to 1992.
[14] Frankel-Wei [07] uses the Swiss franc as the numeraire currency.
[15] Though we can treat exchange rates at the initial time as exogenous, they were estimated in this analysis. As for details, see Appendix B.

and the Japanese yen. The weight on the Japanese yen has been statistically significant since 1986. It was estimated at approximately 30.0 percent between the years 1986 and 1987, however, it decreased to and has stayed at roughly 12.0 percent since 1988. Frankel-Wei [07] also reported that the weight assigned to the Japanese yen was really high between the years 1985 and 1986, and was estimated at approximately 16.0 percent in the full sample periods (1979-1992).[16] Among the ASEAN countries, Indonesia assigned a higher weight to the Japanese yen.

Malaysian Ringgit

The Malaysian monetary authority adopted the managed float system and monitored the value of the Malaysian ringgit against the currency basket composed by major trading partners' currencies. The Malaysian ringgit has been pegged to the US dollar since the year 1998. Our analysis shows that the US dollar, the deutschemark and the Japanese yen received the weights of approximately 82.0 percent, 14.0 percent and 4.0 percent, respectively. In this analysis of Frankel-Wei [07], coefficients of the 3 currencies above were statistically significant and the weight of the deutschemark was twice as much as that of the Japanese yen.

The Philippine Peso

The Philippine peso has been determined by its demand and supply in the foreign exchange market. In other words, the Philippine exchange rate system has been under the free float one. Our estimated weights on the US dollar and the Japanese yen are roughly 90.0 percent and 10.0 percent, respectively. Though the weight of the Japanese yen is statistically significant in our analysis, this was not the case in Frankel-Wei [07] and Kwan [19].

Singapore Dollar

The managed float system has been adopted as the exchange rate policy in Singapore. The Singaporean monetary authority checks the volatility of the Singapore dollar against a currency basket composed by major trading partner currencies like Malaysia. According to our analysis, the US dollar and the Japanese yen compose the Singaporean currency basket. The weights are estimated at roughly 90.0 percent for the US dollar and 10.0 percent for the Japanese yen. Frankel-Wei [07] and Kwan [19] reported that the rough 12.0 percent of the weight was assigned to the Japanese yen as well. The deutschemark share is also statistically significant in their analyses, however, it is not in our analysis.

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[16] Frankel-Wei [07] explains that Indonesia assigned high weight to the yen, due to the increase of the debt in the Japanese yen.

Thai Baht

The Thai baht had been pegged to a currency basket from 1978 to 1996. It was composed by the US dollar and the Japanese yen with the weights of approximately 86.0 percent and 14.0 percent (1978-1980), 89.0 percent and 11.0 percent (1981-1985), and 95.0 percent and 5.0 percent (1986-1996), respectively. By using the data of 1979-1992, it was estimated at roughly 5.0 percent in Frankel-Wei [07]. Frankel-Wei [07] also shows that it was roughly 12.0 percent between the years 1991 and 1992. Kwan [19] also estimated it at approximately 11.0 percent between January, 1991 and May, 1995. The Thai baht seems to have given higher weight to the Japanese yen since 1991.

New Taiwan Dollar

The Taiwanese monetary authority had adopted the managed floating system between the years 1982 and 1988 and has adopted the free floating one since the year 1989. The new Taiwan dollar gives the weights at the US dollar of approximately 80 percent and the Japanese yen at roughly 20.0 percent. The 20.0 percent weight of the Japanese yen is the highest among the Asian countries/regions.

Frankel-Wei [07] estimated the weight of the Japanese yen at roughly 5.0 percent between the years 1979 and 1992. Kwan [19] reported as well that it was approximately 7.0 percent in the sample period from January, 1991 to May, 1995. Kwan [19] also estimated it with weekly data (1st week of January, 1995-3rd week of August, 1995) and reported that it was roughly 31.0 percent. The Taiwanese monetary authority has recently seemed to give higher weight to the Japanese yen.

Chinese Yuan

The Chinese monetary authority had adopted the dual currency system until the year 1993. In 1994, it reformed the system and adopted the market rate as the official rate. It is said that the earlier official rate was overvalued. Hence, this reform was the de-facto devaluation of the Chinese yuan.

