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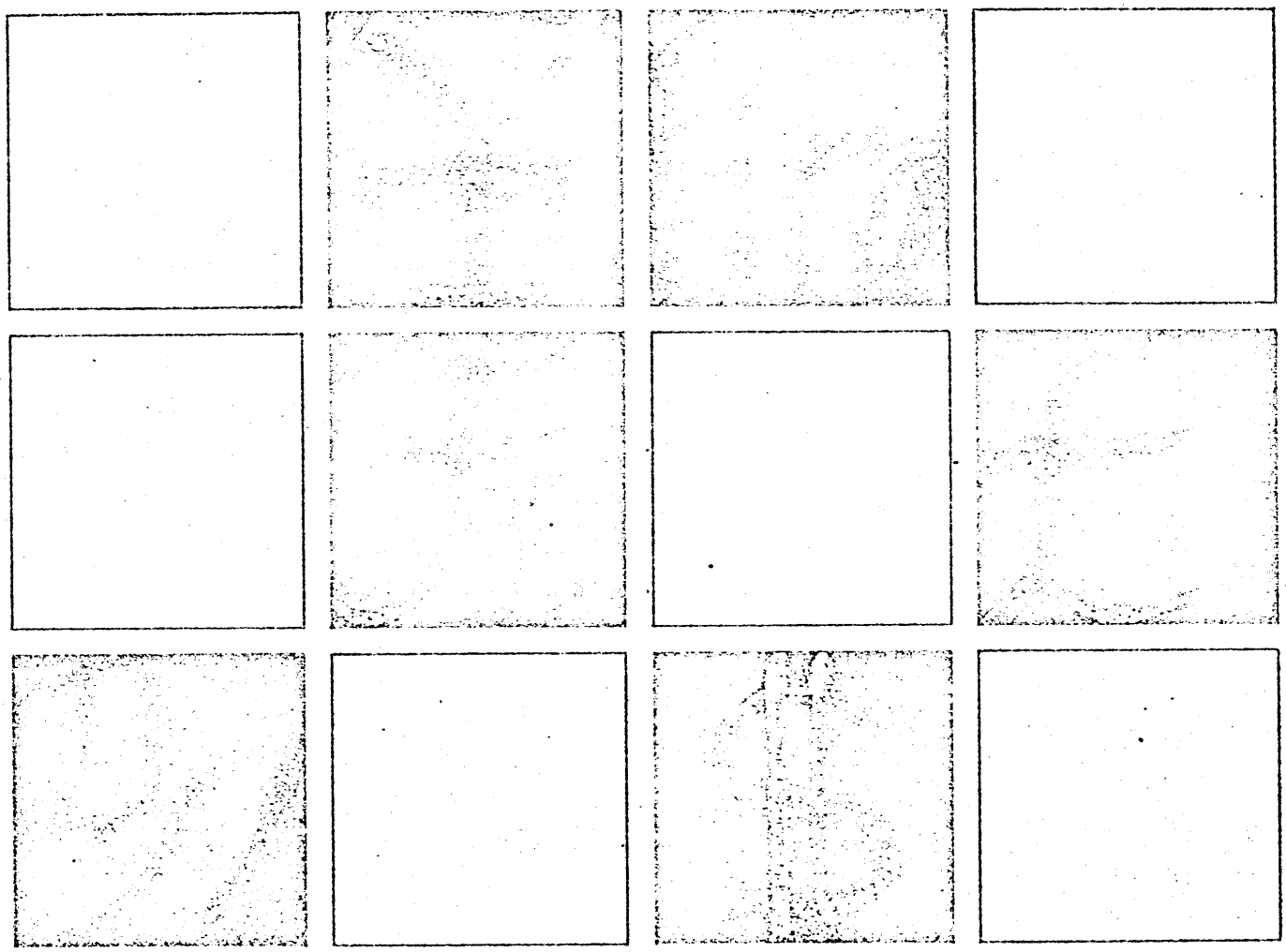

Number 64

OUTPUT, INFLATION, AND THE BALANCE OF PAYMENTS IN A SMALL, FIXED-EXCHANGE RATE ECONOMY: Tests with Data for Korea, 1960-1973

by Sung Y. Kwack

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Output, Inflation, and the Balance of Payments in a Small, Fixed-Exchange Rate Economy: Tests with Data for Korea, 1960-1973

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Increasing interdependence among economies in recent years has stimulated the development of models that take account of such interdependence in order to more adequately analyze an individual country's economic activity and inflation. At the same time, the effects of fiscal, monetary, and exchange rate policies in a small open economy on its output, inflation and balance of payments have been discussed at an abstract level.[1] Little systematic empirical work has yet been undertaken to examine the interesting implications emerging from these recent theoretical developments. In this paper, an attempt is made to provide an econometric framework explicitly allowing for external transactions of goods, services, and financial assets and for the dependence of monetary changes on fiscal deficits and the balance of payments. The model is applied to a highly open but small economy, the Republic of Korea, to demonstrate the usefulness of this framework.

The first section discusses the econometric model of Korea estimated over the periods 1960-1973. Then, prediction errors of dynamic simulations within the sample period and outside the sample period, 1974, are presented. The second section employs dynamic simulations from 1966 through 1970 to focus on the effects over time of changes in domestic fiscal and monetary policies, foreign activity, and the exchange rate. The paper is concluded in the third section with a summary of the main results.

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*This paper represents the views of the author and should not be interpreted as reflecting the views of the Board of Governors of the Federal Reserve System or other members of its staff.

