one-third of the coefficient of VML, since VNA has been about three times as large as VM over the sample period. Equation (12.2) also includes a banking sector interest rate variable for reasons peculiar to the Korean monetary system.

Deposit and loan rates have been fixed by fiat and have been rather inflexible over the sample period. During 1957-64 the bank rates were well below the unorganized money market rates, and as a consequence the banks attracted very little savings and could not play an important role in financing capital formation. Korean monetary authorities state that the demand for loanable funds always was well in excess of supply during this period so various forms of non-price rationing were used to allocate loans.

Late in 1965 the top bank deposit rates were raised to 30% per year, and the top loan rates to 26%. The results were dramatic: savings deposits have been increasing by about 100% per year since then, and the volume of bank loans to industry has risen correspondingly. Thus in this context the interest rate variable signifies availability of savings for investment, and not surprisingly it is statistically significant in all formulations.

Various specifications of the accelerator hypothesis were estimated and some are shown in Table 11-A, page . Equation (12.2) was selected for forecasting. It approximated reasonably well an uneven pattern of investment, as shown in Table 12-A following:

TABLE 16-A

INVESTMENT FUNCTIONS IN AGRICULTURE
(11 OBSERVATIONS: 1957-67)

Equation[1]	Government Savings[2]		Capital[2][3]		Agricultural Output[2]		Constant	R^2 Statistics[4]		Serial Corr.
	GS	GS-GSL	KAL	KALL	VALL	$\frac{VAL-VAL}{VAL}$			SEC	
11.1	0.054 (0.48)				0.149 (3.08)		-29.586 (3.38)	.902	17.22	neg.
11.2	0.380						- 3.109 (1.40)	.810	23.99	neg.
11.3		0.213 (7.64)					- 4.186 (2.04)	.852	21.19	neg.
11.4		0.071 (0.78)		0.126 (0.09)	0.126 (2.27)		-13.188 (0.84)	.900	17.38	none
11.5		0.121 (1.30)		-0.083 (0.16)		0.046 (0.88)	-10.739 (0.26)	.844	21.76	neg.
11.6				0.114 (0.70)	0.136 (2.59)		-41.943 (3.15)	.905	16.96	neg.
11.7		0.073 (0.91)	-0.021 (0.16)		0.126 (2.47)		-23.882 (1.72)	.900	17.36	none
11.8			0.055 (0.53)		0.150 (3.51)		-35.232	.903	17.16	neg.
11.9		0.127 (1.34)	-0.092 (0.45)			0.050 (1.25)	-12.100 (0.76)	.847	21.49	neg.
11.10	0.092 (0.49)			0.228 (0.51)		0.031 (0.50)	-38.887 (1.13)	.823	23.16	neg.
11.11	0.015 (0.12)			0.118 (0.49)	0.133 (2.20)		-39.726 (1.74)	.892	18.11	none.
11.12				0.257 (0.62)		0.045 (0.85)	-66.459 (1.64)	.840	22.03	neg.
11.13	0.034 (0.26)		0.041 (0.34)		0.142 (2.32)		-32.447 (2.58)	.902	17.22	neg.
11.14	0.054 (0.48)				0.149 (3.08)		-29.586 (3.38)	.902	17.22	neg.
11.15	0.105 (0.59)					0.057 (1.63)	-22.834 (1.86)	.839	22.07	neg.
11.16		0.110 (1.33)				0.039 (1.31)	-17.430 (1.69)	.863	20.39	neg.
11.17		0.065 (1.11)			0.124 (2.70)		-25.591 (3.16)			1.76

1/ T-ratio in parenthesis under coefficient.
2/ L, LL, etc. denote lags of one and two years respectively.
3/ Capital in agriculture.
4/ SEC - standard error of estimate divided by mean value of dependent variable (%).
Serial corr.: See footnote and text on page

TABLE 11-A

FUNCTIONS FOR FIXED INVESTMENT IN MINING AND MANUFACTURING
(11 OBSERVATIONS: 1957-67)

Equation	Capital Stock[1] KM	Capital Stock[1] KML	Value Added Mining and Manufacturing[2] ΔVM	Value Added Mining and Manufacturing[2] ΔVML	Value Added Mining and Manufacturing[2] VML	Non-Agricultural GNP[3] VNAL	Non-Agricultural GNP[3] ΔVNAL	Interest Rate[4]	Constant	Statistics[5] R^2	Statistics[5] SPC	Statistics[5] Serial Corr.
12.1[6]		-0.375 (2.68)			0.471 (2.22)			2.353 (6.61)	-11.373	.974	9.91	neg.
12.2		-0.565 (3.54)				0.281 (3.12)		2.599 (10.42)	-46.963 (3.81)	.982	8.36	neg.
12.3	-0.164 (0.57)				0.138 (0.36)			3.009 (4.34)	-11.847 (2.18)	.950	13.79	neg.
12.4	-0.103 (0.22)					0.021 (0.09)		2.963 (2.35)	-13.473 (0.38)	.949	13.91	neg.
12.5	0.744 (2.96)			0.939 (2.78)	0.961 (2.36)				4.574 (0.69)	.913	18.24	none
12.6		-0.468 (1.01)		0.523 (0.80)	0.907 (1.33)				-12.422 (1.48)	.829	25.55	none
12.7		-0.075 (1.77)		0.401 (1.93)				2.436 (6.74)	-7.500 (2.78)	.971	10.44	neg.
12.8	-0.069 (1.32)			0.431 (1.93)				2.503 (5.10)	-8.447 (3.07)	.967	11.25	neg.
12.9		-0.078 (1.32)	0.004 (0.02)					2.831 (7.24)	-8.972 (2.15)	.956	12.93	neg.
12.10		-0.105 (2.25)					0.114 (1.72)	2.722 (8.63)	-6.668 (2.22)	.969	10.85	neg.
12.11	0.102 (1.65)						0.116 (1.51)	2.895 (5.93)	-8.895 (2.57)	.962	12.08	neg.
12.12		0.201 (2.07)					0.236 (1.12)		-5.850 (0.61)	.686	34.61	neg.