According to our analysis, the Chinese monetary authority conducted its exchange rate policy with attention to the US dollar and the Japanese yen. Until the year 1993, the coefficient for the Japanese yen was not statistically significant, thus the Chinese yuan seemed to be pegged to the US dollar. Frankel-Wei [07] also shows almost the same result in the sample period of the years between the years 1979 and 1992. Though the Japanese yen's share has been statistically significant since the year 1994, its share is estimated at roughly 4.7 percent and the remaining 95.3 percent is assigned to the US dollar.

Korean Won

The Korean won had been pegged to the currency basket between the years 1980 and 1996. As a result of our estimation, we found that the US dollar and the Japanese yen composed the Korean currency basket with weights of approximately 88.2 percent and 11.8 percent, respectively. The weight of the Japanese yen was relatively high among the Asian countries. Kwan [19] also estimated the weight of the Japanese yen by using weekly data in the periods from 1986 to 1990 and from 1991 to 1995. Roughly 11.0 percent and 6.0 percent of the weights were assigned to the Japanese yen, respectively. Though both Kwan [19] and our estimates showed high weights on the Japanese yen, Frankel-Wei [07] concluded that the share of the Japanese yen was low or negative.

As a result of this estimation, we find that the high weight is assigned to the Japanese yen in NIEs countries/regions whose industrial structures are similar to Japan's. We also find that the weight on the Japanese yen is relatively low in the ASEAN countries who will not compete with Japan in the export market. The range of the weight assigned to the Japanese yen is roughly between 5.0 percent and 20.0 percent. Hence, we can conclude that the Asian currencies were nearly pegged to the US dollar.

4.1.3 Combining Currency Baskets with Econometric Models

Though we can combine a currency basket, equation (4.10), with a macroeconometric model directly, we adopted the following manner. As we explained, the exchange rates of the Asian countries/regions were almost pegged to the US dollar. They were not completely fixed and data showed that they fluctuated. Let us suppose that relative prices, the interest rate difference and the current account per GDP make the exchange rates fluctuate around the pegged level on a short term basis, then we interpret that the intercept of the exchange rate function, equation (3.19), is the level that the monetary authorities link to the US dollar. Hence, the constant term of the Filatov-Klein exchange rate model can be explained by the currency basket function instead of the estimated intercept. In equation form, we can write an exchange rate function with a currency basket as:

$$(4.11)\qquad e_t = \left(1 - \sum_{i=2} \rho_i\right) R^* + \sum_{i=2} \rho_i \left(R^* / R_i^*\right) R_{it} + o_1 \ln\left(P_t / P_{US,t}\right) + o_2\left(r_t - r_{US,t}\right) + o_3\left(Bal_t / P_t Z_t\right).$$ [17]

4.2 Simulation Analyses on the Exchange Rate Policy

Industrial structures of the Asian countries/regions are different from one another. Generally, the industrial structures of the Asian NIEs (Singapore, Taiwan and Korea) are similar to that of the US and Japan. They compete with Japan in the US market who holds the largest market worldwide. The ASEAN (Indonesia, Malaysia, the Philippines and Thailand) and China will not compete with Japan in the world

[17] Though the original Filatov-Klein model was in log form, we do not use logarithm due to the combining of a

market due to the difference of industrial structure. Therefore, the effects of the yen-dollar rate's movements differ between the Asian NIEs, and the ASEAN and China. We analyze the Asian trade patterns with reference to the weaker yen from the year 1995.

4.2.1 The NIEs Case

The weaker yen from 1995 led to less expensive Japanese products. This means that the competitors' (e.g. the Asian NIEs) export competitiveness was lowered. Thus, their exports to other countries are expected to decrease. Here, we analyzed the case of Korea. In order to maintain its competitiveness, Korea would supposedly increase the weight of yen. We have increased it at a 5.0 percent level from 1995 to examine the changes of the Korean and the Japanese exports to the other countries/regions.

