Econometric Analysis of the Brazilian Economy by Monthly Econometric Model

Takao Fukuchi

IPEA/JICA Workshop

August 14-15, 2001

Rio de Janeiro, Brazil

Econometric Analysis of the Brazilian Economy by Monthly Econometric Model

Takao Fukuchi

IPEA/JICA Workshop

August 14-15, 2001

Rio de Janeiro, Brazil

Econometric Analysis of Brazilian Economy by Monthly Econometric Model

1. Introduction

This paper tries to construct a monthly econometric model for the recent Brazilian economy. The Brazilian economy past a transitory period after the period of hyperinflation, and recently shows a sound recovery. This recent tendency suggests that the basic structure of Brazilian economy has changed drastically from the past structure of the hyperinflation period. But how and when and to what extent the past structure changed? What part of the past structure experienced drastic changes? When the basic economic structure is changing, the expected effects of fiscal and monetary policies, and the optimum policy mix to achieve the set of target also change. So it is of crucial importance to answer these questions to formulate the policy packages to realize a harmonized sound economic growth into the future.

So it is useful to construct a short-term model to clarify the current economic structure and quantitatively analyze the interaction between monetary and real aspects, and some policy effects on the monthly basis. On the other hand, there are many monthly data readily available like exchange rate, interest rate, money supplies, various price indices, production index, exports and imports. So it is worthy to collect these data, and seeks a possibility of constructing a monthly model, and analyzes the basic tendency and some policy effects. But the basic national account statistics is not yet fully prepared as for the three aspects of the economy: expenditure, production, and distribution on the annual and quarterly basis. So I decided to collect the monthly data from various different sources, and combine with the expenditure and production side variables (consumption, investment, exports, imports; primary, secondary, tertiary sector GDP), which I transformed from quarterly basis to monthly data, and construct a prototype model.

The structure of the paper is as follows. Section 2 briefly summarizes the recent tendency of Brazilian economy. Section 3 reports the result of the model construction. Section 4 reports the results of estimation of reaction functions and extension of the model. Section 5 repots the results of simulation studies. Section 6 concludes.

2.Current Trend of Brazilian Economy

After the Real plan, the Brazilian economy past a transitory period, in which the government aimed to realize a sound economic growth while containing the inflation within a controllable range. In this paper I adopted the observation period of 37 months (June 1996 - June 2000), which includes each of 18 months before and after the devaluation of January 1999. In the first 18 moths, there was a severe balance-of-payment crisis, and the foreign currency reserve decreased to a half due to a strong short-term capital flight. The exchange rate regime change

and accompanying devaluation at January 1999 drastically changed the situation. In the latter 18 months, export boosted, and GDP increased rapidly in 2000. The trend of real exchange rate is as follows:

Table.1. Trends of Nominal and Real Exchange Rates.

(1) Period	(2) Exchange Rate	(3) IGPDI	(4) IPCA	(5) (2)/(3)	(6) (2)/(4)
1997.06	1.0769	0.9591	0.9731	1.1228	1.1066
1998.12	1.2087	1.0000	1.0000	1.2087	1.2087
1999.01	1.9832	1.0287	1.0070	1.9278	1.9694
1999.02	2.0648	1.0743	1.0176	1.9219	2.0290
1999.06	1.7695	1.1032	1.0396	1.6039	1.7020
1999.12	1.7900	1.2202	1.0894	1.4669	1.6431
2000.06	1.8000	1.2588	1.1072	1.4299	1.6257

(Source) Calculated by author.

The real exchange rate deflated by deflating by general price (IGPDI) or consumer's price (IPCA) was only gradually depreciated by 7-6% in two years (1997-98). But the trade balance was generally negative in 1997-98, suggesting that the exchange rate be gradually overevaluated. To improve the balance-of-payment, the exchange rate was rapidly devalued at January-February 1999 about 70 percent. This big devaluation exerted big impacts on all economic activities. Naturally it fueled the export expansion, which repercussed to various economic activities through various channels. The general price (IGPDI) increased about 20 percent, while consumer's price (IPCA) increased by only 10 percent. The real exchange rate deflated by IGPDI increased by 26 percent, and the one deflated by IPCA by 20 percent. So the degree of exchange rate passthrough was only about 37-28 percent (=26 or 20 divided by 70%). Brazil was once intensively equipped with the backward or forward indexation mechanism. Therefore, a relatively small inflation and a low degree of passthrough must imply a big structural change in economic mechanism.

Recently in 2000, the Brazilian economy has shown a good recovery. The rate of unemployment peaked last February at 8.16 percent, but went down to 6.8 per cent in October, and 6.2 per cent in November, the lowest level in past three years. Increases of the minimum monthly salary to R$180 (US$92) may exert some pressure on private sector wages. Import increased by 1.32 per cent at $55.8Bn, and exports increased by 14.7 percent at $55.1, so the trade deficit decreased from $1.2 B of 1999 to $691M. These favorable domestic and external issues contributed to the international ratings of the Brazilian economy. Standard and Poor's raised the foreign currency rating of Brazil from B plus to BB minus, and its local currency rating from BB to BB plus. In 2001, the growth rate may reach to 4 per cent, while inflation is controlled, if without serious external disturbances.

So some important questions are:
(1) Why and how the propensity to import has increased quickly?

(2) Why export has increased steadily?
(3) Why the degree of passthrough was rather low?
(4) Why a dual development pattern (stagnated domestic sector and animated foreign sector activity) existed?
(5) How the fiscal-monetary instruments (SELIC, M1, M2, NFSNO) were changed in relation to important macroeconomic targets?
(6) How these fiscal-monetary policies were effective to absorb the external shocks and achieve macroeconomic targets?

Thus one of the main tasks for quantitative modeling is to sketch out the structure of this current transitory period, and analyze the mechanisms and functioning of both brake and accelerator, and of fiscal-monetary policies. Another purpose of this modeling exercise is to check the consistencies between statistical indices from various different sources, and check the possibility of constructing a macro-model, which makes a combined use of these various indices.

3.Estimation of Monthly Econometric Model

The basic structure of the model is as follows. The whole model contains 21 endogenous variables: expenditure-side variables including consumption (CONS), investment (INV), export (X) and import (IM), and GDE; production-side variables including primary, secondary, tertiary GDP; real aspect variables including the utilization index of capital stock (NUCI), real wage (AWR), employment (EMP), unemployment rate (DESA); price variables like consumer's price (IPCA), wholesale price (IGPDI); the balance-of-payment variables (trade balance, current balance, balance of payment and foreign currency reserve).

The main differences compared with the previous modeling work (Fukuchi, September 2000) are: (1) the revision of estimation period to recent there years (June1997- June 2000). Some estimated equations use fairly long lags, so the data was prepared for five years (January 1996-December 2000). The data for July-December 2000 are utilized for simulation study. (2) GDP of primary sector was endogenously explained. (3) I changed the consumer's price index to IPCA, because it is frequently cited as the important inflation target. (4) I explained the unemployment rate and wage rate, so the trend of labor market is endogenously determined. (5) The balance of payment variables such as current balance, balance-of-payment, the foreign currency reserve are endogenously explained, so that the effects of devaluation through the change in balance of payment and foreign currency can be adequately traced. (6) The overall fitting was improved by levying the new criterion.
In all the estimated equations, the explaining variables in principle do not contain any current endogenous variables, so OLS estimations do not incur heavy simultaneity errors, except the production function and the import function. I set the estimation criteria as follows: (1) all explained variables at left-hand side are deflated by suitable variable to eliminate the steady trend. In this way, I tried to avoid possible bias caused by spurious correlation, which can happen, by the existence of common trends between explained and explaining variables. (2) I

required that the determination coefficient is higher than 0.95 to secure a good fitting at single equation estimation, and all T-values bigger than 1.0 to secure the explaining power of each explaining variable. (3) I required that all the MAPE in last five months are less than 10 percent to secure a sufficiently good fitting. (4) I decided to not employ any dummy variables, because they contribute to improve the fitting, but it is difficult to attach reasonable explanations. Instead of using dummy variables, I added the special term, which is a linear combination of foreign portfolio investment, Fi(FPF$), to i-th equation. I interpreted that (FPF$) manifests the expectation to the movement of Brazilian economy, so that the influences of changing expectation of various economic entities can be expressed by functions of (FPF$).

List of Variables:

Endogenous Variables (21):

(Symbol)	(Name)	(Unit)
GDE	:GDE	(1 Billion Real)
GDP	: GDP	(1 Billion Real)
GDPN	: Per-Capita GDP	(1000 Real)
Y1	: GDP of Primary Sector	(1 Billion Real)
Y2	: GDP of Secondary Sector	(1 Billion Real)
Y3	: GDP of Tertiary Sector	(1 Billion Real)
CONS	: Consumption Expenditure	(1 Billion Real)
INV	: Investment	(1 Billion Real)
X	: Export	(1 Billion Real)
IM	: Import	(1 Billion Real)
KR	: Capital Stock	(1 Billion Real)
NUCI	: Utilization Rate Index	(index)
DESA	: Rate of unemployment	(percent)
EMP	: Employment	(1 Million)
AWR	: Wage rate	(index)
IPCA	: Consumers Price Index	(index)
IPGDI	: General price Index	(index)
TB$	: Trade Balance	(1 Million Dollar)
CA$	: Current Balance	(1 Million Dollar)
BP$	: Balance of Payment	(1 Million Dollar)
RES$	: Foreign Currency Reserve	(1 Million Dollar)

Exogenous Variables (18)

BPE$	: Error Term of Balance-of-Payment	(1 Million Dollar)
CAP$	: Capital Balance	(1 Million Dollar)
DPI_Y	: Ratio of Internal Debt to GDP	(Percent)
DPE_Y	: Ratio of External Debt to GDP	(Percent)
DUMDEC	: December Dummy	(1 in December)
FPF$	: Portfolio Foreign Investment	(1 Million Dollar)
GDPUS	: GDP of U.S.A	(1 Trillion Dollar)
KFDI	: Real Stock of Foreign Direct Investment	(1 Billion Real)

M1	: Narrow Money Supply	(1 Billion Real)
M2	: Wide Money Supply	(1 Billion Real)
FDI$	: Foreign Direct Investment	(1Million Dollar)
PFP$	: Foreign Portfolio Investment	(1 Million Dollar)
POIL$	: Oil Price	(Dollar per Barrel)
POP	:Population	(1Million)
PTO	: Economical Active Population	(1 Million)
SELIC	: Interest Rate	(Percent)
RATE	: Exchange Rate	(Real per Dollar)
SERF$	: Service balance	(1 Million Dollar)
T	: Time Trend	(January 1995=1)

Monthly Model of Brazilian Economy (June 1997-June 2000: 37 samples)
(Version-1: Fiscal & Monetary Instruments (SELIC, M1, M2, NFSNO) are exogenous)

(E-1) Consumption Expenditure (CONS)

(CONS)/(POP)(-1)*100=471.36-6.084*(GDE)(-1)/(POP)(-1)+0.006647*((GDE)(-)
(0.49) (-1.52) (1.54)
/(POP)(-))^2-4.447*(SELIC)(-1)/(SELIC)(-5)+1680E03*(NFSNO)(-)/(KR)(-1)
(-3.13) (4.27)
+0.0003432*(M2)(-2)/(IPCA)(-2)-0.0001969*(M2)(-4)/(IPCA)(-4)
(3.44) (-2.03)
-6.663*(DESA)(-1)+1867*(POP)-1)/(POP)(-2)-119.5*(DES)(-1)/(GDE)(-1)
(-5.61) (8.24) (-2.95)
-16.34*(RATE)(-1)/(RATE)(-2)-22.55*(RATE)(-1)/(RATE)(-7)
(-3.18) (-4.46)
-154.6*(IPCA)(-4)/(IPCA)(-13)-333.0*(IGPDI)(-1)/(IGPDI)(2).
(-2.59) (-3.40)
-22.30*(POIL$)(-1)/(POIL$)(-3)+F1(FPF$)+u
(-4.07)

R^2=0.9657, RA^2=0.9315, SE=2.434, SD=9.305, DW= 2.70, F=28.21

(E-2) Investment Expenditure (INV)

(INV)/((KR)(-1))*1000=42.053+6.923*(GDP)(-1)/(GDP)(-7)+0.08971*(NUCI)(-9)
(2.49) (1.95) (1.73)
-0.02224*((SELIC)(-8)-(IPCA)(-8)+(IPCA)(-9))+59.18*(M2)(-2)/KR(-2)
(-1.14) (9.58)
+63.55*(IM)(-1)/(GDE(-1)+464.1*(IM)(-2)/(KR)(-2))-0.7709*(DESA)(-1)
(3.21) (3.60) (-2.80)
-46.94*(IGPDI)(-1)/(IGPDI)(-2)-146.4*(KFDI)(-1)/(KR)(-1)+F2(FPF$)+u
(-3.07) (-16.65)

R^2=0.9911, RA^2=0.9877, SE=0.5880, SD=5.3190, DW=1.57, F=291.63

(E-3) Capital Stock (KR)

(KR) = (1-0.005)*(KR)(-1) + (INV)

(E-4) Export (X)

(X)/((KR)(-7))*E04=-1531.97+0.4202*(GDPUS)(-3) -1.298*(NUCI)(-7)
(-1.96) (1.87) (-1.88)
-38.11*(GDE)(8)/(GDE)(-12)+140.4*(Y1)(7)/(Y1)(-8)
(-1.09) (1.86)
+344.78*(RATE)(-1)/(IGPDI)(-1) +15.42*(RATE)(4)/(IGPDI)(-4)
(7.02) (2.00)
+38.28*(RATE)(-7)/(RATE)(-10)+1121*(IM)(-10)/(KR)(-11)
(3.51) (1.36)
+220.5*(KR)(-7)/(KR)(-12) -1721*(KFDI)(-6)/(KR)(-6)
(1.70) (-2.38)
+2.651*(POIL$)(-7)+F4(FPF$)+u
(3.15)

R^2=0.9678, RA^2=0.9390, SE=4.51, SD=18.28, DW=2.64, F=33.61

(E-5) Import (IM)

(IM)/(KR)(-7))*(IGPDI)/(RATE)*1000=-7.692+0.7653*(SELIC)(-1)/(SELIC)(-3)
(-1.34) (3.03)
+1.050*(SELIC)(-4)/(SELIC)(-9)+ 29.63*(RES$)(-10)/(KR)(-10)
(4.47) (2.81)
+18.60*(M2)(-3)/(KR)(-3)+1.813*(POIL$)(-4)/(POIL$)(-7)
(2.23) (2.38)
-2.126*(RATE)(-1)+1.785*(RATE)(-10)-0.06680*(NUCI)(-11)
(-4.09) (1.73) (-1.30)
-6.781*(INV)(-2)/(INV)(-13)+207.7*(INV)(-11)/(KR)(-11)
(-2.90) (4.89)
+8.409*(IGPDI)(-4)/(IGPDI)(-11)+F5(PFP$)+u
(2.36)

R^2=0.9930, RA^2=0.9861, SE=0.328, SD=2.785, DW=2.62, F=143.25

(E-6) GDE

(GDE)=(CONS)+(INV)+(X)-(IM)

(E-7) GNP

(GNP)=(GDE)

(E-8) Per-capita GDP (GDPN)

(GDPN)=(GDP)/(POP)

(E-9) Rate of Utilization (NUCI)

(NUCI)/(GDP)*(KR)(-1)=198.71+0.6183*(NUCI)(-1)/(GDE)(-1)*KR(-2)
(0.47) (5.03)
-9076*(EMP)(-1)/(KR)(-1)+11.96*(SELIC)(-1)/(SELIC)(-3)

(-2.63) (1.37)
+880.3*(IPCA)(-1)/(IPCA)(-7)-5.693*(PTO)(-7)/(POP)(-7)
(3.28) (-2.03)
+39.59*(RATE)(-1)/(RATE)(-5)-152.1*(IM)(-1)/(Y2)(-2)+F9(PFP$)+u
(2.03) (-1.07)

R^2=0.9854, RA^2=0.9812, SE=16.64, SD=121.53, DW=2.01, F=236.2

(E-10) GDP of Primary Sector (Y1)
(Y1)/(KR)(-7)*1000=-32.03+34.03*(M2)(-7)/(KR)(-7)+0.5031*(IM)(-7)/(IM)(-10)
(-2.50) (10.75) (1.72)
+213.6*(INV)(-7)/(KR)(-8)+14.64*(GDE)(-1)/(GDE)(-2)
(11.53) (4.38)
+4.008*(CONS)(-1)/(CONS)(-7)+20.72*(IPCA)(-12)/(IGPDI)(-12)
(2.39) (3.95)
+3.838*(KFDI)(-7)/(KR)(-6)-0.1509*(PTO)(-3)/(POP)(-3)
(7.01) (-2.31)
-0.7595*(X)(-1)/(X)(-12)+u
(-2.29)