1/ Capital stock in mining and manufacturing (L is for one year lag).
2/ Value added in mining and manufacturing (L is for one year lag).
3/ Non-agricultural GNP (L is for one year lag).
4/ Highest bank savings deposit rate (as an index of all bank savings deposit rates).
5/ Standard error of estimate, divided by mean value of dependent variable (%).
6/ T-ratio is in parenthesis below coefficient.

TABLE 12-A

ACTUAL AND COMPUTED VALUES OF INVESTMENT IN MINING AND MANUFACTURING, EQUATION (12.2)

	Actual	Computed
1957	20.6	19.7
1958	18.2	18.8
1959	13.6	12.7
1960	16.2	13.0
1961	14.2	18.1
1962	18.5	19.9
1963	25.5	24.1
1964	23.3	25.4
1965	32.0	30.9
1966	63.7	64.0
1967	55.8	55.1

A.6.3 Social Overhead Investment Functions

Accelerator type functions provide a somewhat better explanation of investment in this sector than does a simple income relation. Two years' lagged capital stock and income performed better than current and one year lagged variables, a reflection of the long gestation lag in this sector. Government savings proved to be significant, as expected, but with a one-year lag. Some sample equations are set out in Table 12-A. Equation 13.1 was selected for forecasting.

A.6.4 Service Sector Investment Functions

In this sector the accelerator does not provide a substantial improvement over simple relations to income. The change in service sector income, current and lagged, is not a significant variable and service sector capital stock is significant only in combination with total non-agricultural income. (This may be a reflection of the difficulty of obtaining accurate measurements of income in services.)

The bank interest rate is not important for explaining fluctuations in service income since most capital formation is financed through the unorganized money market. However, there is some evidence that the influence of the interest rate is negative when it operates, in contrast to the positive influence on mining and manufacturing capital formation. This confirms hypotheses put forth by monetary authorities in Korea who feel that the 1965 bank interest rate increase set off a substantial reallocation of savings away from the unorganized money market and into banks. This caused a scarcity of funds on the unorganized market which is the primary source of loanable funds for the service sector.

A.6.5 Inventory Investment Functions

Inventories in Korea consist primarily of agricultural products (mostly grains). Due to the influence of weather on agriculture, by far the largest part of inventory fluctuations is attributable to fluctuations in agricultural output.

A relatively simple formulation of inventory behavior provided an explanation of 88% of the observed movements in inventories:

$$(15.1)\quad II = \underset{}{-9.548} + \underset{(3.08)}{0.301}\Delta VA + \underset{(4.36)}{1.207}\ IMPG \qquad \underset{(6.27)}{}$$

$$(\bar{R}^2 = .878, \quad \text{serial corr.: None})$$

where II is inventory investment and IMPG denotes imports of grains. This function captured very well the many turning points in the inventory series. The rather high percentage (30%) of agricultural production going into inventories

TABLE 12-A

SOCIAL OVERHEAD INVESTMENT FUNCTIONS

Equation 1/	Capital Stock Social Overhead 2/		Government Savings 2/			Value-Added Social Overhead 2/	GNP	Non-Agricultural GNP	Constant	Statistics		
	KOLL	VOLL	GSL	GSLL	GSL+ GSLL	VOL	V	VNA		R^2	SEC	Serial Corr.
13.1	-0.747 (3.89)	5.562 (4.61)	1.184 (3.36						-48.536 (6.30)	.944	16.69	neg.
13.2	-0.592 (2.05)	6.351 (3.35)		-0.370 (0.78)					-38.035 (3.45)	.865	25.87	none
13.3	-0.880 (3.50)	5.770 (4.11)			0.734 (2.42)				-51.342 (5.14)	.920	19.91	neg.
13.4	-0.803 (3.02)				0.503 (1.47)	4.859 (3.59)			-39.387 (4.30)	.904	21.82	none
13.5	-0.651 (2.55)		0.724 (1.42)			4.455 (3.05)			-35.823 (4.38)	.903	21.97	none
13.6								0.180 (8.83)	-43.123 (4.90)	.885	23.87	none
13.7							0.133 (6.90)		-60.582 (4.42)	.823	29.60	none

1/ T-ratios are in parentheses below the coefficients.
2/ L, LL denote lags of one and two years respectively.

TABLE 13-A

SERVICE SECTOR INVESTMENT FUNCTIONS
(11 OBSERVATIONS: 1957-67)

Equation	Capital[1/2/]		Value Added		Non-Agricultural GNP[1/]		GNP	Interest[4/]	Constant	Statistics		
	KS	KSL	VS	VSL	VNA	VNAL				R^2	SEC	Serial Corr
14.1		-0.035				0.132 (1.40)		0.486 (1.29)	-15.903 (1.54)	.936	10.78	neg.
14.2	-0.009 (0.12)		0.278 (2.42)					-0.032 (0.10)	-35.638 (4.94)	.968	7.64	neg.
14.3	-0.115 (2.14)				0.199 (5.32)			-0.315 (1.47)	-9.880 (2.49)	.988	4.62	neg.
14.4		0.017 (0.14)		0.204 (1.26)				0.617 (1.64)	-31.671 (3.19)	.933	11.01	neg.
14.5	-0.007 (0.11)		0.272 (3.02)						-35.070 (8.73)	.972	7.15	neg.
14.6	-0.086 (1.60)				0.164 (5.28)				-9.759 (2.30)	.987	4.49	neg.
14.7					0.123 (8.62)			0.145 (0.61)	-16.900 (6.33)	.983	5.55	neg.
14.8							0.079 (3.80)	0.168 (0.37)	-25.582 (3.24)	.938	10.63	neg.
14.9			0.262 (19.73)						-34.894 (10.08)	.975	6.75	neg.
14.10					0.115 (24.98)				-15.874 (7.96)	.984	5.36	neg.