Table 4 shows selected sectors' import changes from the Business as Usual (BAU) scenario. We chose Malaysia as the other country/region as an example. For intermediate inputs, we have found large changes in these categories: weaving and dyeing, leather and leather products, and motorcycles and bicycles industries. According to our results, the Korean exports will have an increase of over 10,000 dollars except for in the leather and leather products sector. Meanwhile, the Japanese exports will show a decrease of under 5,000 dollars. With regards to final demands, there will be considerable changes in the exports of the metal products, heavy electric machinery, and engines and turbines sectors. Korea's heavy electric machinery exports will increases over 100,000 dollars. On the other hand, Japan's heavy electric machinery exports will show a decrease of roughly 50,000 dollars. By increasing the weight of yen in the Korean currency basket, Korean exports will increase and Japanese exports will decrease. We find this increase/decrease in both intermediate inputs and final demands as well as large changes in the final demand sectors - the reason being that Korea and Japan mainly produce final goods. Table 4 also presents percentage changes in the Korean and Japanese exports to Malaysia. All changes are less than 0.1 percent. In particular, percentage changes of Japanese exports are quite minute. These results indicate that increasing the yen's weight under the movement of the weaker yen will prevent the Asian currencies from losing their competitiveness, however small the effects may be.

4.2.2 The ASEAN and China Case

As for the ASEAN and China, the weaker yen will improve their current accounts. They import mainly capital goods from Japan, and those prices in the US dollar will decrease by the weaker yen. Therefore, we expect exports of Japan to the ASEAN and China to be decreased. We have created a strong yen movement from 1995 by subtracting 0.5 from the constant term of the Japanese exchange rate function. Then, we have chosen Thailand as an example to check the differences of the Japanese exports to

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currency basket.

Thailand. This simulation result is in Table 5. For intermediate inputs, there are big changes in other basic industrial chemicals, glass and glass products, and electronics and electronic products sectors. We find the largest effect in the glass and glass products industry. As for final demands, exports of cement and cement products, metal products, and ordinary industrial machinery change greatly among the 78 sectors. Comparing the increase of intermediate inputs to that of final demands, the figures are much larger in intermediate inputs. Percentage changes in Table 5 range from 0.2 percent to 0.3 percent for intermediate inputs and from 0.02 percent to 0.17 percent for final demands. Though the weak Japanese yen will decrease the Japanese exports to Thailand, the effects are expected to be limited.

4.3 A Simulation on Investment Booms

Over-borrowings and over-investments were found in Asia. International capital inflows increased not only investments but also imports. Investments, imports and manufacturing production are explained by using foreign capitals (net direct investments, net portfolio investments and net other investments). Then, we assume that a country controls its capital inflows to 70.0 percent. In this analysis, we examine the Thai imports movements.

Table 6 presents changes in the Thai imports for selected sectors. Regarding intermediate inputs, there are large effects in the fiber crops, fish products, and weaving and dyeing sectors, in particular. A decrease of imports in the weaving and dyeing sector is three times larger than the other two sectors, coming to roughly 18,000,000 dollars in 1992 and 25,000,000 dollars in 1997. As for final demands, large amounts of imports are decreased in the slaughtering, meat products and daily products, knitting, and chemical fertilizers and pesticides industries. They range from 50,000 dollars to 3,800,000 dollars. Decreases in intermediate inputs are much larger than those in final demands. This shows that the international capital flowed into Thailand had induced imports of intermediate goods rather than final goods. We also find that decreases from 1994 to 1996 are smaller than in other years. Table 7 shows growth rates of foreign capitals invested in Thailand between the years 1990 and 1997. In 1992, the summation of the three foreign investments is recorded at approximately -20.0 percent. Except for the years 1992, 1996 and 1997, the growth rates are positive. Hence, we consider that the minus growth rate in 1992 and low growth rates between the years 1993 and 1994 had affected decreases of imports from 1994 to 1996 because of the need for time lags in investments. Percentage changes range roughly from -5.5 percent to -0.1 percent. The figures are the largest among the three simulations, though the results cannot be simply compared.

