Quantitative Analysis of the Structure and Behavior of Imports in Korea

Hwang Ho Shin*

I. Introduction

There have been a number of studies and analyses designed to explain imports and exports disaggregated by commodities in many countries. These analyses, however, all concentrate on the trading patterns of industrial countries, and there has been very little of systematic analyses of the imports and exports by types of commodities for developing countries.

There is, of course, an obvious reason for ignoring these countries, and that has to do with the availability, or rather paucity, of adequate data; it is widely known that the data on prices of disaggregated imports and exports are most difficult to obtain.

The purpose of this paper is to study and analyze the behavior of the imports of Korea at disaggregated levels during the period 1965~74. Data on imports at a disaggregated level have recently been made available in Korea for a seven-commodity breakdown. These seven categories cover some 90% of the total Korean imports.

II. Statistical Data

Data on imports at a disaggregated level include the value and price for each of these categories on an annual basis, as well as the prices of domestic competing product.

* Lecturer, Department of Foreign Trade, College of Economics and Political Science, Suk Myung Woman's University.

This paper chose price index evaluated by the base year, 1970, in the measurement of relative price ratio. There are obvious reasons for the difficulty in finding out the needed data. In fact, Korean government are not willing to announce the proper data or prices of imports or domestic commodities.

The categories of analyzing the behavior of imports is limited to seven disaggregated commodities demanded by domestic market. As mentioned above, these categories compose nearly total imports. It is, however, doubtful whether domestic commodities in Korea are competitive or not. Though the industrialization has been promoted and the real national income has been anually increased, the imports of Korea tend also to increase and the Korean commodities are not comparatively advantageous to the other exporting countries. These seven categories are as following;

1) metals and metal products,
2) machinery and machine parts,
3) industrial chemicals,
4) medicine and pesticides,
5) synthetic resin,
6) rubber
7) lumber

The detailed items, specifications, and units of these catagories are shown in Appendix.

III. Specif'cation of a Import Function

The demand for imports is specified in the simplest from; that is, the quantity demanded of the i^{th} import commodity is related to its own price, the price of the domestic-competing commodity and to the level or domestic real income. In fact, it would have been, however, preferable to relate the demand of i^{th} import commodity to total domestic expenditure on the i^{th}

commodity. Such data are not available; total real income is used instead. The i^{th} equation is written in log-linear form as follow;

$$\log M_i=\alpha_{0i}+\alpha_{1i}\log\left(\frac{PM_i}{PD_i}\right)_t+\alpha_{2i}\log Y_t+u_t \qquad (1)$$

where

M_i=quantity of the i^{th} import commodity

PM_i=price of the i^{th} import commodity

PD_i=price of the i^{th} domestic commodity

Y=real gross domestic product

As the function is specified in terms of logarithm, the parameters α_{1i} and α_{2i} are the relative price and real income elasticities of imports, respectively. The signs are expected to be

$\alpha_{1i}<0$ and $\alpha_{2i}>0$.

A rise in the relative price of imports will reduce the imports demanded and a similar rise in real income will increase it. However, the sign of α_{2i} could easily be negative. Imports are the differences between domestic consumption and domestic production. As real income rises the domestic production of importables could rise faster than consumption so as to reduce the volume of imports.[1]

Since attention is generally focused on import elasticities, the formulation of the functions in terms of logarithm allows these parameters to be obtained directly from an equation such as (1). Further more, this formulation allows imports to react proportionally to a rise and fall in the explanatory variables; and with the assumption of constant elasticities, it avoids problems of varying elasticities connected with a linear demand function.

If equation (1) was specified in linear terms, the coefficients of price and real income for aggregate imports can be derived simply as weighted

1) Magee, S.P., "Prices, Incomes, and Foreign Trade," presented at the Conference on Research in Internation Trade and Finance, Princeton, March 30-31, 1973.

averages of the coefficients from the equations for disaggregated imports. However, the log-linear specification needs a further adjustment for a statistical problem which, if not accounted for, would involve a bias in the calculation of the aggregate price and income elasticities. This adjustment will be discussed here.[1)]