R^2=0.9935, RA^2=0.9914, SE=0.2480, SD=2.681, DW=1.80, F=464.1

(E-11) GDP of Secondary Sector (Y2)
(Y2)/(KR)(-7)*E03=46.36+73.80*(M2)(-1)/(KR)(-1)+107.6*(M2)(-5)/(KR)(-5)
(3.01) (6.19) (6.34)
-751.4*(INV)(-2)/(KR)(-3)+0.1149*(GDE)(-1)/(POP)(-1)
(-4.49) (5.94)
-0.002324*(GDE)(-7)/(POP)(-7)+3.618*(RARE)(-1)/(IPCA)(-1)
(-1.36) (3.78)
-1.610*(T)+u
(-18.48)

R^2=0.9963, RA^2=0.9955, SE=0.81, SD=12.08, DW=1.55, F=1141.4

(E-12) GDP of Tertiary Sector (Y3)
(Y3)=(GDP)-(Y1)-(Y2)

(E-13) Rate of unemployment (DESA)
(DESA)=245.64+2.281*(AWR)(-2)/(AWR)(-3)+0.7192*(GDE)(-5)/(EMP)(-5)
(4.35) (2.13) (1.69)
+0.1279*(PTO)(-2)/(POP)(-2)-2.206*(KFDI)(-4)/(KFDI)(-8)
(2.47) (-3.19)
+0.1404*(KR)(-2)/(EMP)(-2)-243.9*(KR)(-2)/(KR)(-3)
(1.40) (-4.77)
+0.4154*(RATE)/(RATE)(-2)-0.2178*(T)+F13(FPF$)+u
(1.05) (-5.69)

R^2=0.9667, RA^2=0.9479, SE=0.1685, SD=0.7389, DW=2.66, F=51.44

(E-14) Employment (EMP)
(EMP)=(PTO)*(1-(DESA)/100)

(E-15) Wage rate (AWR)
(AWR)/(AWR)(-1)=6.2102-3.914*(EMP)(-1)/(EMP)(-2)+0.007597*(NUCI)(-1)
(4.41) (-3.39) (7.04)
+0.005443*(NUCI)(-2)+0.003689*(NUCI)(-7)-0.02369*(DESA)(-1)
(3.38) (3.63) (-6.68)
+0.005075*(DESA)(-7)-0.5197*(IPCA)(-1)/(IPCA)(-7)
(2.36) (-3.90)
+0.02456*(RATE)(-1)/(RATE)(-3)+0.006686*(GDE)(-1)/(POP)(-1)
(1.61) (2.59)
-0.007378*GDE)(-2)/(POP)(-2)-0.7183*(GDE)(-1)/(EMP)(-1)
(-2.88) (-2.72)
+0.7802*(GDE)(-2)/(EMP)(-2)-0.1300*(GDE)(-3)/(EMP)(-3)
(2.90) (-2.96)
-0.2225*(FDI$)(-1)/(KFDI)(-2)-0.7495*(AWR)(-1)/(AWR(-2)
(-2.68) (-6.90)
-0.5798*(AWR)(-2)/(AWR)(-12)+0.02069*(DUMDEC)+u
(-6.93) (2.54)

R^2=0.9759, RA^2=0.9544, SE=0.007582, SD=0.03553, DW=2.39, F=45.39

(E-16) Consumer Price Index (IPCA)
(IPCA)/(IPCA)(-2)*E03=1165.22+15.91*(RATE)(-1)
(4.45) (6.40)
+5.464*(RATE)(-2)/(RATE)(-8)+16.02*(M1)(-1)/(M1)(-4)
(1.83) (2.22)
-72.88*(M2)(-1)/(M2)(-8)+149.7*(POP)(-1)/(POP)(-10)
(-5.20) (1.67)
-0.1080*(SELIC)(-7)-0.1327*(SELIC)(-12)+
(-2.46) (-1.85)
+0.4201*((NFSNO)(-4)-(NFSNO)(-5))+4.665*(POLI$)(-1)/(POIL$)(-12)
(1.31) (2.16)
-268.5*(CPIUS)(-1)/(CPIUS)(-3) +F16(FPF$)+u
(-1.15)

R^2=0.9517, RA^2=0.9131, SE=2.0459, SD=6.9421, DW=2.35, F=24.65

(E-17) General Price Index (IGPDI)
(IGPDI)/(IGPDI)(-1)*E03=435.94+29.18*(RATE)/(RATE)(-1)
(1.79) (4.25)
+75.81*(RATE)(-1)/(RATE)(-2)+12.98*(RATE)(-1)/(RATAE)(-3)
(6.56) (2.08)
+41.58*(RATE)(-2)/(IGPDI)(-2)+20.43*(M1)/(M1)(-1)

(5.06) (2.20)
+26.20*(M1)(-1)/(M1)(-2)-1.003*((DPI_Y)(-1)+(DPE_Y)(-1))
(2.18) (-3.66)
+12.97*(POIL$)(-4)/(POIL$)(-9)+372.0*(POP)(-1)/(POP)(-2)
(4.10) (1.55)
+0.3533*(AWR)(-1)-0.5450*(NUCI)(-6)+F17(FPF$)+u
(1.85) (-2.20)

R^2=0.9532, RA^2=0.9268, SE=2.725, SD=10.078, DW=2.38, F=36.09

(E-18) Trade Balance (TB$)
(TB$)=((PX)(X)-(PIM)(IM))/(RATE)

(E-19) Current Balance (CA$)
(CA$)=(TB$)+(SERF$)

(E-20) Balance- of Payment (BP$)
(BP$)=(CA$)+(CAP$)

(E-21) Foreign Currency Reserve (RES$)
(RES$)=(RES$)(-1)+(BP$)+(BPE$)

(FPF$-function)
F1(FPF$)=-0.1700*(FPF$)(-1)/(FPF$)(-4)+0.1532*(FPF$)-1)/(FPF$(-7)
(-2.54) (1.89)
-0.2938*(FPF$)(-3)/(FPF$)(-6)+0.2253*(FPF$)(-4)/(FPF$)(-11)
(-3.70) (2.24)
F2(PFP$)=0.03906*(FPF$)(-1)/(FPF$)(-3)
(3.27)
F4(FPF$)=-0.0001868*(FPF$)(-2)+0.2331*(FPF$)(-1)/(FPF$)(-4)
(-2.54) (1.89)
-0.6587*(FPF$)(-1)/(FPF$)(-12)-0.4950*(FPF$)(-4)/(FPF$)(-13)
(-3.70) (2.24)
+0.3020*(FPF$)(-7)/(FPF$)(-10)
(1.26)
F5(FPF$)=-1.31E-02*(FPF$)(-1)/(FPF$)(-2)-1.28E-02*(FPF$)(-1)/(FPF$)(-5)
(-1.45) (-1.87)
-1.73E-02*(FPF$)(-1)/(FPF$)(-6)+6.80E-02*(FPF$)(-1)/(FPF$)(-11)
(-1.81) (4.19)
-6.20E-02*(FPF$)(-1)/(FPF$)(-12)-3.15E-02*(FPF$)(-4)/(FPF$)(-14)
(-3.63) (-2.31)
+2.41E-04*(FPF$)(-5)-1.31E-04*(FPF$)(-6)
(3.56) (-1.45)
F9(PFP$)=-0.7125*(FPF$)(-1)/(FPF$)(-2)
(-1.98)
F13(FPF$)=5.282E-05*(FPF$)(-1)-6.433E-05*(FPF$)(-3)+1.076E-04*(FPF$)(-5)
(-1.09) (-1.75) (1.29)

+3.921E-05*(FPF$)(-7)+1.155E-05*(FPF$)(-8)
(1.29) (4.42)

F16(FPF$)=0.001089*(FPF$)(-1)+0.0007560*(FPF$)(-2)
(3.70) (2.08)
-0.3902*(FPF$)(-4)/(FPF$(-11)-0.1429*(FPF$)(-5)/(FPF$)(-12)
(-5.30) (-6.81)
+0.1014*(FPF$(-4)/(FPF$)(-8)-0.2487*(FPF$(-3)/(FPF$(-8)
(2.69) (-3.33)

F17(FPF$)=-0.1717*(FPF$)(-1)/(FPF$)(-2)+0.07641*(FPF$)(-1)/(FPF$)(-5)
(-1.79) (1.27)

(Note) R and RA are the multiple correlation coefficients before and after the correction of degree of freedom, SE and SD are the standard deviation of equation error and of explained variable. DW is the Durbin-Watson statistic. The number in parenthesis is the t-value. The value in the parenthesis after the variable shows the number of lags.

In the course of estimation, I paid a special care to avoid any spurious relations, which might be caused by the existence of secular trends of left-had side variable. Table.2 shows the results of the Dicky-Fuller equations of first order with and without trend for the explained variables. As the t-value of estimated coefficient of lagged variable exceeded 2.0 wither in (1) or (2), the null-hypothesis of zero coefficients (the existence of unit root) was rejected by these simple tests.

Table 2. Results of Dicky-Fuller Test.

Left-hand Side Variable	(1) With trend	(2) Without trend
(CONS)/(POP)(-1)	(-) 3.23	(-) 2.85
(INV)/(KR)(-1)	(-) 4.28	(-) 5.84
(X)/(KR)(-7)	(-) 4.28	(-) 5.56
(IM)*(IGPDI)/(RATE)/(KR)(-7)	(-) 2.39	(-) 1.53
(NUCI)/(GDE)*(KR)(-1)	(-) 2.44	(-) 1.74
(Y1)/(KR)(-7)	(-) 21.77	(-) 19.99
(Y2)/(KR)(-7)	(-) 16.42	(-) 16.63
(IPCA)/(IPCA(-1)	(-) 2.98	(-) 2.94
(IGPDI)/(IGPDI)(-1)	(-) 3.65	(-) 3.35
(DESA)	(-) 1.19	(-) 2.05
(AWR)/(AWR)(-1)	(-) 6.83	(-) 6.93

(Note) The Dicky-Fuller first order equation is calculated as follows for a left-hand side variable (X): $\triangle X=a+bX(-1)+c(Time)+u$. The figures in Table.2 show the T-values of coefficient (b).

Based on the results of single estimation, I first constructed 21 equations model which treats M2 and exchange rate (RATE) as exogenous, so consists of (E-1)-(E-17) and (E-20)-(E-23). I implemented the final test for 37 months (June 1997-June 2000), and calculated the mean absolute percentage error (MAPE,%) for the last 10, 5 and 3 months. The results are shown in Table 3.

Table 3.MAPEs of Final Test and Correlation Coefficient

Variables	Last 10 mon.	Last 5 mon.	Last 3 mon.	Det.Coefficient
CONS	1.7589	1.9613	2.1380	0.9657
INV	4.1982	4.8772	5.7529	0.9911
X	6.9883	7.4940	7.4562	0.9678
IM	8.5984	8.6149	6.3567	0.9930
GDE	2.4764	2.5579	3.3912	.....
GDPN	2.4764	2.5579	3.3912	.....
NUCI	1.7328	1.3743	1.1883	0.9854
KR	2.3784	3.1687	3.5514	.....
Y1	4.1639	4.3466	4.7547	0.9935
Y2	2.4661	2.8675	2.0845	0.9963
Y3	4.4599	5.3464	5.5529	.....
IPCA	0.6734	0.6957	0.7477	0.9517
IGPDI	0.4956	0.6905	0.8559	0.9532
AWR	2.3918	2.9697	1.4294	0.9759
EMP	0.6708	0.5755	0.4567	.....
DESA	8.0128	7.1463	5.9347	0.9667
RES$	2.6551	3.0860	3.9493	.....

(Source) Calculated by author. MAPEs for balance-of-payment variables (TB$, CA$, BP$) are not listed, because they can take zero values, so MAPEs are meaningless.

Table 3 shows a good result of final test for 37 months for all endogenous variables. MAPEs of all endogenous variables were controlled less than 10 percent. and At the final 3months, MAPES of 12 variables were less than 5 percent, even though relatively big disturbances happened at the beginning of 1999. Thus the model showed a sufficient capacity of explanation to describe the changes of variables.

Causal ordering map of the model is as follows. There are three groups of exogenous variables: (1) overseas variables including dollar oil price (POIL$), GDP of U.S.A (GDPUS), consumer's price of U.S.A (CPIUS), foreign direct investment (FDI$), portfolio investment (FPF$), real stock of FDI (KFDI), exchange rate (RATE), (2) domestic and other variables including population (POP), economically active population (PTO), employment (EMP), unemployment rate (DESA), industrial production index (IPI), wage rate (AWR), time (T), (3) monetary and fiscal variables including narrow money (M1), wider money (M2), money market interest rate (SELIC), fiscal expenditure (DES), fiscal revenue (REC), ratio of external debt over GDP (DPE/Y), primary fiscal requirement (NFSPPR), nominal fiscal requirement (NFSNO).

There are four groups of endogenous variables : (1) price variables including general price (IGPDI), consumers price (INPC), export price (PX), import price (PIM), (2) expenditure side variables including investment (INV), consumption (CONS), export (X), import (IM), GDE, (3) production side variables including primary sector GDP (Y1), secondary sector GDP (Y2), tertiary sector GDP (Y3),

per-capita GDP (GDPN), capital stock (KR), rate of utilization (NUCI), (4) balance-of-payment variables including trade balance (TB$), current balance (CA$), balance-of-payment (BP$), foreign currency reserve (RES$).

In principle, all the estimating equations contain only the predetermined variables. The price variables (consumers price (IPCA), wholesale price (IGPDI), and the expenditure variables (consumption (CONS), investment (INV), export (X), import (IM)) are explained by three groups of exogenous variables and lagged endogenous variables. Then, GDE is determined by summing-up these expenditure items. By definition, GDP equals to GDE. ON the other hand, the production function determines GDP based on employment, capital stock multiplied by the utilization rate, and other variables, which influence to the added-value ratio. So the utilization rate index (NUCI) is determined based on GDE-GDP identity and the production function. GDP of primary and secondary sector are decided by structural equations, and then GDP of tertiary sector is decided as residual. The capital stock and the per-capita GDP are decided by definition. The trade balance (TB$) is defined by dollar value of export minus import. Then current balance (CA$) ands balance-of-payment (BP$) are defined, and, finally the foreign currency reserve (RES$) is defined including the error term of balance of payment (BPE$).

The fiscal and monetary variables exert various effects to the real and price variables. I interpret that M1 relates to the market transaction and to inflation, while M2 manifests the financial deepening. So, the influences of money supplies are dual: narrow money supply (M1) influences to domestic prices (IGPDI,INPC) and consumption expenditure (CONS), while wide money supply (M2) expresses the supply of working capital, and influences to investment, export, import, Y1 and Y2, and also to export and import price.

Figures 1-16 show the trends of each endogenous variable estimated by the relevant structural equation. In these figures, X-ACT, X-EST and X-FIN indicate the actual values, the estimated values by the single equation estimation, and the values by final test of variable (X), respectively. The final test refers to the result by the extended version-2 model, which incorporated the reaction functions of instruments. Usually the final test of version-1 model is far better, so the insertion errors at the end of observation period are smaller in version-1 model.

Figure 1 shows the trend of consumption expenditure (CONS). There were short-term or seasonal cycles in 1997 and 1998, while the cycle of 1999 was modified by a downfall in February 1999. As the levels of end-of-year (December; 48,60,72) are roughly similar, there does not exist a discernible increasing trend. In the equation (E-1), the per-capita consumption was explained by 15 explaining variables including GDP growth rate, increment of price growth, real money supply, population growth, unemployment rate, fiscal expenditure variables. The linear and squared terms of per-capita GDP have negative and positive signs, and suggest a marginally increasing propensity-to-consume. Final test nicely traced the actual trend except an overestimation at the end.