5 Conclusions

In this study, we estimated currency composites in the Asian currency baskets. Then, we constructed an international input-output model linked with macroeconometric models of Indonesia, Malaysia, the Philippines, Singapore, Thailand, China, Taiwan, Korea, Japan and the United States. Using this system, we tested the effects of the Asian currency basket policies on trade patterns and that of investment booms on trade patterns. Findings can be summarized as follows:

1. The weight of the Japanese yen has been low in the Asian currency baskets. It ranges roughly from five percent to twenty percent.
2. In the process of the weak yen movements, increasing the weight of yen helps the Asian countries/regions whose industrial structures are similar to that of Japan's (e.g. the Asian NIEs) to maintain their competitiveness.
3. As for a country/region whose industrial structure is complementary to Japan (e.g. ASEAN and China), the weaker yen improves their current accounts.
4. International capital inflows increased investments and imports. If the Asian governments had controlled capital inflows, trade deficits might have been less than they were.

In this analysis, we treat policy instruments as given. Though we can simulate the effects of a given policy instrument, we cannot evaluate whether that policy instrument is optimal. For further analysis, we will compute the optimal policy instruments through estimations of the social welfare functions by optimal control techniques.

Table 1 Sector Classification

01	Paddy	37	Pulp and paper
02	Cassava	38	Printing and publishing
03	Natural rubber	39	Synthetic resins and fiber
04	Sugar cane and beet	40	Other basic industrial chemicals
05	Oil palm and coconuts	41	Chemical fertilizers and pesticides
06	Fiber crops	42	Drugs and medicine
07	Other grain	43	Other chemical products
08	Other food crops	44	Refined petroleum and its products
09	Other commercial crops	45	Tires and tubes
10	Livestock and poultry	46	Other rubber products
11	Forestry	47	Cement and cement products
12	Fishery	48	Glass and glass products
13	Crude petroleum and natural gas	49	Other non-metallic mineral products
14	Copper ore	50	Iron and steel
15	Tin ore	51	Non-ferrous metal

16	Iron ore	52	Metal products
17	Other metallic ore	53	Agricultural machinery and equipment
18	Non-metallic more and quarrying	54	Specialized industrial machinery
19	Oil and fats	55	Ordinary industrial machinery
20	Milled rice	56	Heavy electric machinery
21	Other milled grain and flour	57	Engines and turbines
22	Sugar	58	Electronics and electronic products
23	Fish products	59	Other electric machinery and appliance
24	Slaughtering, meat products and daily products	60	Motor vehicles
25	Other food products	61	Motorcycles and bicycles
26	Beverage	62	Aircrafts
27	Tobacco	63	Shipbuilding
28	Spinning	64	Other transport equipment
29	Weaving and dyeing	65	Precision machines
30	Knitting	66	Plastic products
31	Wearing apparel	67	Other manufacturing products
32	Other made-up textile products	68	Electricity, gas and water supply
33	Leather and leather products	69	Building construction
34	Timber	70	Other construction
35	Wooden furniture	71	Wholesale and retail trade
36	Other wooden products	72	Transportation

Table 1 (continued)

73	Telephone and telecommunication	76	Other services
74	Finance and insurance	77	Public administration
75	Education and research	78	Unclassified

Table 2 Several Features of Macroeconometric Models

	Indonesia	Malaysia	Philippines	Singapore	Thailand
Type	Supply	Supply	Supply	Demand	Supply
Endogenous variables	50	48	50	34	53
Exogenous variables	12	14	9	13	14
Frequency	Annual	Annual	Annual	Annual	Annual
Final test	1978-1997	1975-1997	1980-1997	1979-1997	1978-1997

	China	Taiwan	Korea	Japan	USA
Type	Supply	Demand	Demand	Demand	Demand
Endogenous variables	37	42	46	75	56
Exogenous variables	9	13	13	14	9
Frequency	Annual	Annual	Annual	Quarterly	Quarterly
Final test	1983-1997	1982-1997	1980-1997	1990:1-1996:1	1985:1-1998:2