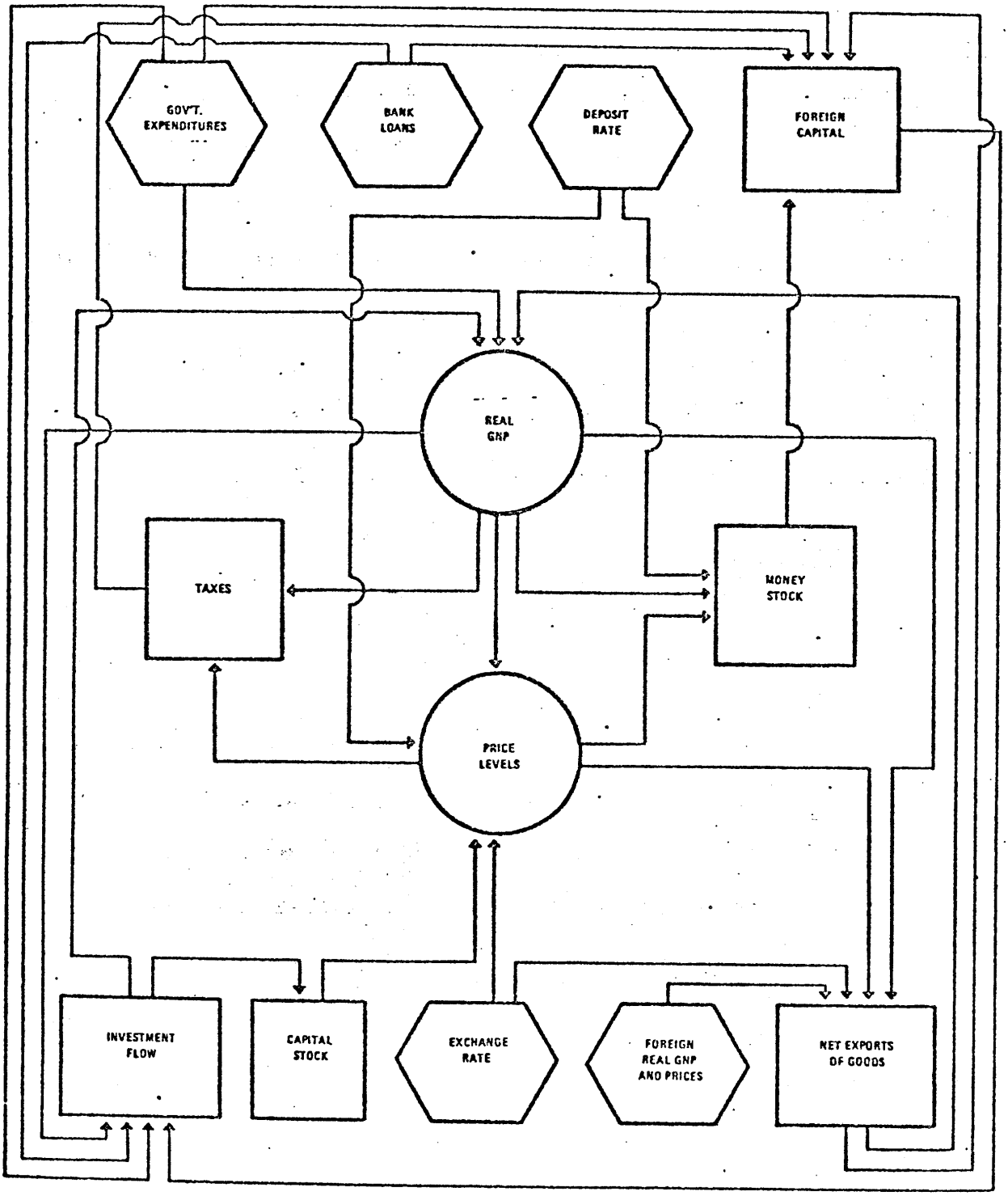
I. A Model of the Korean Economy

The Korean model reported in this paper is constructed with the following main assumptions about the economy: (a) it engages in transactions with the rest of the world in both goods and services, and assets; (b) the size is small in the sense that the price levels and activities abroad are given; (c) the domestic and foreign assets are perfect substitutes for each other[2]; and (d) the banking system passively accommodates the needs for financing the government deficits and takes no sterilization operations to offset the effects of changes in international reserves on the money supply. The Korean model contains 13 behavioral and 13 identity equations; 17 exogenous variables uniquely determine the movements of the 26 endogenous variables. The 13 sectoral equations explain the behavior of consumption, investment, exports, imports, demand for money, transfer receipts from abroad, net factor income from abroad, taxes, and prices. The model is closed with 13 identities determining aggregate activity, money supply, and the balance of payments, and defining aggregate foreign activity, foreign prices, and an effective exchange rate. Figure 1 is a flow chart of the model which shows the interrelationships among various sectors of the economy.

The structural coefficients of each equation in the model are estimated, using ordinary least squares, with annual data over the period 1960 through 1973. Consequently, estimates of the structural coefficients are subject to simultaneous equation bias. The figures in parentheses under the estimated coefficients are t-statistics; and $\bar{R}^2$,

Figure 1

SIMPLIFIED FLOW CHART OF THE MODEL



1. The variables in ⊂⊃ are exogenous variables.
2. Arrows ( ) indicate the directions of main influence.

SEE, and DW stand for the coefficients of determination adjusted for degrees of freedom, the standard error of estimate, and the Durbin-Watson statistic, respectively. The sources of data used are the Bank of Japan [1], the Bank of Korea [2], Board of Governors of the Federal Reserve System [5], International Monetary Fund [15], and the U.S. Department of Commerce [26].

Table 1 presents the estimated equations, identities, and definition of symbols.[3] Real private consumption expenditures as given in (1) is assumed to depend upon real net national product and private transfer receipts excluding taxes. The income elasticity of real consumption is estimated at about 0.9, which seems to be acceptable. Real private net domestic investment flow (including changes in inventories), as given in (2), is determined by changes in real domestic product and changes in private borrowings from the domestic banking system and abroad. The increase in private borrowings directly raises the speed of adjustment of the existing stock to desired levels through increasing the availability of funds and indirectly represents the reduction in the rate of interest on borrowed funds through increasing the supply of funds. In both cases, its effect on domestic investment inflow is expected to be positive and is found to spread over a 4 year period. However, measures of the cost of capital are not included because of inadequate information on the after-tax rate of return or market interest rates.

Equation (3) determines the quantity of real exports. In addition to foreign real income and relative prices, the lending by the domestic

Table 1

A Small Open Economy Model: Korea, 1960-1973

I. BEHAVIORAL EQUATIONS

(1) Private consumption expenditures

$$\log\left(\frac{C^P}{P}\right) = \underset{(6.54)}{0.625} + \underset{(3.26)}{0.426}\log(y_d) + \underset{(3.40)}{0.473}\log(y_d)_{-1}$$

$\bar{R}^2 = 0.997$ SEE = 0.025 DW = 1.202

(2) Net private investment expenditures

$$\frac{NI^P}{PM} = \underset{(2.86)}{-12.493} + \underset{(11.42)}{0.569}\,\Delta\frac{GDP}{PGNP} + \underset{(3.83)}{0.227}\left[\frac{\Delta NDA^P + \Delta FK^P}{PM}\right]$$

$$+ \underset{(8.95)}{0.169}\left[\frac{\Delta NDA^P + \Delta FK^P}{PM}\right]_{-1} + \underset{(3.61)}{0.113}\left[\frac{\Delta NDA^P + \Delta FK^P}{PM}\right]_{-2}$$

$$+ \underset{(1.95)}{0.056}\left[\frac{\Delta NDA^P + \Delta FK^P}{PM}\right]_{-3}$$

$\bar{R}^2 = 0.987$ SEE = 9.796 DW = 1.916

(3) Exports of goods and services, excluding factor income

$$\log\left(\frac{EX}{PX}\right) = \underset{(1.383)}{-4.978} + \underset{(2.12)}{1.546}\log(y_f) + \underset{(3.17)}{0.007}\frac{DBF}{PM}$$

$$- \underset{(1.93)}{0.695}\log\left(\frac{PX}{PF\cdot E}\right) - \underset{(2.40)}{0.760}\log\left(\frac{PX}{PF\cdot E}\right)_{-1} - \underset{(2.77)}{0.771}\log\left(\frac{PX}{PF\cdot E}\right)_{-2}$$

$$- \underset{(3.05)}{0.727}\log\left(\frac{PX}{PF\cdot E}\right)_{-3} - \underset{(3.24)}{0.628}\log\left(\frac{PX}{PF\cdot E}\right)_{-4}$$

$$- \underset{(3.37)}{0.473}\log\left(\frac{PX}{PF\cdot E}\right)_{-5} - \underset{(3.45)}{0.264}\log\left(\frac{PX}{PF\cdot E}\right)_{-6}$$

$\bar{R}^2 = 0.997$ SEE = 0.067 DW = 1.487

(4) Imports of goods and services, excluding factor income

$$\log\left(\frac{IM}{PM}\right) = \underset{(18.65)}{-5.607} + \underset{(7.84)}{3.088}\log\left(\frac{C^P+NI^P+CCA^P+I^g+C^g}{P}\right)$$

$$\underset{(3.79)}{-1.533}\log\left(\frac{C^P+NI^P+CCA^P+I^g+C^g}{P}\right)_{-1}$$

$$\underset{(3.35)}{-0.306}\log\left(\frac{PM}{P}\right) \underset{(3.35)}{-0.229}\log\left(\frac{PM}{P}\right)_{-1}$$

$$\underset{(3.35)}{-0.153}\log\left(\frac{PM}{P}\right)_{-2} \underset{(3.35)}{-0.076}\log\left(\frac{PM}{P}\right)_{-3}$$

$\bar{R}^2 = 0.991$ SEE = 0.078 DW = 2.347

(5) Net factor income receipts from abroad

$$\frac{NYF}{PGNP} = \underset{(2.57)}{-13.039} + \underset{(3.49)}{0.154}\, y_f \underset{(4.32)}{-0.033}\frac{GDP}{PGNP} + \underset{(5.71)}{0.747}\left(\frac{NYF}{PGNP}\right)_{-1}$$

$\bar{R}^2 = 0.942$ SEE = 1.774 DW = 2.110

(6) Private transfer receipts from abroad

$$\log\left(\frac{PNTR}{PGNP}\right) = \underset{(5.38)}{-8.678} + \underset{(6.87)}{1.996}\log(y_f)$$