FIGURE 1. TREND OF CONSUMPTION (CONS)

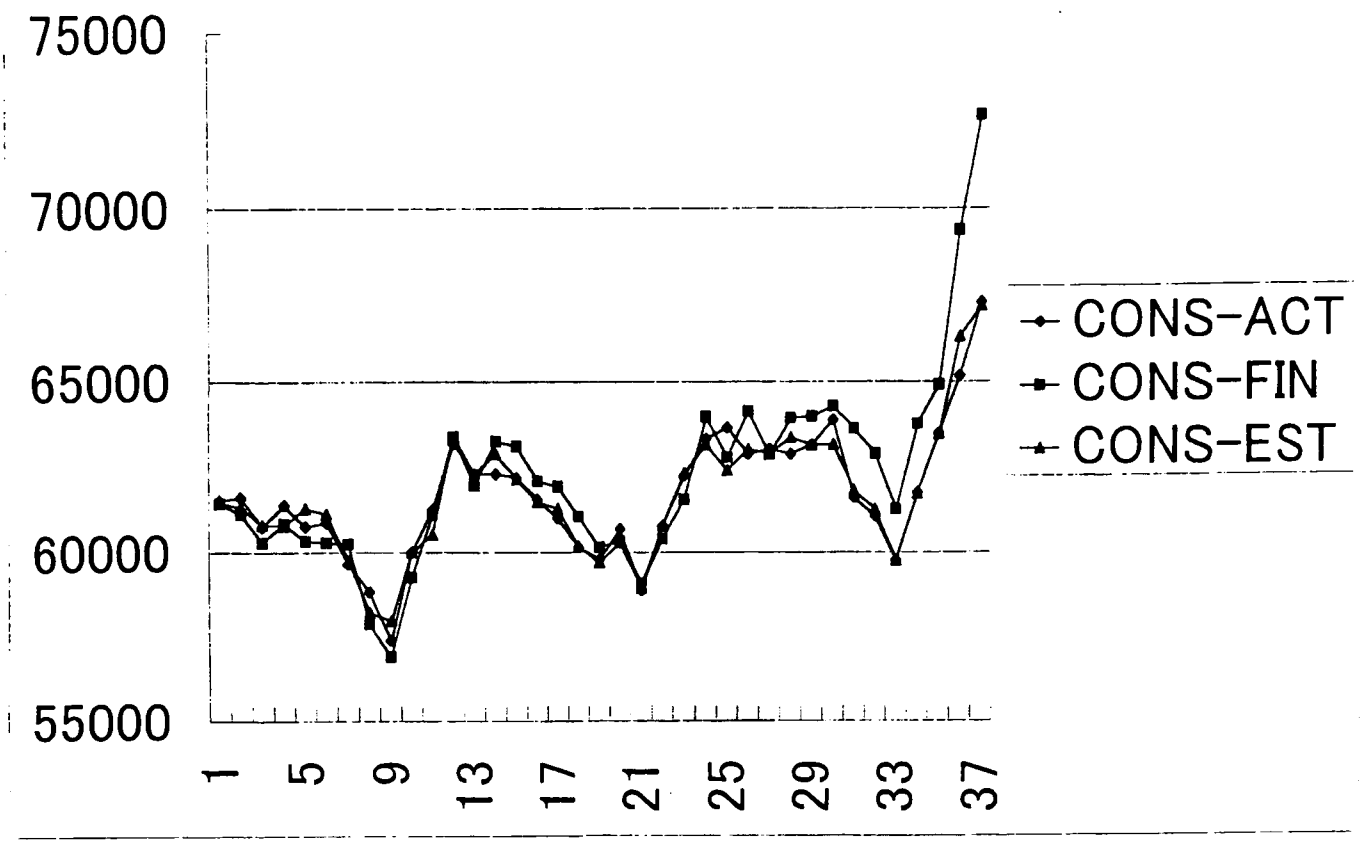


FIGURE 2. TREND OF INVESTMENT (INV)

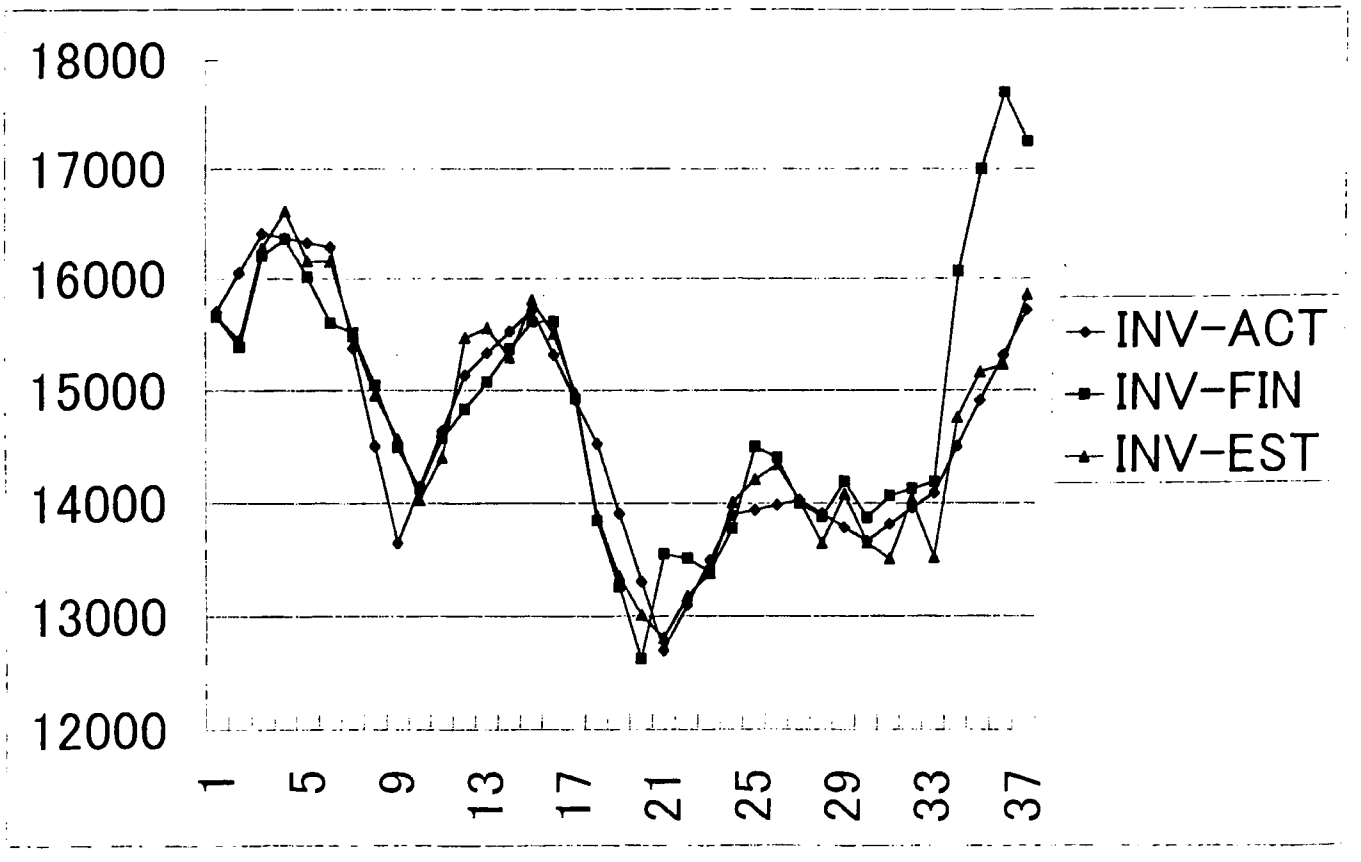


Figure 2 shows the trend of investment (INV). (E-2) equation explains the investment over capital stock or investment growth rate by 11 explaining variables. GDP growth rate, import ratio, M2 supply influence positively, while real interest rate, unemployment rate, FDI stock ratio, general price growth exert negative effects. The positive influence of rate-of-utilization may imply the lagged effect of demand growth. The investment showed a decreasing trend in 1997-98. After the devaluation, it still stagnated at low level, and showed a quick recovery in 2000, and came back to the level of 1997. Final test result was good, except the overestimation in 2000.

Figure 3 shows the trend of export. In equation (E-4), export, which is normalized by capital stock, depends positively on increments of GDP of U.S.A, and lagged import, which represent the supply of intermediate goods or working capital, and oil price growth, while rate of utilization and GDE growth exert negative effects as the potential supply to export sector would decrease. Also FDI growth exerts a negative effect, perhaps because many FDI are domestic-market oriented. In this equation, the change of exchange rate exerts a strong positive effect on export as expected. As there is a time lag of about 7-8 months between the contract decision and actual delivery, many variables are lagged by 7-8 months. In the past, there was a mildly decreasing trend in 1997and 1998. After the devaluation of January-February 1999, export jumped up, and became doubled in 12 months. As the nominal and real exchange rates were devaluated by 70 or 50-60 percent, such a jump of 100 can not be easily predicted if only through the price effect of the exchange rate devaluation. So the jump was caused not only by favorable price effect of devaluation, but also by other favorable conditions.

Figure 4 shows the trend of import. In equation (E-5), dividing by capital stock also normalizes import. Import over capital positively relates to money supply (M2), foreign currency holding, oil price growth, wholesale price growth as expected. The exchange rate exerts a short-term negative effect and medium-term negative effect, but as a whole exerts a positive effect. The investment growth exerts a negative effect through increasing supply capacity, but the growth lagged 11 months exerts a positive effect perhaps through increasing demand of capital goods import. SELIC growth affects positively, perhaps because it may imply the increasing domestic production cost or creating an expectation of balance-of-payment crisis and resulting import decrease. The basic characteristic of import trend in 1997-2000 is a steady increasing trend. In two years between January 1997 and December 1999, import became 2.34 times. Import increased by 64 percent in January 1997-December 1998, and also by 42 percent in 1999 after a rapid devaluation at January-February 1999. Such a steadily increasing trend can not be adequately understood because a rapid devaluation must exert a strong pressure to cut import. The import propensity of import (import over GDP) was 4.91 percent (January 1997), 7.97 percent (December 1998), and 10.91 percent (December 1999), and relatively low from the international standard. So we can interpret that the Brazilian economy is currently in the process of opening-up, and such a basic structural trend dominates, and overcome the negative impacts of devaluation. The trade balance (dollar export minus dollar import) recorded a

FIGURE 3. TREND OF EXPORT (X)

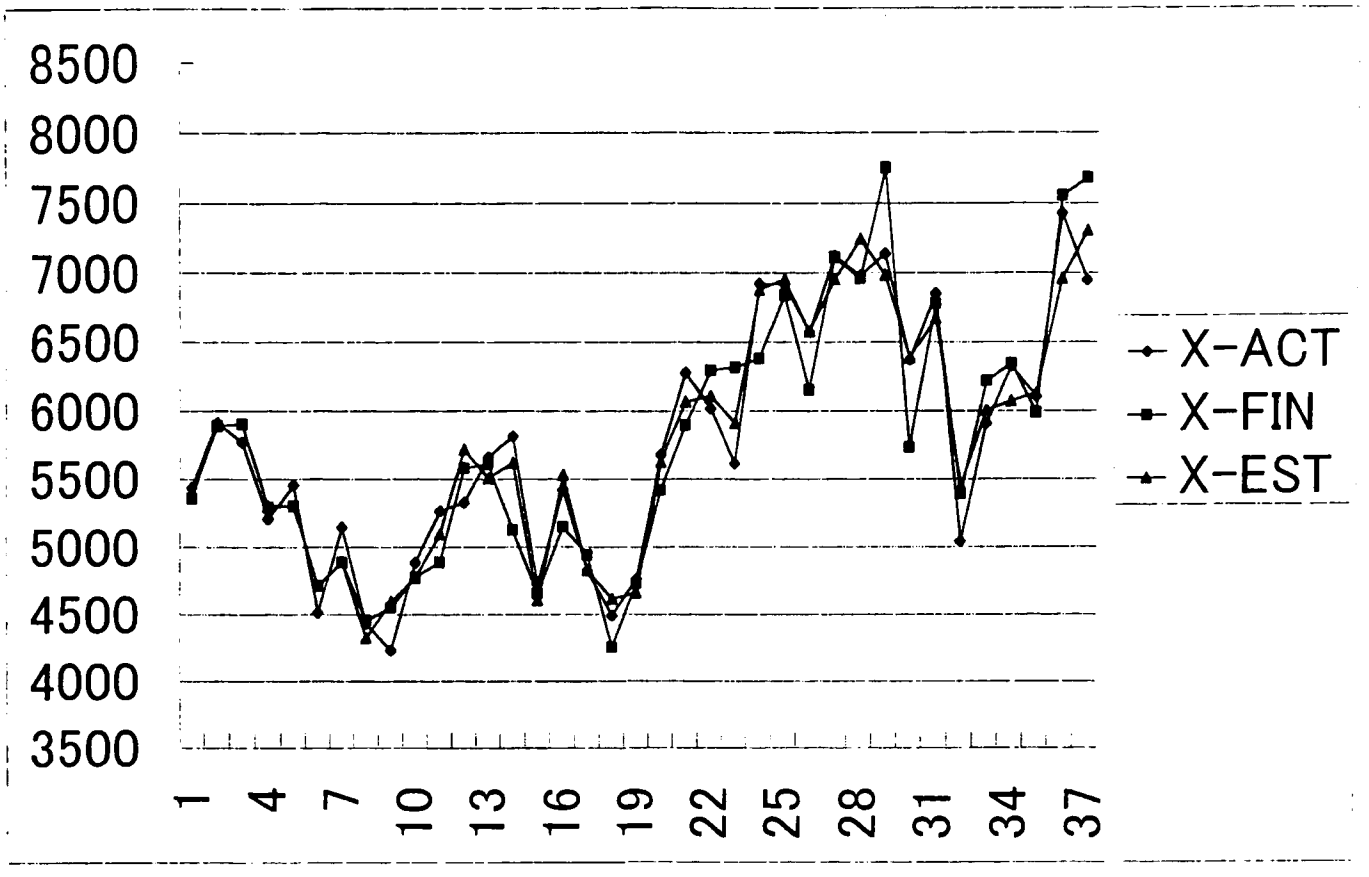
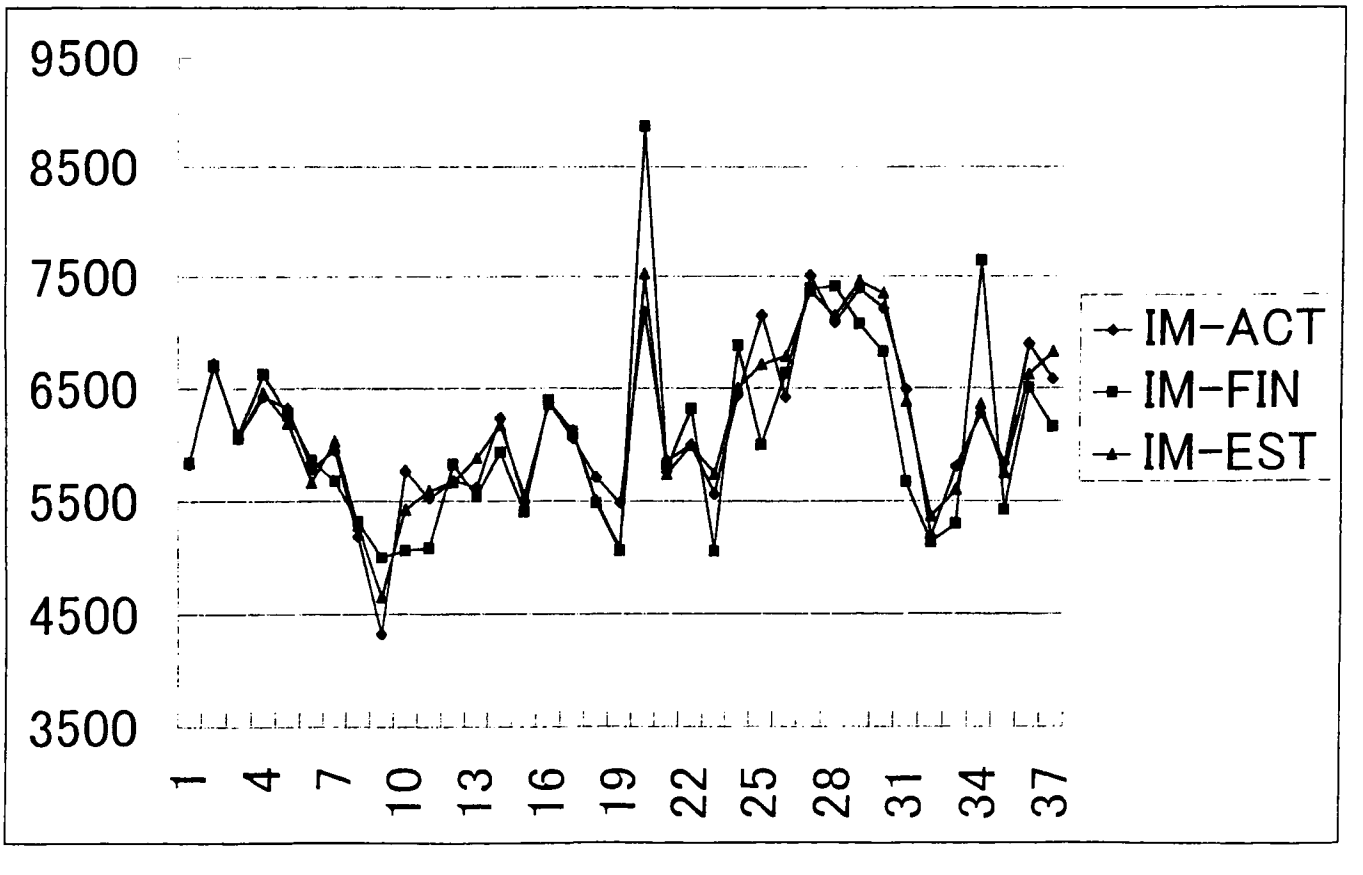


FIGURE 4. TREND OF IMPORT (IM)



deficit of $ 978 M in 1999 even after a big devaluation.