Equation (1) can be rewritten as

$$M_{it}=e^{\alpha_{0i}}\cdot P_{it}^{\alpha_{1i}}\cdot Y_t^{\alpha_{2i}}\cdot e^{u_t} \tag{2}$$

where

$$P_i=\frac{PM_i}{PD_i}$$

The price elasticity of imports is $\frac{\partial M_i}{\partial P_i}\cdot\frac{P_i}{M_i}=\alpha_{1i}$ (3)

and the real income elasticity is

$$\frac{\partial M_i}{\partial Y}\cdot\frac{Y}{M_i}=\alpha_{2i} \tag{4}$$

Therefore, the total relative variation in imports is

$$\frac{dM_i}{M_i}=\alpha_{1i}\frac{dP_i}{P_i}+\alpha_{2i}\frac{dY}{Y} \tag{5}$$

Since $\sum_i M_i=M$, the variation in total imports is

$$\frac{dM}{M}=\sum_i\alpha_{1i}\frac{dP_i}{P_i}\cdot\frac{M_i}{M}+\sum\alpha_{2i}\frac{dY}{Y}\cdot\frac{M_i}{M} \tag{6}$$

and the overall price elasticity is

$$\alpha_1=\frac{\partial M}{\partial P}\cdot\frac{P}{M}=\sum_i\alpha_{1i}\frac{M_i}{M}\quad\frac{dP_i}{P_i}\cdot\frac{P}{dP} \tag{7}$$

1) The analysis here follows that of Barker's method. Refer to Barker, T. S., "Aggregation Error and Estimates of the U.K. Import Demand Function," in K. Hilton and D.E. Heathfield(eds.), *The Econometric Study of the United Kingdom*, London, 1970.

The aggregate price elasticity is therefore dependent on the individual price elasticities (α_{1i}), the share of the individual imports in total imports (M_i/M), and the variation in the ratio of the relative price of individual imports to the relative price of total imports. This last term is referred to as a "distribution elasticity." A weighted sum of the disaggregated import elasticities would equal the "true" elasticity if the distribution elasticities equaled to one and were uncorrelated with $\alpha_{1i}(M_i/M)$.

The aggregate elasticities will be calculated both as simple weighted averages of the elasticities of individual imports and as obtained by the method of equation (7) for the overall price elasticity.[1]

IV. Empirical Results

Equation (1) was estimated for each category of imports as well as for aggrgate imports. The method of estimation was ordinary least squares and the period observed was 1965~1974. The results are shown in Table I. The table shows the estimated price and income elasticities with their respective standard errors in parentheses below, the coefficient of determination, R^2, and the standard error of the estimated equation, S.E.

In certain cases there was evidence of first-order autocorrelation in the residuals, u_t, therefore these particular equations were reestimated subject to a first-order autoregressive process as

$$u_t=\rho u_{t-1}+\varepsilon_t \tag{8}$$

where ρ is the coefficient of autocorrelation with a restriction of $|\rho|<1$, and ε_t is an error term with the usual properties.

1) Since we are using the same income variable the distribution elasticity is necessarily equal to unity.

Table I. **Estimates of Individual Import Equations**

Categories	Constant	Price Elasticity	Income Elasticity	R^2	S.E.
metals and metal products	−5.70797	−2.38535 (0.76681)	2.66392 (0.14402)	0.99043	0.05892
machinery and machine parts	−5.85336	−2.25460 (1.75727)	2.82770 (0.34754)	0.95108	0.14158
industrial chemicals	−8.84005	−0.34495 (1.05766)	3.69693 (0.46074)	0.98225	0.08470
medicine and pesticides	−10.42407	−0.23844 (2.48373)	4.04693 (0.90293)	0.86518	0.29172
synthetic resin	−5.60682	0.69803 (0.34306)	2.37606 (0.26080)	0.99463	0.04610
rubber	−3.08738	−6.16197 (0.98226)	1.56865 (0.13760)	0.99263	0.04229
lumber	−6.34647	−2.12166 (0.54993)	2.76400 (0.14139)	0.99097	0.05569

The results in Table I show that all of the categories of imports have the expected negative signs of price elasticities except synthetic resin. The estimates of the price elasticity range from −6.16197 for rubber imports to −0.23844 for importe of medicine and pesticides. The estimates of the price elasticity, however, shows 0.69803 for synthetic resin, which describes that inspite of a rise in the relative price of imports the quantity demanded was increased.

In general the sizes of these elasticities conform with theoretical expectations. The estimated income elasticities are positive and significant for imports of all categegories. In some cases price elasticity the estimated elasticities were not significantly different from zero. The fits of the equaticns are reasonablly good.

On the other hand, the distribution elasticities were calculated for each category of imports using a regression equation of the form

$$\Delta \log P_{it} = \beta_i \Delta \log P_t + v_t \tag{9}$$

where $P_i = \frac{PM_i}{PD_i}$ and $P = \sum_i P_i$

β_i is the distribution elasticity and v_t is a random error term. The estimates of β_i is shown in Table II.

Table II. **Distribution Elasticities**

Categories	Distribution Elasticity
metals and metal products	1.28235
machinery and machine parts	1.44297
industrial chemicals	0.32758
medicine and pesticides	0.45130
synthetic resin	0.47270
rubber	−0.15488
lumber	2.53006

From the disaggregated equation estimates, the aggregate price and income elasticites can be derived using the method outlined in Section III. These aggregate elasticities were calculated using the 1970 shares of individual imports in total imports. The first column of the total shows the elasticities without including the distribution elasticities while the second column calculation takes account of these. In Table III below are shown the derived elasticities.