1/ LL stands for one year lag.
2/ Capital stock in services.
3/ Value added in services.
4/ Banking sector interest rate, as represented by the highest annual savings deposit rate.

is explained by the fact that national accounts inventories are measured at the end of the calendar year, only three months after the rice harvest. There could also be a statistical compensation for the low negative constant term.

Addition of a variable denoting change in mining and manufacturing output was not fruitful, for, although the goodness-of-fit was improved, this variable's coefficient took a negative sign, as shown below:

$$(14.2)\quad II = \underset{(2.42)}{-6.675} + \underset{(2.97)}{0.233}(\Delta VA) + \underset{(6.86)}{1.435}\ IMPG - \underset{(2.42)}{0.354}(\Delta VM)$$

$$R = .908 \qquad DW = 1.30$$

A.7.0 Import Functions

The marginal import rate in Korea was fairly high in the 1957-67 period - 32% of GNP, but the pattern of growth was uneven. Through 1965 there was an irregular upward trend marked by absolute declines in imports in four years, 1958, 1959, 1961, and 1964. In 1966 and 1967, the dollar value of imports jumped 59% and 37%, and it appears that the 1968 increase will be about 35% - 40%.

Total imports are broadly related to GNP and somewhat more closely related to non-agricultural GNP over this period. The ratio of the exchange rate to the price index also is a significant variable. However, the regressions of total imports on these variables are not very accurate: the standard error of estimate is $80 million to $100 million (out of an average import level of about $450 million).

The explanation of import behavior is improved substantially by disaggregation into major commodity groups. Some experimentation was conducted prior to settling on four categories: capital goods, grain, fuels, and all others. The latter category is predominantly raw materials and semi-manufactured commodities for use in industry. SITC codes for the categories and the import time series are listed in an appendix.

A.7.1 Capital Goods Imports

This category accounted for a large part of the 1966-67 jump in imports and it quite clearly is related to non-agricultural fixed capital formation. The exchange rate plays a less important but significant role. The following equation was used:

$$(16.1)\quad IMPK = \underset{(0.35)}{-2.465} + \underset{(10.82)}{0.433}(IFT-IFA) - \underset{(1.65)}{0.062}\ XVR$$

$$\bar{R}^2 = 0.927,\ \overline{SEC} = 23.61,\ \text{Serial corr.: negative.}$$

where

IFT = total fixed investment

IFA = agricultural fixed investment

XVR = ratio of official exchange rate to be GNP price index (GNP deflator index)

IMPK = imports of capital goods

The coefficient value of 0.433 is in line with cross-sectional estimates of the share of imported capital goods in non-agricultural capital formation.

A.7.2 Imports of Fuels

Until Korea's first oil refinery commenced operation in 1964, fuel imports had been petroleum products and a little anthracite coal. Since then crude petroleum has accounted for an increasingly large share of fuel imports. Both before and after the oil refinery completion, income levels and the quantity of domestic coal produced were important determinants of fuel imports. Coal production is relevant not only because there have been some coal imports but also because there has been some scope for coal-oil substitution in industrial and office heating and in production of electric power. The equations, which are estimated in 1965 prices, indicate that domestic coal was underpriced by about 20%-30% in 1965, relative to imported fuels. In 1967 the price of coal was increased by about 25%.

The exchange rate is not significant in fuel imports, which confirms the general belief that demand for fuel tends to be price-inelastic.

The fuel import equations are as follows:

(17.1) IMPP = -1.932 + 0.053 VNA - 1.188 COAL
(1.17) (6.58) (4.98)

$\bar{R}^2$ = .847, SPC = 11.07, DW = 2.19; 10 observations, 1958-67.

(17.2) IMPP = 1.697 + 0.057 VNA - 1.367 COAL
(0.90) (6.37) (5.48)

$\bar{R}^2$ = 800, SPC = 12.33, DW = 1.96; 11 observations, 1957-67.

(17.3) IMPP = -6.587 + 0.203 VNA - 4.308 COAL - 3.980 XVR
(0.55) (4.74) (2.76) (0.33)

$\bar{R}^2$ = 0.754, $\overline{SPC}$ = 14.45, DW = 1.86; 11 observations

where

IMPP = Imports of fuels

VNA = Non-agricultural GNP

COAL = Domestic coal production (1000 won)

XVR = Ratio of official exchange rate to GNP price index

$\overline{SEC}$ = Standard error of estimates, divided by mean value of dependent variable

DW = Durbin-Watson statistic

A.7.3 Imports of Grains

Grain imports are less susceptible than other imports to statistical analysis, being largely dependent on US PL 480 policies. However, there is an approximate relation between the arrival of imported grains and consumption needs, as measured by domestic consumption and domestic production levels. The following equation was derived from the 1958-67 data:

$$(18.1)\quad IMPG = \underset{(0.87)}{11.620} + \underset{(2.77)}{0.201}\,CP - \underset{(2.34)}{0.433}\Delta VA,$$

$$\bar{R}^2 = 0.464,\ SEC = 36.23,\ DW = 2.30,$$

where IMPG = imports of grains,

CP = private consumption

ΔVA = change in agricultural production.

Because of lags in PL 480 arrivals and the effects of commercial grain imports, the correlation between total grain imports and the won value of PL 480 contributions in the Korean balance of payments is rather low, 0.397. The standard error of estimate in equation (18.1) is 4.3 million won, more than one-third of the average value of grain imports but less than 4% of the average value of total imports.