Figure 5 shows the trend of rate of utilization (NUCI). There is a cyclical tendency in 1997 and 1998. In 1999, there was big downfall in January-February, but after that the trend came back to usual pattern, and returned to the same level at the end of the years. The final test result traced the actual trend fairly well except the overestimation at the end. Actually the utilization rate (NUCI) was determined by GDP production function, (E-8), and GDE-GDP identity. So the good fitting of NUCI implies a good fitting of production function and of GDE. The production function explained GDP by effective capital stock (capital stock multiplied rate of utilization), employment, growth of economically active population (PTO), import, consumer's price growth, exchange rate, and SELIC. The additional variables (SELIC, import, ratio of economically active population, price growth) represent some shift factors. The fact that the utilization rate remained stable implies that the effective demand and supply capacity basically matched at the end of observation period. This can be a factor of low inflation pressure, and of low degree of passthrough.

Figure 6 shows the trend of GDP of primary sector (Y1). It showed a rather stable stagnant trend in 1997 and 1998. In 1999, it leveled up perhaps due to the rapid devaluation and accompanying export growth, and showed a rapid growth in 2000. GDP of primary sector (Y1) was explained by (E-10), which considered supply side factors like capital stock, import, economically active population ratio, money supply, investment growth, and demand factors like consumption growth, export growth, consumer's price growth, GDE growth. The FDI stock ratio exerts a positive effect. The final test result well traced the movement, except an overestimation in the end.

Figure 7 shows trend of GDP of secondary sector (Y2). The equation (E-11) explained the actual trend by some supply side factors like capital stock, money supply (M2), and demand factors like per-capita GDP. The real exchange rate also exerts a positive effect. Recent investment growth exerts a negative effect perhaps due to import increase. The time trend has a negative effect, which may represent a shift of industrial structure. The trend in the first 18 months was decreasing, and decreased by more than 10% in 1997-98. The rapid devaluation of January-February 1999 could not rapidly animate this sector, and the level was stagnated in 1999. Only after the time lag of one year, it started a rapid growth in 2000. The final test traced well this trend except an overestimation at the end.

Figures 8 and 9 show the trends of consumer's price (IPCA) and wholesale price (IGPDI), both of which show stable increasing trend, which were accelerated greatly after the drastic devaluation of January-February 1999. The trend of consumer's price was heavily influenced by the trend of wholesale price. In equation (E-17), the change of general price (IGPDI) is explained by 12 variables: positively influenced by changes of money supply, exchange rate, oil price, population growth, real wage, and by debt ratios, time trend, and ratio of economically active population, and negatively influenced by rate of utilization and

FIGURE 5. TREND OF UTILIZATION RATE (NUCI)

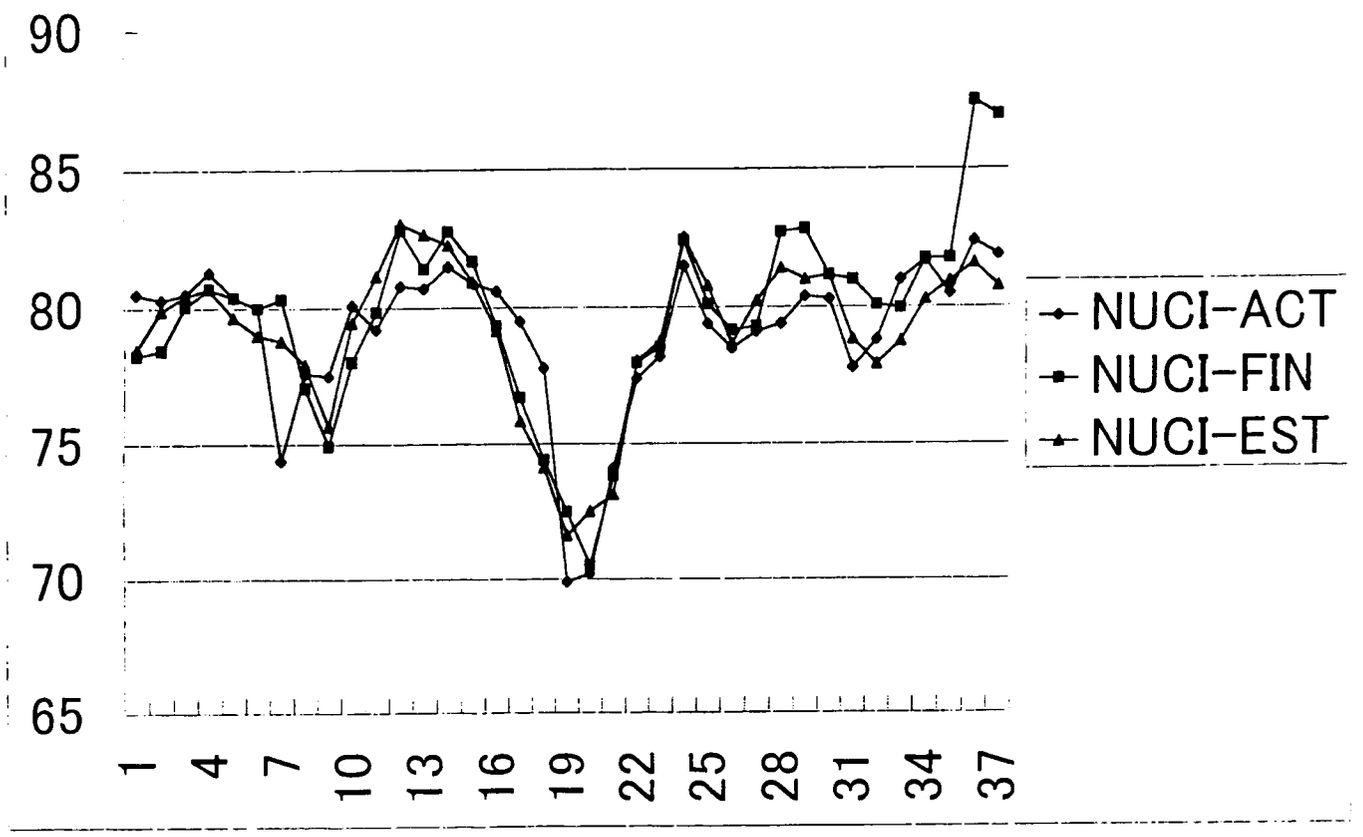


FIGURE 6. TREND OF PRIMARY—SECTOR GDP (Y1)

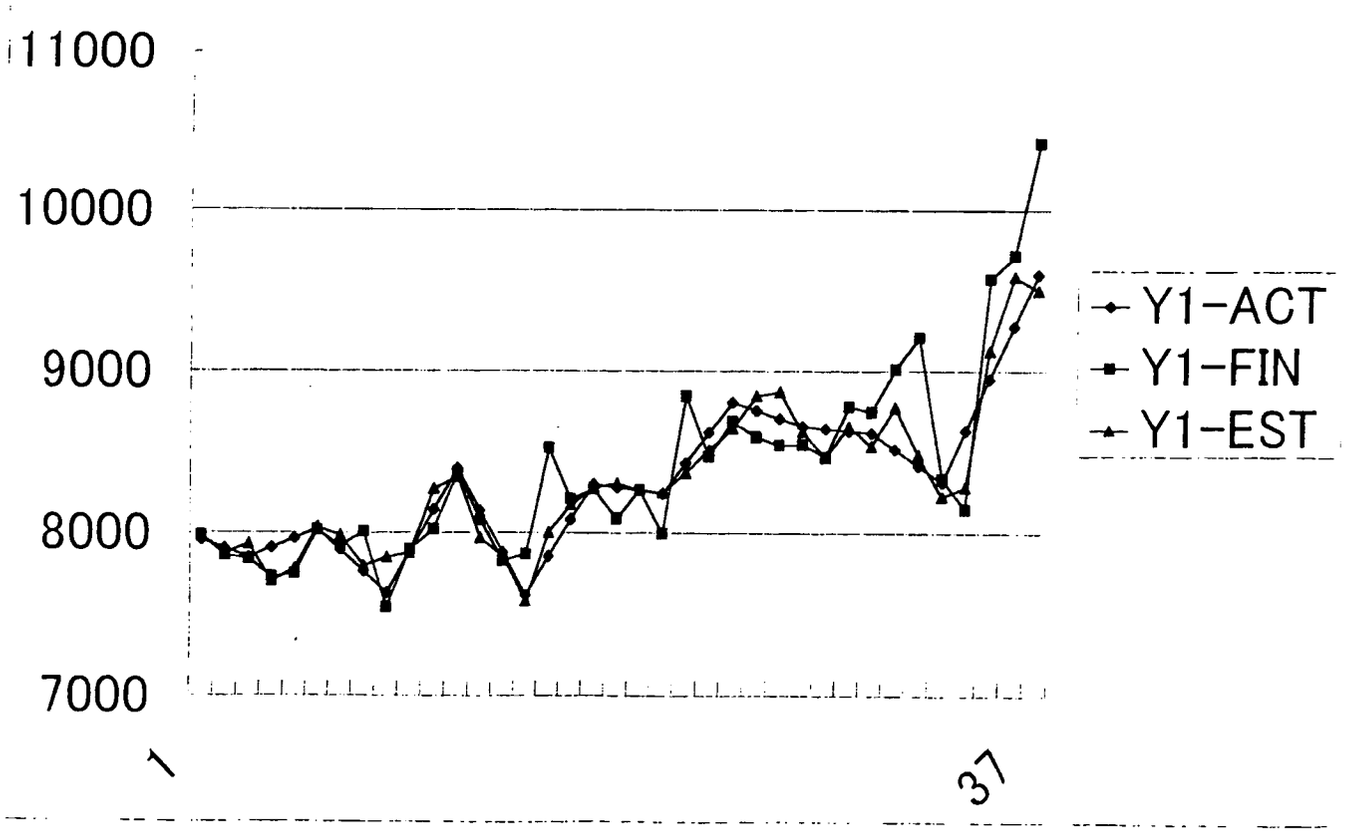


FIGURE 7. TREND OF SECONDARY SECTOR GDP (Y2)

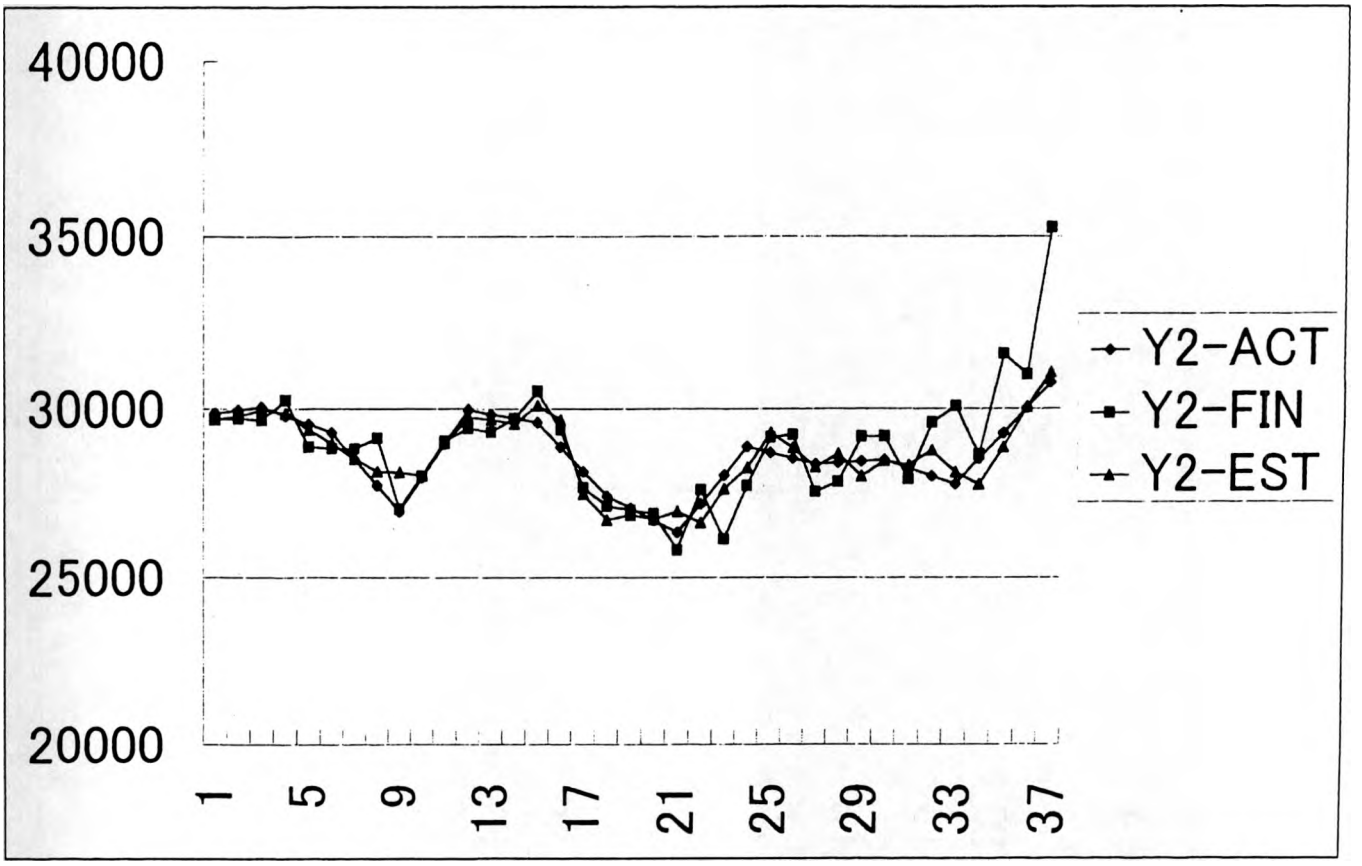
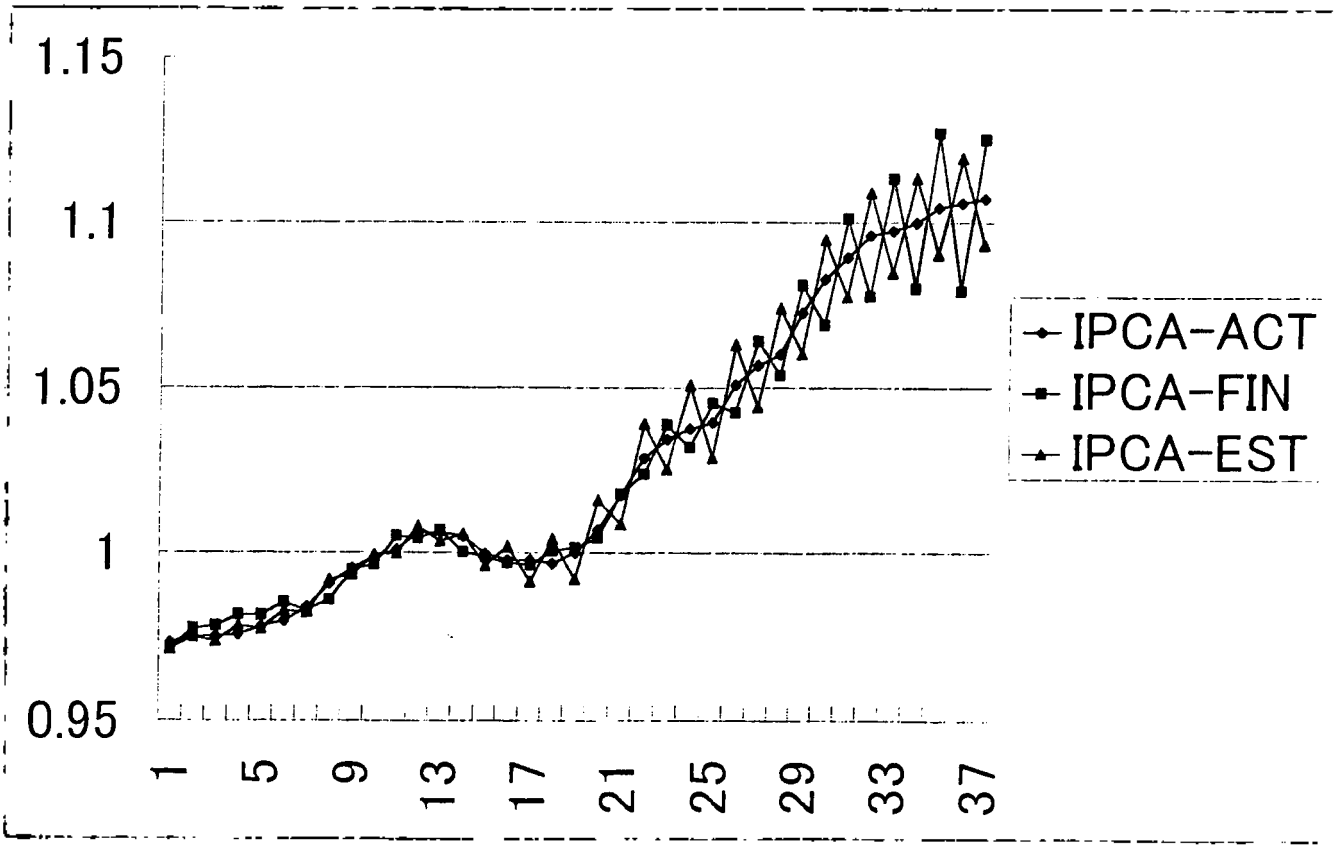


