Journal of Rural Development 7 (*June 1984*): 1~18

PREDICTION OF LONG-TERM DEMAND FOR FARM-FOOD PRODUCTS IN KOREA: MODEL DEVELOPMENT AND APPLICATION TOWARD 2001*

LEE JUNG-HWAN**
CHO DUCK-RAE***

For decades demand predictions for farm-food products have been made extensively by planning officials as well as by agricultural economists because detailed information on the future demand for farm-food products is essential for planning agricultural development programs. Most of those previous attempts can be characterized by two features: the use of a single demand equation specified intuitively and estimated by commodity using national per capita consumption of farm-food products to obtain price and income elasticities and the assumption that the obtained elasticities are constant over the predicting period.

In those attempts, therefore, demand for each commodity is determined one by one independently and change proportionally according to the increase of income without limitation. In addition, demand for farm-food products, for example, the demand for wheat is determined as a function of its own price and income despite the fact that the demand for wheat is not determined by its own utility and price but derived from the consumer's demand for foods made from it—breads, noodles, and cakes. As a result, internal consistency is not maintained, violating the budget constraint as well as the biological limitation particularly in the long-term prediction. This deficiency results from a prevalent gap between theory and prediction model. This gap forces economists to start their prediction by deciding that theory can be sacrificed for the sake of practical operation.

In the present study, two complementary courses of action are taken to cope with the gap between the theory and the prediction model. First, the demand function is strictly specified in the framework of classical de-

* The authors are grateful to Dr. Sung Bai-Young, Dr. Kim Byung-Ho, Professor Cho Suk-Jin and Mr. Hyun Kong-Nam for helpful comments on the earlier draft. This is a revised English version of the article, "Long-Term Prediction of Food Consumption in Korea," Korea Rural Economics Review VI-3, 1983, PP 19-32.
** Senior Fellow, Korea Rural Economics Institute, Seoul, Korea.
*** Researcher, Korea Rural Economics Institute, Seoul, Korea.

mand theory and estimated using household budget data. As the functional form of the demand function, AIDS (Almost Ideal Demand System) proposed by Deaton and Muellbauer which assumes Engel Curves to be nonlinear and income and price elasticities to be variable according to the level of income and price is adopted. In addition, the household is dichotomized into the farm household and the non-farm household and a separate demand system is applied to each of them because there are crucial differences between them in terms of socio-economic conditions. Second, the predition of the demand for farm-food products is obtained in three steps: in the first step, given the disposable income, total consumption expenditure is determined with the total consumption function; in the second step, food demand is predicted by commodity with the demand system under the constraint of total expenditure determined in the first step; in the third step, food demand is converted into demand for farm-food products with input-output coefficients of processed foods.

The plan of the paper is as follows. In Section I the total consumption function is estimated and, given disposable income, total consumption expenditure is predicted with the estimated function. Section II presents the modified AIDS. Section III describes the estimation of the demand system. In Section IV food demand is predicted and the predicted food demand is converted into the demand for farm-food products in Section V. We end with the concluding remarks of Section VI.

I. Total Consumption Expenditure

As the basic functional form Keynesian type consumption function is adopted;

(1) $TC(t) = a + bY(t)$

where TC stands for total expenditure per person, Y is disposable income per person, and t is the t-th period. Annual Reports of Urban Household Survey, which is conducted by the Economic Planning Board, for the years 1964 to 1981 provided the expenditure data for the non-farm household and for the farm household the Report on the Results of Farm Household Economy Survey,which is conducted and published by the Ministry of Agriculture and Fisheries, for the years 1964 to 1981 was used. For the non-farm household equation (1) was modified as follows to relieve auto-correlation of the error term[1]:

[1] Adding an error term, E(t), to equation(1), we have
(i) $TC(t)=a+bY(t)+E(t)$
Meanwhile, we assume the existence of first-order auto-correlation in E(t)
(ii) $E(t)=\alpha E(t-1)+V(t)$
where v(t) is a random variable with mean of zero and no auto-correlation.
Substituting (ii) into (i), one obtains
(iii) $TC(t)=(1-\alpha)a+bY(t)-\alpha bY(t-1)+\alpha TC(t-1)+V(t)$

(2) $TC_u(t) = A_{u0} + A_{u1}Y_u(t) + A_{u2}Y_u(t-1) + A_{u3}TC_u(t-1)$

where the subscript u means the urban household. The estimated results are shown in Table 1. Meanwhile, for the farm household, the partial adjustment type of equation (1) specified as follows showed the best fit.

(3) $TC_f(t) = A_{f0} + A_{f1}Y_f(t) + A_{f2}TC_f(t-1)$

where the subscript f denotes the farm household. The estimated results are presented in Table 2.

TABLE 1 PARAMETER ESTIMATES OF THE NON-FARM HOUSEHOLD CONSUMPTION FUNCTION

Parameters	Estimates	
A_{u0}	8,332.6800	
A_{u1}	0.7244	(16.717)
A_{u2}	−0.5255	(3.3283)
A_{u3}	0.7170	(3.7371)
R^2	0.9969	

Notes: The figures in parentheses are t-values.

