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The impact of PL 480 shipments on prices and domestic production of foodgrains in Korea

Sang Gee Kim

To the Graduate Council:

I am submitting herewith a thesis written by Sang Gee Kim entitled "The impact of PL 480 shipments on prices and domestic production of foodgrains in Korea." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agricultural Economics.

James G. Snell, Major Professor

We have read this thesis and recommend its acceptance:

Frank Goode, Charles L. Cleland

Accepted for the Council:
Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

June 10, 1971

To the Graduate Council:

I am submitting herewith a thesis written by Sang Gee Kim entitled "The Impact of PL 480 Shipments on Prices and Domestic Production of Foodgrains in Korea." I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agricultural Economics.

James L. Sh[illegible]
Major Professor

We have read this thesis and recommend its acceptance:

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Accepted for the Council:

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THE IMPACT OF PL 480 SHIPMENTS ON PRICES AND DOMESTIC PRODUCTION OF FOODGRAINS IN KOREA

A Thesis

Presented to

the Graduate Council of

The University of Tennessee

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

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by

Sang Gee Kim

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ABSTRACT

The main purpose was to evaluate the effect of PL 480 shipments of cereals to Korea on domestic prices and production during the past fourteen years. Secondary data were used for the study with most of data derived from the publications compiled by the various governmental agencies in Korea. PL 480 shipments data were taken from the semiannual and annual reports on Food for Peace published by the House of Representatives of the United States.

An attempt was made to analyze the impact of Public Law 480 gratis assistance to Korea and to identify some quantitative magnitude of effects of the commodities shipped under PL 480 on prices and domestic production of foodgrains.

Though the accuracy of data and the performance of the model presented some problems, the results seem to be compatible with the hypothesis; that is, PL 480 imports tend to lower the price of domestically produced grains and lead to a decline in domestic production. However, after taking account of possible price and production disincentives, the net effect of the imports indicates that there has been a positive contribution to domestic levels of consumption.

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CHAPTER I

INTRODUCTION

There has been a good deal of argument over the effects of U.S. Public Law 480 (formally called the Agricultural Trade Development and Assistance Act of 1954) shipments to Korea. Specifically, the effect of PL 480 imports on prices and production of domestic cereals was of particular concern to the economic professionals and policy makers in the country.[1] The effects have also been widely discussed among economists within the United States and in several recipient countries since the Law was enacted.

It seems that most of the examination of the internal impact of PL 480, Title I, has been largely concentrated upon (1) the effects on agricultural production, (2) the induced change in consumption, and (3) the impact upon the rate and character of the development programs. However, due to the differences in economic situations and policy

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[1] Some examples are: Young K. Shim, "The Food Problems in Korea," Journal of Agricultural Economics [Korean Agricultural Economics Association], 4:28-36, December 1961; Jin W. Park, "Technique of a Successful Rice Culture Farm and Economic Analysis of Input and Output," The Research and Guidance, Vol. 43 (Suwon, Korea: The Office of Rural Development, 1968), pp. 24-25; Pal Y. Moon, "Measuring the Effects of Grain Prices," Journal of Agricultural Economics [Korean Agricultural Economics Association], 10:41-42, November 1968; Sung H. Ban, "Effects of Commercialization of Farm Products on Farm Income and the Efficiency of Agricultural Production," Journal of Agricultural Economics [Korean Agricultural Economics Association], 7:79-87, December 1964; G. B. Tolley, "The Agricultural Price Policy in Korea," Dong-A Ilbo [Seoul, Korea], October 30, 1970, p. 3.

implications among the recipient countries studied, it is difficult to generalize as to the specific effect.[2]

Korea has been one of the major recipient countries for U.S. PL 480 disposals. Of the total market value of $11,668 million programmed under Title I for all countries during the period July 1, 1955, to December 31, 1969, $642 million (approximately 5.5 percent) was for Korea.[3]

Of all the cereals available for human consumption in Korea during the period 1956-1969, some 8 percent were from the gratis assistances under PL 480, Title I.[4] In a country like Korea, which is temporarily unable to meet its food needs from domestic supply, this would be a relative advantage to her economy, if the PL 480 shipments result in a net increase in food available per capita. However, if there is a disincentive effect due to lower domestic prices of sufficient strength to reduce domestic production by a greater quantity than the PL 480 shipments, the results would be harmful to the recipient country.

Even though there has been concern over the possible incentive or disincentive effects over the years, no attempt has been made to study the impact of PL 480 gratis imports on Korean agriculture in a systematic and analytic way.

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[2]Lawrence Witt and Carl Eicher, "The Effects of United States Agricultural Surplus Disposal Programs on Recipient Countries," Research Bulletin 2 (East Lansing: Michigan State University, 1970), pp. 29-38.

[3]Douglas Hedley and David Peacock, "Food for Peace, PL 480 and American Agriculture," Agricultural Economics Report, No. 156 (East Lansing: Michigan State University, February 1970), p. 33.