FIGURE 8. TREND OF CONSUMER'S PRICE (IPCA)



fiscal debt ratios. Among them, the influences of exchange rates dominate to explain a steep increase in 1999. In equation (E-16), the growth rate of consumer's price (IPCA) was strongly positively influenced by wholesale price growth, and additionally explained by other 10 variables: positively by the changes of exchange rate, money supply (M1), the ratio of economically active population, and negatively by per-capita GDP, unemployment rate, rate of utilization, real wage growth (as the surrogate of productivity). As a whole, the actual trends of two prices were very well traced by single equation estimation and also by the final test , except the cyclical errors of IPCA in 1999-2000. These errors were small in the final test of version-1 model without reaction functions, so were created by the interaction between instruments and IPCA, which is one of the target variable.

Figures 10 shows the trends of GDE, which is defined as the sum of expenditure variables. It showed a stagnant trend in 1997-99, but showed a rapid recovery in 2000. The actual trend was nicely traced except an overestimation in 2000.

Figure 11 shows the trend of tertiary sector GDP (Y3), which is defined as the residual of GDE minus (GDP of primary and secondary sector). The actual trend showed a slightly increasing trend with a minor cyclical movement in each year, but the trend of final test showed an increasingly volatile movement after 1998, which were originated by GDE errors because the estimated results of GDP of primary and secondary sectors were rather minor.

Figure 12 shows the trend of foreign currency reserve (RES$). Except the former half of 1998, it showed a steadily declining trend due to a massive short-term capital outflow. The drastic devaluation of January- February 1999 created a small jump through 1999, but it decreased once again in 2000, partly because the spurt of export after devaluation boom was greatly offset by the import increase.

Figure 13 shows the trend of real wage index (AWR). It shows a jump at every December based on bonus payment. In (E-15), this is explained by December dummy (DUMDEC) with a positive coefficient. Wage change is also influenced positively by rate of utilization exchange rate, and negatively by employment growth, price growth, and lagged value, FDI growth. The influences of unemployment rate and labor productivity (GDP over employment) are cyclically changing. The linear and second terms of per-capita GDP have positive and negative signs. The real wage shows a cyclical downward trend until the devaluation, and then an increasing trend. By (E-15), the trend of wage is well traced except some cyclical errors.

Figure 14 shows the trend of employment. Actually it was defined by the multiplication of economically active population (PTO) with (1-DESA(rate of unemployment)). The good fit in Figure 14 implies that the fit of unemployment rate in (E-13) was relatively good. The rate of unemployment is explained positively population growth, per-employment GDP, real wage growth, exchange rate growth, capital intensity of labor, and negatively by capital stock growth, FDI stock growth and time trend. The trend of employment was cyclical and stagnant

FIGURE 9. TREND OF WHOLESALE PRICE (IGPDI)

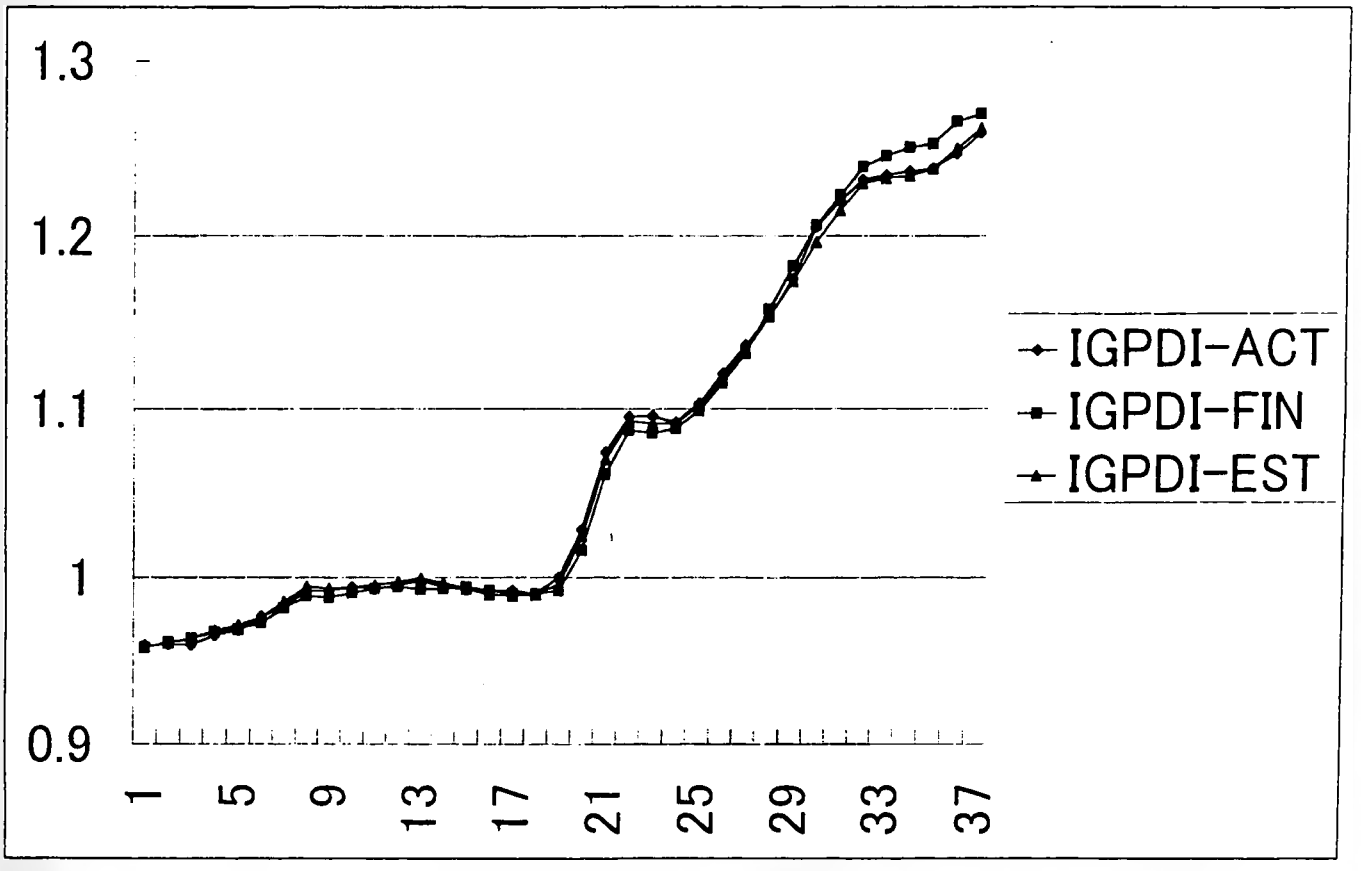


FIGURE 10. TREND OF GDE (GDE)

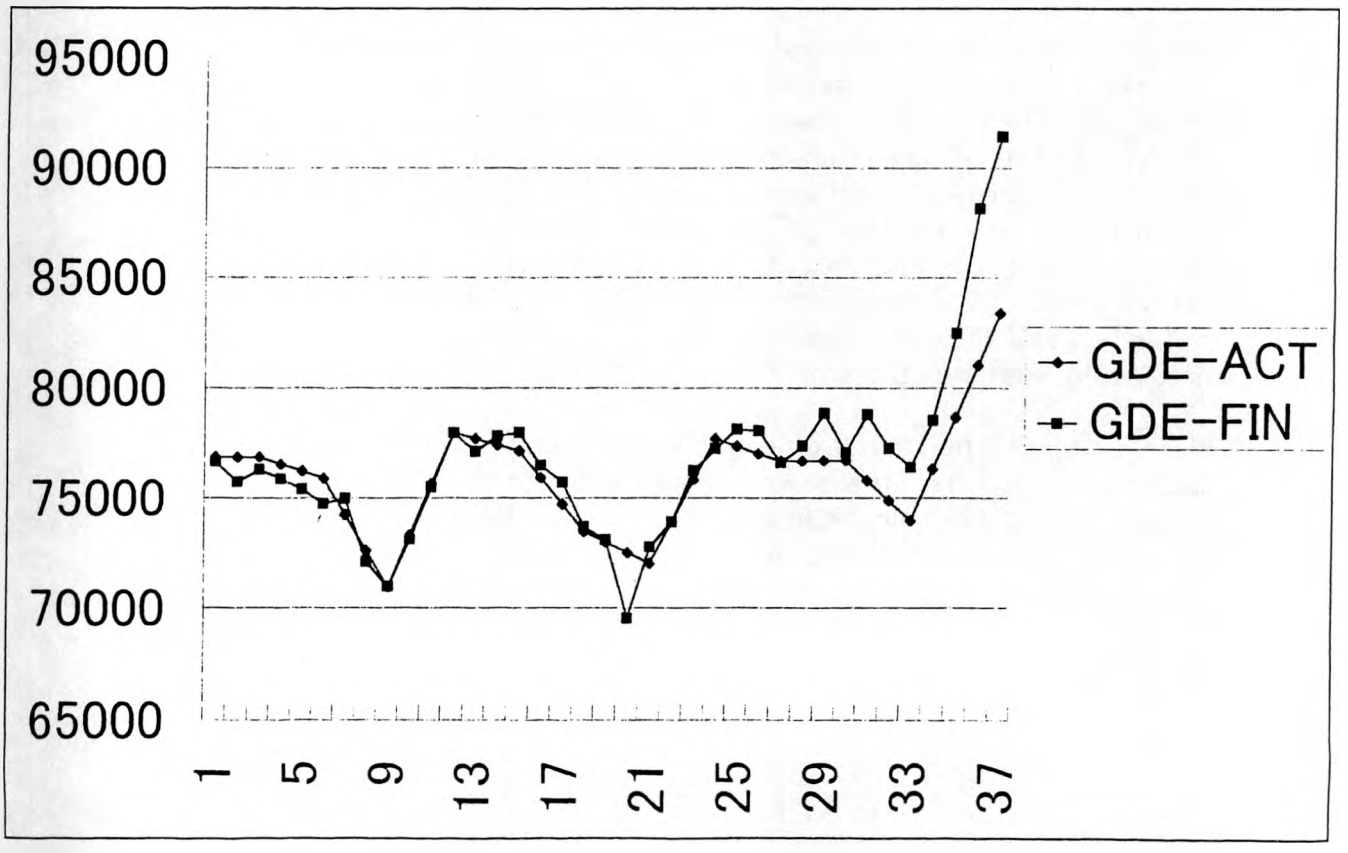


FIGURE 11. TREND OF TERTIARY SECTOR GDP (Y3)

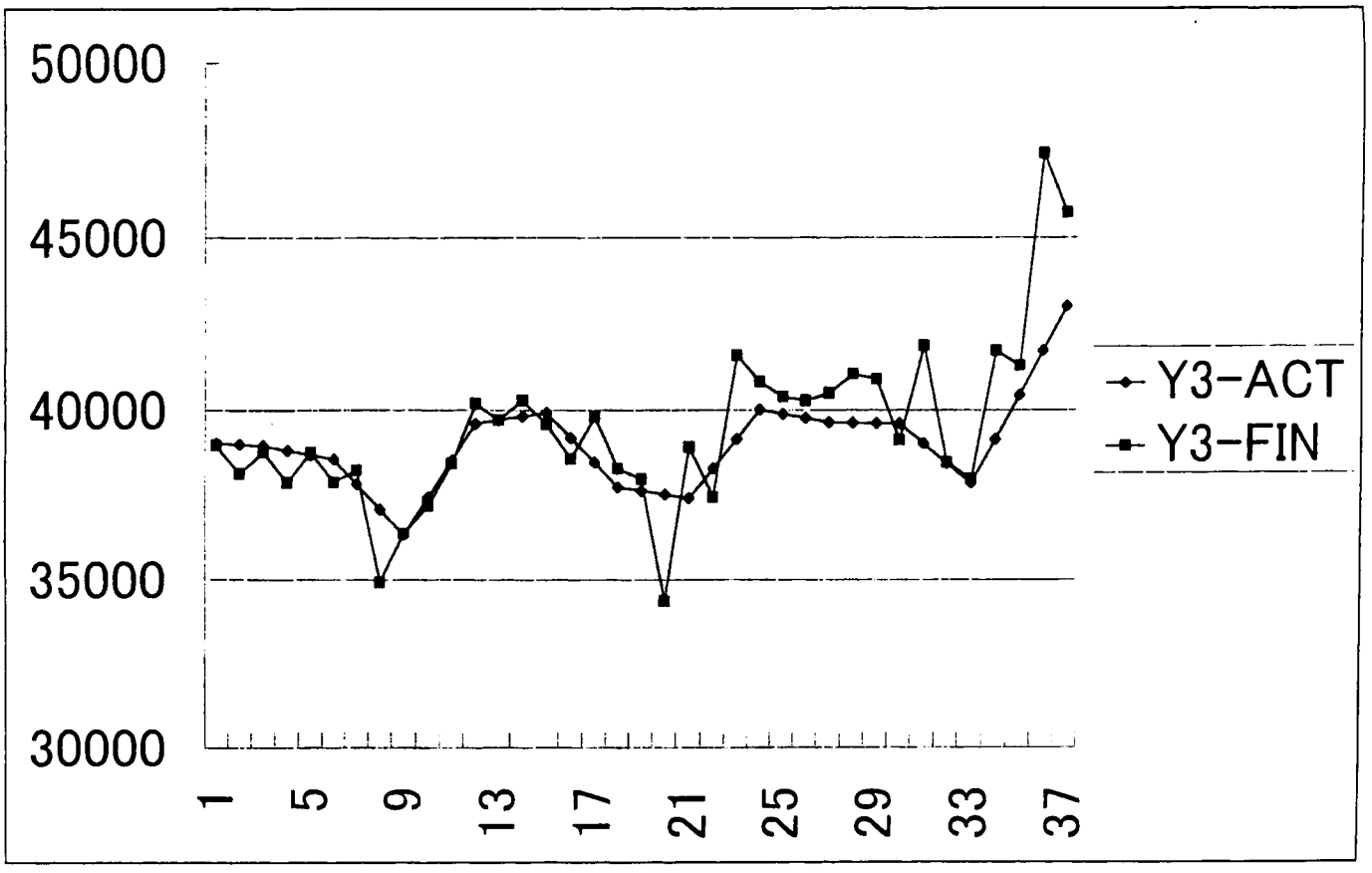


FIGURE 12。TREND OF FOREIGN CURRENCY RESERVE (RES$)