TABLE 2 PARAMETER ESTIMATES OF THE FARM HOUSEHOLD CONSUMPTION FUNCTION

Parameters	Estimates	
A_{f0}	4,239.3945	
A_{f1}	0.3641	(5.4674)
A_{f2}	0.5480	(4.7589)
R^2	0.9819	

Notes: The figures in parentheses are t-values.

For the actual prediction, disposable income was assumed to increase 5.6% per annum from 1981 to 1991 and 5.1% from 1991 to 2001 (KDI, 1983). The actual computation procedures are as follows: For the non-farm household,

(4) $TC_u(t) = TC_u(t-1) + dTC_u(t)$
where $dTC_u(t) = A_{u1}dY_u(t)$
For the farm household,

(5) $TC_f(t) = TC_f(t-1) + dTC_f(t)$
where $dTC_f(t) = A_{f1}dY_f(t) + A_{f2}dTC_f(t-1)$

II. Demand System for Food

The demand function can be derived from a specific preference system consistent with classical demand theory. The consumer preference system can be defined by three alternatives in the context of demand theory (Sawada, 1981). The traditional procedure to derive the demand system is to set up the direct utility function and then to apply the first order condition of utility maximization. The Linear Expenditure System belongs to this. The second procedure is to specify the indirect utility function and then to apply Roy's Identity. The Logarithmic Linear Expenditure System belongs to this. The third procedure, to be adopted in this study, is to define the expenditure(cost) function and then to apply the Shephard's Lemma to derive the compensated demand system. The compensated demand system is transformed into the ordinary demand system by substituting the indirect utility function.

The expenditure function can be specified as a flexible functional form (6) that has enough parameters to be regarded as a reasonable approximation to whatever the true function may be (Deaton and Muellbauer, 1980).

$$(6)\quad \ln C = \alpha_0 + \sum_i \alpha_i \ln P_i + \frac{1}{2}\sum_i\sum_j \gamma_{ij}^* \ln P_i \ln P_j + \beta_0 U \Pi P_i^{\beta_i}$$

where C stands for total expenditure, P is the price of the i-th commodity, and α_i, β_i and γ_{ij}^* are parameters. Since the cost function should be homogeneous in P, we have

$$(7)\quad \sum_i \alpha_i = 1, \sum_i \gamma_{ij}^* = \sum_j \gamma_{ij}^* = \sum \beta_i = 0$$

Taking the logarithmic derivative of the expenditure function with respect to price, and applying the Shephard's Lemma, we have the budget share equations in prices and utility, i.e., a Hicksian demand function. For a utility-maximizing consumer, (6) can be inverted to give U as a function of P and TC, the indirect utility function. Substituting the result into the Hicksian demand function, we obtain the budget share function of P and TC, i.e., AIDS demand functions.

$$(8)\quad w_i = \alpha_i + \sum_j \gamma_{ij} \ln P_j + \beta_i \ln \frac{TC}{P}$$

The price index P is defined as follows.

$$(9)\ \ln P = \alpha_0 + \sum_i \alpha_i \ln P_i + \frac{1}{2}\sum_i\sum_j \gamma_{ij} \ln P_i \ln P_j$$

where $\gamma_{ij} = \frac{1}{2}(\gamma_{ij}^* + \gamma_{ji}^*)$

The theoretical restrictions apply directly to the parameters: Adding-up requires $\sum_i \alpha_i = 1$, $\sum_i \beta_i = 0$, $\sum_i \gamma_{ij} = 0$ for all j. Homogeneity is satisfied if and only if, for all i, $\sum_j \gamma_{ij} = 0$, while symmetry is satisfied provided $\gamma_{ji} = \gamma_{ij}$ for all i and j. In the AIDS, income and price elasticities are measured as (Ray, 1980),

$$(10)\quad \eta_i = \frac{\beta_i}{\hat{w}_i} + 1 \qquad i = 1, \cdots\cdots, n$$

$$(11)\quad \varepsilon_{ij} + \frac{g_{ij}}{\hat{w}_i} - \eta_i \hat{w}_j \qquad i,j = 1, \cdots\cdots, n$$

where η_i is income elasticity, ε_{ij} is price elasticity,
and $g_{ij} = \gamma_{ij} + \beta_i \beta_j \ln\left(\frac{TC}{P}\right) - \hat{w}_i \delta_{ij} + \hat{w}_i \hat{w}_j$ and δ_{ij} denote the Kronecker delta. Note that $\hat{w}_i$ denotes predicted budget share.

Equation (10) shows that the i-th commodity is necessity if $\beta_i < 0$. However, with $\beta_i < 0$, W_i decreases with income so that the commodity turns out to be inferior in the end. On the contrary, if $\beta_i > 0$, the *i*-th commodity is luxurious and w increases with income. However, note that, with $\beta_i > 0$, income elasticity can not be less than unity in any case, so that the commodity is preserved as luxurious. In other words, the Engel curves implied by the AIDS are non-linear but monotonic, which contradicts reality. For example, Figure 1 illustrates that the Engel curves of the Korean non-farm household for selected food items, based on cross section data, are not monotonic. Therefore the AIDS can be modified as a quadratic form to make it more flexible.

$$(12) \qquad w_i = \alpha_i + \sum \gamma_{ij} \ln P_j + \beta_i \ln TC/P + \lambda_i \left\{\frac{\ln TC}{P}\right\}^2 \qquad i = 1, \cdots\cdots, n$$

where $\sum \lambda_i = 0$ and all other restrictions imposed on (8) are also in effect.[2] In the quadratic AIDS, income and price elasticities are computed by substituting β_i and β_j in (10) or (11) with $(\beta_i + 2\lambda_i \ln TC/P)$ and $(\beta_j + \lambda_j \ln TC/P)$ respectively.