Table III. **Derived Aggregate Import Elasticities**

Classification	Weighted Average	Weighted Average Including Distribution Elasticities
Aggregate price elasticity	−1.82985	−0.92241
Aggregate income elasticity	2.84917	2.84917*

* The distribution elasticsty for income equal to unity since the same variable was used in all the imports equations.

It may be seen from Table III that the aggregate elasticities derived from the results of the disaggregated import equations are substantially different from the price and income elasticities obtained by estimating an aggregate import equation directly as shown in Table I.

V. Conclusion

It appears from the results of this paper that simple specifications involving only relative prices and real incomes as explanatory variables are adequate to explain a large proportion of the variations in Korean imports. This is true both at the aggregated as well as disaggregated levels.

The weighted average of the price and income elasticities of individual imports were larger than the corresponding elasticities obtained from directly estimating an equation for aggregate imports. This would imply that there may be a downward aggregation bias. An evidence of upward bias in the price elasticity is also found when simple weighted average of the component price elasticities is taken.

REFERENCES

[1] Kreinin, M. E., "Price Elasticities in International Trade," *The Review of Economics and Statistics*, 44 (Nov. 1967).

[2] Kreinin, M. E., "Disaggregated Import Demand Functions - Some Further Results," *Southern Economic Journal*, 40 (July 1973).

[3] Houthakker, H. S., and Magee, S. P., "Income and Price Elasticities in World Trade," *The Review of Economics and Statistics*, 51 (May 1969).

[4] Junz, H., and Rhomberg, R. R., "Price and Export Performance of Industrial Countries, 1953~1963," *IMF Staff Papers*, July, 1965.

[5] Barker, T. S., "Aggregative Error and Estimates of the U.K. Import Demand Function," in K. Hilton and D. E. Heathfield(eds.), *The Econometric Study of the United Kingdom*, London, 1970.

[6] Magee, S. P., "Prices, Incomes and Foreign Trade," paper presented at the Conference on Research in International Trade and Finance, Priceton, March 30-31, 1973.

[7] Adler, F. M., "The Relationship between the Income and Price Elastici-

ties of Demand for U.S. Exports, *The Review of Economics and Statistics,* May, 1974.

[8] Leamer, E. E., and Stern, R. M., *Quantitative International Economics,* Boston, Allyn and Bacon, 1970.

DATA SOURCES

[1] The Bank of Korea, *Economic Statistics Yearbook,* 1965~1974; Monthly Economic Statistics, Dec. 1969, Dec. 1974, and Sept. 1975.

[2] Korean Economic Planning Board, unpublished data.

[3] Korean Traders Association, *Statistical Yearbook of Foreign Trade,* 1965~1974.

[4] The Bank of Korea, Department of I.C., unpublished data.

APPENDIX

Pricing Items, Specification and Unit

Item	Specification	Unit
METALS AND METAL PRODUCTS		
Steel bar	high speed, round, bar dia. 30mm	kg
Ibeam	200mm × 100mm × 7mm	kg
Angle	150mm × 150mm × 12mm	kg
Channel	300mm × 90mm × 9mm	kg
Stainless steel sheet	SUS 24, 1mm thick	kg
Stainless steel sheet	SUS 27, 1mm thick	kg
Silicon steel sheet	RM 14	kg
Steel pipe	STB 35, outer diameter 76.2mm, 4mm thick	feet
Zinc ingot	99.99% and up	MT
Tin ingot	99.99% and up	MT
MACHINERY AND MACHINE PARTS		
Saw	round, dia. 14", for wood working	piece
Twist drill	$\frac{1}{8}$", Japan	piece
Drill	shank twist, $\frac{1}{16}$", Japan	dozen