Attempts to find a consistent explanation for non-grain food imports were unsuccessful, probably because the structure of imports changed considerably during the period. In the earlier years of the sample period food imports consisted of relief goods; in the later years, however, imports have increasingly tended to be luxury food items. In recent years, non-grain foods have comprised less than 2% of total imports, so in the estimated equations they are grouped with the raw material imports and semi-manufactured imports in the category "other imports".

A.7.4 Functions of Other Imports

As noted, this category comprises mostly raw materials and semi-manufactured goods for use in industry; therefore, it is most directly related to non-agricultural production. Demand for these commodities is more price-elastic than the demand for imported fuels, as is evident in the equation in Table 14-A on the next page. As indicated, slight differences in the definition of "other imports" do not affect the basic relationship. When variable total exports are included as a factor in place of non-agricultural GNP, the equation changes very little. This would be expected from the observed close relationship between export growth and non-agricultural income growth. When total GNP is used in place of non-agricultural GNP, the statistical errors increase.

The dependence of production on imported goods is rather high - the ratio of income to imported inputs is about 29%. This is a reflection of the lack of industrial natural resources in Korea; it confirms the view that Korea's road to higher income lies through trade; that is, through the role of entrepot nation. (See Table 14-A following.)

A.8 Exchange Rate Determination

During the period 1957-67, the average annual exchange rate moved by 20% to 100% on four separate occasions, and by about 2½% on one occasion. A fixed exchange rate system was formally in effect until April, 1964, when a nominally floating rate was adopted. Explaining these changes causally is facilitated if a distinction is made between short-run and long-run equilibrium, and the analysis focuses on the short-run equilibrium. The latter long-run equilibrium is defined as the rate which would exist without net capital inflows and transfer payments - the "unsupported" rate. The short-run equilibrium rate is determined in each period by the demand for and supply of foreign exchange, without regard to the origin of those demands and supplies. In view of the continuous presence of substantial capital inflows and transfer payments during the period studied, the short-run concept of rate equilibrium is adopted.

The relation between imports and the exchange rate may be specified in either simultaneous or recursive form. The choice depends on the length of the unit time period and the length of lags in the adjustment process. Both formulations were tested on the Korean data, and the recursive version was found to be a much better explanation of observed behavior. This finding corroborates the judgment of many "Koreanists" that movements in the rate generally occur only after significant disequilibrium has persisted for at least a year.

In simultaneous form, the rate may be expressed in the standard fashion as an equilibrium price:

$$(1)\quad D = a_1 + b_{11}Y_1 + \ldots + b_{1n}Y_n + c_1 XR + FXA$$

$$(2)\quad S = a_2 + b_{21}Z_1 + \ldots + b_{2n}Z_n + c_2 XR + FT$$

$$(3)\quad D = S$$

TABLE 14-A

EQUATIONS FOR OTHER IMPORTS
(10 OBSERVATIONS, 1958-67)

Equation 1/	Dependent Variable 2/	Non-Agricultural GNP	Ratio of Exchange Rate to GNP	Constant	$\bar{R}^2$	Statistics 3/ SPC	Serial corr.
19.1	IMPO1	0.287 (8.14)	-0.122 (1.56)	-12.416 (0.75)	.887	12.69	negative
19.2	IMPO2	0.281 (7.94)	-0.134 (1.71)	-22.678 (1.37)	.881	15.49	none
19.3	IMPO3	0.286 (7.71)	-0.147 (1.77)	-19.286 (1.11)	.873	15.56	none
19.4	IMPO4	0.292 (7.99)	-0.133 (1.65)	-9.016 (0.53)	.882	12.69	negative

1/ T-ratios are given in parenthesis below the coefficients.
2/ IMPO1 = IMPO2 plus fertilizer imports.
IMPO2 = Imports of services and all commodities except grains, non-grain foods, fertilizer, capital goods, and fuels.
IMPO3 = IMPO2 plus non-grain food imports.
IMPO4 = IMPO plus fertilizer and non-grain food imports.
3/ SPC = Standard error of estimate divided by mean value of the dependent variable (%)

where

D, S = demand for, supply of foreign exchange ;

$(a_1 ; b_{11}Y_1 \cdots b_{1n}Y_n)$ represents those factors determining demand for imports ;

FXA = net foreign exchange accumulation (+) or decumulation (-) ;

$(a_2 ; b_{21}Z_1 \cdots b_{2n}Z_n)$ represents those factors determining sales of exports.

FT = net foreign capital inflows plus transfer payments from abroad;

XR = exchange rate, won per dollar. 1/

These equations yield

$$(4)\quad XR = \left(\sum_j b_{2j}Z_j + a_2 + FT - \sum_j b_{1j}Y_j - a_1 - FXA\right)/(c_2 - c_1)$$

Assuming downward sloping demand curves and upward sloping supply curves, $c_1 < 0$ and $c_2 > 0$, so $(c_2 - c_1) > 0$. If exports are exogenous in the model, (4) becomes

$$(4')\quad XR = \left(EXP + FT - \sum b_{1j}Y_j - a_1 - FXA\right)/c_1^*$$

$c_1^* = -c_1 > 0$, and EXP = total exports.

In recursive form, the system may be written as follows:

$$(5)\quad XR = a' + b'S^{-1} + c'D^{-1}$$
$$= a + \sum b_{2j}Z_j^{-1} + FT^{-1} - \sum b_{1j}Y_j^{-1} - FXA^{-1}$$

$$(6)\quad IMP = a_1 + \sum b_{1j}Y_j + c_1 XR$$

$$(7)\quad EXP = a_2 + \sum b_{2j}Z_j + c_2 XR$$

$$(8)\quad FT = \overline{FT}$$

$$(9)\quad FXA = EXP + FT - IMP$$

1/ With slight modifications in the structure, XR can be replaced by the ratio of the exchange rate to the domestic price index.

where the superscript indicates a one year lag. (In forecasting, the equations are solved in the order given.)