The demand functions (8) and (12) are not amenable to econometric analysis because of the large number of independent parameters entering the equations. The length of the time series available is short relative to the number of items that enter into the consumption budget, and the problem is further complicated by multicollinearity among price series.

In order to cope with these problems, restrictions implied by the neoclassical theory of consumer choice are imposed as already mentioned. And further, the utility function is assumed to be weakly separable so that utility maximization takes place in two stages: in the first stage, income is first allocated to groups of commodities, and then, in the second stage, the optimal levels of commodity demand within each group are determined within the group budget constraint determined in the first stage(Bieri and de Janvry, 1970).

Final income and price elasticities in the two-stage demand system are computed as,

$$(13) \qquad \eta_r = \eta_R \times \eta_r^R \qquad (r \in R)$$

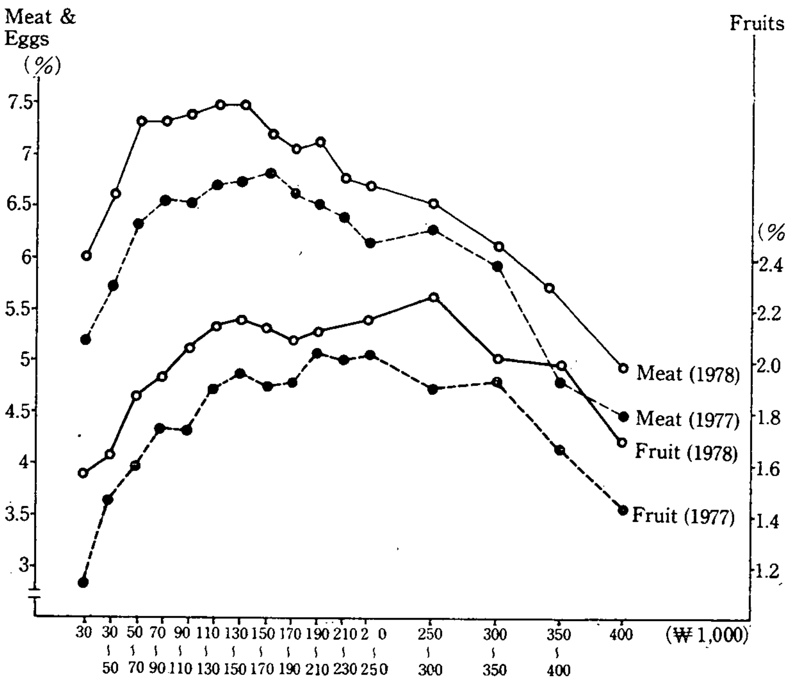
$$(14) \qquad \varepsilon_{rr'} = \varepsilon_{rr'}^R + (1 + \varepsilon_{RR})\, \eta_{r'}^R \; \hat{w}_r^R \; (r',\ r \in R)$$

$$(15) \qquad \varepsilon_{rk} = \varepsilon_{RK} \; \eta_r^R \, \hat{w}_k^K \qquad (r \in R, \quad k \in K)$$

where R and K denote groups of commodities, r and k stand for commo-

[2] Recently Binswanger and Swamy applied the quadratic AIDS to the Indian case.

FIGURE 1 Budget Shares by Income Class



dities, and the superscripted η^R,ε^R and $\hat{w}$ denote the conditional elasticities and budget shares.

III. Parameter Estimation of the Demand System

Two sets of estimates were obtained from both time series and cross section data and they were combined with appropriate weights so that information from both data sets could be utilized in the prediction. Commodities are first classified into eight food groups and one non-food: the eight food groups are cereals and potatoes, livestock products and fish, vegetables, condiments, confectionaries and soft drink, alcoholic drink, other food and restaurant meals. The system of cereals and potatoes includes six commodities: rice, barley, beans, miscellaneous cereals, wheat products and potatoes. For the subsystem of livestock products and fish, the commodities are beef, pork, chicken, other meat, eggs and fish. Eggs and fish are in the same group with meat since they are regarded as good substitutes for meat in the Korean diet. The subsystem of confectionaries and soft drink includes four commodities: soft drinks, candy and cakes, fruits and milk. In conclusion, the demand system includes twenty-two food commodities and one non-food aggregate.

Annual household time series and/or cross sectional budget data by income class for the period 1964 to 1981 were used for parameter estimation. Household budget data were obtained from the same source mentioned in Section I. Consumer Price Index reports by the EPB were used as a price index for the non-farm household when the item of the CPI coincides with our classification. Otherwise, unpublished data kept by the EPB were used to compute the price index. For the farm household, famer's selling prices and purchasing prices were averaged weighting self-supplied and purchased shares of each commodity to obtain the farmer's actual consuming prices.