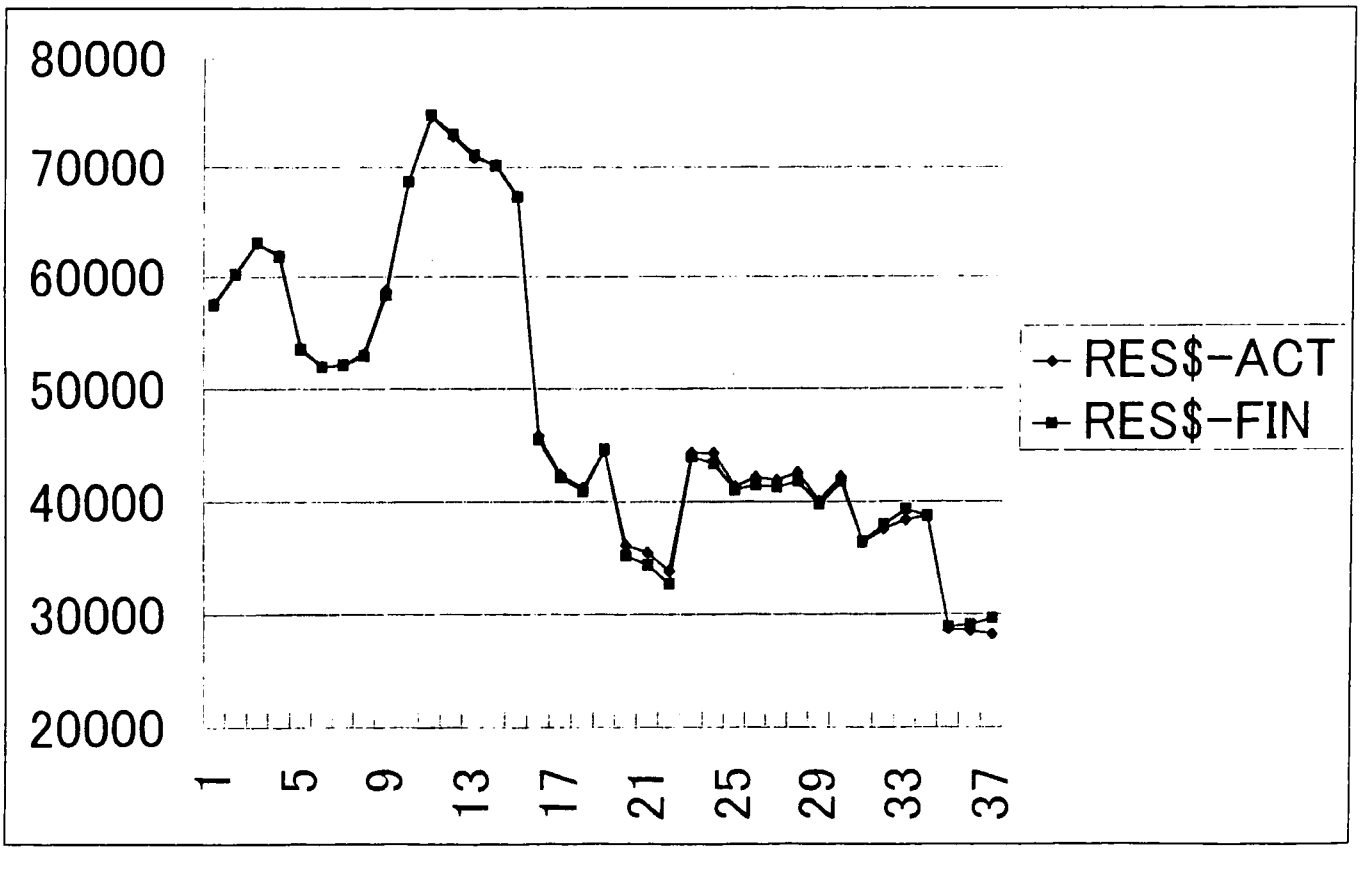


FIGURE 13. TREND OF REAL WAGE (AWR)

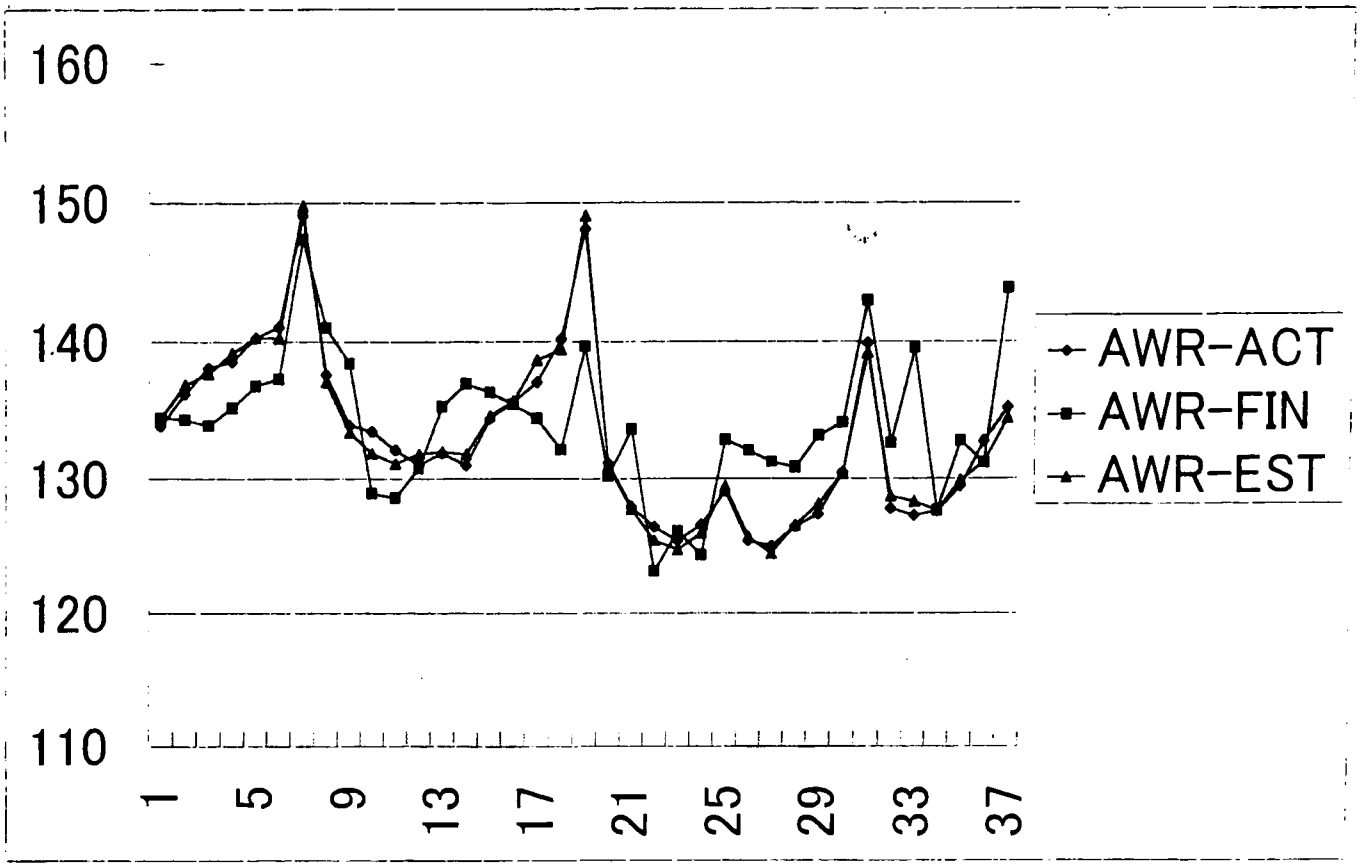
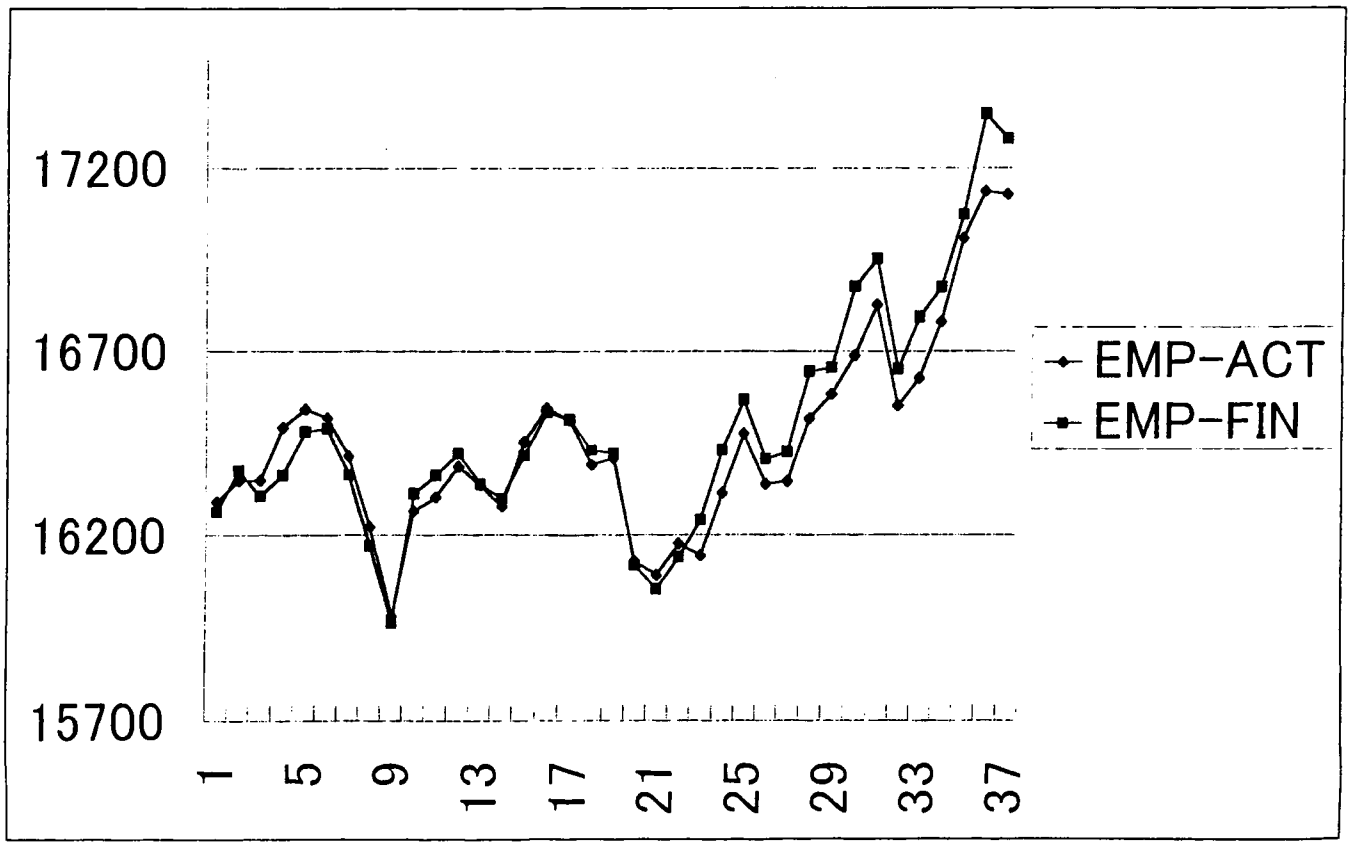


FIGURE 14. TREND OF EMPLOYMENT (EMP)



in 1997-98. After the devaluation at January 1999, it showed a sound growth in 1999-2000 due to increasing trends of every sector.

Figure 15 shows the trend of unemployment rate (DESA). It drastically increased from 5.5% to 8% in 1997-98. After the devaluation, it was stagnated at around 7.5%, then once again increased to 8%, and decreased to 7% in 2000. In (E-13), the unemployment rate (DESA) is influenced positively by wage rate growth, population growth, exchange rate growth, capital intensity of labor (KR/EMP), labor productivity (GDP/EMP), and negatively by FDI stock growth, capital stock growth, and time trend. The single-equation estimate well traced the actual trend, but the final test result underestimated by about 1% in 1999-2000.

The contrasting trends exist in the labor market: a recent decreasing trend of unemployment rate and a quick recovery and growth of level of employment, and on the other, a stagnant trend of real wage. But the wholesale price increased by 25%, and the consumer's price increased by 11% after the devaluation. So the nominal wage did increase by these rates, while real wage was roughly constant in 1997-2000. As a whole, the Brazilian labor market is still characterized with the existence of abundant unskilled labor supply. So the increase of employment in modern sector did not result in a sharp increase of real wage level.

Figure 16 shows the trend of per-capita monthly GDP in dollars (y$), which was defined by dividing per-capita GDE by exchange rate. It is not formally used in the model, but Figure 15 shows its trend to see the dual effects of exchange rate (as deflator and an indicator of international competitiveness). There was a decreasing trend, and decreased by 15% in 1997-98. The devaluation at January 1999 exerted a strong negative effect, so per-capita dollar GDP quickly dropped to 230. But the devaluation exerted a strong positive effect due to improving competitiveness and export boom to the economy, so per-capita dollar GDP has been quickly recovering to the pre-devaluation level. The final test nicely traced the actual trend.

The results of final test were relatively good in terms of MAPE. But the observations above suggest that the final test errors were relatively big for Y1, Y2, and Y3 especially in 2000. The conventional wisdom might suggest the introduction of dummy variables because the various non-economic shocks are conceivable in such a period of big devaluation. But I did not employ any dummies against this conventional wisdom. So the results might show the limit of estimation and explanation without dummies. In a sense, a part of the remaining disturbances are cost of this strategy.

4. Estimation of Reaction Functions

In section 3, four variables (SELIC, M1, M2, NFSNO), which are the main fiscal and monetary instruments were treated as exogenous. Government changes these instruments to achieve the short-term and long-term economic targets, while considering the important restraints. So when these variables are regressed to economic variables including major target variables, the coefficients would