Equation (5) may be estimated as is - with the determinants of exports and imports as the arguments - or the import and export variables themselves may be used as arguments.

Variations on equations (4), (4'), and (5) were estimated from the 1957-67 data. Equations (4) and (4') were rejected: in all cases the importing-determining variables took the wrong sign. (See Table 18-A on the following page.) This is no doubt due to the common tendency for importers to stockpile in anticipation of devaluation - which in turn makes devaluation more likely. Such a hypothesis on importing behavior can be expressed easily by adding expectational variable to (6), and letting that variable be dependent on current and lagged balance of payments variables. In particular, if expectations depend on the rate of foreign exchange accumulation, then

$$(6)\quad IMP = a_1 + \sum b_{1j} Y_j + c_1 XR + d_1 FXA^{-1}$$

where d_1 has a negative sign. Then

$$(5)\quad XR = f\,(FXA^{-1},\ FXA^{-2},\ z_j^{-1},\ FT^{-1},\ Y_j^{-1})$$

where the coefficients of FXA^{-1} and FXA^{-2} are negative. These equations describe the data fairly well and with correct signs. (See Table 15-A.)

TABLE 15-A

EXCHANGE RATE EQUATIONS

	Equations	$\bar{R}^2$	Statistics $\overline{SPC}$	Serial Corr.
I.	Equations of Type (5)[1/]			
(20.1)	39.534 + 256.119 VPIL (1.77) (3.44) -1.623 + 1.033 IMPL (1.60) (0.91)	.918	18.0%	neg.
(20.2)	-39.749 + 227.600 VPIL - 0.701 F* (0.50) (2.31) (2.63) +0.323 VNAL (0.96)	.919	17.9%	neg.
(20.3)	29.631 + 289.153 VPIL - 0.771 F* (1.26) (5.47) (2.77) +0.287 IFT (0.67)	.914	14.7%	neg.
II.	Equations of Type (5')			
(20.8)	-30.562 + 265.368 VPI (1.61) (11.26) 0.771 (FXAL + FXALL) (1.31)	.935	14.8%	neg.
(20.9)	-27.303 + 260.975 VIP (1.30) (10.32) -90.139 FXA* (1.02)	.929	15.5%	neg.

1/ VPI = GNP price index
IMP = total imports of goods and services
F* = net foreign capital inflow plus transfer payments
FXA = foreign exchange accumulation
L,LL denote lags of one and two years

APPENDIX B

STOCHASTIC EQUATIONS IN THE FORECASTING MODEL

B.1 Production Functions

Agriculture

$$VA = -368.379 + 0.293\ LAND + 12.362W$$
$$(20.98) \quad (35.76) \quad (11.73)$$

$$\bar{R}^2 = 0.994 \quad \overline{SPC} = 1.06$$

Mining and Manufacturing

$$VM = 3.370\ KM^{0.268}\ VO^{0.648}$$
$$(2.03) \quad (0.91) \quad (2.51)$$

$$\bar{R}^2 = 0.994$$

Social Overhead

$$VO = 0.436\ KO^{0.839}$$
$$(4.51) \quad (22.90)$$

$$\bar{R}^2 = 0.981$$

Services

$$VS = 132.106 + 0.764\ (VM + VO + NFI)$$
$$(38.58) \quad (38.85)$$

$$\bar{R}^2 = 0.993 \quad \overline{SPC} = 1.64$$

Net Factor Income from Abroad

$$NFI = 4.591 + 0.405\ (EGSV + EMSC)$$
$$(11.21) \quad (15.37)$$

$$\bar{R}^2 = 0.959 \quad \overline{SPC} = 10.79$$

B.2 Consumption Functions

Private Consumption

$$CP = 111.183 + 0.379\ \overline{(V - TAXIM) + (VL - TAXIML)}$$
$$(9.27) \quad (41.44)$$

$$\bar{R}^2 = 0.995 \quad \overline{SPC} = 1.18$$

Government Non-Defense Consumption

$$CGC = 18.481 + 0.059\ VNA$$
$$(8.36) \quad (11.30)$$

$$\bar{R}^2 = 0.920 \quad \overline{SPC} = 4.98$$

B.3 Investment Functions

Agriculture

$$IFA = -12.100 - 0.092KAL + 0.050\,(VAL + VALL) + 0.127\,(GS + GSL)$$
$$(0.76) \quad (0.45) \quad (1.25) \quad (1.34)$$

$\bar{R}^2 = 0.847 \quad \overline{SPC} = 21.49$

Mining and Manufacturing

$$IFM = -12.422 + 0.907VML + 0.523\ VML - 0.468\ KML$$
$$(1.48) \quad (1.33) \quad (0.80) \quad (1.01)$$

$\bar{R}^2 = 0.829 \quad \overline{SPC} = 25.55$

Social Overhead

(a)
$$IFO = -60.582 + 0.133V$$
$$(4.42) \quad (6.90)$$

$\bar{R}^2 = 0.823 \quad \overline{SPC} = 29.60$

(b)
$$IFO = -48.536 + 5.562\ VOLL - 0.747\ KOLL + 1.184\ GSL$$
$$(6.30) \quad (4.61) \quad (3.89) \quad (3.36)$$