[4]Yearbook of Agriculture and Forestry Statistics, 1960, 1965, and 1970 (Seoul, Korea: Ministry of Agriculture and Forestry, Republic of Korea, 1961, 1966, and 1971).

I. OBJECTIVE OF STUDY

The implicit hypothesis is that PL 480 shipments to Korea have had a disincentive effect on domestic production. The study is based on the assumption that the importation of cereals under PL 480 most likely leads to lower prices and a decline in domestic supply but that the decrease in domestic supply is less than the quantity imported gratis. Thus, there is probably a net addition to the quantity available for domestic consumption, which is a significant contribution in a shortage economy.

Specifically, the objectives of this study are:

1. To analyze the effects of the PL 480 shipments on prices and production of domestically produced food grains under static conditions.
2. To evaluate the impact of PL 480 on prices and domestic supply of cereals of Korea over time.

The primary concern is with price and production responses to PL 480 imports rather than with such socioeconomic effects as the increased consumption levels or nutritional needs, income redistribution, resource allocation, and political stability. It is assumed, however, that the information presented would indirectly help domestic producers to be able to make efficient future decisions on how to adjust their own cereals production, if PL 480 shipments continue.

Knowledge about the magnitude of estimates affecting farm prices and production can also help the government to set up agricultural economic policy.

II. SOURCE OF DATA

The data used in this study are secondary. The sources of the data are: (1) Yearbooks of Agriculture and Forestry Statistics compiled by the Korean Ministry of Agriculture and Forestry, (2) Korea Statistical Yearbook and Major Economic Indicators completed by the Economic Planning Board of Korea, (3) Economic Statistics Yearbook and Review of Korean Economy by the Bank of Korea, (4) Agricultural Yearbook by the National Agricultural Cooperative Federation, and (5) The Semiannual Report on Activities under Agricultural Trade and Assistance Act of 1954, July 1, 1954, through June 30, 1963, and Annual Report on PL 480, Food for Peace, 1964 through 1969, the House Documents published by the House of Representatives of the United States.

Insofar as the production of domestic grains is concerned, it is believed that the data are relatively reliable as a scientific method of three-stages stratified sampling has been employed to collect information. The data on prices of commodities, national income, and commercial imports present some problem. However, it should be pointed out that there are no alternatives other than those officially accepted by both internal and external agencies concerned.

III. METHOD AND PROCEDURE

An econometric model containing six simultaneous equations was utilized in studying the impact of PL 480 imports on domestic prices and supply of food grains. The structural parameters were estimated by the use of the two-stage least squares method. The direct reduced form

coefficients were used to derive several static and dynamic multipliers. These multipliers were thus employed to determine the impact of PL 480 shipments on domestic prices and supplies in Korea.

CHAPTER II

THEORETICAL FRAMEWORK

This study is based on the economic model developed by Jitender Mann for measuring the effects of imports of food on domestic supply.[1] The model assumed that the impact of PL 480 shipments to a recipient country depends on (1) price elasticity of domestic supply, (2) price elasticity of domestic demand, (3) the ratio of shipments to total quantity demanded rather than the ratio to domestic output, (4) commercial imports other than under PL 480, and (5) the withdrawal from stocks.[2]

In order to estimate the impact of the PL 480 shipments on prices and production of domestically produced food grains, an economic framework of analysis is set up in terms of (1) a supply equation, (2) a demand equation, (3) an income-generation equation, (4) a commercially-based import equation, (5) a change-in-stocks equation, and (6) a market-clearing identity.

The quantity of cereals consumed during a given year comes from four sources: (1) domestic production, (2) PL 480 shipments,

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[1] See Jitender S. Mann, "The Impact of PL 480 Imports on Prices and Domestic Supply of Cereals in India," The Journal of Farm Economics, 49(1):132-139, February 1967.

[2] Franklin M. Fisher, "A Theoretical Analysis of the Impact of Food Surplus Disposal on Agricultural Production in Recipient Countries," The Journal of Farm Economics, 45:863-874, November 1963. In his pioneering work in 1963, Fisher developed a conceptual framework in order to measure the effect of surplus shipments to recipient countries. Unlike Mann, he does not take into account commercial imports and a change in domestic grain stocks.

(3) commercial procurement abroad, and (4) the withdrawal from stocks carried over. Since 1956, the commercial imports of food grains into Korea have been almost completely controlled by the government. The Korean government also purchases food grains in the domestic market.[3]

The grains imported under PL 480 along with those procured both internally and externally except the emergency stocks are sold by the government to the consumers through a large number of licensed retail stores--often called the "fair price shops." A comparison of the actual stocks of cereals held by the state and the storage capacity available to the government brings out the difficulty faced in building up a buffer stock.[4]

Food imported under PL 480 is, to a large extent, rapidly passed on to the domestic consumers through the marketing channels of the National Agricultural Cooperative Federation (NACF) and the retail stores authorized by the government. Thus, it becomes available for consumption during the year that it is imported.