Table 3 Shares of Composite Currencies in the Asian Currency Baskets

	Indonesia		Malaysia		
	US Dollar	Yen	US Dollar	Yen	Deutschemark
1978	1.000	0.000	1.000	0.000	0.000
1979	1.000	0.000	1.000	0.000	0.000
1980	1.000	0.000	1.000	0.000	0.000
1981	1.000	0.000	1.000	0.000	0.000
1982	1.000	0.000	1.000	0.000	0.000
1983	1.000	0.000	1.000	0.000	0.000
1984	1.000	0.000	1.000	0.000	0.000
1985	1.000	0.000	1.000	0.000	0.000
1986	0.702	0.298	1.000	0.000	0.000
1987	0.702	0.298	1.000	0.000	0.000
1988	0.877	0.123	1.000	0.000	0.000
1989	0.877	0.123	1.000	0.000	0.000
1990	0.877	0.123	0.849	0.033	0.119
1991	0.877	0.123	0.849	0.033	0.119
1992	0.877	0.123	0.822	0.041	0.138
1993	0.877	0.123	0.822	0.041	0.138
1994	0.877	0.123	0.849	0.033	0.119
1995	0.877	0.123	0.802	0.045	0.153
1996	0.877	0.123	0.802	0.045	0.153
1997	0.892	0.108	0.849	0.033	0.119

Table 3 (continued)

	Philippines		Singapore	
	US Dollar	Yen	US Dollar	Yen
1978	1.000	0.000	1.000	0.000
1979	1.000	0.000	1.000	0.000
1980	1.000	0.000	1.000	0.000
1981	1.000	0.000	1.000	0.000
1982	1.000	0.000	1.000	0.000
1983	1.000	0.000	1.000	0.000
1984	1.000	0.000	1.000	0.000
1985	1.000	0.000	1.000	0.000
1986	0.907	0.093	0.888	0.112
1987	0.907	0.093	0.888	0.112
1988	0.907	0.093	0.888	0.112
1989	0.907	0.093	0.888	0.112
1990	0.943	0.057	0.895	0.105
1991	0.943	0.057	0.895	0.105
1992	0.907	0.093	0.895	0.105
1993	0.938	0.062	0.895	0.105
1994	0.907	0.093	0.895	0.105
1995	0.907	0.093	0.895	0.105
1996	0.907	0.093	0.895	0.105
1997	0.907	0.093	0.895	0.105

Table 3 (continued)

	Thailand		China	
	US Dollar	Yen	US Dollar	Yen
1978	0.864	0.136	1.000	0.000

1979	0.864	0.136	1.000	0.000
1980	0.864	0.136	1.000	0.000
1981	0.887	0.113	1.000	0.000
1982	0.887	0.113	1.000	0.000
1983	0.887	0.113	1.000	0.000
1984	0.886	0.114	1.000	0.000
1985	0.890	0.110	1.000	0.000
1986	0.943	0.057	1.000	0.000
1987	0.943	0.057	1.000	0.000
1988	0.943	0.057	1.000	0.000
1989	0.943	0.057	1.000	0.000
1990	0.943	0.057	1.000	0.000
1991	0.943	0.057	1.000	0.000
1992	0.943	0.057	1.000	0.000
1993	0.943	0.057	1.000	0.000
1994	0.943	0.057	0.953	0.047
1995	0.943	0.057	0.953	0.047
1996	0.943	0.057	0.953	0.047
1997	0.954	0.046	0.953	0.047

Table 3 (continued)

	Taiwan		Korea	
	US Dollar	Yen	US Dollar	Yen
1978	1.000	0.000	1.000	0.000
1979	1.000	0.000	1.000	0.000
1980	1.000	0.000	0.882	0.118
1981	1.000	0.000	0.882	0.118
1982	0.809	0.191	0.882	0.118
1983	0.809	0.191	0.882	0.118

1984	0.809	0.191	0.882	0.118
1985	0.809	0.191	0.882	0.118
1986	0.809	0.191	0.882	0.118
1987	0.809	0.191	0.882	0.118
1988	0.809	0.191	0.882	0.118
1989	0.809	0.191	0.882	0.118
1990	0.809	0.191	0.882	0.118
1991	0.809	0.191	0.882	0.118
1992	0.809	0.191	0.882	0.118
1993	0.809	0.191	0.882	0.118
1994	0.809	0.191	0.882	0.118
1995	0.809	0.191	0.882	0.118
1996	0.809	0.191	0.882	0.118
1997	0.809	0.191	0.882	0.118

Table 4 Selected Sectors' Import Changes from the BAU Scenario (from Korea or Japan to Malaysia)