$\bar{R}^2 = 0.781$ SEE = 0.315 DW = 0.596

(7) Taxes, net of private transfer receipts for current and capital expenditures from government

$$TNTR = \underset{(0.48)}{8.464} + \underset{(17.67)}{0.115}\,(GNP+IM-CCA^P-CCA^g)$$

$\bar{R}^2 = 0.960$ SEE = 44.019 DW = 0.718

(8) Demand for money (M2)

$$\log\left(\frac{MS}{PGNP}\right) = \underset{(22.64)}{-6.953} + \underset{(41.65)}{1.833}\log\left(\frac{GNP}{PGNP}\right) + \underset{(3.44)}{1.718}\,RT$$

$$- \underset{(4.25)}{1.595}\log\left(\frac{PGNP}{PGNP_{-1}}\right) - \underset{(7.19)}{1.162}\log\left(\frac{PGNP}{PGNP_{-1}}\right)_{-1}$$

$$- \underset{(5.27)}{0.999}\log\left(\frac{PGNP}{PGNP_{-1}}\right)_{-2} - \underset{(5.13)}{0.894}\log\left(\frac{PGNP}{PGNP_{-1}}\right)_{-3}$$

$$- \underset{(3.82)}{0.632}\log\left(\frac{PGNP}{PGNP_{-1}}\right)_{-4}$$

$\bar{R}^2 = 0.995$ SEE = 0.076 DW = 2.573

(9) Wholesale prices

$$\log(P) = \underset{(2.38)}{0.413} + \underset{(2.35)}{0.142}\log(WR) + \underset{(3.71)}{0.349}\log(PM) + \underset{(1.83)}{0.256}\log(PR)$$

$$+ \underset{(2.48)}{0.785}\left[\log\left(\frac{GDP}{PGNP}\right) - \log K\right]$$

$\bar{R}^2 = 0.991$ SEE = 0.044 DW = 1.638

(10) Wage rate

$$\log(WR) = \underset{(13.2)}{-10.694} + \underset{(12.7)}{1.679}\log K + \underset{(4.82)}{0.268}\log RT - \underset{(1.84)}{2.836}\log N$$

$$+ \underset{(3.04)}{0.601}\log(PGNP)$$

$\bar{R}^2 = 0.999$ SEE = 0.030 DW = 2.457

(11) Export prices

$$\log(PX) = \underset{(2.24)}{1.618} + \underset{(11.4)}{1.198}\log(P) - \underset{(2.26)}{0.243}\log K$$

$\bar{R}^2 = 0.979$ SEE = 0.068 DW = 1.391

(12) Import prices

$$\log(PM) = \underset{(0.84)}{0.016} + \underset{(36.2)}{0.807}\ \log(PFX)$$

$\bar{R}^2 = 0.990$ SEE = 0.050 DW = 1.301

(13) Government's capital consumption allowance

$$\frac{CCA^g}{P} = \underset{(2.47)}{0.851} + \underset{(10.5)}{0.003}\ K_{-1}$$

$\bar{R}^2 = 0.894$ SEE = 0.515 DW = 1.827

II. IDENTITIES

(14) Private capital consumption allowance

$$\frac{CCA^P}{P} = 0.04\ K_{-1} - \frac{CCA^g}{P}$$

(15) Capital stock

$$K = \frac{NIP}{P} + \frac{I^g}{P} - \frac{CCA^g}{P} + K_{-1}$$

(16) Gross domestic expenditures

$$GDP = C^P + NI^P + CCA^P + I^g + C^g + EX - IM$$

(17) Gross national expenditures

$$GNP = GDP + NYF$$

(18) Real disposable income, net of depreciation, taxes and transfer receipts

$$y_d = \frac{GNP + PNTR}{PGNP} - 0.04\ K_{-1} - \frac{TNTR}{PGNP}$$

(19) Implicit GNP deflator

$$PGNP = GDP/\left(\frac{C^P + NI^P + CCA^P + I^g + C^g}{P} + \frac{EX}{PX} - \frac{IM}{PM}\right)$$

(20) Supply of money including time and savings deposits

$$MS = NDA^P + NDA^g + NFA$$

(21) Change in the banking system's investment and lending to government

$$\Delta NDA^g = C^g + I^g - CCA^g - TNTR - GNTR - \Delta FK^g$$

(22) Change in the banking system's net foreign assets

$$\Delta NFA = EX - IM + NYF + GNTR + PNTR + \Delta FK^g + \Delta FK^P$$

(23) Foreign real income

$$y_f = (XNP_{US}{}^{0.5})(XNP_{JA} \cdot 0.0027663)^{0.5}$$

(24) Implicit exchange rate index

$$E = \frac{EKO}{130}\left(\frac{EJA}{0.27663}\right)^{0.5}$$

(25) Foreign wholesale prices

$$PF = (P_{US})^{0.5}(P_{JA})^{0.5}$$

(26) Foreign export prices

$$PFX = (PX_{US})^{0.5}(PX_{JA})^{0.5}$$

III. DEFINITIONS (* indicates exogenous variable)

*C^g = Government consumption expenditures, billions of Won

C^P = Private consumption expenditures, billions of Won

CCA^g = Government capital consumption allowance, billions of Won

CCA^P = Private capital consumption allowance, billions of Won

*DBF = Banking system's loans for support of exports, end of year, billions of Won

E = Implicit effective exchange rate index, 1963 = 1.00

EX = Exports of goods and services, excluding factor income, billions of Won

*EJA = U.S. cents per Japanese yen

*EKO = Korean Wons per U.S. dollar

*FK^g = Government borrowings from abroad, end of year, billions of Won

FK^P = Private borrowings from abroad, end of year, billions of Won

GDP = Gross domestic expenditures, billions of Won

GNP = Gross national product, billions of Won

*GNTR = Government's transfer receipts from abroad, billions of Won

*I^g = Government's gross domestic investment, billions of Won

IM = Imports of goods and services, excluding factor income,

K = Physical capital stock, end of year, billions of Won

MS = Money supply (M1 + time & saving deposits), end of year, billions of Won

NDA^g = Banking system's investment and lending to government, end of year, billions of Won

*NDA^P = Banking system's investments and lending to domestic private, end of year, billions of Won

NFA = Banking system's net foreign assets, end of year, billions of Won

*N = Population index, 1963 = 1.00

NI^P = Private net investment expenditures, billions of Won

NYF = Net factor income receipts from abroad, billions of Won

P = Wholesale price index for all commodities, 1963 = 1.00

$*P_{JA}$ = Japanese wholesale price index for industrial products, 1963 = 1.00

$*P_{US}$ = U.S. wholesale price index for industrial products, 1963 = 1.00

PF = Foreign wholesale price index, 1963 = 1.00

PFX = Foreign export price index, 1963 = 1.00

PGNP = Implicit GNP deflator, 1963 = 1.00

PM = Implicit price deflator of imports, 1963 = 1.00

PNTR = Private transfer receipts from abroad, billions of Won

*PR = Wholesale price index for grains, electric power, and tobacco

PX = Implicit price deflator of exports, 1963 = 1.00

$*PX_{JA}$ = Japanese export price index, 1963 = 1.00

$*PX_{US}$ = U.S. export price index, 1963 = 1.00

*RT = Interest rate on time deposits, fraction

TNTR = Taxes, net of private transfer receipts for current and capital expenditures from governments, billions of Won

WR = Manufacturing wage index, 1963 = 1.00

$*XNP_{JA}$ = Japanese real GNP, billions of 1963 Yen

$*XNP_{US}$ = U.S. real GNP, billions of 1963 dollar

y_d = Real disposable income, billions of 1963 Won

y_f = Foreign real GNP, billions of 1963 dollar

banking system to the private sector for the promotion of exports (DBF) has a positive effect. The long-run price elasticity is about 4, whereas the impact price elasticity is 0.7. This is not surprising because most Korean exportables are non-raw materials and non-agricultural goods, and the estimates are consistent with the price elasticity estimates of U.S. imports.[4] Conversely, the quantity of real imports is price-inelastic even in the long-run, as indicated in equation (4). This appears to be in line with the prior supposition that imports of raw material and agriculture goods are not very substitutible. The long-run income elasticity of imports, 1.5, turns out to be lower than the short-run elasticity, 3.0. Although the long-run elasticity estimate is acceptable, the short-run elasticity estimate is quite high. This may call for some improvement in the specification.