The quantity available from domestic production for domestic

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[3]The Korean government mainly procures and sells rice and barley in an attempt to stabilize the seasonal variation in prices of those staple food grains and to secure flexible war-emergency needs. During the past nine years from 1961 to 1969 after the government procurement was brought about, the ratio of quantity procured to total domestic production was, on the average, 4.2 percent of rice and 3.9 percent of barley per annum. This operation is disregarded in this study, though the price effect through grain market operations are important. At the same time, there has been no change in emergency stock over the years due to simply replacing old grain with newly procured grains. See Yearbook of Agriculture and Forestry Statistics, 1970 (Seoul, Korea: Ministry of Agriculture and Forestry, Republic of Korea, 1971), pp. 128, 132.

[4]Ibid, pp. 14, 225.

consumption during a year is mostly the result of production decisions made during the previous year. For instance, rice which is harvested toward the end of 1960 and is available for consumption during 1961 was sown during the mid-point of 1960. The production process in agriculture is not instantaneous; thus, the quantity available for consumption during the time period t is the result of production decisions made during time period t-1 and the decision is a function of the price of food grains during time period t-2.

It is also a function of weather conditions and quantity of fertilizers used. As a result, the supply function is conceptualized as:

$$Q_{s/t} = f\ (P_{t-2},\ C_t,\ F_t),$$

where

$Q_{s/t}$ is the quantity of cereals domestically produced for consumption during time period t.

P_{t-2} is the price of all the cereals during the time period t-2.

C_t represents the climate or weather variables during time period t.

F_t represents the quantity of fertilizers actually consumed.

According to the past agronomic research in Korea, meterological factors such as rainfall, temperature, and sun radiation and chemical fertilizers during the growing season, particularly for the paddy-rice, have been one of the most important variables influencing yield and production. Conventional weather indexes were used to represent those meteorological factors, assuming that all factors other than such

direct influence of weather as rainfall, temperature and sunshine are held constant.[5]

It is hypothesized that the demand for cereals is a function of the price of a commodity, the price of other related foods, and consumer income:

$$Q_{d/t} = f\ (P_t,\ P_{o/t},\ Y_t),$$

where

$Q_{d/t}$ is the per capita quantity of cereals demanded.

P_t is the price of cereals.

$P_{o/t}$ is the price of those other than cereals.

Y_t is per capita real income.

Korea was a predominantly agricultural country during the period extending from 1956 to 1969 covered in this study, though there have been recent upswings to transform the economy into a somewhat industrialized stage. On the average, some 40 percent of the yearly national income has been originated in the agricultural sector of the economy.[6] Consequently, it cannot be assumed that real income is determined primarily from outside the system. National income is also influenced by investments of the central and provincial governments.

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[5]Variables held constant here included insect damage, plant diseases, and other accidental occurrences. However, trend due to the differences in original soil fertility and acidity, crop varieties, and cultural practices is removed by fitting a linear regression line to the data. See J. L. Stallings, "Weather Indexes," Journal of Farm Economics, 42:180-185, 1960; L. H. Shaw, "The Effect of Weather on Agricultural Output: A Look at Methodology," Journal of Farm Economics, 46:225-226, 1964; and J. P. Doll, "An Analytical Technique for Estimating Weather Indexes from Meteorological Measurements," Journal of Farm Economics, 49:79-82, 1967.

[6]Economic Statistics Yearbook, 1965 and 1969 (Seoul, Korea: The Bank of Korea, Republic of Korea, 1966 and 1970).

These investments are on the various programs included in the First Five-Year and Second Five-Year Economic Development Plans and on several activities not included in the national plannings.

Accordingly, the income-generation equation is set up as:

$$Y_t = f\ (Q_{s/t},\ GI_t),$$

where:

GI_t is per capita nonconsumption expenditure or investment by the government, and the other symbols are as described above.

It is assumed that the commercial imports are considered to depend on the domestic production, the amount of PL 480 shipped, and the withdrawal from opening stock. As a result, the commercial import equation is expressed as:

$$I_t = f\ (Q_{s/t},\ W_t,\ L_t),$$

where:

I_t is the amount of commercial imports.

W_t is the amount of substracting ending stock from opening stock.

L_t is the quantity of PL 480 shipments, and the other is as above.

Finally, the change in stocks depends on the domestic production, commercial imports, PL 480 imports, and the opening stock:

$$W_t = f\ (Q_{s/t},\ I_t,\ L_t,\ S_t),$$

where:

S_t represents the opening stock, and the others are as symbolized above.

There are, thus, six variables to be explained: $Q_{s/t}$, $Q_{d/t}$, P_t, Y_t, I_t, and W_t along with seven predetermined variables P_{t-2}, C_t, F_t, $P_{o/t}$, GI_t, L_t, and S_t; but there are only five simultaneous equations

in the system. A market-clearing identity is needed to close the system, i.e.,

$$Q_{d/t} = Q_{s/t} + L_t + I_t + W_t.$$

CHAPTER III

STRUCTURAL FORM OF THE MODEL

I. ESTIMATING THE STRUCTURAL EQUATIONS OF THE SYSTEM

The method of two-stage least squares was employed to estimate the coefficients of the structural equations of the system. Since the production equation in the model is a uniequational complete model,[1] the Ordinary Least Squares method was used for this function.