Unit: $1000

	Intermediate inputs					
	Korea			Japan		
Sector No.	29	33	63	29	33	63
1990	0.000	0.000	0.000	0.000	0.000	0.000
1991	0.000	0.000	0.000	0.000	0.000	0.000
1992	0.000	0.000	0.000	0.000	0.000	0.000
1993	0.000	0.000	0.000	0.000	0.000	0.000
1994	0.000	0.000	0.000	0.000	0.000	0.000
1995	21.975	1.711	18.728	-3.395	-0.096	-2.526
1996	19.561	1.645	14.639	-2.964	-0.058	-3.206
1997	15.355	1.190	10.166	-1.610	-0.147	-4.051

	Final demands					
	Korea			Japan		
Sector No.	54	58	59	54	58	59
1990	0.000	0.000	0.000	0.000	0.000	0.000
1991	0.000	0.000	0.000	0.000	0.000	0.000
1992	0.000	0.000	0.000	0.000	0.000	0.000
1993	0.000	0.000	0.000	0.000	0.000	0.000
1994	0.000	0.000	0.000	0.000	0.000	0.000
1995	28.423	223.000	5.377	-15.724	-62.486	-2.084
1996	25.360	190.328	4.841	-13.928	-48.747	-1.763
1997	20.020	136.342	3.695	-11.312	-32.507	-1.272

Table 4 (continued)

Unit: Percentage

	Intermediate inputs					
	Korea			Japan		
Sector No.	29	33	63	29	33	63
1990	0.000	0.000	0.000	0.000	0.000	0.000
1991	0.000	0.000	0.000	0.000	0.000	0.000
1992	0.000	0.000	0.000	0.000	0.000	0.000
1993	0.000	0.000	0.000	0.000	0.000	0.000
1994	0.000	0.000	0.000	0.000	0.000	0.000
1995	0.048	0.035	0.080	-0.004	-0.006	-0.007
1996	0.040	0.033	0.063	-0.003	-0.004	-0.009
1997	0.031	0.023	0.044	-0.002	-0.009	-0.012

	Final demands					
	Korea			Japan		
Sector No.	54	58	59	54	58	59
1990	0.000	0.000	0.000	0.000	0.000	0.000

1991	0.000	0.000	0.000	0.000	0.000	0.000
1992	0.000	0.000	0.000	0.000	0.000	0.000
1993	0.000	0.000	0.000	0.000	0.000	0.000
1994	0.000	0.000	0.000	0.000	0.000	0.000
1995	0.070	0.077	0.066	-0.001	-0.003	-0.001
1996	0.060	0.063	0.056	-0.001	-0.002	-0.001
1997	0.050	0.048	0.044	-0.001	-0.002	-0.001

Table 5 Selected Sectors' Exports Changes from the BAU Scenario (from Japan to Thailand)

Unit: $1000

	Intermediate inputs			Final demands		
Sector No.	40	50	60	49	54	57
1990	0.000	0.000	0.000	0.000	0.000	0.000
1991	0.000	0.000	0.000	0.000	0.000	0.000
1992	0.000	0.000	0.000	0.000	0.000	0.000
1993	0.000	0.000	0.000	0.000	0.000	0.000
1994	0.000	0.000	0.000	0.000	0.000	0.000
1995	1079.718	3963.840	2397.367	40.063	642.662	417.116
1996	1067.646	4085.664	2303.210	39.150	402.212	301.633
1997	1053.192	4022.212	1786.803	33.790	98.792	174.900

Unit: Percentage

	Intermediate inputs			Final demands		
Sector No.	40	50	60	49	54	57
1990	0.000	0.000	0.000	0.000	0.000	0.000
1991	0.000	0.000	0.000	0.000	0.000	0.000
1992	0.000	0.000	0.000	0.000	0.000	0.000
1993	0.000	0.000	0.000	0.000	0.000	0.000
1994	0.000	0.000	0.000	0.000	0.000	0.000
1995	0.288	0.275	0.184	0.170	0.171	0.167
1996	0.273	0.264	0.167	0.153	0.098	0.113

1997	0.270	0.264	0.142	0.136	0.025	0.064

Table 6 Selected Sectors' Imports Changes from the BAU Scenario (Thailand)