Equation (5) shows the positive relationship between net factor income abroad and economic activity in the current and previous periods. Also, private transfer receipts from abroad, given in (6), are assumed to relate positively to foreign activity. Not surprisingly, the transfer receipts are sensitive to variations in business conditions abroad. Equation (7) describes private taxes net of current and capital transfer receipts from government. Given tax rates, the taxes net of transfer receipts are postulated to depend on the tax base, measured by nominal GNP and imports net of capital depreciation.

In equation (8), the demand for real money inclusive of time and savingsdeposits is a function of real GNP, a 5 year distributed lag function of inflation rates, and the interest rate on time and savings deposits.

The deposit rate is fixed exogenously by the monetary authority. The effect on money demand from a change in the deposit rate is a priori indeterminate because an increase in the deposit rate leads to an increase in the demand for the time and savings deposits and also a decrease in the demand for currency and demand deposits. Nevertheless, the empirical finding of the positive effect indicates that a rise in the deposit rate generates a rise in the money balance, thus providing an increased supply of funds available for private investment.[5] The importance of private wealth is ignored because of the lack of quantitative information on financial wealth.

As shown in equation (9), the wholesale price index is determined by the wage rate; import price; wholesale prices of grain, electric power and tobacco set exogenously by the government; and the capacity utilization rate represented by the ratio of real GDP to the capital stock. The wage rate is assumed to be flexible and determined by the price level and the demand for labor in excess of the labor supply.[6] Labor demand is positively related to the capital stock and the ratio of the deposit rate to the wage rate. A profit-maximizing substitution between labor and capital with given relative factor prices is assumed, noting that labor is the abundant factor and cost of capital is partially represented by the interest rate. Equations (9) and (10) together imply that price levels and wage rates are simultaneously determined by both foreign forces--import prices--and domestic forces--the capacity utilization rate, the capital stock and the interest rate.[7] The export price in (11) is assumed to be associated positively with domestic price and negatively associated with the capacity to produce exportables. The

small country is not completely a price taker in selling its goods and services. But, the country is assumed to be a price taker in purchasing foreign goods and services. Hence, the import price as given in (12) is determined by foreign export prices adjusted for exchange rate variation.

Equations (13)-(15) define the rate of depreciation of physical capital stock as 4% per year. Equations (16) through (19) provide definitions of several measures of domestic activity and the implicit GNP price deflator. Equations (20)-(22) define the sources of increases in the money supply as autonomous increases in the bank's lending to the private sector, financing of government fiscal deficits, and increases in net foreign assets. Changes in nominal money demand are determined by equation (8), and the bank lending to the private sector is a policy instrument. Thus, equating money demand and supply implies that the balance of payments identity (22) can be used for determining changes in the private borrowings from abroad. This shows that conditions in the money market play an important role in determining the capital inflows as well as the balance of payments. This approach to explaining capital flows is conceptually equivalent to the conventional approach of predicting capital flows from the demand for foreign assets, as shown in Appendix I.[8]

Equations (24)-(27) define aggregate foreign income, wholesale prices, export price, and the effective exchange rate. The weight 0.5 given to the United States is based on the relative value shares of exports and imports.

Table 2

Dynamic Prediction Error Analysis

	Within the Sample Period, 1960-1973		Outside the Sample Period, 1974	
	MB	RMSE as % of Actual Mean	MB	RMSE as % of Actual Mean
PGNP	-0.02	3.62	-0.29	8.04
P	-0.01	3.40	-0.46	11.33
PX	-0.02	7.34	-0.55	14.07
PM	0.01	4.20	-1.28	22.52
WR	-0.06	11.04	1.46	16.28
C^P/P	-5.78	4.58	226.56	18.77
NI^P/P	-9.95	34.40	-61.62	16.45
EX/PX	-1.83	16.31	160.85	30.17
IM/PM	-8.07	10.90	85.46	16.62
GDP/PGNP	-8.74	5.79	238.55	12.23
GNP/PGNP	-8.78	5.49	225.85	11.70
EX	-13.86	25.90	246.24	11.86
IM	-14.48	7.77	-280.78	9.64
EX-IM	0.62	-59.17	527.02	-63.09
GDP	-38.15	7.52	225.09	3.21
GNP	-37.60	7.17	189.05	2.72
ΔNFA	-13.00	451.10	794.31	-165.76
ΔNDA^g	5.95	1788.49	-377.95	-465.80
ΔMS	-7.06	54.68	416.36	92.16

MB (MEAN BIAS) is Σ (solved - actual)/N and RMSE (ROOT MEAN SQUARED ERROR) is $[\Sigma \text{ (solved - actual)}^2/N]^{0.5}$, where N is a number of observations (N = 14). Prices are expressed in 1963 = 1.0, whereas all other variables are in billions of Won.

The adequacy of the model for policy analysis is provided by the predictive ability of the system of equations as a whole. Tests of predictive ability are based on the results from dynamic simulations within and outside the sample period. The statistics of mean bias and root mean squared error as % of actual mean for the major endogenous variables are presented in Table 2. The equation explaining the government deficit financing (ΔNDA^g) seems to perform poorly and causes substantial errors in explaining changes in net foreign assets as well. This is also confirmed in the prediction outside the sample period for 1974. Since the values of all the exogenous variables used for 1974 are actual values, the mean bias is the prediction error. For 1974, the model predicts price levels lower than the actual and levels of real activity higher than actual. As a result, the errors for the nominal values of GDP and GNP are very small and amount to about 3% of actual values. In addition, the actual and predicted values for real GNP, the implicit GNP deflator, nominal exports and nominal imports of commodities and services excluding factor income are plotted in Figures 2-5, respectively. Considering that the predicted value of exports for 1973 is substantially lower due to a reduction in the real volume of loans for export promotion induced by increased import prices, these figures reveal that the system as a whole adequately traces the actual performance of the Korean economy. Thus, the model is deemed acceptable as a tool for the simulation exercises of the following section.