The resulted structural form is as follows:[2]

$$y_1 = \underset{(31.6100)}{61.3900} + \underset{(0.1829)}{0.2115}z_1 + \underset{(0.3520)}{1.0113}z_2 + \underset{(0.4445)}{0.8335}z_3 \qquad (3.1)$$

$$y_2 = \underset{(66.6700)}{133.5000} + \underset{(0.5402)}{0.2671}y_3 + \underset{(0.0015)}{0.0030}y_4 - \underset{(0.7737)}{0.0587}z_4 \qquad (3.2)$$

$$y_4 = \underset{(3352.0000)}{7532.0000} + \underset{(0.1770)}{62.8100}y_1 + \underset{(0.0565)}{1.6490}z_5 \qquad (3.3)$$

$$y_5 = \underset{(11.7700)}{-96.2200} + \underset{(0.6032)}{0.5969}y_1 + \underset{(0.8620)}{0.3656}y_6 + \underset{(0.4512)}{0.6882}z_6 \qquad (3.4)$$

$$y_6 = \underset{(41.6200)}{98.5000} - \underset{(0.2179)}{0.5245}y_1 - \underset{(0.1976)}{0.0115}y_5 - \underset{(0.2159)}{0.1519}z_6 + \underset{(0.1537)}{0.1537}z_7 \qquad (3.5)$$

where

y_1 = per capita domestic supply of grains (kilograms).

y_2 = per capita quantity of grains demanded (kilograms).

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[1] According to Karl A. Fox, a uniequational complete model is defined as one in which there is only one non-lagged endogeneous variable and in which there is no correlation between the disturbances and the predetermined variables. See Karl A. Fox, Econometric Analysis for Public Policy (Ames, Iowa: Iowa State College, 1958), pp. 33-34.

[2] Standard errors are in parentheses below the estimated structural parameters.

y_3 = weighted index of wholesale prices of grains deflated by wholesale price index of all commodities (1965 = 100).

y_4 = per capita gross national income held constant at 1965 market prices (Wons).[3]

y_5 = per capita quantity of grains commercially imported (kilograms).

y_6 = per capita quantity withdrawn from the opening grain stocks (kilograms).

z_1 = weighted index number of wholesale prices of grain lagged by two years and deflated by the index of wholesale prices of all commodities (1965 = 100).

z_2 = weather indexes (referred to relative index of dividing actual yield by predicted trend value obtained by fitting a linear regression to the original data).

z_3 = quantity of fertilizers in elements actually used per Tanbo[4] planted (kilograms).

z_4 = weighted index number of wholesale prices of foods other than grains (1965 = 100) deflated by the index of wholesale prices of all commodities.

z_5 = per capita government investment held constant at 1965 prices (Wons).

z_6 = per capita quantity of grains-imports under PL 480 (kilograms).

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[3]One dollar is equivalent to about 270 Wons at 1965 prices.

[4]One tanbo is equal to 0.245 acre.

z_7 = per capita quantity of the opening stocks of grains (kilograms).

Discussion of the Statistical Results

Concerning the supply equation, the coefficient of z_1 is positive and is consistent with the standard economic theory. The model indicates that weather z_2 and fertilizers z_3 are positively related to yield and production of grains.

Since the supply function was fitted by the traditional ordinary least squares method, the goodness of fit may be tested by the F statistic. The computed F-value and R^2 for the equation are 5.5640 and 0.6253, respectively. The F value is significant at the 5 percent level.

The estimated price elasticity of supply at the mean is 0.1095. This is less than a previous study for the price elasticity of production for rice. Pal Y. Moon's estimates based on Cobb-Douglas model for the years 1958-66 are 0.223 for rice and 0.390 for barley.[5]

For the demand equation, the positive sign of the income coefficient is as was hypothesized. The coefficient of prices for grains and other foods is not consistent with the usual microeconomic theory. It is known, however, that in an ever-changing economic system as opposed to a stable static situation, there are always some dynamic discrepancies between the current values of endogeneous variables and their long-run equilibrium values. These gaps or discrepancies

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[5]Pal Y. Moon, "Measuring the Effects of Grain Prices," Journal of Agricultural Economics [Korean Agricultural Economics Association], 10:44, 1968.

are due largely to changes in both endogeneous and predetermined variables over time.[6]

For example, a demand function could shift more rapidly than the supply function due to some changes in exogeneous variables such as continuous growth of population and income, or unstudied variables. The long-term equilibrium position of supply and demand after interacting simultaneously with the other factors endogeneous and exogeneous to the system could result in an upward-sloping statistical demand curve, at least for the particular time period of the economy studied.[7]

Therefore, the positive price coefficients may be the result of the data. Although each series of data originated in the static conditions, the data were generated over time, that is, time series data, and is subjected to dynamic market adjustments.[8]

The estimated price and income elasticities of demand are 0.1166 and 0.3553, respectively.