$\bar{R}^2 = 0.944 \quad \overline{SPC} = 16.69$

Services

$$IFS = -15.874 + 0.115$$
$$(7.96) \quad (24.98)$$

$\bar{R}^2 = 0.984 \quad \overline{SPC} = 5.36$

Inventories

$$II = -9.548 + 0.301\ VA + 1.207\ IMPG$$
$$(3.08) \quad (4.36) \quad (6.27)$$

$\bar{R}^2 = 0.878$

B.4 Import Functions

Capital Goods

$$IMPK = -2.465 + 0.433\,(IFT-IFA) - 0.062 \times XVR$$
$$(0.35)\quad (10.82)\qquad\quad (1.65)$$

$$\bar{R}^2 = 0.927 \quad \overline{SPC} = 23.61$$

Fuels

$$IMPP = -1.932 + 0.053\,VNA - 1.188\,COAL$$
$$(1.17)\quad (6.58)\qquad (4.98)$$

$$\bar{R}^2 = 0.847 \quad \overline{SPC} = 12.33$$

Grains

$$IMPG = 11.620 + 0.201CP - 0.433\,VA$$
$$(0.87)\quad (2.77)\quad (2.34)$$

$$\bar{R}^2 = 0.464 \quad \overline{SPC} = 36.23$$

Other Goods & Services*

$$IMPO4 = -9.036 + 0.292\,VNA - 0.133\,XVR$$
$$(0.53)\quad (7.99)\qquad (1.65)$$

$$\bar{R}^2 = 0.882 \quad \overline{SPC} = 12.69$$

B.5 Government Revenues

Customs Duties

$$CUSTOM = 2.871 + 0.089\,IMPO4$$
$$(2.41)\quad (6.91)$$

$$\bar{R}^2 = 0.824 \quad \overline{SPC} = 12.03$$

Internal Taxes and Monopoly Profits

$$TAXIM = 19.947 + 0.067\,(ADMIN1)\,(VNA)$$
$$(12.55)\quad (24.17)$$

$$\bar{R}^2 = 0.983 \quad \overline{SPC} = 4.68$$

Nontax Revenues

$$NONTAX = 2.455 + 0.013\,(ADMIN1)\,(V)$$
$$(0.94)\quad (4.76)$$

B.6 Exchange Rate

$$XR = 39.534 + 256.119\,VPIL - 1.623F^* + 1.033\,IMPL$$
$$(1.77)\quad (3.44)\qquad\quad (1.60)\qquad (0.91)$$

$$\bar{R}^2 = 0.918 \quad SPC = 18.0$$

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* Including non-grain foods, but mostly raw materials and semi-manufactureds.

APPENDIX C
SOURCES AND METHODS FOR COMPILING DATA

C.1 National Accounts

The national accounts data and GNP by sector of origin are taken from the official Korean national accounts in 1965 prices. Dollar values are obtained uniformly by conversion with an exchange rate of 264 won to the dollar. See, for example, Economic Planning Board, Economic Statistics Yearbook, 1968, Tables 7 and 8. Investment by sector is taken from the same set of accounts; op. cit., Table 12.

C.2 Imports and Exports

Total imports, c.i.f., are taken from official Korean trade and balance of payments data. Constant price won values and dollar values are equivalent at an exchange rate of 264 won to the dollar. Commodity imports by SITC category (IMPR, IMPP, IMPG, IMPF in the tables below) are taken from dollar customs clearance data compiled by the Korean Ministry of Finance. See Bank of Korea, Korea Statistical Yearbook, 1967, Table 212; Economic Planning Board, Economic Statistics Yearbook, 1968, Table 158. Service imports implicit in the category "other imports" are derived from the difference between total imports, c.i.f., and the sum of commodity imports. In compiling imports by category, the imports listed as "unclassifiable" in the Korean statistics were distributed proportionately over all categories. (This procedure improved the statistical fit of the individual import equations.)

C.3 Transfer Payments and Capital Inflows

Total transfer payments, and government and private transfer payments are taken from official Korean balance of payments statistics. See Bank of Korea, Economic Statistics Yearbook, 1968, Table 141; Economic Planning Board, Korea Statistical Yearbook, 1967, Table 221; and earlier issues of both publications. In these statistics, PL 480 Title II receipts are classified as private transfer payments, and Title I receipts are government transfer payments. In AID's accounting, both items are considered to be government transfer payments. Korean government and USAID estimates of the timing of commodity arrivals and counterpart fund deposits differ slightly, so there are slight differences in their estimates of annual transfer payments in the balance of payments. For the sake of historical continuity, the Korean government estimates have been adopted. Estimates of Japanese government transfer payments are taken from the FY 1970 Program Memorandum prepared by the AID Mission in Korea (Appendix B, Table 4). Total foreign capital inflows correspond to the trade gap plus foreign exchange accumulation minus transfer payments. Specifically, in the Korean accounts, net foreign capital inflows may be calculated by summing the following items: (1) on the capital and monetary gold account: (a) net private capital, (b) net local government capital, (c) net central government capital, (d) net open account position of the central bank, and (e) net position on other accounts of the central bank; (2) net errors and omissions in the balance of payments.

C.4 Foreign Exchange Accumulation

Corresponding to the operating definition of capital inflows, foreign exchange accumulation is defined to be the sum of the following items on the

capital and monetary gold account: (a) net position with the IMF, (b) net foreign assets, (c) net monetary gold account, (d) net position with other monetary institutions.

C.5 Capital Inflows by Type

Total foreign capital inflows are taken from official Korean balance of payments data, as noted above, but published Korean statistics do not include capital account details. The breakdown into direct, private long-term, and government long-term are taken from the FY 1970 Program Memorandum prepared by the A.I.D. Mission in Korea (FY 70 PM, Annex B, Table 3). The short-term inflow data in the PM's are rough estimates, so for this study the short-term inflows were taken as residuals: the difference between total capital inflows, from the balance of payments data, and other types of inflows, from the PM. The estimates of arrivals of U.S. and Japanese Government long-term capital are taken from Appendix C of the FY 1970 PM.