Time series household budget data were first applied to (8) with an error term, which is assumed to have expectation zero, to be temporally uncorrelated and have a contemporaneous variance-covariance. Price index can be approximated with the Divisia Index to make equation (8) a linear regression since it has been shown that if the cost function is a translog form, the Divisia Index provides estimates of changes in real income (Jorgenson and Zvi Griliches, 1971).

$$(16) \qquad d\ln P^* = \sum\frac{1}{2}\left\{w_i(t) + w_i(t-1)\right\}d\ln P_i$$

were P* means the approximated price index.

If restrictions across equations are imposed, OLS estimates are no longer efficient despite the fact that all equations contain the same explanatory variables. Therefore, the seemingly unrelated regression problem applies, and the Restricted Generalized Least Squares (RGLS) has to be applied to all equations simultaneously (Johnston, 1972, pp. 155–159, 238–241). However, in actual estimation one equation has to be dropped from the model because only n—1 equations are linearly independent due to $\sum w_i = 1$. Parameters of the dropped equation are computed using the homogeneity restriction. Estimated results are not presented here but are available upon request. Income and own price elasticities implied by the demand system estimated using time series data are presented in Table 3. Since the discussion about details of these results is beyond the objective of this paper, we point out only that the magnitudes and signs of the estimated elasticities are generally relevant.

Meanwhile, to obtain another set of estimates for β_i and λ_i, time series pooled cross section data for the period 1966 to 1981 were applied to the equation (12), in which price terms are subtracted and yearly dummies are set in constant terms to absorb all price effects between years. Income elasticities computed are shown in Table 4.

For the actual prediction, two sets of estimates obtained above were combined; coefficients β_i and λ_i of the first stage system were determined as the arithmatic average of the two estimates mentioned above with equal weights for 1981 to 1991, and 5/6 to corss section estimates and 1/6 to time

TABLE 3 INCOME AND OWN PRICE ELASTICITY ESTIMATES OF FOOD, 1975

	Expenditure Elasticity		Price Elasticity		Income Elasticity	
	Urban	Rural	Urban	Rural	Urban	Rural
Cereals	0.1344	0.2213	−0.3679	−0.2062	0.1094	0.2142
Rice	0.1676	0.2400	−0.5968	−0.3249	0.1364	0.3290
Barley	−0.3209	−0.2359	−0.8813	−0.3797	−0.2612	−0.2283
Beans	0.9291	0.1784	−0.9382	−0.6605	0.7564	0.1726
Misc. Cereals	0.0592	0.1423	−1.9450	−0.6240	0.0482	0.1377
Wheat Products	0.0817	0.0981	−2.6838	−0.1654	0.0665	0.0949
Potatoes	0.2339	0.0524	−1.1397	−1.5104	0.1904	0.0507
Livestock Products	0.9479	2.1555	−0.7498	−1.5698	0.7717	2.0859
Beef	0.9326		−1.5200		0.7592	
Pork	0.8287	2.8108	−1.4174	−1.4100	0.6746	2.7200
Chicken	1.6523		−1.0411		1.3451	
Other Meat	0.8982		−0.9322		0.7312	
Fish	0.7924	1.4907	−1.2920	−1.1565	0.6451	1.4426
Eggs	1.4353	4.0250	−0.5864	−1.4885	1.1685	3.8950
Vegetables	0.7614	1.2159	−0.9297	−0.9999	0.6199	1.1766
Other Food	1.1189	1.8916	−1.7560	−1.0315	0.9109	1.8305
Condiments	1.0096	1.4405	−0.8754	−1.3360	0.8219	1.3940
Confectionaries & Soft Drink	1.4227	1.5143	−1.1710	−1.6435	1.1582	1.4654
Fruis	1.1638	1.3017	−0.8331	−1.6364	0.9474	1.2597
Cakes	1.2756	1.5414	−0.7784	−1.5867	1.0385	1.4916
Soft Drink	1.8368	1.6694	−1.3338	−1.2152	1.4953	1.6155
Milk	2.1716	4.3173	−1.4304	−1.7881	1.7679	4.1779
Alcoholic Drink	2.2088	0.7267	−1.5934	−1.8892	1.7982	0.7032
Restaurant Meals	2.4240	2.5500	−3.1138	−1.0031	1.9734	2.4676
Non-Food	1.3161	1.4093	−0.8746	−1.0155	1.0714	1.3638

TABLE 4 INCOME ELASTICITIES OF THE FIRST STAGE DEMAND SYSTEM OBTAINED FROM THE CROSS SECTION DATA, NON-FARM HOUSEHOLD

Commodity Groups	Income Elasticities
Cereals	0.5819
Livestock Products & Fish	1.0944
Vegetables	0.7462
Other Food	0.7269
Condiments	0.9591
Confectionaries & Soft Drink	1.0335
Alcoholic Drink	0.8220
Restaurant Meals	1.3480
Non-food	1.1977

series estimates for 1991 to 2001. The weights are chosen arbitrarily so as to obtain reasonable prediction for all commodities at the same time. However, cross section data were available only for nine commodity groups of the non-farm household. Therefore, we assumed that λ_i of the farm household is the same as that of the non-farm household. For the second stage demand systems, time series estimates were applied without adjustment. It can be safely said, however,that the quadratic characteristic of the Engel Curves was reflected already in the first stage demand system. Final coefficients used for the actual prediction are presented in Tables 5 and 6.