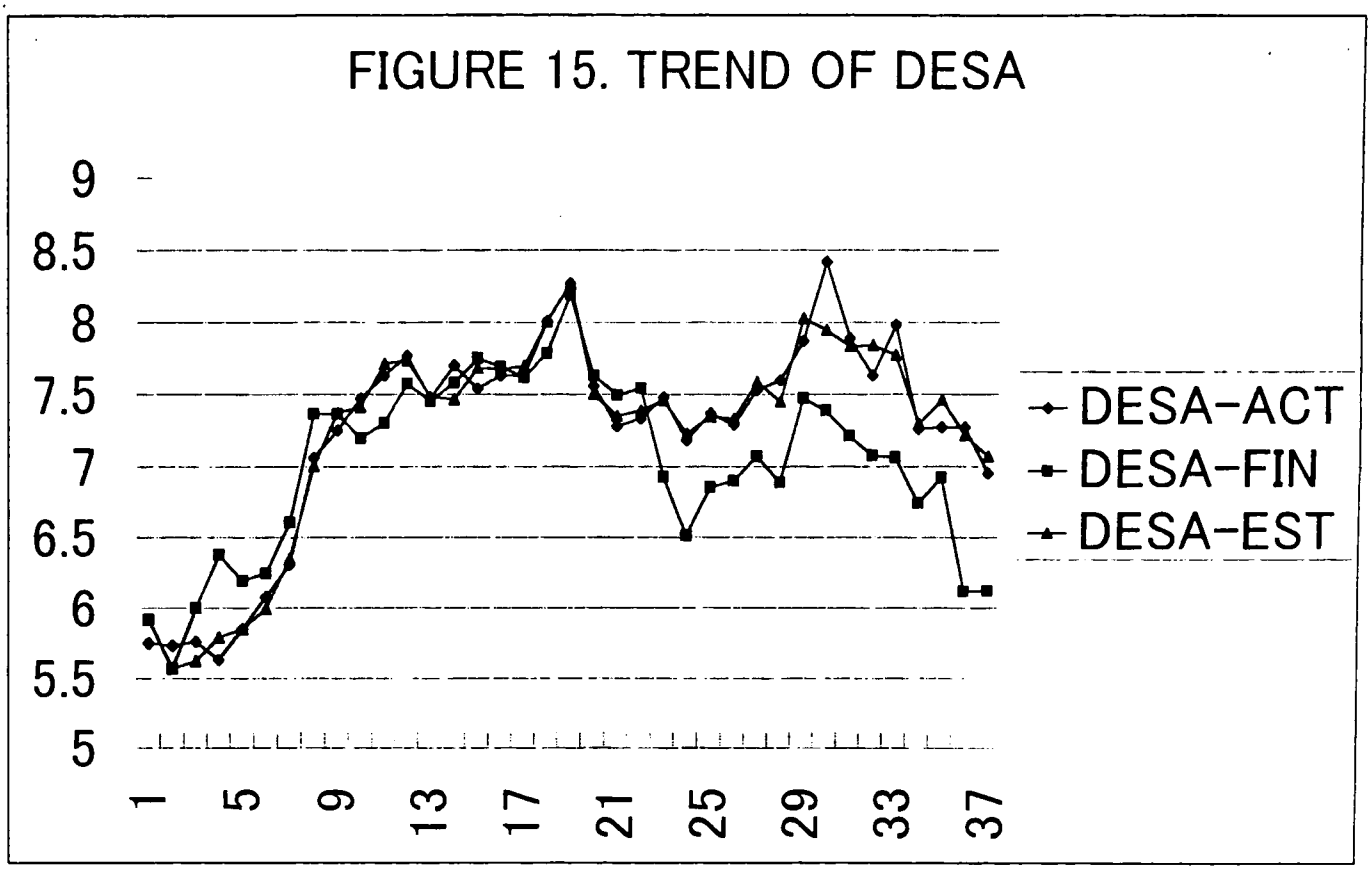
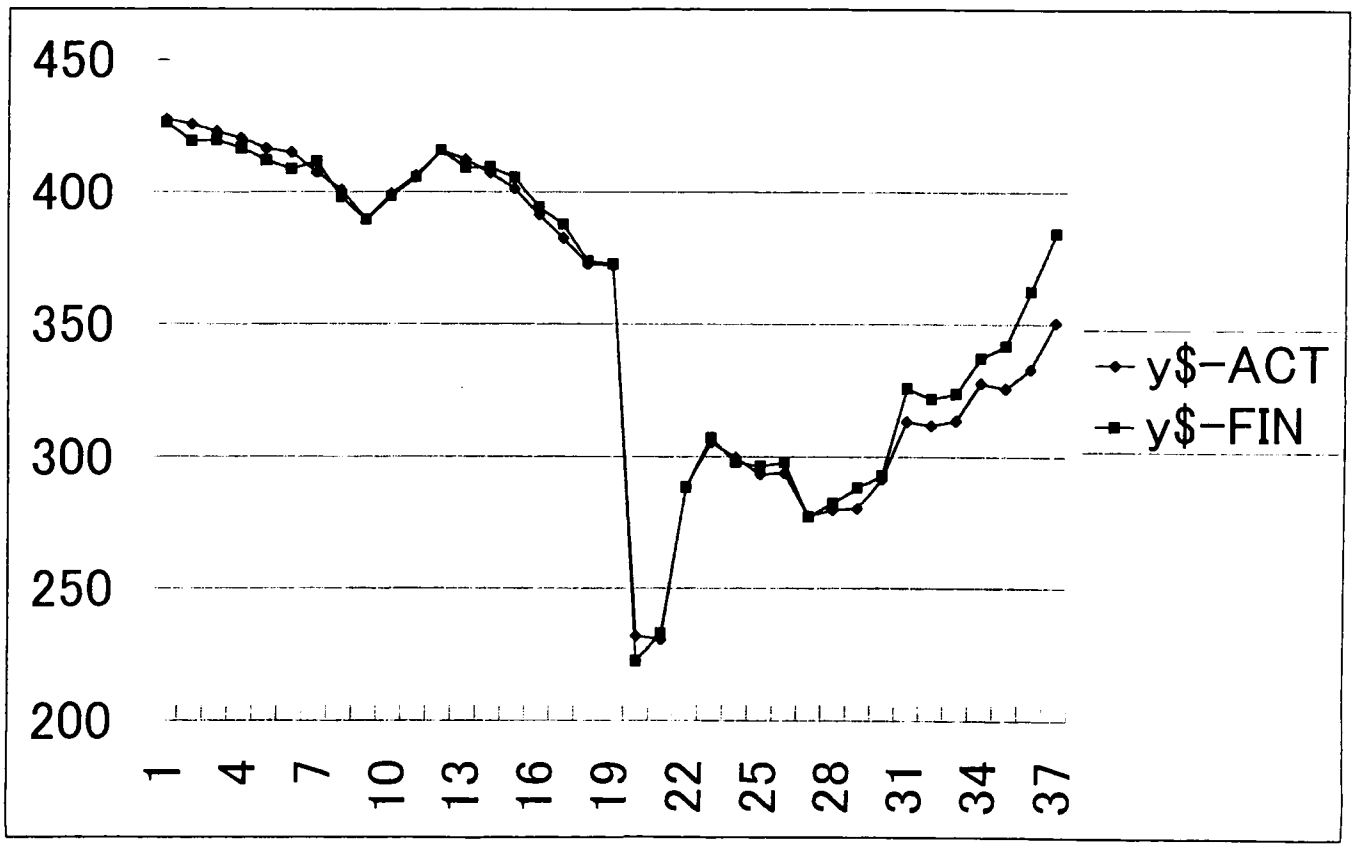


FIGURE. 16 . TREND OF PER—CAPITA MONTHLY GDP （y$）。



manifest the attitude or reaction of government to manipulates the instruments. In certain political situation, the attitude of government would change abruptly. So the nature of reaction function is fragile, and its estimation is usually very difficult. In this section, I first report the results of estimation of reaction functions separately. Then, I enlarge the version-1 model to version-2 incorporating these additional functions.

Monthly Model of Brazilian Economy (June 1997-June 2000: 37 samples)
(Version-2: Fiscal & Monetary Instruments (SELIC, M1, M2, NFSNO)
are endogenous)

(E-1)-(E-21) same as Version-1.

(E-22) SELIC (SELIC)

(SELIC)=-14.1405-8.005E-04*(BP$)(-2)+9.836E-04*(BP$)(-3)-3.557E-04*(BP$)(-5)
(-0.07) (-2.77) (3.40) (-1.37)
-18.86*(RATE)/(RATE)(-1)+13.29*(RATE)/(RATE)(-7)
(-3.20) (3.06)
-49.97*(M2)(-1)/M2)(-7)-65.79*(M2)(-1)/(M2)(-4)
(-2.86) (-2.95)
+331.1*(IPCA)(-1)/(IPCA)(-2)-357.3*(IPCA)(-3)/(IPCA)(-8)
(2.04) (-3.84)
+130.1*(GDE)(-1)/(GDE)(-2)+60.88*(GDE)(-4)/(GDE)(-12)
(2.57) (2.52)
-0.4936*(NFSNO)(-1)+104.8*(FDI$)(-1)/(KFDI)(-2)
(-1.16) (4.00)
+10.23*(POIL$)(-1)/(POIL$)(-7)+F22(FPF$)+u
(2.53)

R^2=0.9501, RA^2=0.9103, SE=2.6150, SD=5.0642, DW=2.44, F=23.83

(E-23) Narrow Money Supply (M1)

(M1)/(GDE)(-1)/(IGPDI)(-1)=3.9824+1.177*(IPCA)(-1)/(IPCA)(-12)
(3.89) (6.51)
+0.7829*(IGPDI)(-1)/(IGPDI)(-2)+0.1925*(IGPDI)(-4)/(IGPDI)(-7)
(1.78) (1.91)
-1.105*(GDE)(-1)/(GDE)(-2)+0.7880*(M1)(-1)/(GDE)(-2)/(IGPDI)(-2)
(-8.08) (14.41)
-2.581*(M1)(-1)/(M2)(-1)+0.4239*(PTO)(-1)/(PTO)(-13)
(-8.13) (3.15)
+0.01825*(SELIC)(-1)/(SELIC)(-2)+0.03306*(SELIC)(-1)/(SELIC)(-7)
(2.18) (4.57)
-0.2220*(RATE)(-1)/(IPCA)(-1)+0.05612*(RATE)(-1)/(RATE)(-2)
(-6.28) (1.77)
+0.01224*(NFSNO)(-1)+0.1418*(RES$)(-1)/(RES$)(-2)-0.002051*(NUCI)(-2)
(8.02) (6.83) (-1.34)
-4.840*(CPIUS)(-4)/(CPIUS)(-8)-2.657E-05*(CA$)(-1)+F23(FPF$)+u

(-5.82) (-7.21)

R^2=0.9802, RA^2=0.9604, SE=0.009312, SD=0.04683, DW=2.88, F=49.59

(E-24) Wide Money Supply (M2)

(M2)/(GDE)(-1)/(IGPDI)(-1)=4.6082-5.974*((IPCA)(-2)-(IPCA)(-3))
(4.95) (-1.68)
+0.003409*((SELIC)(-1)-(IPCA)(-1)+(IPCA)(-2))-6.517*(GDE)(-1)/(GDE)(-2)
(1.62) (-5.11)
+1.936*(GDE)(-1)/(GDE)(-4)+8.050E-05*(CA$)(-2)+1.790E-05*(CAP$)(-2)
(3.95) (3.06) (4.60)
+0.3041*(RATE)/(RATE)(-1)+0.9525*(M2)(-1)/(GDE)(-2)/(IGPDI)(-2)
(2.03) (28.36)

R^2=0.9894, RA^2=0.9847, SE=0.05740, SD=0.4653, DW=1.61, F=212.76

(E-25) Necessity of Financial Sector (NSFNO)

(NFSNO)=-138.3284+31.44*(GDE)(-1)/(GDE)(-8)-0.0003294*(CA$)(-3)
(-2.46) (4.81) (-1.25)
+85.69*(IPCA)(-1)/(IPCA)(-2)+9.6558E-05*(RES$)(-1)+0.9565*(DPI_Y)(-1)
(1.57) (3.26) (7.10)
+0.4945*(DPE_Y)(-1)+0.1506*(SELIC)(-1)+19.89*(CONS)(-1)/(CONS)(-4)
(3.20) (7.38) (2.54)
-0.2768*(POIL$)(-2)-1.428*(DESA)(-4)-0.1256*(GDE)(-1)/(POP)(-1)
(-3.49) (-3.65) (-3.32)
+29.93*(IGPDI)(-1)/(IGPDI)(-7)-3.771*(RATE)(-4)/(RATE)(-)
(3.01) (-3.07)
+0.1406*(NUCI)(-3)-1.386*(M2)(-7)+F25(FPF$)+u
(1.71) (-1.30)

R^2=0.9901, RA^2=0.9791, SE=0.4533, SD=3.1377, DW=3.21, F=89.85

F22(FPF$)=-0.1230*(FPF$)(-1)/(FPF$)(-7)+0.2903*(FPF$)(-4)/(FPF$)(-15)
(-1.45) (2.96)
F23(FPF$)= -0.005960*(FPF$)/(FPF$)(-5)-0.001463*(FPF$)(-2)/(FPF$)(-3)
(-1.86) (-4.68)
F24(FPF$)= -2.704E-05*(FPF$)(-2)-2.112E-05*(FPF$)(-3)-1.850*(FPF$(-4)
(-2.54) (-2.14) (-1.60)
F25(FPF$)=-0.08821*(FPF$)/(FPF$)(-2)+0.0005905*(FPF$)(-6)
(-9.49) (5.54)
+0.02603*(FPF$)(-7)+0.05043*(FPF$)(-12)
(2.05) (4.59)

Figure 17 shows the trend of SELIC. It shows two big humps in 47-8th months (November-December 1997), and also in 58-59th and 62-63rd months (October-November 1998 and February-March 1999).

In (E-13), SELIC is positively influenced by GDE growth, FDI growth, and oil price, and negatively influenced by M2 and NFSNO. Therefore when the GDE

FIGURE 17. TREND OF SELIC (SELIC)

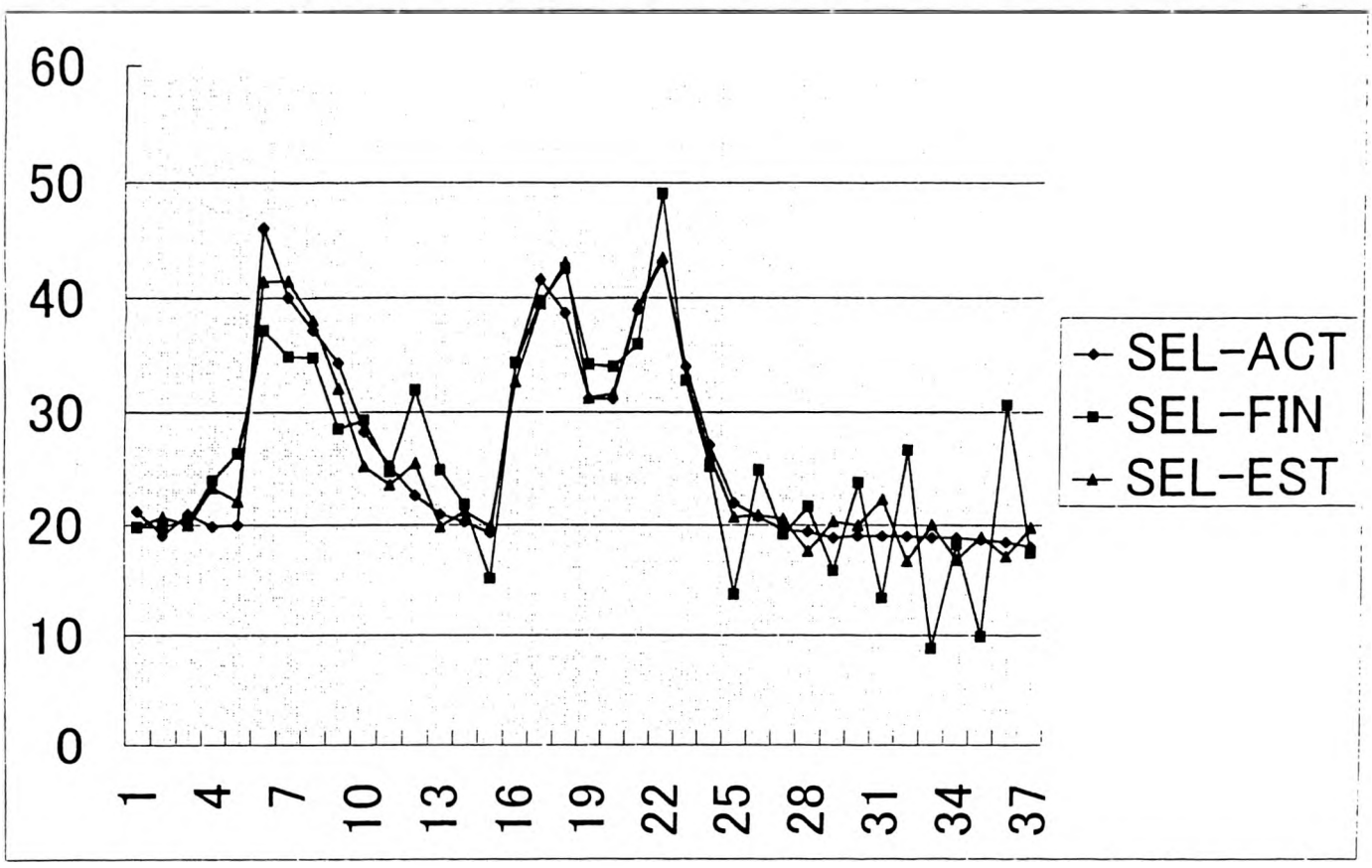


FIGURE 18. TREND OF M1 (M1)