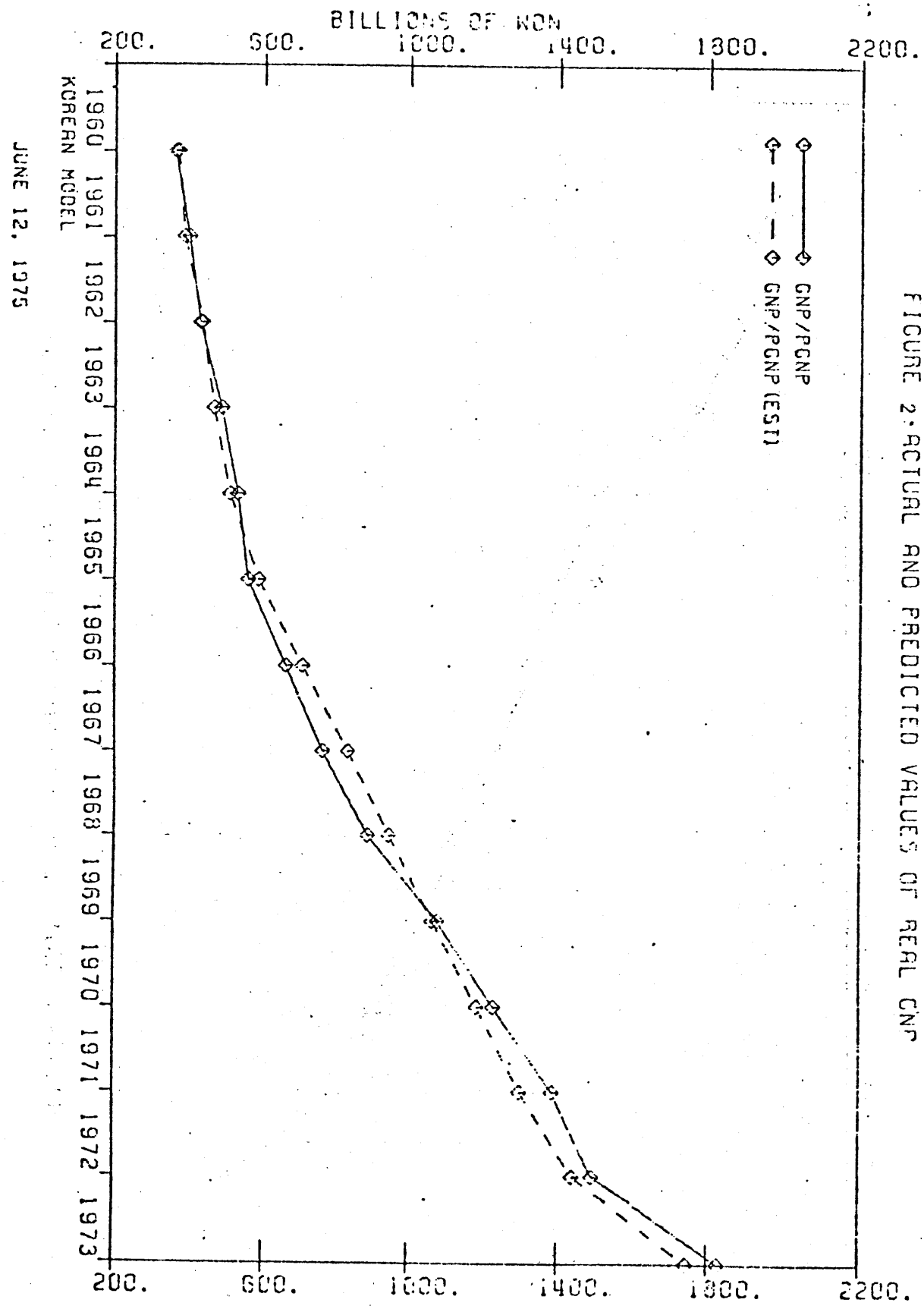


FIGURE 2: ACTUAL AND PREDICTED VALUES OF REAL GNP

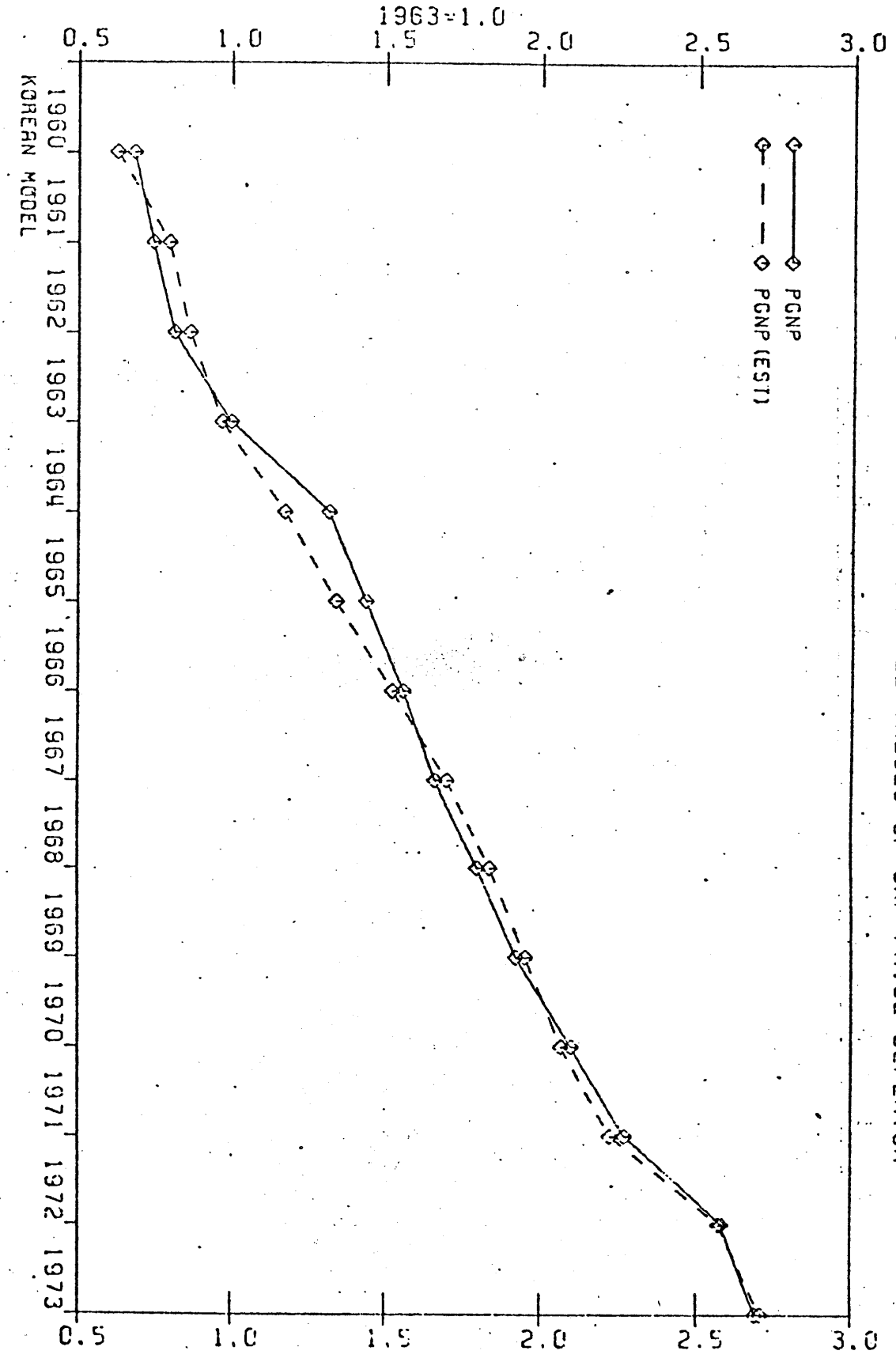


FIGURE 3: ACTUAL AND PREDICTED VALUES OF GNP PRICE DEFLATOR

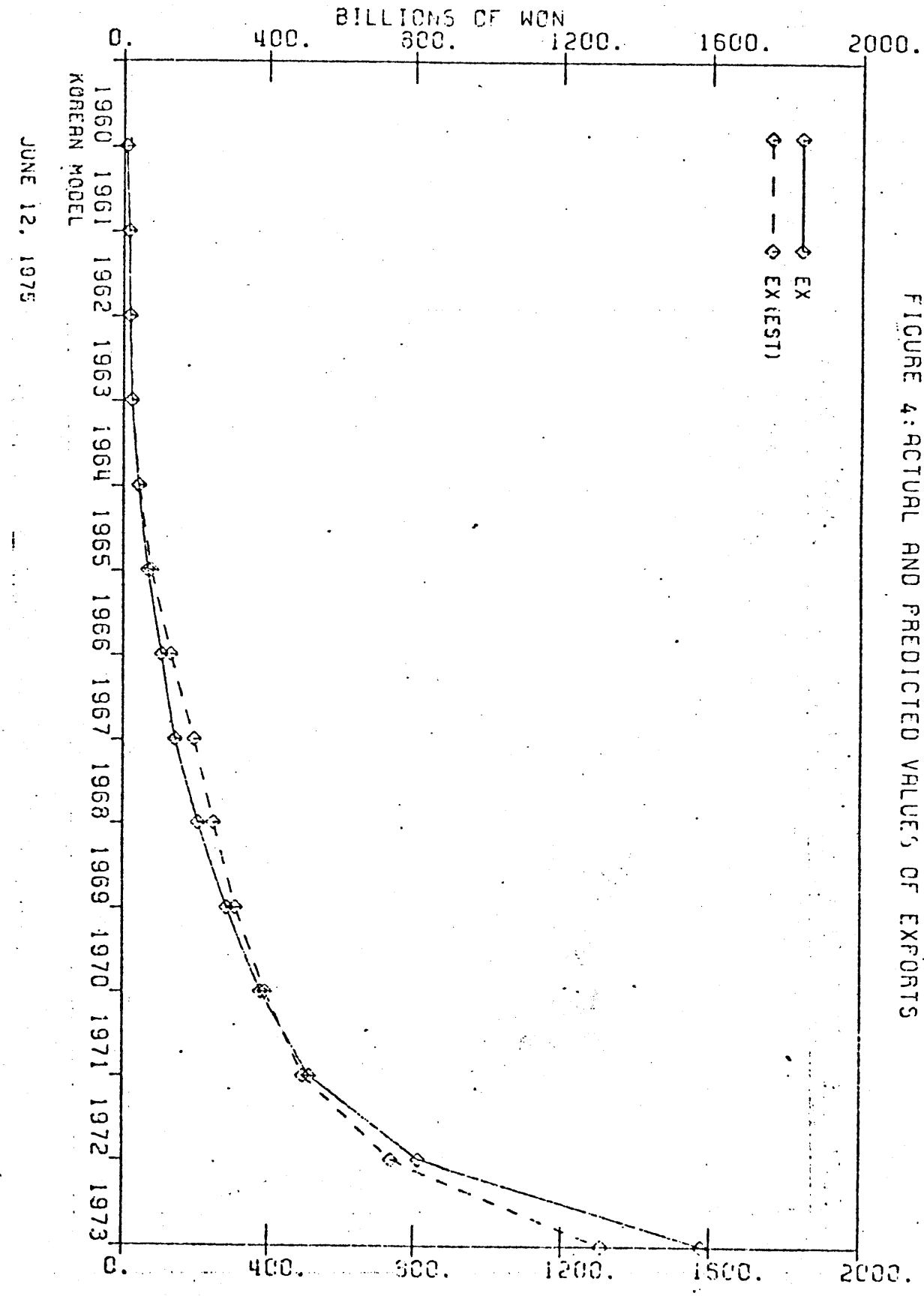


FIGURE 4: ACTUAL AND PREDICTED VALUES OF EXPORTS

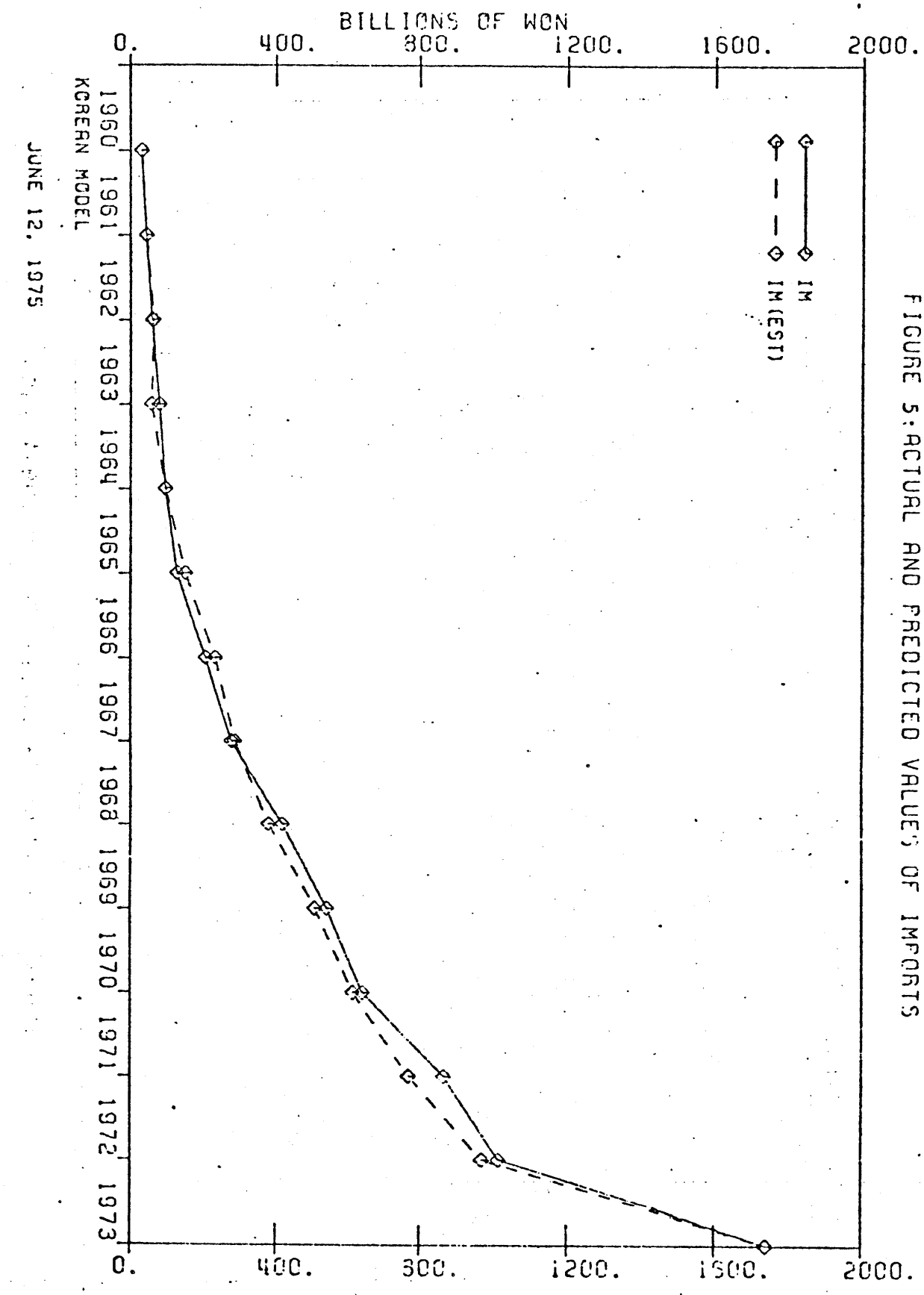


FIGURE 5: ACTUAL AND PREDICTED VALUES OF IMPORTS

II. Simulation of the Model

Thus far, the equation specifications underlying the model have been examined. To investigate the effects of fiscal, monetary, and exchange rate policies, dynamic simulations are conducted over the period 1966-1970. In each simulation with an exogenously originated shock, all other exogenous variables remain unchanged. Thus, the differences between the shocked and the control solution estimate the responses of the model. Values of the responses over time are reported for five exogenous changes:[9] (a) a 15 billion won sustained increase in nominal government expenditures, (b) a 5 percentage point rise in the time deposit rate, (c) a 3 billion won sustained increase in bank lending to the domestic private sector, (d) a $70 billion sustained increase in U.S. real GNP and (e) a 10% sustained devaluation of the Korean won against the U.S. dollar. The model is nonlinear and simultaneous. Consequently, the magnitudes of the responses are sensitive to the time when the change in an exogenous variable is initiated as well as the magnitude of the shock.

The first three shocks represent changes in fiscal and monetary policies. The effects of these changes on output, prices, and external transactions obtained by the simulations are summarized in Table 3. As can be seen, the autonomous change in nominal government expenditures raises real GNP by about 7 billion won