IV. Forecasting Food Demand

Method

The cost share of the R-th commodity group at time t is defined as

(17) $$w_R(t) = w_R(t-1) + dw_R(t)$$

Taking the time derivative of (12), setting relative prices constant, and substituting the result into (17), we obtain

(18) $$\hat{w}_R(t) = w_R(t-1) + \{\beta_R + 2\lambda_R \ln TC(t)\}\ GTC(t),$$

where GTC means the growth rate of total expenditure.
Therefore, we have

(19) $$TC_R(t) = TC(t) \times \hat{w}_R(t)$$

(20) $$w_r^R(t) = w_r^R(t-1) + \beta_r GTC_R(t)$$

Meanwhile, by definition

(21) $$w_r^R(t) = \frac{CQ_r^R(t) \times P_r^R(t)}{TC_R(t)}$$

Thus, we have

(22) $$GCQ_r^R(t) = \{\beta_r + 2\lambda_r \ln TC_R(t)\}\ GTC_R(t)/w_R(t) + GTC_r^R(t)$$

TABLE 5 PARAMETERS OF THE FIRST STAGE DEMAND SYSTEM FOR FORECASTING

Commodity Groups	Farm Household		Non-Farm Household			
			1981–1990		1991–2001	
	β_R	λ_R	β_R	λ_R	β_R	λ_R
Cereals & Potatoes	−0.1875	0.0089	−0.1505	0.0089	−0.1155	0.0149
Livestock Products & Fish	0.0197	−0.0077	0.0015	−0.0077	0.0050	−0.0128
Vegetables	−0.0018	−0.0046	−0.0097	−0.0046	−0.0099	−0.0077
Other Food	0.0006	−0.0006	−0.0018	−0.0006	−0.0047	−0.0009
Condiments	0.0042	−0.0031	−0.0007	−0.0031	−0.0014	−0.0052
Confectionaries & Soft Drink	0.0034	−0.0033	0.0089	−0.0033	0.0038	−0.0054
Alcoholic Drink	−0.0030	−0.0003	0.0046	−0.0003	0.0003	−0.0004
Restaurant Meals	0.0040	−0.0004	0.0113	−0.0004	0.0070	−0.0007
Non-Food	0.1604	0.0111	0.1364	0.0111	0.1154	0.0182

TABLE 6 PARAMETERS OF THE SECOND STAGE DEMAND SYSTEM FOR FORECASTING, β_r

Commodity		Farm Household	Non-Farm Household
Cereals & Potatoes	Rice	0.0766	−0.0114
	Barley	0.0000	0.0000
	Beans	−0.0089	0.0378
	Misc. Cereals	0.0000	0.0000
	Wheat Products	−0.0250	−0.0366
	Potatoes	−0.0427	0.0102
Livestock Products & Fish	Beef	0.1245 (Beef, Pork, Chicken, Other Meat)	−0.0043
	Pork		−0.0135
	Chicken		0.0379
	Other Meat		−0.0012
	Fish	−0.1670	−0.0731
	Eggs	0.0425	−0.0542
Confectionaries & Soft Drink	Fruit	−0.0683	−0.0843
	Cakes & Candy	0.0061	−0.0027
	Soft Drink	0.0150	0.0388
	Milk	0.0472	0.0729

where CQ_r denotes the quantity index of the r-th commodity, and GCQ_r is its growth rate. Thus

(23) $$CQ^R_r(t) = CQ^R_r(t-1)\{1 + GCQ^R_r(t)\}$$

Forecasted results are presented in Tables 7 and 8.

Investigating the predicted demand for the nine commodity groups we find that in the non-farm household demand for all food items increases except for cereals, the consumption of which keeps on decreasing. Particularly, demand for alcoholic drink and restaurant meals increases most rapidly, more so than that for non-food items. Meanwhile, in the farm household, demand for cereals seems to increase a little bit up to 1987 but begins decreasing thereafter while livestock products and restaurant meals

TABLE 7 FORECASTED DEMAND BY GROUP OF COMMODITY, INDEX BASED ON 1981

	Farm Household					Non-Farm Household				
	1981	1986	1991	1996	2001	1981	1986	1991	1996	2001
Cereals & Potatoes	100.0	103.6	101.4	89.3	61.3	100.0	95.3	93.8	76.6	62.5
Livestock Products & Fish	100.0	137.2	185.2	244.2	314.4	100.0	123.6	150.7	173.7	193.5
Vegetables	100.0	121.2	144.1	166.0	182.4	100.0	112.2	119.0	107.5	72.0
Other Food	100.0	127.9	164.0	209.0	264.5	100.0	123.3	150.7	173.6	197.1
Condiments	100.0	128.7	165.4	210.3	264.2	100.0	122.7	148.0	166.4	179.5
Confectionaries & Soft Drink	100.0	127.0	157.1	186.3	208.7	100.0	130.1	167.6	203.1	243.3
Alcoholic Drink	100.0	120.2	144.4	171.9	202.1	100.0	138.4	188.3	234.8	292.7
Restaurant Meals	100.0	157.8	241.6	358.4	519.6	100.0	148.4	214.9	287.2	383.1
Non Food	100.0	136.7	188.7	260.4	358.6	100.0	134.3	181.6	240.1	318.8

show the highest increasing rate.