The estimated income generation function reveals that the marginal investment-output ratio is about 1.65. It would mean that a unit increase in per capita nonconsumption expenditure by the government results in a 1.65 unit increase in per capita gross income. That is, the economy as a whole has the increasing returns to investment. This

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[6]Pinhas Zusman, "Dynamic Discrepancies in Agricultural Economic Systems," Journal of Farm Economics, 44:744-753, 1962.

[7]E. J. Working, "What Do Statistical Demand Curves Show?" Quarterly Journal of Economics, 41:212-235, 1927.

[8]T. F. Dernburg and D. M. McDougall, Macroeconomics (New York: McGraw-Hill, 1968), pp. 89-96, and L. V. Manderscheid, "Some Observations on Interpreting Measured Demand Elasticities," Journal of Farm Economics, 46:128-136, 1964.

estimate would be compatible with Irma Adelman's study based on an econometric model designed to appraise the achievements of Korea's Second Five-Year Economic Development Planning.[9]

The coefficients of the commercial import equation are not consistent with the hypothesized signs. Imports vary positively with domestic production, PL 480 shipments, and withdrawals.

On the other hand, the signs of all the coefficients in the withdrawal equation coincided with our a priori knowledge. The withdrawal from the government stocks is inversely related to domestic supply, commercial imports, and PL 480 imports and positively related to the opening stocks.

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[9]Irma Adelman, ed., Practical Approaches to Development Planning: Korea's Second Five-Year Plan (Baltimore: Johns Hopkins Press, 1969), pp. 79-87.

CHAPTER IV

ANALYSIS OF THE IMPACT OF PL 480 IMPORTS

The main objective was to evaluate the effect of U.S. surplus disposal on production of domestically grown foodgrains. Consequently, emphasis is given on the following specific questions:

1. If PL 480 shipment to Korea is raised by one unit in a given year and restored to its original level, what will happen to domestic prices of grains during the same year?

2. If a unit increase in PL 480 is sustained at its new level, what will happen to the current and future prices of domestic cereals?

3. What is the impact of such change to the consecutive value of domestic production if a unit change in PL 480 is not restored?

4. What is the total net impact of such change to domestic production over a given time period?

I. DERIVATION OF STATIC AND DYNAMIC MULTIPLIERS

In order to examine the equilibrium impact of a change in any exogeneous variable on each endogeneous variable, it is necessary that each current endogeneous variable in the system is explicitly expressed in terms of all the predetermined variables. In other words, the reduced form of the model is needed.[1] Statistically, it is assumed that the disturbance term in the reduced form is uncorrelated with the predetermined variables so that the prediction of the endogeneous

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[1] See R. J. Wonnacott and T. H. Wonnacott, Econometrics (New York: John Wiley and Sons, 1970), pp. 161, 162.

variable is given by the linear function of all the predetermined variables. It should be noted, however, that in this study the direct reduced form is used, which yields consistent estimators of the coefficients of the reduced form. But the estimators are less efficient than that of the derived reduced form.[2]

The direct reduced form is obtained by regressing each of five endogeneous variables except domestic production, y_1, on seven predetermined variables in the system without any restrictions. That is, each equation in the reduced form can be written as follows.

$$y_1(t) = a_{10} + p_{11}z_1(t) + p_{12}z_2(t) + p_{13}z_3(t) + 0 + 0 + 0 + 0 + e_1(t) \quad (4.1)$$

$$y_2(t) = a_{20} + p_{21}z_1(t) + p_{22}z_2(t) + \ldots . p_{27}z_7(t) + e_2(t) \quad (4.2)$$

$$y_3(t) = a_{30} + p_{31}z_1(t) + \ldots \quad (4,3)$$

. . . . . .

. . . . . .

$$y_6(t) = a_{60} + p_{61}z_1(t) + \ldots p_{67}z_7(t) + e_6(t) \quad (4.6)$$

where

y_i = each current endogeneous variable,

p_{ij} = coefficient of the j^{th} predetermined variable in the i^{th} equation, and for t = 1,2,3 . . . 14.

By partially differentiating each endogeneous variable $y_i(t)$ with respect to predetermined variable $z_j(t)$ and rearranging, we obtain a particular coefficient matrix P_{ij}. The coefficient matrix, P, of the reduced form for the present model is shown in Table I. The matrix P

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[2]For detailed discussion on the related problem, see A. S. Goldberger, Econometric Theory (New York: John Wiley and Sons, 1964), p. 365.