initially and by about 10 billion won after 5 years. The greatest response of the economy occurs at the second year, and the impact seems to decline thereafter. Over the 5-year path, the response to a change in government expenditures appears to be low. This is plausible, however, because the government deficit causes a substantial deficit in the external balance of goods and services

Table 3

Time Path of the Effects of an Increase in Government Expenditure, Time Deposit Interest Rate, and Domestic Monetary Expansion

	K	P	GNP/PGNP	EX	IM	EX-IM	ΔNFA
15 billion increase in government spending ($\Delta(C^g+I^g)$)							
1st yr.	8.364	0.461	7.312	0.110	16.690	-16.580	-8.359
2nd yr.	15.936	0.657	13.009	-0.202	11.019	-11.220	-6.271
3rd yr.	19.559	0.332	12.106	-1.201	8.936	-10.137	-7.262
4th yr.	22.556	0.045	10.410	-1.835	9.326	-11.160	-8.939
5th yr.	26.107	-0.099	10.081	-1.635	10.814	-12.449	-9.431
5 percentage point increase in time deposit rate (ΔRT)							
1st yr.	1.999	0.648	0.248	0.232	2.039	-1.807	15.597
2nd yr.	5.309	0.540	0.833	-0.609	3.094	-3.703	10.084
3rd yr.	10.371	0.387	1.419	-1.790	5.420	-7.210	16.470
4th yr.	18.062	0.290	2.561	-2.925	9.254	-12.179	23.859
5th yr.	28.482	0.207	4.963	-3.987	13.417	-17.403	28.016
3 billion increase in bank lending to private (ΔNDA^{P*})							
1st yr.	-0.001	0.0	0.001	0.010	0.003	0.007	-2.999
2nd yr.	0.013	0.0	0.023	0.032	0.023	0.008	-2.981
3rd yr.	0.016	0.0	0.043	0.056	0.007	0.049	-2.963
4th yr.	0.016	0.0	0.048	0.087	0.039	0.048	-2.961
5th yr.	0.023	0.0	0.064	0.122	0.057	0.065	-2.932

Government expenditure, time and savings deposit rate, and the change in bank lending to the private sector were individually shocked and dynamic simulations were run from 1966-1970. *ΔDBF (loans for exports) is also increased by 0.027 billion.