The predicted results of the second stage demand system show that demand for beans in the non-farm household will drop almost to zero. However, it should be noticed that total demand, including soybean products such as soybean cake and sauce, may not decrease so fast or may even increase. This point will be investigated in Section V. It may be worthwhile to note that livestock products demand will increase more rapidly in the farm household than in the non-farm household.

V. Conversion of Food Demand to Demand for Farm-Food Products

Farm-food products are consumed in various types of food. For example, eggs are used in bread, cakes and restaurant meals as well as in home consumption. To find out the total demand for eggs, we have to first compute the quantity to be used in these foods respectively and then to sum them all up.

In the actual computation, the following formula is used.

$$(25)\qquad TQ_i(t) = \sum_j VQ^F_{ij} \times CQ^F_j(t) \times POP^F(t) + \sum_j VQ^u_{ij} \times CQ^u_j(t) \times POP^u(t)$$

where TQ_i stands for total consumption of the i-th farm-food product, VQ_{ij} denotes quantity of the i-th farm-food product used in the j-th food in the base year, POP means population index and CQ_{ij} demand index for the j-th food. The superscript F means the farm household and u the nonfarm household. VQ_{ij} were computed from the "1978 Input-Output Table" published by the Bank of Korea and is presented in the Appendix. Population was obtained from the Population-Migration Model of the

TABLE 8 FORECASTED DEMAND BY COMMODITY, INDEX BASED ON 1981

		Farm Household					Non-Farm Household				
		1981	1986	1991	1996	2001	1981	1986	1991	1996	2001
Cereals & Potatoes	Rice	100.0	103.7	101.5	89.4	62.4	100.0	95.6	84.9	78.1	64.9
	Barley	100.0	103.4	101.4	90.2	64.8	100.0	95.6	84.8	78.0	64.8
	Beans	100.0	101.6	100.6	95.2	80.0	100.0	83.7	45.0	23.7	N.A.
	Misc. Cereals	100.0	103.4	101.4	90.2	64.8	100.0	95.6	84.8	78.0	64.8
	Wheat Products	100.0	100.7	100.3	97.5	86.8	100.0	97.9	92.3	88.4	79.9
	Potatoes	100.0	98.1	99.2	103.9	106.0	100.0	93.8	79.0	70.0	53.0
Livestock Products & Fish	Beef, Pork, Chicken, Other Meat	100.0	148.3	214.3	299.0	403.9					
	Beef						100.0	123.0	149.1	171.0	189.6
	Pork						100.0	121.0	144.3	163.6	179.7
	Chicken						100.0	134.4	175.8	212.3	244.4
	Other Meat						100.0	122.9	148.8	170.5	188.9
	Fish	100.0	119.6	138.3	153.8	164.0	100.0	118.6	138.8	155.0	168.4
	Eggs	100.0	155.6	233.3	335.3	463.5	100.0	136.5	180.6	219.8	254.2
Confectionaries & Soft Drink	Fruit	100.0	121.9	144.9	166.1	181.6	100.0	123.5	150.8	174.8	200.3
	Cakes	100.0	127.4	157.8	187.2	209.3	100.0	125.8	156.6	184.3	214.6
	Soft Drink	100.0	129.4	162.6	194.8	219.4	100.0	138.5	188.6	237.5	294.3
	Milk	100.0	150.6	211.7	274.8	324.9	100.0	141.5	196.2	250.0	313.0

Korea Rural Economics Institute. The computed total and per capita per year consumption are shown in Tables 9 and 10 respectively.

Table 9 shows that rice per capita consumption steadily decreases down to 86kg while the demand for vegetables increases up to 1991 but decreases thereafter. In Japan, the rice per capita consumption in 1981 was about 75kg and vegetable consumption reached the maximum level in the mid-1970s and began decreasing. It is striking that wheat, beans and miscellaneous cereals consumption increases while their home consumption decreases as shown in Tables 7 and 8. This contradiction is mainly due to the fast increase in indirect consumption. That is, wheat consumption increases mainly due to the rapid increase of candy and cake consumption, miscellaneous cereals due to condiments and starch, and beans mianly due to soybean cakes and sauce.