Plier	8″, Japan	piece
Bit rock drill	40mm × 800mm, Sweden	piece
Tap and dies	$\frac{1}{8}$″, Japan	piece
Hand tap	$\frac{5}{32}$″, Japan	set
Carburetor	Toyota, Corona(1970 model), Japan	piece
Connecting rod	Toyota, Corona(1969 model), Japan	piece
Cylinder head	Toyota, Corona(1969 model), Japan	piece
Typewriter	S.C.A. model 16″, U.S.A.	set
Drilling	large size, radial drilling 2-130, Japan	set
Grinder	Tabel 24″, Japan	set
Traveller	No. 1/0～5/0, 5,000 pieces per can, Japan	can
Oil burner	Sun-ray, model $\frac{1}{8}$ h.p., U.S.A.	piece
Oil burner	Wayne $\frac{1}{8}$ h.p., U.S.A.	piece
Fuel pump assembly	Corana, Japan	piece
Rock drill	P.Y. 24″, Japan	set
Drill chuck	$\frac{1}{2}$″, Japan	piece
Bearing	No. 6201, Japan	piece
Bearing	No. 32217, Japan	piece
Resistor	stationary 4.7k-Ω, Japan	100 pieces
Stethoscope	three bell, Japan	set
Vacuum tube	35w4, Japan	piece
Pipe wrench	8″, Japan	piece
Sphygmomanometer	mercury, Japan	set
Watch, wrist	"Bulova", men's, 23 jewels, with calendar, stainless case, Swiss	each
Watch, wrist	"Mondia", women's, 17 jewels, with calendar, stainless case, Swiss	each
INDUSTRIAL CHEMICALS		
Sulphur	powder, 39.5%	MT
Styrene	industrial, monomer	MT
Naphthalene	crystal	MT
Butanol	industrial, Japan	drum(160kg)
Ethylene glycol	industrial, Japan	drum(200kg)
Prophylene glycol	industrial, Japan	drum(200kg)
Phenol	crystal, Japan	MT
Cresol	prime liquid, U.S.A.	drum(200kg)
Acetone	98% and up, Japan	drum(160kg)
Methyl ethyl ketone	Japan	drum(160kg)
Nitric acid	industrial, 42 degree Japan	MT

Oxalic acid	99% and up, Japan	MT
Maleic anhydride	industrial, Japan	MT
Phthalic anhydride	industrial, Japan	MT
Lactic acid	Takeda, Japan	bottle
Tartaric acid	granular; Germany	MT
Citric acid	granular, Germany	MT
Methyl salicylate	Japan	can
Antioxidant for rubber	Norac D	bag
Accelerator for rubber	D. Japan	bag
Mercury	99%, Japan	can
Phosphoric acid	85% and up, Japan	MT
Caustic soda	solid, alkalinity 98%, Japan	drum(160lb.)
Aluminium oxide	99%, Japan	MT
Chromic anhyoride	industrial, Japan	MT
Barium chloride	Japan	MT
Nickel sulphate	nickel 20% - 22%	MT
Sodium phosphote	dibasic tribasic, Japan	bag
Sodium cyanite	Japan	MT
Sodium borate	Industrial, granulor, U.S.A.	MT
Titanium oxide	Anatase type, powder, 98%	MT
Alkalic dye	Auramine "O", Germany	kg
Acid dye	Kiton brown R	kg
Tanning extract	Mimosa 62%, solid	bag
Lithopone	powder, 30%, Holland	MT
MEDICINES & PESTICIDES		
Aspirin	Japanese phormacopoeia	kg
Anesthesin	Japanese pharmacopoeia	kg
Procaine H.C.L.	W.G. pharmacopoeia	kg
Aminopyrine	Japanese pharmacopoeia	kg
Sulpyrine	Japanese pharmacopoeia	kg
Sulfaguanidine	Japanese pharmacopoeia	kg
Sulfathiozole	Japanese pharmacopoeia	kg
Vitamin C	food additive Japan	kg
Tocopheryl	18%, Japanese pharmacopoeia	kg
Piperazine adepate	Japanese pharmacopoeia	kg
Penicillin	Retarpen 12 million unit, Austria	ampule
Kidola tab.	1, 000T, Japan	B.T.
Trancopal tab.	100mg×500T, Japan	box
Contac 600	4 cap., U.S.A.	P.K.
Complamin	150mg×30T, W.G.	box
Purinor Lni.	5cc×50A, W.G.	box

Essential cap.	368, W.G.	box
A.T.P. Lni.	granular, 10mg×50A×2ml, Japan	box
A.T.P. tab.	Daiichi Entric 20mg×100T, Japan	Tin
Gammalon	300T, Japan	B.T.
Neoiscotin tab.	100T, Japan	B.T.
Sptol tab.	1,000T, Japan	B.T.
Herbicide	Machete, granular 5%	bag
Pesticide	Lebaycid, emulsive 50%	bottle
Insecticide	Bla-s, emulsive 2%	bottle
SYNTHETIC RESIN		
Nitro cellulose	RS $\frac{1}{2}$, Japan	drum(100kg)
Methyl cellulose	4,000 CPS, Japan	kg
Polypropylene resin	fiber grade (virgin) filament, Japan	MT
Polypropylene resin	blow or film extrution, Japan	MT
Acrylic resin	emission, U.S.A.	MT
Polyethylene resin	low density blow or film extrution	MT
Coumaron resin	adhesive, Japan	MT
RUBBER		
Raw rubber	RSS No. 1	MT
Syntheic rubber	No. 1778 or 1712, Japan	MT
LUMBER		
Log, Douglas fir		1/300m^3
Log, lauan		board feet