TABLE I

THE ESTIMATES OF THE DIRECT REDUCED FORM OF THE SYSTEM

Endogeneous variables	Predetermined variables							
	z_1	z_2	z_3	z_4	z_5	z_6	z_7	1
y_1	0.2115	1.0110	0.8335	0.0000	0.0000	0.0000	0.0000	61.3900
y_2	-0.0321	0.9710	-2.1090	0.2622	0.0086	0.7270	-0.2408	96.1200
y_3	-0.2584	-0.2259	1.5550	0.2889	0.0036	-0.3476	-1.2410	117.2000
y_4	1.9576	0.3814	0.9377	0.4736	1.2170	6.5430	5.4410	11160.0000
y_5	0.0103	0.2454	-0.2624	-0.0771	0.0085	-0.0554	-0.9228	-8.2070
y_6	0.0049	-0.9037	-3.3420	0.6064	0.0050	-0.4995	-0.3089	60.7000

shows how much a unit change in the j^{th} predetermined variable during a given time period t influences the i^{th} endogeneous variable during the same year, with all other predetermined variables held constant. Each element of P is commonly called the "impact multiplier" and defined as

$$p_{ij} = \partial y_i(t)/\partial z_j(t). \tag{4.7}$$

For the previous questions, it can be seen that the responseness of prices and domestic supply of grains to a unit change in PL 480 aid can be examined in terms of a unit shock or one-time impulse, assuming that this shock is not sustained. However, to find out impact of successive imports of PL 480 on prices and domestic production, it is necessary to develop two more dynamic multipliers. It should be recalled that z_1, the index of wholesale prices of grains in the supply equation, is the two year lagged value of the current price index of foodgrains, y_3.

After partitioning[3] the reduced form coefficients in y_1 and y_3 into:

$$P_1 = (P_{11}P_{12}) \qquad \text{where } P_{11} = p_{11}, \text{ and}$$
$$P_{12} = (p_{12}p_{13} \cdot \cdot \cdot p_{17}a_{10}),$$
$$P_3 = (P_{31}P_{32}) \qquad \text{where } P_{31} = p_{31}, \text{ and}$$
$$P_{32} = (p_{32}p_{33} \cdot \cdot \cdot p_{37}a_{30})$$

and

$$Z_j = (Z_1Z_2), \qquad \text{where } Z_1 = z_1, \text{ and}$$
$$Z_2 = (z_2z_3 \cdot \cdot \cdot z_7\ 1)$$

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[3]For the detailed derivation of matrix partitioning and delay multipliers, see J. Johnston, Econometric Method (New York:

and rearranging these partitioned coefficients by the geometric progressions,[4] the so-called "delay multipliers" can be obtained. They are defined as

$$\partial y_1(t)/\partial z_6(s) = p_{11}p_{36}p_{31}^{s/2} + p_{16} \tag{4.8}$$

and

$$\partial y_3(t)/\partial z_6(s) = p_{36}p_{31}^{s/2} . \tag{4.9}$$

As stated above, the index s (refers to progressive power) increases by two-time periods since z_1 is the value of y_3 lagged by two years.

The delay multipliers have a dynamic property which measures the impact of a unit change in the j^{th} predetermined variable during a specific year s on the i^{th} endogeneous variable during each successive year t and in general is defined as

$$\partial y_1(t)/\partial z_j(s) \tag{4.10}$$

where

i = number of endogeneous variables in the system,

j = number of predetermined variables, and

for t = 1,2,3 . . . T

s = 0,2,4 . . . S.

However, the delay multiplier (4.8), developed to measure the effect of PL 480 on domestic production, must be adjusted. Since the

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McGraw-Hill, 1966), chapter 3; A. S. Goldberger, Econometric Theory (New York: John Wiley and Sons, 1964), pp. 373-378; and J. S. Mann, "The Impact of PL 480 Imports on Prices and Domestic Supply of Cereals in India," Journal of Farm Economics, 49:136-139, 1967.

[4]Ross Bardell and Abraham Spitzbart, College Algebra (New York: Addison-Wesley, 1966), chapter 10.

production function in the model is formulated in terms of two year lagged price, the partitioned p_{11} does not coincide with p_{31} and p_{36} in time path considered. Therefore, to remove time discrepancy between the coefficients P_1 and P_3 in the reduced form matrix, it is necessary that we consecutively substract a unit of time from the superscript s/2 of the delay multiplier (4.8). The impact multiplier p_{16} disappeared because of zero value of z_6 coefficient in the reduced form production equation. As a result, the delay multiplier measuring the impact of a unit change in PL 480 imports on domestic supply during the successive time periods is given as

$$\partial y_1(t)/\partial z_6(s) = p_{11}p_{36}p_{31}^{s/2-1} . \qquad (4.11)$$

Secondly, in order to find the cumulative impact of PL 480 shipments on prices and domestic production of grains over a given time period, the successive delay multipliers in both (4.8) and (4.11) are simply summed. The partial sum of these multipliers is called the "cumulated multipliers." The estimated delay and cumulated multipliers by the equations (4.9) and (4.11) are given in Tables II and III, respectively.