Per capita meat demand will increase up to 24.7kg in 2001 from 10.2kg in 1981, and milk demand will rise to 54.4kg from 14.4kg at present. These figures can be compared with current consumption in Japan, that is, meat consumption is about 21kg and milk 65kg. Looking at the forecasted results by commodity, beef consumption per capita will increase up to 6.4kg from 2.4kg at present and that total demand will reach about 326 thousand M/T, that is, 3.5 times the present consumption. It is worthwhile to note that 36 percent of total beef demand is derived from restaurant

TABLE 9 FORECASTED TOTAL DEMAND BY COMMODITY

	Total Quantity Demand				Growth Rate		
	1971	1981	1991	2001	1971–81	1981–91	1991–2001
	…… Thousand M/T ……				…… % per annum ……		
Cereals & Potatoes	8,865	8,307	9,275	9,184	△0.65	1.11	△0.10
Rice	4,597	5,109	5,221	4,380	1.06	0.22	△1.74
Barley	1,276	499	437	303	△8.96	△1.32	△3.60
Wheat	1,054	1,333	1,889	2,458	2.38	3.55	3.01
Misc. Cereals	76	413	644	881	18.44	4.54	3.18
Beans	221	380	492	609	5.57	2.62	2.16
Potatoes	1,641	573	592	553	△9.99	0.33	△0.68
Vegetables	2,224	4,801	7,376	6,720	8.00	4.39	△0.93
Fruit	327	760	1,476	2,342	8.80	6.86	4.72
Meat	211	394	792	1,259	6.44	7.23	4.74
Beef	48	93	195	326	6.84	7.68	5.27
Pork	113	210	392	590	6.39	6.44	4.17
Chicken	50	91	205	343	6.17	8.46	5.28
Eggs	106	211	486	820	7.13	8.70	5.37
Milk	73	558	1,442	2,778	22.56	9.96	6.78
Fish	489	1,005	1,769	2,566	7.47	5.82	3.79
Oil & Fats	74	231	432	648	12.11	6.39	4.16
Oil	48	169	316	478	13.41	6.46	4.23
Fats	26	63	115	170	9.25	6.20	3.99

TABLE 10 FORECASTED DEMAND PER CAPITA PER YEAR

Unit: kg

	1971	1981	1991	2001
Cereals & Potatoes	269.0	214.5	205.6	179.9
Rice	139.5	131.9	115.7	85.8
Barley	38.7	12.9	9.7	5.9
Wheat	32.0	34.4	41.9	48.2
Miscellaneous Cereals	2.3	10.7	14.3	17.3
Beans	6.7	9.8	10.9	11.9
Potatoes	49.8	14.8	13.1	10.8
Vegetables	67.5	124.0	163.5	131.7
Fruit	9.9	19.6	32.7	45.9
Meat	6.4	10.2	17.6	24.7
Beef	1.5	2.4	4.3	6.4
Pork	3.4	5.4	8.7	11.6
Chicken	1.5	2.4	4.5	6.7
Eggs	3.2	5.4	10.8	16.1
Milk	2.2	14.4	32.0	54.4
Fish	14.8	26.0	39.2	50.3
Oil & Fats	2.2	6.0	9.6	12.7
Oil	1.5	4.4	7.0	9.4
Fats	0.8	1.6	2.6	3.3

meals. Per capita demand for pork, chicken, and eggs will increase up to 11.6kg, 6.7kg and 16.1kg respectively, which means their total consumption will be 2.8, 3.8, and 3.9 times present levels.

Finally to check the relevance of the prediction, implicit income elasticities implied by the prediction were computed with

$$\eta_i(t) = GCQ_i(t) \,/\, GY(t). \tag{26}$$

where GY means growth rate of income. As shown in Table 11, almost all estimates are plausible and coincide well with the Japanese experience.

VI. Conclusions

In this study, demand for farm-food products was predicted with an approach different from previous studies. That is, farm-food product demand was not forecasted directly but through household food demand. Household food demand was predicted with the demand system estimated with household budget data and then converted into demand for farm-food products. As the functional form of the demand system, the AIDS system was applied.

Applying this approach to 2001 in Korea, we could obtain plausible and consistent results for almost all commodities. The most striking result is that rice per capita consumption will decrease to 86kg from the present level of 130kg, while meat and milk consumption will increase to 24kg

TABLE 11 IMPLICIT INCOME ELASTICITIES IMPLIED BY THE PREDICTION FOR THE YEARS 1981, 1991 AND 2001

	Farm Household			Non-Farm Household		
	1981	1991	2000	1981	1991	2000
Cereals	0.1937	−0.1425	−1.2025	0.0695	−0.0050	−0.3843
Rice	0.1905	−0.2638	−1.7872	0.0509	−0.1899	−0.8681
Barley	0.1632	−0.2632	−1.5668	0.0825	−0.0485	−0.4782
Wheat	0.2605	0.2453	−0.1712	0.2494	0.2614	0.1412
Misc. Cereals	0.5266	0.5967	0.3015	0.4924	0.3783	0.2185
Beans	0.2614	0.1664	0.0452	0.4091	0.3064	0.4729
Potatoes	0.0460	0.1583	−0.0409	0.0125	−0.1263	−0.8186
Vegetables	0.7281	0.6344	0.3326	0.5199	−0.0127	−1.4857
Fruit	0.6498	0.5866	0.2218	0.7727	0.6035	0.5219
Meat	1.4832	1.3814	1.1532	0.7751	0.6590	0.4382
Beef	1.9971	1.6461	0.5974	0.7816	0.6577	0.5776
Pork	0.9537	1.1199	1.3931	0.6754	0.5538	0.3492
Chicken	1.9971	1.5562	1.2757	1.0614	0.8219	0.4895
Eggs	1.7485	1.4377	1.1894	1.1278	0.8704	0.4666
Milk	2.1904	1.1111	0.6072	1.2762	0.9952	0.8753
Fish	0.7099	0.4643	0.1384	0.6616	0.4985	0.3118
Oil & Fat	0.9300	0.9247	0.8569	0.7645	0.6097	0.3579
Oil	0.9145	0.9294	0.8540	0.8202	0.6127	0.4015
Fats	0.9674	0.9135	0.8638	0.6122	0.6010	0.3026