Unit: $1000

	Intermediate inputs			Final demands		
Sector No.	6	23	29	24	30	43
1990	-1156.780	-771.797	-5495.699	-377.573	-757.502	-743.250
1991	-2306.858	-1656.647	-11422.175	-807.638	-1626.076	-1591.979
1992	-3701.560	-2623.241	-18035.739	-1265.366	-2552.964	-2501.981
1993	-3203.876	-2516.481	-16727.551	-1182.301	-2406.884	-2330.528
1994	-450.337	-751.355	-1567.418	-54.920	-163.886	-66.420
1995	-140.933	-1210.008	-3334.701	-165.941	-396.288	-295.684
1996	-643.753	-1564.711	-3910.153	-255.434	-583.137	-492.663
1997	-6181.420	-5123.657	-25289.914	-1837.266	-3796.577	-3749.508

Unit: Percentage

	Intermediate inputs			Final demands		
Sector No.	6	23	29	24	30	43
1990	-0.933	-0.183	-1.424	-1.838	-1.838	-1.838
1991	-1.701	-0.365	-2.934	-3.680	-3.694	-3.666
1992	-2.554	-0.513	-3.781	-5.260	-5.295	-5.219
1993	-2.015	-0.440	-2.999	-4.359	-4.426	-4.289
1994	-0.268	-0.118	-0.257	-0.195	-0.290	-0.117
1995	-0.075	-0.175	-0.544	-0.545	-0.645	-0.480
1996	-0.324	-0.212	-0.571	-0.799	-0.901	-0.756
1997	-3.097	-0.645	-2.799	-5.488	-5.590	-5.464

Table 7 Growth Rates of Foreign Investments in Thailand (Percent per Annum)

	NDI	NPI	NOI	ALL
1990	33.468	-102.563	101.714	37.862
1991	-19.818	112.812	46.261	29.252
1992	6.475	-1240.340	-34.118	-19.428
1993	-20.111	490.170	-47.238	10.822
1994	-44.404	-54.511	153.678	15.876
1995	35.380	64.456	88.890	80.065
1996	18.797	-13.156	-12.664	-11.057
1997	138.923	22.794	-269.120	-186.612

Notes: NDI = Net direct investments
NPI = Net portfolio investments
NOI = Net other investments
ALL = NDI + NPI + NOI
Source: IMF, *International Financial Statistics*.

Appendix A Data Sources

A1 Indonesia

A1.1 Employment, National Accounts, Prices, Government Finance and External Indebtedness: The Asian Development Bank, *Key Indicators of Developing Asian and Pacific Countries*, various issues.

A1.2 Exchange Rate, Money Supply, Interest Rates, International Reserves and Balance of Payments: International Monetary Fund, *International Financial Statistics*, CD-ROM.

A2 Malaysia

A2.1 Employment, National Accounts, Prices, Government Finance and External Indebtedness: The Asian Development Bank, *Key Indicators of Developing Asian and Pacific Countries*, various issues.

A2.2 Exchange Rate, Money Supply, Interest Rates, International Reserves and Balance of Payments: International Monetary Fund, *International Financial Statistics*, CD-ROM.

A3 Philippines

A3.1 Employment, National Accounts, Prices, Government Finance and External Indebtedness: The Asian Development Bank, *Key Indicators of Developing Asian and Pacific Countries*, various issues.

A3.2 Exchange Rate, Money Supply, Interest Rates, International Reserves and Balance of Payments: International Monetary Fund, *International Financial Statistics*, CD-ROM.

A4 Singapore

A4.1 Employment, National Accounts, Prices, Government Finance and External Indebtedness: The Asian Development Bank, *Key Indicators of Developing Asian and Pacific Countries*, various issues.

A4.2 Exchange Rate, Money Supply, Interest Rates, International Reserves and Balance of Payments: International Monetary Fund, *International Financial Statistics*, CD-ROM.

A5 Thailand

A5.1 Employment, National Accounts, Prices, Government Finance and External Indebtedness: The Asian Development Bank, *Key Indicators of Developing Asian and Pacific Countries*, various issues.