P is the wholesale price index (in percent of the price index before the shock occurred; GNP/PGNP is real GNP; EX is export value of goods and services; IM is import value of goods and services; and ΔNFA is change in net foreign assets; K is capital stock (all in billion of Won).

amounting to 11 billion won and a rise of the wholesale price by about 0.3 percent. As expected, the rise in government expenditures leads to a deficit of about 8 billion won in the balance of payments, although there are foreign capital inflows of about 2 billion won on the average.

Let the monetary authority permit a 5 percentage point rise in the rate on time deposits without allowing for any change in the rates on bank loans.[10] The rise in the deposit rate is found to bring forth a rise in real GNP of about 0.3 billion won initially and 5 billion won after 5 years. Real domestic investment is stimulated by the induced private capital inflows which adjust the supply of money to the demand for money. The wage rate is increased by an increased demand for labor in response to the rise in the deposit rate and the subsequent rise in the capital stock. The increased wage rate together with the capacity utilization rate raises price levels. Given the nominal value of government expenditures, the increase in prices (including the GNP deflator) reduces real government spending and, thereby, lowers the increases in real GNP. Obviously, the rise in domestic prices and the rise in real GNP produce a deficit in the balance of real net exports of goods and services. The rise in export price induced by the rise in domestic prices and the real trade deficit cause a deficit in the nominal balance of 8 billion won on the average over a 5 year period. In addition, the net capital inflow is quite substantial, amounting to 10 billion won on the average. Thus, the capital inflow which more than compensates the deficit in the balance of goods and services leads to an increase in net foreign assets held by the banking system.

Investment and loans of the banking system to the domestic private sector are considered in this paper as a monetary instrument. Lending to the private sector is a domestic source component of the money supply, as stated in equation (20), and an increase in this monetary policy instrument is similar to a reduction in the market lending rate in a developed economy, by increasing the supply of loanable funds. As revealed in the table, the change in the monetary policy instrument is not effective in bringing about changes in income and price levels.[11] It is accompanied by a reduction in the capital inflow and a balance of payments deficit of about 3 billion won. That is to say, the availability of investible funds--bank loans and foreign capital borrowings remains unaffected by a change in the domestic source. This result, however, rests on the implicit assumption underlying investment equation (2) that private borrowing from the domestic banking system is a perfect substitute for borrowing from abroad and on the absence of sterilization operations by the monetary authority. If these assumptions were replaced by more realistic assumptions--that the two sources of funds have differential effects on domestic investment because of differential risks, and a partial sterilization operation is undertaken to stabilize the movement of the money supply--the rise in the domestic base would have been partially offset by the reduction in the capital inflow.[12] In this case, the monetary policy instrument will produce changes in domestic income and price levels. Consequently, the conclusion that the monetary policy is an ineffective instrument should not be accepted without the foregoing explicit qualifications.

Table 4 presents the simulation results regarding changes in U.S. real GNP. The rise of $70 billion in U.S. real GNP roughly brings forth a rise of $8.5 billion in aggregate foreign income, as is clear from equation (23). This rise, of course, leads to a rise in the real exports in excess of real imports, thereby resulting in a substantial rise in real GNP of about 16 billion won. The accompanying increase in real demand calls for increases in price levels. The rise in price levels is about 0.8 percent, on the average. The increase in real income and price levels causes a rise in the demand for nominal money. This increased demand for money can be satisfied with an increase in the foreign source of the money supply which induces a surplus in the balance of payments, as shown in the table. In this sense, a balance of payments problem can be said to be a monetary problem. It does not necessarily follow from this that an excess demand for money is the only condition that matters, unless all the goods as well as assets are homogeneous enough for the law of one price for one good to prevail in the world.[13]

Finally, simulation experiments are carried out to determine the effects on income, price levels, and the balance of payments of a hypothetical devaluation of the Korean won by 10 percent in 1966. The results, presented in Table 4, show that domestic prices increase as the result of the currency depreciation.[14] For instance, wholesale price levels are higher by about 5 percent than would have been expected in the absence of this policy change. The currency depreciation initially decreases the nominal balance of goods and services trade by 6 billion won mainly because of the inelastic demand for imports in the short-run.

Table 4

Time Path of the Effects of an Increase in U.S. Real GNP and the Exchange Rate

	K	P	GNP/PGNP	EX	IM	EX-IM	ΔNFA
70 billion increase in U.S. real GNP (ΔXNP_{US})							
1st yr.	4.653	0.769	9.585	8.220	8.056	0.164	7.189
2nd yr.	7.565	1.051	15.715	11.135	9.037	2.098	10.811
3rd yr.	7.458	0.971	17.083	11.965	8.495	3.470	12.321
4th yr.	5.971	0.819	16.832	12.784	9.480	3.304	12.932
5th yr.	5.009	0.768	17.720	15.296	12.636	2.660	15.227
10% devaluation of Korean Won (ΔEKO)							
1st yr.	0.981	3.374	3.882	8.380	14.497	-6.117	4.516
2nd yr.	4.731	4.086	11.987	19.754	20.659	-0.906	15.303
3rd yr.	9.322	4.816	22.362	34.559	30.520	4.039	27.553
4th yr.	12.765	5.380	32.392	53.457	42.717	10.740	41.989
5th yr.	17.535	5.759	42.472	79.279	60.142	19.136	59.131

U.S. real GNP and the exchange rate were individually shocked and dynamic simulations were run from 1966-1970. P is wholesale price index in percent of the price index before the shock occurred; GNP/PGNP is real GNP; EX is export value of goods and services; IM is import value of goods and services; and ΔNFA is change in net foreign assets; K is capital stock (all in billions of Won).

This initial adverse effect terminates within 3 years from such an exchange rate change. Hence, the time path of the devaluation effect on goods and services trade exhibits the J-curve behavior that has recently found favor in attempts to understand the effects of the depreciation of the U.S. dollar in 1971. From the first year, however, the real balance of goods and services trade turns a surplus, thereby bringing about a rise in real GNP. Moreover, the positive effect on real income tends to increase as the real trade balance tends to improve over time. Also, the balance of payments has a surplus of 30 billion won on average, as a result of the currency depreciation. The important conclusion from this result is that a currency depreciation can be effective, as long as relative prices after the devaluation differ from relative prices before the devaluation (partially due to the existence of non-tradeable goods sector). This proposition holds regardless of whether domestic and foreign assets are perfect substitutes.

III. Conclusions

This paper attempts to provide an empirical framework for the analysis of output, inflation, and balance of payments behavior in a small open economy. The model presented in the paper is designed to meet this expository purpose. Thus, much remains to be improved in the sectoral specifications. Nevertheless, the results emerging from the simulations seem to add an interesting perspective regarding foreign influences on economic activity and inflation of a small open economy and the effectiveness of its fiscal, monetary, and exchange rate policies in altering its domestic activity and inflation.