C.6 Government Budget

Compiling a consistent set of budget variables in constant prices for central plus local governments required reconciling current price revenue and expenditure data with national accounts control totals on government consumption and savings. Budget data correspond to the "General Account" in Korean statistics, which includes local governments but excludes government corporations. The latter are included in data on the private sector. Total government consumption in 1965 constant won is taken from the national accounts tables. Government savings are taken in current prices from lines 16 and 17 in the national accounts table titled "General Government Revenues and Expenditures" (Bank of Korea, Korea Statistical Yearbook, 1967, Table 49; Economic Planning Board, Economic Statistics Yearbook, Table 15.) These figures include depreciation allowances. This estimate of savings does not correspond to the definition of "government capital formation" used by Adelman-Kim, which includes transfers to the private sector. The latter corresponds to "gross government loans and investment" in the Korean statistics. Conversion to constant 1965 prices was carried out by deflating with the fixed investment deflator implicit in the national accounts.

A total government expenditure deflator was then derived from the computed current and constant price series of government consumption plus savings. This deflator (GDEFL in the tables below) was applied to the various categories of revenues, which are published only in current prices.

Government defense expenditure figures are taken from the general government account and deflated by the computed government expenditure deflator, rather than by the government consumption deflator, since defense expenditures include some capital formation activities.

On the revenue side, customs duties in current prices were taken to be the tariff revenues (Korea Statistical Yearbook, 1967, Table 258). Total

taxes in current prices were assumed to be the sum of indirect taxes, direct taxes on corporations, and direct taxes on households and private non-profit institutions in the national accounts general government budget tables (lines 3, 4, 5, Table 49, Korea Statistical Yearbook, 1967). Internal taxes plus monopoly profits (TAXIM) were derived as the difference between total taxes and customs duties. Non-tax revenues are a residual item, corresponding to the difference between total expenditures, consumption plus savings, and total domestic and foreign revenues. Foreign counterpart revenues are derived in current from the national accounts general government budget tables (line 7, Table 49, Korea Statistical Yearbook, 1967). These estimates do not correspond precisely to the Program Memorandum estimates, due to differences in estimating the timing of arrival and sales of counterpart commodities.

C.7 Capital Stock Series

Official Korean statistics do not include aggregate or sectoral capital stock figures. The capital stock estimates by sector were derived by summing depreciated investment. A family of stock series can be derived for any one sector by varying the depreciation rate and/or initial capital stock value. The values for the first few years are particularly sensitive to the initial values assumed, and for the service sector some experimentation was conducted with different capital series and investment functions estimated therefrom. The following depreciation rates and initial capital-output ratios were assumed for each sector:

Sector	depr. rate	initial K/O
A	0.04	1.00
M	0.06	0.55
O	0.04	4.00
S	0.04	1.18

C.8 Prices

The wholesale price index is the published nation-wide index covering all classes of commodities; it is based on a continuous sample survey of more than 1,000 individual prices. The GNP deflator index is that which is implicit in the national accounts. The annual exchange rate series was constructed by taking annual averages of the official monthly rates. The interest rate variable was taken to be the highest savings deposit rate since all deposit and loan rates tend to move in parallel over time. All commercial banks have the same interest rate structure.

HISTORICAL DATA SERIES

Income by Sector and Consumption

billion 1965 won

Date	VA	VM	VO	VS	NFI	V
1955	224.06	52.50	12.07	178.16	7.75	447.36
1956	213.23	61.45	15.17	184.24	7.38	480.47
1957	230.57	69.13	15.92	199.52	7.59	522.73
1958	246.26	74.42	18.08	205.34	7.59	551.69
1959	243.66	81.33	20.83	222.27	7.75	575.84
1960	243.97	88.81	22.90	226.01	7.38	589.07
1961	268.53	91.64	23.15	224.50	5.79	613.61
1962	252.37	106.00	26.30	234.82	6.48	634.97
1963	270.56	123.49	30.57	261.62	6.79	693.03
1964	314.31	130.14	35.62	263.71	6.53	750.31
1965	311.63	157.54	42.40	286.63	7.65	805.85
1966	345.91	181.43	49.91	323.49	13.08	913.82
1967	325.27	222.20	61.33	365.10	22.29	995.43

VA = Income in agriculture, forestry, fisheries
VM = Income in mining and manufacturing
VO = Income in social overhead, (transportation and storage, electric power, communications, water, and sanitary services)
VS = Income in services (construction, banking and insurance, trade, housing and real estate, public administration, and other services)
NFI = Net factor income from abroad
V = GNP

billion 1965 won

Date	VNA	C	CP	CG	CGC	GD
1955		483.98		61.09		
1956	262.24	510.58	444.85	65.73	34.64	31.11
1957	292.16	537.66	471.32	66.34	31.40	34.94
1958	305.43	556.57	486.05	70.52	36.21	34.31
1959	332.18	578.39	508.55	69.84	38.35	31.49
1960	345.10	594.33	523.30	71.13	41.71	29.42
1961	345.08	598.22	528.38	69.84	40.92	28.92
1962	382.60	639.40	568.96	70.44	41.36	29.08
1963	422.47	661.58	587.74	73.84	46.20	27.64
1964	436.00	691.62	620.44	71.18	42.52	28.66
1965	494.22	745.10	669.08	76.02	46.31	29.71
1966	567.91	801.75	716.99	84.76	51.99	32.77
1967	670.16	871.16	783.92	93.42	58.37	35.05

VNA = Total non-agricultural income
C = Total consumption
CP = Private consumption
CG = Government consumption
CGC = Government non-defense consumption
GD = Defense expenditures

Investment

billion 1965 won

Date	IFO	IFS	IFT	II	IFA	IFM
1955						
1956	10.40	19.13	52.77	4.52	5.07	18.17
1957	15.88	18.39	61.31	26.60	6.48	20.17
1958	15.21	19.06	57.79	19.93	5.35	18.17
1959	16.62	23.08	59.29	-1.46	5.99	13.60
1960	13.20	25.39	61.71	.77	6.97	16.15
1961	20.44	22.24	65.26	7.69	8.35	14.23
1962	28.40	30.42	84.05	-6.06	6.72	18.51
1963	38.63	31.52	105.95	31.32	10.28	25.52
1964	26.97	32.41	93.33	21.08	10.66	23.29
1965	31.16	40.86	117.64	.84	13.67	31.95
1966	56.52	47.22	190.63	16.75	23.16	63.73
1967	87.55	63.59	226.27	9.63	19.29	55.84