A5.2 Exchange Rate, Money Supply, Interest Rates, International Reserves and Balance of Payments: International Monetary Fund, *International Financial Statistics*, CD-ROM.

A6 China

A6.1 Employment, National Accounts, Government Finance and External Indebtedness: The Asian Development Bank, *Key Indicators of Developing Asian and Pacific Countries*, various issues.

A6.2 Exchange Rate, Money Supply, Interest Rates, International Reserves, Balance of Payments and Prices: International Monetary Fund, *International Financial Statistics*, CD-ROM.

A7 Taiwan

A7.1 Employment, National Accounts, Prices, Government Finance, External Indebtedness, Exchange Rate, Money Supply, Interest Rates, International Reserves and Balance of Payments: The Asian Development Bank, *Key Indicators of Developing Asian and Pacific Countries*, various issues.

A8 Korea

A8.1 National Accounts and Prices: The Organization for Co-operation and Development, *Quarterly National Accounts*, CD-ROM.

A8.2 Employment, Government Finance and External Indebtedness: The Asian Development Bank, *Key Indicators of Developing Asian and Pacific Countries*, various issues.

A8.3 Exchange Rate, Money Supply, Interest Rates, International Reserves and Balance of Payments: International Monetary Fund, *International Financial Statistics*, CD-ROM.

A9 Japan

A9.1 National Accounts and Prices: Economic Planning Agency, *Annual Report on National Accounts*, various issues.

A9.2 Labor Data: The Organization for Co-operation and Development, *Quarterly Labour Force Statistics*, various issues.

A9.3 Monetary Data: Bank of Japan, *Financial and Economic Statistics Monthly*, various issues.

A10 USA

A10.1 National Accounts and Prices: The Organization for Co-operation and Development, *Quarterly National Accounts*, CD-ROM.

A10.2 Labor Data: The Organization for Co-operation and Development, *Quarterly Labour Force Statistics*, various issues.

A10.3 Government Finance: *Economic Report of the President*, various issues.

A10.4 Monetary Data: International Monetary Fund, *International Financial Statistics*, CD-ROM.

Appendix B Computation of Currency Baskets

In a currency basket system, shares of currencies and initial exchange rates are unknown parameters. We estimate the initial exchange rates instead of giving them exogenously. We explain the estimation method using Korea as an example. Since the year 1980, the Korean government/monetary authority had conducted its exchange rate policy under the basket peg system, up to the year 1996. Due to the Asian currency crises, Korea withdrew the basket peg policy and then adopted the free-floating system. The estimation result[18] shows that the Korean won was pegged to a currency basket composed by the US dollar and the Japanese yen. In this case, the first and second terms of the right hand side should be the value of the Korean currency basket. We can write them as follows:

(B.1) $(1-\rho)R^*$ = the coefficient of the intercept = 792.308

(B.2) $\rho\left(R^*/R^*_{jpn}\right)$ = the coefficient of the Japanese yen = 0.913

where R^*_{jpn} is the initial Japanese yen per the US dollar. Inserting equation (B.1) into equation (B.2) yields:

(B.3) $R^* - 0.913R^*_{jpn}$ = 792.308.

We computed equation (B.3) with data on exchange rates of both the won and the yen. Results are provided in Table B1. The coefficient of the intercept, which is 792.308, lies between the years 1996 and 1997. Using data of the years 1996 and 1997, we calculate weights to obtain the intercept as the weighted average. They are 0.3576 and 0.6424, respectively. Then, we can compute the initial exchange rates of the Korean won and the Japanese yen with these weights. The computed values are 898.787 Korean won and 116.65 Japanese yen. By inserting computed results into equation (B.1) or (B.2), we can obtain the share of the Japanese yen in the Korean currency basket at roughly 11.847 percent.

Table B1 Computed Values of Equation (B.3)

	EKOR-0.913*E
1980	400.417
1981	479.677
1982	503.671
1983	558.904
1984	589.125
1985	652.179
1986	727.642
1987	690.514
1988	614.472
1989	545.457
1990	575.460
1991	610.476
1992	664.996
1993	701.115
1994	710.135
1995	685.393

[18] See equation (3.49).

1996	705.136
1997	840.824

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