Fiscal policies are found to affect significantly income, price levels, and the balance of payments. Monetary policies affecting interest rate differentials are seen to promote the transformation of domestic savings into domestic capital formation, thereby affecting domestic output and price levels. On the other hand, monetary policies to increase the domestic source of the money supply seem to have a limited influence on economic conditions. As discussed, the effectiveness of money supply policies depends crucially on the degree of the substitutibility between funds borrowed internally and externally. A given change in the domestic base of the money supply may become more effective when domestic assets are lesser substitutes of foreign assets.

Changes in the exchange rate and foreign activity and price levels have substantial influence on domestic activity and price levels. Taking account of these foreign influences when formulating national policies would facilitate achievement of the policy targets of a small open economy. This interdependence suggests further investigation of a broader issue, namely, how and in what ways, a small economy can be insulated at minimum cost from undesirable disturbances originating abroad.

FOOTNOTES

*The author is an economist, Division of International Finance, Board of Governors of the Federal Reserve System. I want to thank Howard Howe for incisive comments and acknowledge helpful discussion of the issues dealt with in this paper with R. Berner, P. Clark, R. Emery, L. Girton, Dale Henderson and Guy Stevens. The conclusions of this paper are solely those of the author and do not necessarily reflect the views of the Board of Governors of the Federal Reserve System. This paper will be published in the Proceedings of the Pacific-Basin Central Bank Conference on Econometric Modeling, May 27-29, 1975, Federal Reserve Bank of San Francisco.

[1]See Turnovsky and Kaspera [25], Henderson [13], and Dornbusch [9] for examples of recent studies, and Otani [23] for an example of an empirical study.

[2]This assumption itself needs to be tested, and an empirical test is now in progress.

[3]The sectoral specifications are similar to the theoretical specifications of Turnovsky and Kaspera [25], with some modifications.

[4]U.S. price elasticity estimates of U.S. imports of manufactured goods are around 2.5. See Houthakker and Magee [14] and Kwack [18]. The income and price elasticity estimates of exports by the Bank of Korea [4] are 3.4 and 0.7, and the income and price elasticity estimates of imports are 1.7 and 0.7, respectively.

[5]This finding is in agreement with the argument of Emery [10] that the rise in time and savings deposits since the Korean interest rate reform of September 1965 has not been accomplished by a relative decline in the demand deposits. He also argues that the interest rate policy in less developed countries aims at mobilizing more domestic savings to finance a higher rate of capital formation.

[6]A more realistic wage equation is the specification generating very sticky wage response to changes in prices and capital stock in the short-run and increasing responses as time goes on.

[7]See Kwack [20] for a list of references of this type of analysis.

[8]I am indebted to Dale Henderson for showing a proof of the proposition in a two country world and want to acknowledge that Appendix I may be regarded as a summary of his framework.

[9]The magnitudes of the shocks (a), (c), and (d) are about 10% of the values for 1966.

[10]A rise in the deposit rate without changes in loan rates puts the financial burden on commercial banks. Implicitly, the Bank of Korea is assumed to take measures for reducing the financial burden, for example, lowering rediscount rates.

[11]See Mundell [22] for a theoretical discussion.

[12]For empirical evidence of this, see Herring and Marston [12].

[13]The reason for this is that, if the small-country assumption for capital and goods markets is introduced, the money market condition is the only factor. For monetarist views, see Borts and Hanson [6], Girton and Roper [11], Johnson [16], and Komiya [17]. For a comprehensive comparison between the monetarist and conventional views, see Branson [7] and Henderson [13], who conclude that the monetarist view is a special case.

[14]Kwack [20] presents the evidence in the case of 11 developed countries.

APPENDIX I

Equivalence of Monetary Approach of Balance of Payments to Conventional Approach in General Equilibrium Framework

Assume that 4 economic agents - private, government, bank, and foreign residents and 6 goods and assets - consumption goods, capital good, government bonds, foreign bonds, bank money, and international reserves. The following consolidated sheet can be set:

Units/ types	Consumption Goods	Capital Goods	Gov't Bonds	Foreign Bonds	Bank Money	Int'l Reserves	Interest Income	Taxes
Private	$C-Q_C$	$I-Q_I$	ΔB^P	ΔF^P	ΔM^P	0	$-(iB^P+*F^P)$	T^P
Gov't	G	0	$-\Delta B$	0	0	0	iB	$-T$
Bank	0	0	ΔB^b	0	$-\Delta M$	ΔR	$-iB^b$	iB^b
Foreign	$-Q_C^*$	I^*	ΔB^*	$-\Delta F^*$	ΔM^*	$-\Delta R^*$	$-(iB^*-i^*F^*)$	0
Prices	P_C	P_I	q	Eq*	1	1	q,Eq*	1,q

where:

- C = private demand for consumption goods
- Q_C = private output of consumption goods
- I = private gross investment demand
- Q_I = private output of capital goods
- B^P = private holdings of domestic bonds
- F^P = private hondings of foreign bonds
- M^P = private holdings of money
- δ = depreciation rate

i = domestic bond rate

i^* = foreign bond rate

T^P = private tax payments, net of subsidies

G = government spending

B = government supply of bonds

T = tax receipts, net of subsidies

B^b = central bank's holdings of domestic bonds

M = money supply

R = central bank's reserve holdings

Q_C^* = foreign supply of consumption goods to home country

I^* = foreign demand for capital goods to home country

B^* = foreign holdings of domestic bonds

F^* = foreign supply of bonds to home country

R^* = foreign reserve holdings

q = domestic bond price (related to i)

q^* = foreign bond price (related to i^*)

E = exchange rate (No. of home currency per foreign)

Let us assume that the capital gains due to changes in bond prices are zero, $\Delta q = 0$ and $\Delta q^* = 0$, and that F^* is denominated in foreign currency. The budget constraints for agents are derived from the consolidated sheet:

(1) Private sector

$$P_C C + P_I I - \delta P_I K + \Delta M^P + q\Delta B^P + K\Delta P_I + Eq^*\Delta F^P + q^* F^P \Delta E$$
$$= P_C Q_C + P_I Q_I + iqB^P + i^* Eq^* F^P - T^P - dP_I K + K\Delta P_I + q^* F^P \Delta E$$

(2) Government sector

$$P_C G = T+q\Delta B-iqB, \text{ where } T = T^P+iqB^b$$

(3) Bank sector

$$\Delta M = q\Delta B^b+\Delta R \quad \text{(assuming tax payment to government = } iqB^b\text{)}$$

(4) Foreign sector

$$P_I I^*-P_C Q_C^*+i^*Eq^*F^*-iqB^*+q\Delta B^*+\Delta M^*-Eq^*\Delta F^*-q^*F^*\Delta E = \Delta R^* .$$

Assuming the asset market is initially in stock equilibrium, the equilibrium for each of goods, bonds, and money markets must satisfy the following:

(5) $P_C Q_C+P_I Q_I = P_C C+P_I I+P_C G-P_C Q_C^*+P_I I^*$

(6) $\Delta B^P+\Delta B^b+\Delta B^* =\Delta B$

(7) $\Delta F^P = \Delta F^*$

(8) $\Delta M^P + \Delta M^* = \Delta M$

(9) $\Delta R^* = \Delta R$

Equation (4) for changes in the international reserves can be re-written using (5) and (9),

(10) $\Delta R = \{P_C Q_C+P_I Q_I-(P_C C+P_I I+P_C G)\} + \{i^*Eq^*F^P-iqB^*\}$

$+ \{q\Delta B^*+\Delta M^*-Eq^*F^P-q^*F^P\Delta E\}$

This equation is an absorption framework for analyzing payments. Moreover, the combination of (2), (3), (6)-(8) and (10), equation (10) becomes

(11) $\Delta R = \Delta M^P+ \Delta M^*-q\Delta B^b$.

Equation (11) is the basis of a monetary approach to the balance of payments. As shown above, as long as the specification maintains that the sum of excess demand in the economy is zero, Equation (11) is derived from equation (4) which represents the basis of a conventional approach. Therefore, two approaches are equivalent to each other. By the same token, capital flows (as well as international payments account) specified on the basis of the demand for foreign bonds are equivalent to those specified on the basis of the excess demand for money in a general equilibrium framework.

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