and 54kg from the present level of 10kg and 14kg respectively. This dramatic change in food demand will force us to alter the concept of "staple food" in Korea and to reorganize the land utilization structure. In addition, rapid increase in demand for livestock products results in a tremendous swelling of feed import if we want to keep our present self-sufficiency rate of livestock products. Thus, we have to search for a way that feed—whatever it may be, —can be produced in Korea and to switch the food grain policy from "saving rice consumption" to "promoting preference for rice"

APPENDIX INPUT-OUTPUT RELATION BETWEEN FOOD & AGRICULTURAL PRODUCTS IN NON-FARM HOUSEHOLDS

Unit: M/T

	Home Consumption	Indirect Consumption							
		Wheat Products	Other Food	Condiments	Cakes	Soft Drink	Milk	Alcoholic Drink	Restaurant Meals
Rice	3492.51	0.51		18.90				13.54	18.90
Barley	108.98			7.78				42.18	4.29
Beans	113.66	10.64	86.83	44.50	8.70		13.34		3.31
Miscellaneous Cereals	131.29	2.07	187.87	19.58		2.56		19.56	2.07
Wheat		796.33		15.73	284.60			145.14	44.92
Potatoes	355.37		42.92		1.15			214.41	0.17
Beef	67.07		0.44						15.17
Pork	178.50		5.19						1.16
Chicken	79.47		0.49						
Fish	837.06		21.61		0.50				17.29
Eggs	183.15	1.69			0.87		0.11		0.08
Vegetables	3343.42	16.32	154.11	144.99					136.35
Fruit	695.86	0.23	14.67			0.08		0.23	0.08
Milk	547.84								
Oil			22.40	98.70		8.00			5.20
Fats			0.10	46.10					2.30

APPENDIX INFUT-OUTPUT RELATION BETWEEN FOOD & AGRICULTURAL PRODUCTS IN FARM HOUSEHOLDS

Unit: M/T

	Home Consumption	Indirect Consumption							
		Wheat Products	Other Food	Condiments	Cakes	Soft Drink	Milk	Alcoholic Drink	Restaurant Meals
Rice	1571.02			6.13				4.46	1.02
Barley	375.30			2.40				13.82	0.30
Beans	68.36	1.98	13.41	13.72	1.10		0.23		0.23
Miscellaneous Cereals	32.09	0.37	29.03	5.91		0.17		6.44	
Wheat		148.23		4.80	35.32			47.86	2.93
Potatoes	166.69		6.65		0.11			70.59	
Meat	44.86		0.48						1.19
Fish	124.02		3.32		0.10				1.11
Eggs	24.71	0.32			0.11				
Vegetables	925.15	2.88	24.01	44.65					9.12
Fruit	46.51		2.28					0.08	
Milk	10.16								
Oil			3.40	30.40		0.60			0.40
Fats				14.20					0.20

CITIED REFERENCES

Bieri, J. and A. de Janvry, "Empirical Analysis of Demand under Consumer Budgeting," *Giannini Foundition Monograph*, No. 30, 1970.

Deaton, A. and J. Muellbauer, "An Almost Ideal Deamnd System," *American Economic Review*, 70, 1980, pp. 312-326.

Johnston, J., *Econometric Methods*, 2nd ed. McGraw-Hill 1972.

Jorgenson, D.W. and Zvi Griliches, "Divisia Index Numbers and Productivity Measurement," *Review of Income and Wealth*, 17-2, 1971, pp. 227-229.

Robert, S.P. and L.R. Daniel, *Econometric Models and Economic Forecasts*, 2nd ed. McGraw Hill, 1981.

Ray, R., "Analysis of a Time Series of Household Expenditure Surveys for India," *Review of Economics and Statistics*, pp. 595-602.

Sawada, M., "Almost Ideal Demand System to Soykuryo Juyo Bunseki" (Almost Demand System and Food Demand Analysis), *Nokei Ronso* 37, 1981.

Swamy, G. and H.P. Bins Wanger, "Flexible Consumer Demand Systems and Linear Estimation: Food in India," *American Journal of Agricultural Economics*, 1983, pp. 675-684.

Bank of Korea, *Input-Output Table* 1980, 1983.

Korea Rural Economics Institute, *Food Balance Sheet* in 1982, 1983.

KDI, Kukka Baljeon Janggi Kusang (Draft) (Korea in 2000 year), 1983.

Ministry of Agriculture and Forestry, Reports of Farm Household Economy Survey Results, 1964-1982.

Economic Planning Board, *Annual Reports of Urban Household Economy Survey*, 1964-1981.