IFA = Fixed investment in agriculture
IFM = Fixed investment in mining and mfg.
IFO = Fixed investment in social overhead
IFS = Fixed investment in services
IFI = Total fixed investment
II = Inventory investment

Imports

billion 1965 won

Date	IMP	IMPG	IMPK	IMPP	IMPF	IMPOI
1955						
1956	104.57					
1957	123.07	24.23	12.19	12.52	6.68	67.45
1958	106.55	14.42	10.35	10.47	4.07	67.24
1959	87.41	4.90	11.71	10.69	2.77	57.34
1960	100.10	6.20	12.08	6.92	3.31	71.59
1961	90.81	8.78	12.32	7.95	2.89	58.87
1962	120.17	10.62	18.48	8.10	2.27	80.70
1963	152.67	28.36	30.57	9.09	3.58	81.07
1964	114.04	16.10	18.41	7.53	1.99	70.01
1965	128.93	14.36	19.31	8.25	2.40	84.61
1966	205.31	16.18	45.33	11.20	2.93	129.67
1967	280.92	20.22	81.89	16.26	4.84	157.71

IMP = Total imports, c.i.f.
IMPG = Imports of grains (SITC 04)
IMPK = Imports of capital goods (SITC 7)
IMPP = Imports of fuels (SITC 3)
IMPF = Imports of food (SITC 0 and 1, except 04)
IMPOI = All other imports; mainly industrial raw materials and semi-manufactures, plus services

PRICES

YEAR	WPI	VPI	XR	INT
1955				
1956	81.0		50.0	
1957	94.1	37.8	50.0	.120
1958	88.2	37.6	50.0	.120
1959	90.6	38.4	50.0	.111
1960	100.0	41.9	62.6	.100
1961	113.2	48.4	130.0	.127
1962	123.8	54.9	130.0	.150
1963	149.3	70.4	130.0	.150
1964	201.1	92.9	214.8	.150
1965	221.2	100.0	264.0	.1875
1966	238.0	112.9	272.0	.300
1967	253.4	126.1	273.0	.300

WPI = Wholesale price index
VPI = GNP deflator index
XR = Official exchange rate, won per dollar
INT = Highest bank interest rate on time deposits

Trade Balance in Dollars

million dollars

Date	IMPCD	IMPSD	EXPTD	EMSCD	EJ	EXPSD
1955						
1956						
1957	442.7	24.0	0.2	10.4	46.0	56.6
1958	378.17	25.4	0.3	7.7	73.3	81.3
1959	303.81	27.3	0.4	9.6	74.9	84.9
1960	343.53	35.7	0.4	9.3	74.4	84.1
1961	316.14	27.9	1.4	9.7	93.6	104.7
1962	421.78	33.4	3.1	9.4	95.9	109.8
1963	560.27	18.0	2.7	8.2	77.8	88.7
1964	404.35	27.7	2.8	10.1	79.0	91.9
1965	463.44	25.0	7.7	12.1	94.9	114.7
1966	716.44	61.3	16.2	19.5	168.7	204.4
1967	996.25	67.9	16.3	27.7	279.2	323.2

IMPCD = Total commodity imports
IMPSD = Service imports
EXPTD = Exports on travel account (tourism)
EJ = Exports on government account, plus civilian remittances from overseas employment
EMSCD = Miscellaneous non-commodity exports (transportation and insurance, investment income, non-monetary gold)
EXPSD = total service exports
= EXPTD + EJ + EMSCD
= EXPSD + EXPGD

million dollars

Date	EXPGD	EXPD	IMPD	CURD	FXAD
1955		71.0	339.1	268.1	-1.7
1956		65.0	396.0	331.0	2.5
1957	22.2	78.8	466.2	387.4	17.0
1958	16.5	97.8	403.6	305.8	30.9
1959	19.8	104.7	331.1	226.4	0.8
1960	32.8	116.9	379.2	262.3	9.8
1961	40.9	145.6	344.0	198.4	50.0
1962	54.8	163.2	455.2	292.0	-38.4
1963	86.8	175.5	578.3	402.8	-37.2
1964	119.1	209.0	432.0	221.0	0.2
1965	175.1	289.8	488.4	198.6	9.9
1966	250.3	454.7	777.7	323.0	98.9
1967	320.2	643.4	1064.0	420.7	111.1

EXPGD = Total commercial commodity exports
EXPD = Total exports
= EXPGD + EXPSD
IMPD = Total imports, c.i.f.
CURD = Current account balance
FXAD = Foreign exchange accumulation

Transfer Payments and Capital Inflows

million dollars

Date	TR	TRG	TRJ	TRP	FK
1955					
1956					
1957	348.9	322.8	--	29.1	20.5
1958	348.9	322.6	--	26.3	-12.2
1959	243.9	226.7	--	17.2	-16.7
1960	275.7	256.1	--	19.6	-3.6
1961	231.5	206.9	--	24.6	16.9
1962	236.5	200.0	--	36.5	17.1
1963	259.5	207.5	--	52.0	106.1
1964	194.9	141.0	--	53.9	26.3
1965	203.3	134.6	--	68.7	5.2
1966	219.6	122.0	29.3	97.6	202.3
1967	225.2	134.5	37.4	90.7	306.6

TR = Net transfer payments from abroad
TRG = Government transfer payments
TRJ = Japanese government transfer payments
TRP = Private transfer payments
FK = Net capital inflows