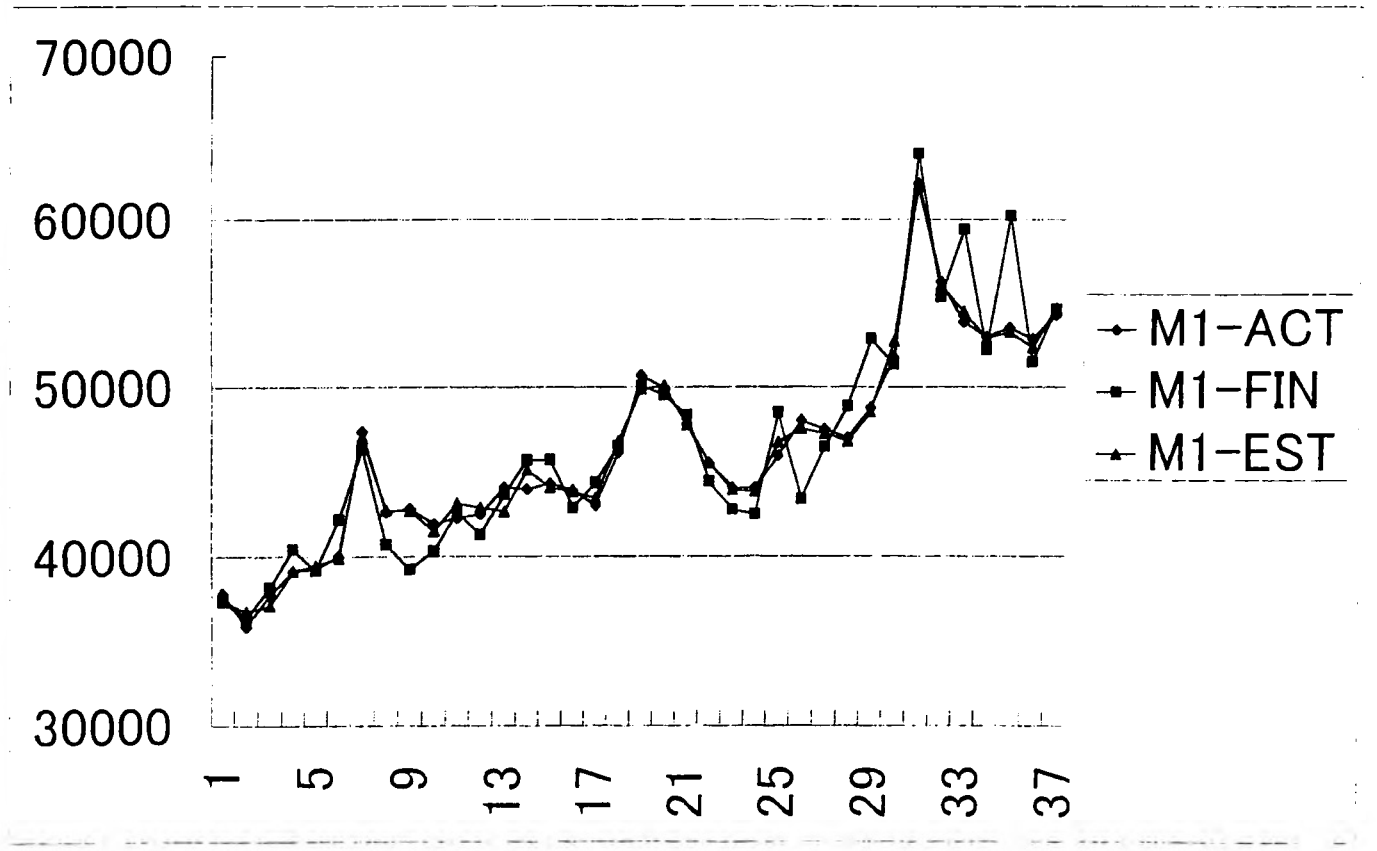


FIGURE 19. TREND OF M2 (M2)

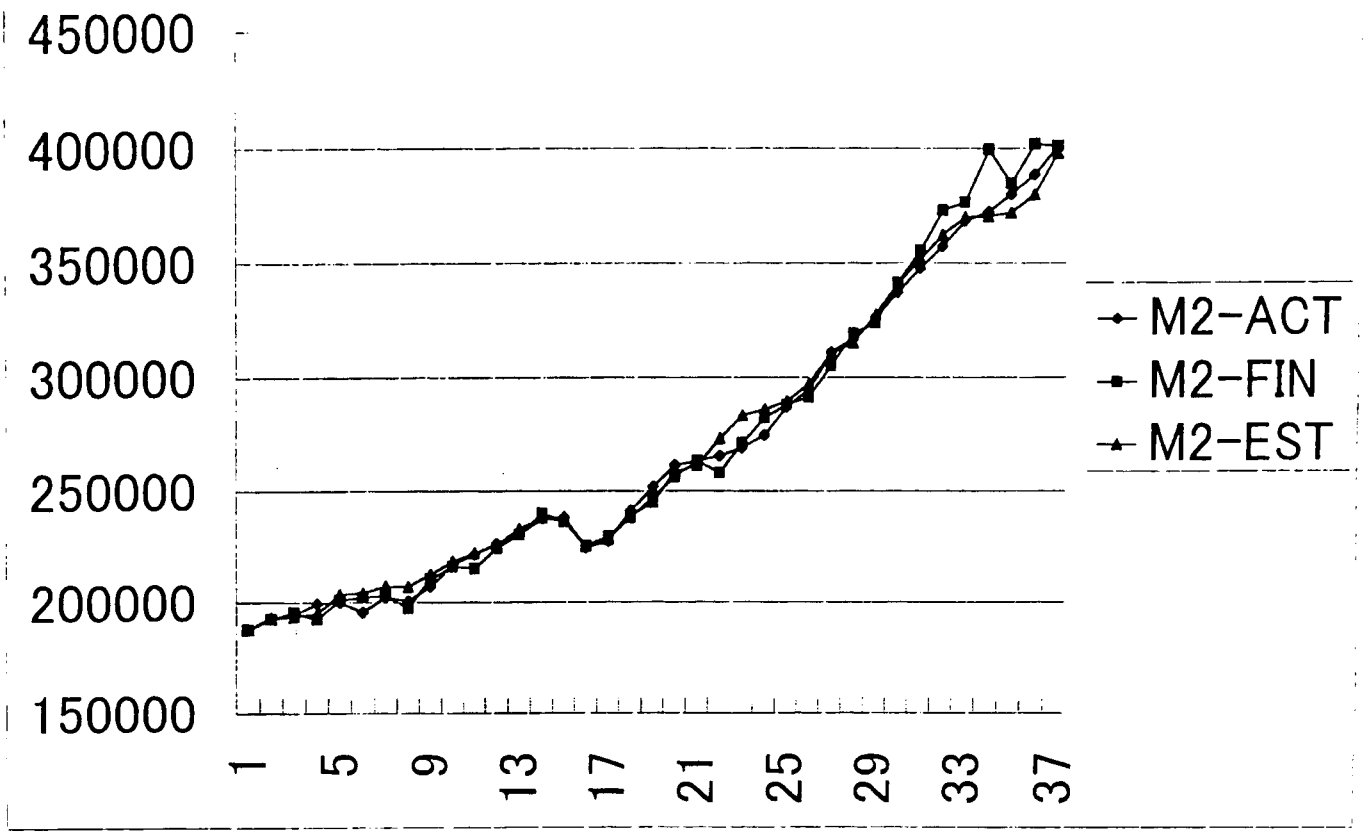
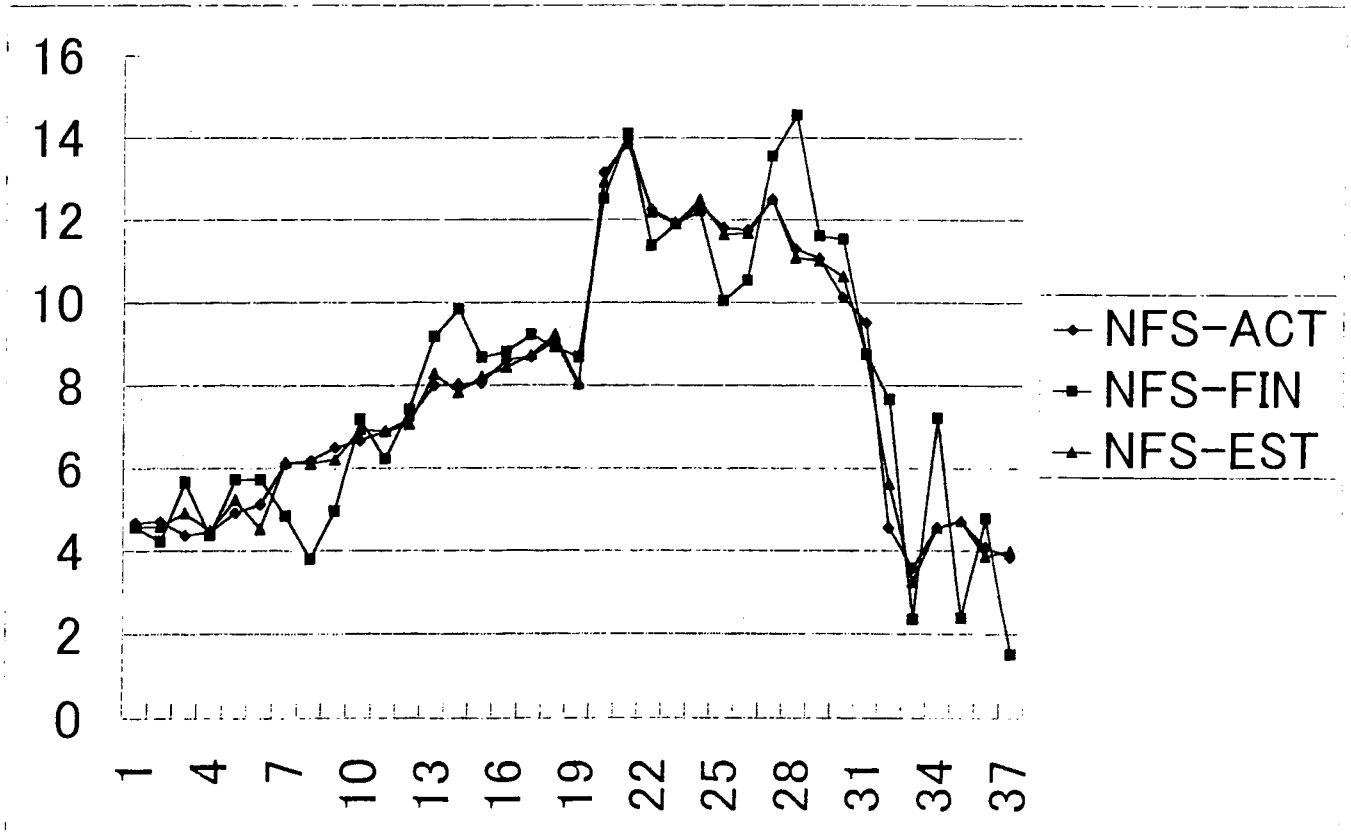


FIGURE 20. TREND OF FINANCIAL SECTOR REQUIREMENT (NFS)



growth is high and the economy is overheated, SELIC goes up. When the ratio of financial sector nominal requirement (NFSNO) is high, SELIC goes down. These are understood as the reasonable reaction of central bank. The M2 increase will negatively influence to SELIC based on the market pressure. But the reaction of SELIC to balance-of-payment, exchange rate change, and IPCA growth are more complex, because their coefficients are changing signs based on the number of lags. The sum of reaction coefficients to balance-of-payment is negative, so when the surplus gets bigger based on short-term capital inflow, SELIC tends to be lower. When SELIC is explained by these 13 variables, the result of single-equation estimation nicely traced the actual trend as shown in Figure 17. But when the reaction functions are included, the final test caused some cyclical errors in last 12 months. It seems that the consistent explanation of big humps and the constancy in last 12 months is very difficult, not to mention the possibility of structural change or break after the summer of 1999.

Figures 18 and 19 show the trends of M1 and M2. The trend of M2 is a steady growth, while the one of M1 is a relatively volatile cyclical growth. (E-23) and (E-24) show that both of them are well explained by major macroeconomic targets and other factors. Both of them are influenced positively by SELIC growth, exchange rate change, lagged value, and negatively by GDE growth. But the reaction to price growth differs as positive (M1, perhaps as the result) and negative. The response to the current balance is positive (M2) and negative (M1). Based on these different reaction coefficients, two trends are well traced in the final test, except cyclical errors of M1 in 2000.

Figure 20 shows the trend of the ratio of nominal financial sector requirement (NFSNO), which exhibits three different phases: a steady increase in 1997-98, an elevated big hump and gradual decrease in 1999, and a constantly low level in 2000. In (E-25), NFSNO is influenced positively by GDE and consumption growth, price (IPCA and IGPDI) growth, foreign currency reserve, SELIC, and rate of utilization, and negatively by per-capita GDP, M2, exchange rate change, current balance, and oil price. The ratio of external and internal debt to GDP also affects positively. The last effect and the positive effect of SELIC are easily understood as the natural consequence of increasing burden of interest payment. But other effects are understood to manifest the governmental reaction to the economic trend. The final test well traced the actual trend, except cyclical errors in 2000.

The results of final test of extended version-2 are summarized inTable.4.

Table.4. Result of Final Test after Endogenization of Instruments

Variables	Last 10 mons.	Last 5 mons.	Last 3 mons.
Instruments			
SELIC	29.4330	34.4743	38.6831
M1	4.5467	5.5182	5.2703
M2	2.3477	2.8337	1.5567
NSFNO	34.2450	34.4748	38.6831
Others			

CONS	3.2276	4.4805	5.5443
INV	5.8534	10.1718	13.1273
X	4.6694	3.9530	4.7225
IM	7.7713	9.9484	6.4072
GDE	4.0802	5.8874	7.7505
GDPN	4.9802	5.8874	7.7505
NUCI	2.9128	3.0311	4.6039
KR	2.2621	3.2358	3.7645
Y1	4.6518	5.2254	6.7588
Y2	4.8353	6.8978	8.5968
Y3	4.4414	5.7953	7.3658
IPCA	1.4766	1.8660	2.0271
IGPDI	0.7375	1.0902	1.1620
AWR	3.6549	3.9586	3.3763
EMP	0.7720	0.8116	0.8341
DESA	9.3618	10.2226	10.8273
RES$	1.4678	1.9655	2.4392

(Source) Calculated by author.

By the inclusion of reaction functions and extension of the veriosn-1 model into version-2, the final test result deteriorated especially for the year 2000.

The chronological process of structural changes of Brazilian economy after the hyperinflation period is an interesting theme. Fiorencio-Moreira (FM, 1999) discussed the exchange rate passthrough in different regimes based on their VAR model including INPC, SELIC and exchange rate, and defined the degree of indexation by maximum Eigen root. They showed that the degree decreased drastically after the Real Plan and was stable until the beginning of 1999. The final test result in Table 3 suggests that the movement of the private economy can be well described by the version-1 model. But the result of final test in Table 4 is worse than the one of Table 3. So there may exist a possibility of structural change in reaction functions of public sector.

5. Simulation Experiment

(This part will be reported by Prof. Obayashi)

6. Summary and Conclusion

I collected some monthly data and combined with the manufactured the monthly series from quarterly national income data, and constructed a prototype monthly model of the Brazilian economy (June 1997-June 2000) with 21 endogenous variables and a suitable set of exogenous variables. I paid special efforts to avoid the secular trends of left-hand-side variables. I did not use any dummy variables, but used the portfolio foreign investment as a surrogate measure to manifest the changing expectation to the current trend of Brazilian economy. The OLS estimation results shows a good final test result, in which the MAPEs of all

endogenous variables were controlled less than 10% after 36 times insertion.

The model was then applied to simulation studies of changing the important political instruments (exchange rate, SELIC, money supply) with different initial dates to clarify the size of effects and their nature (convergence or divergence). Although the fitting was good in terms of MAPEs in final test, there are some problems, which need further improvements. Also Chow tests pointed out the good possibilities of structural changes of endogenous variables. So the further improvement of single equation estimation is necessary. Further trials of endogenization of important reaction functions such as exchange rate, money supply and SELIC are also the important remaining tasks.

Takao Fukuchi (Asahi University, JICA)

References.

(1) Fiorencio, Antonio and Ajax R.B. Moreira (July, 1999), Latent Indexation and Exchange Rate Passthrough, Texto Para Discussao No. 650, p.1-20.
(2) Fukuchi, Takao and Suminori Tokunaga (1999), Simulation Analysis of Exchange Rate Dynamics: The Case of Indonesia, The Developing Economies, Vol.37, No.1, pp. 35-58.
(3) Fukuchi, Takao (September 2000), Inflationary Burst and Free-Fall in Krismon Period – A Vicious Circle Between Real and Monetary Aspects of Indonesian Economy, The Developing Economies, Vol. 38, No. 3, pp. 257-307.
(4) Fukuchi, Takao (September 2000), An Investigation of Virtuous Circle Between Real and Monetary Aspects of the Brazilian Economy, Discussion Paper No.27, IPEA, p.1-14.
(5) Fukuchi, Takao （August 2001）, Shock-Absorption Capacity of Fiscal-Monetary Policies – Analysis by Short-term Brazilian Decision Model, (mimeographed).