II. ANALYSIS OF THE IMPACT OF PL 480 SHIPMENTS ON PRICES AND DOMESTIC PRODUCTION OF GRAINS

The specific problems established in the preface of this chapter can be solved in terms of the various multipliers derived in the previous section.

To answer question one, the impact multiplier p_{36} (the element in the third row and the sixth column of the coefficient matrix, P,

TABLE II

THE DELAY AND CUMULATED MULTIPLIERS: IMPACT OF PL 480 IMPORTS ON THE INDEX OF WHOLESALE PRICES OF GRAINS

Year	Delay multipliers	Cumulated multipliers
0	-0.34760	-0.34760
2	0.08982	-0.25780
4	-0.02320	-0.28100
6	0.00599	-0.27501
8	-0.00155	-0.27656
10	0.00040	-0.27616
12	-0.00010	-0.27626

TABLE III

THE DELAY AND CUMULATED MULTIPLIERS: THE IMPACT OF PL 480 IMPORTS OF GRAINS ON PER CAPITA DOMESTIC PRODUCTION OF GRAINS

Year[a]	Delay multipliers	Cumulated multipliers
2	-0.07352	-0.07352
4	0.01839	-0.05513
6	-0.00491	-0.06004
8	0.00127	-0.05877
10	-0.00033	-0.05910
12	0.00080	-0.05902
14	-0.00002	-0.05904

[a]Since it is assumed that domestic supply is not responded to the current price, the original year 0 is omitted.

in Table I, page 19) is used. The computed impact multiplier measuring the effect of a unit change in PL 480 grain imports on domestic prices of foodgrains during a time period t is -0.3476. This means, for example, that if per capita quantity of PL 480 imports of cereals had been increased by one kilogram during 1965, the index of wholesale prices of these grains would have declined by 0.3476 percentage points during the same year.

Second, the delay and cumulated multipliers in Table II are used to answer question (2). According to Table II, the price index falls by 0.3476 percent during the original year, goes up by 0.08982 during the second year, falls again by 0.0232 during the fourth year, and so on. With an increase in the time period, the negative effects in the price index of grains due to the PL 480 imports are dampened as shown in the second column of Table II. On the other hand, it can be seen in the third column that the cumulative or consecutive impact on prices tends to last for a considerable time.

Third, to solve question three, the delay and cumulated multipliers in Table III can be used. The estimated delay multiplier in the second column of Table III shows that if the import of grains under PL 480 is raised by one kilogram per person during the original year and is not restored at its original level, the per capita domestic supply decreases by 0.07352 kilogram in the second year, increases by 0.01839 kilogram in the fourth year, decreases again by 0.00491 kilogram in the sixth year, and so on. It appears that the cumulative adverse effects of PL 480 assistance on domestic production have existed since the shipments were begun, although they do not seem to be serious.

More specifically, the cumulated multiplier or the partial sum of delay multipliers for each year evaluates the successive net effects of PL 480 imports on domestic foodgrain production over time.

The cumulated multipliers in the third column in Table III, page 24, indicate that if per capita quantity of PL 480 grains during the time period 0 is increased by one kilogram, the total decline in domestic production over the following two years will be 0.07352 kilogram, over the following four years 0.05513, over six years 0.06004, and so on.

However, there has been a considerable gap between the per capita quantity of cereals demanded and the per capita quantity available from domestic supply in Korea since 1956.[5] Under this situation, it seems that after taking account of both price and production effects, it is meaningful to examine the total net impact of PL 480 gratis assistance to Korea during the past 14 years.

For the final question, let us suppose that per capita import under PL 480 is increased by one kilogram in 1956 and sustained. There is no damage to domestic production during that year and hence net addition to domestic consumption of grains is one kilogram per person. In 1958, the domestic supply of grains declines by 0.07352 kilogram per person and the net shipment is 0.92648 kilogram. In 1960, the domestic supply rises by 0.01839 kilogram per person (see the second column of Table III), and the total decline in domestic production for the years 1956, 1958, and 1960 is 0.05513 kilogram per capita (see the third column of Table III). Therefore, the total net addition

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[5] See Appendix Table V.

to domestic demand for the corresponding years is 0.94487 kilogram per person. A similar interpretation can be made for the subsequent years. These total net effects are given in Table IV. Even if the adverse impact of PL 480 grants to domestic prices and production has occurred over the year studied, the net effects were always positive.

TABLE IV

THE NET EFFECT ON DOMESTIC CONSUMPTION OF AN INCREASE OF PER CAPITA PL 480 IMPORTS BY ONE KILOGRAM

Year	Per capita PL 480 import	Cumulative effect on production	Net effect
	kg		
0	1	0.00000	1.00000
2	1	-0.07352	0.92684
4	1	-0.05513	0.94487
6	1	-0.06004	0.93996
8	1	-0.05877	0.94123
10	1	-0.05910	0.94090
12	1	-0.05902	0.94098
14	1	-0.05904	0.94096

CHAPTER V

SUMMARY AND CONCLUSIONS

The analysis of the impact of PL 480 gratis assistance to domestic production of foodgrains in Korea was performed in terms of a system of simultaneous equations encompassing supply, demand, income-generation, commercial import, and stock-withdrawing functions.

Each equation in the system was overidentified, and the two-stage least squares method was employed to estimate the parameters of the structural form. The first stage computation gave the estimated parameters of the direct reduced form. The static and dynamic analysis of the impact was based on various multipliers which are functions of the elements of the matrix of the reduced form coefficients.

The resulted impact, delay, and cumulated multipliers support the belief that the imports of foodgrains under PL 480 program lower the price of those grains and lead to a decline in domestic production of cereals. However, the total decrease in internal supply appeared to be less than the quantity shipped under the program. There was, therefore, a net addition to the domestic consumption, and since the need for consumption has exceeded domestic production, this would be a positive contribution to the Korean economy.

Though the accuracy of the basic data is somewhat questionable, this study would provide at least an indication that the PL 480 aid to Korea has not seriously affected the domestic production of foodgrains.

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APPENDIX

TABLE V

TREND OF PER CAPITA QUANTITY OF GRAINS SUPPLIED AND DEMANDED, 1956 THROUGH 1969, KOREA[a]

Year	Domestic production	Commercial imports	PL 480 imports	Government stocks	Quantity demanded[b]
	kilograms				
1956	174	21	15.0	1.5	211
1957	184	39	8.3	2.2	231
1958	195	36	37.8	1.6	256
1959	199	9	13.9	14.2	223
1960	189	16	12.0	12.8	224
1961	205	21	8.2	4.8	237
1962	178	17	37.9	2.1	234
1963	182	46	14.2	1.3	234
1964	208	30	25.6	9.1	245
1965	197	21	4.8	26.7	221
1966	216	17	6.8	27.7	222
1967	195	35	7.0	44.0	232
1968	184	47	27.2	47.6	262
1969	209	74	34.8	42.8	312

[a]All aggregate data were divided by the estimated population.

[b]Per capita quantity demanded is equal to domestic supply plus commercial imports plus PL 480 shipments plus withdrawal from government stocks.

Source: For all the quantities except PL 480 imports, Year Book of Agriculture and Forestry Statistics, 1956 to 1970 (Seoul, Korea: Ministry of Agriculture and Forestry, 1957-1971); for the PL 480 shipments, Semiannual and Annual Report on PL 480, Food for Peace, 1954 to 1969, House Documents (Washington: Government Printing Office, 1955-1970).

TABLE VI

TREND OF INDEX NUMBER OF WHOLESALE PRICES OF GRAINS, OTHER FOODS, AND ALL COMMODITIES, KOREA

Year	All commodities	Grains[a]	Other foods[a]	Price of grains[a] lagged by two years
	1965=100	1965=100	1965=100	1965=100
1956	37	115	71	71
1957	43	113	78	94
1958	40	98	85	115
1959	41	83	86	113
1960	45	91	91	98
1961	51	100	86	83
1962	56	96	88	91
1963	68	127	95	100
1964	91	119	109	96
1965	100	100	100	127
1966	109	97	101	119
1967	116	101	98	100
1968	125	105	106	97
1969	134	115	111	101

[a]They refer to the relative indexes deflated by the index of wholesale prices of all commodities.

Source: Economic Statistics Year Book (Seoul, Korea: Bank of Korea, 1970), pp. 328-331.

TABLE VII

TREND OF PER CAPITA INCOME AND INVESTMENT BY GOVERNMENT, AT 1965 PRICES, KOREA

Year	Gross national income	Investment
	Wons[a]	
1956	21539	1946
1957	22778	2550
1958	23366	2448
1959	23706	2441
1960	23580	2470
1961	23876	2539
1962	24023	3180
1963	25494	3898
1964	26837	3338
1965	28108	4090
1966	31338	6537
1967	33098	7719
1968	36664	10591
1969	41585	12982

[a] At 1965 constant price, $1 = 270 wons.

Source: Korean Statistical Year Book (Seoul, Korea: Economic Planning Board, 1960 and 1970).

TABLE VIII

WEATHER INDEX, AND QUANTITY OF FERTILIZERS PER TANBO PLANTED, KOREA

Year	Weather index[a]	Quantity of fertilizers[b]
		kilograms
1956	87	7.25
1957	103	7.33
1958	105	6.67
1959	104	5.85
1960	99	5.96
1961	108	6.42
1962	92	9.30
1963	108	12.59
1964	108	14.32
1965	93	14.75
1966	104	16.53
1967	94	19.31
1968	91	18.98
1969	105	21.44

[a]Weather index refers to the relative index of dividing actual weighted yields of rice, barley and wheat grains by estimated trend values obtained by fitting a regression to the original yields.

[b]Fertilizer was measured in terms of elements of N, P, K per tanbo actually used.

Source: Year Book of Agriculture and Forestry Statistics, 1956 to 1970 (Seoul, Korea: Ministry of Agriculture and Forestry, 1957-1971).

VITA

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