ON THE OPTIMAL COMBINATION OF AGRICULTURAL PRICE AND STRUCTURAL POLICIES

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I. Introduction

It is agreed generally in the developed countries that one of the most important objectives of the agricultural policy should be the improvement of the level of income in the agricultural sector, so that the disparity between sectoral incomes could be eliminated. For the attainment of this objective the policies to improve the agricultural structure are to be carried out in the first place to raise the productivity in the agricultural sector. But the structural policy requires a long time to be sufficiently effective. Faced with the claims of farmers for the higher income level the government tends to resort easily to the more direct means - mostly of price policy nature - expecting quicker effects. Such price-political means are however not only apt to delay the adjustment of agriculture to the economic structural changes, but also they are likely to be a heavy burden to the budget. For example in Japan the producers' price for rice is set higher than the consumers' price and the deficit due to this double price setting amounted in 1973 to 490.6 bil. yen (about 1.6 bil. US dollars), which should be borne by the government.

In this paper we will attempt to determine the optimal price level for agricultural products and to find the otpimal combination of agricultural price - and structural policies which minimizes the government expenditures for agricultural supports.

2. The derivation of the optimal price level for agricultural products

The problem to be solved here is how to harmonize the policies to support agriculture with the lessening of the fiscal burden. On the one hand it should be aimed at to give more financial aids to the receivers in the agricultural sector and on the other hand the mitigation of the burden to the budget should be considered in the supporting policy of agriculture. One way to reach the desired solution may be to formulate explicitly the objective function of the government in the domain of agricultural policy. This function will consist of two terms.

Firstly to take into account the positive effect of agricultural supports the aggregated income originating from the agricultural production appears in the function as the product of agricultural price (P) with the level of production (X). This agricultural price will be set relative to the price for non-agricultural goods and services, the latter being set unity without loss of generality. The share (a) of the agricultural labor force in the total force in the total will be used as an exponential weight. The self-comsumption of foods by farmers will be reduced from the income. The price policy

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affects directly the income level through the agricultural price P. Secondly against this positive effect the aggregate non-agricultural income in constant prices (Y) can play the counterbalancing role in the function, when the expenditures for food on the part of the non-agricultural population are reduced from the income. The share of labor force in the non-agricultural sector (1-a) will also be given to this "disposable" income as an exponential weight.

The objective function of the government is defined with these variables as follows:[1]

$$(1) \qquad Z = \left[PX(1-a)\right]^{a} \left[Y - PX(1-a)\right]^{1-a}$$

P: the price for agricultural goods relative to the price for non-agricultural goods and services

X: the level of agricultural output

a: the share of labor force engaged in the agricultural sector

Y: non-agricultural income in constant prices

This objective function can be interpreted as a kind of the aggregated national income and may be related to the Benthamian welfare principal of the greatest happiness for the greatest number, though the aggregated income does not mean directly the social welfare. A rise in the agricultural price increases Z through the first term and decreases it through the second.

Supposing that the government wishes to maximize the function (1), the following equation will be derived from the condition of maximization, in which the partial derivative of Z with respect to P is set equal to zero.[2]

$$(2) \qquad PX(1-a) = aY$$

This equation states that the agricultural income, reduced of the self-consumption of foods, should occupy the share (a) of non-agricultural income at the optimum.

Differentiating the equation (2) with respect to time and transforming the result into the form, in which the variables are expressed in the rate of change, we obtain a formula which determines an optimal change rate, accordingly an optimal level, of the agricultural price.

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[1]This function takes the same form as of the Cobb-Douglas production function, so that it possesses some propertes implicit in this type of function, the homogeneity of degree one.

[2]It is assumed that the price and the production are not dependent, namely the price level is supposed to be determined after the production. The unexpected over- or underproduction might be managed through the stock policy. The dependence of production on the price seems to be related to the expective future movement of the price.

$$(3) \qquad \dot{P}_p = \dot{Y} + \frac{\dot{a}}{1 - a} - \dot{X}$$

In this formula the rate of change of the agricultural price depends on the rates of change of three variables. The higher the growth rate of non-agricultural income is, the higher will be set the price level for agricultural products. The more the labor input in the agricultural sector decreases and the higher the level of agricultural production is, the lower will become the price level. In the formula (3) the agricultural price is directly related to the economic growth, which produces generally the sectoral income disparity in the industrialized countries. In this sense the normative price determined through the equation (3) can be called the parity maintaining or disparity eliminating price (designated as PP in the following). This price bears, if partly, the effects of agricultural structural policy on the lessening of labor input in agriculture. The rationalization of agricultural structure will contribute to the lowering of agricultural price through the rural exodus. The effect of over- or under production on the price might appear more than proportionately, but it could be managed partly through the inventory control and partly through the exportation and the development aids.

If the nominal income disparity due to inflation is to be considered in the determination of the agricultural price, the rate of general price rise (Q) can be added to the formula (3) to obtain the second normative price (P_i) which implies the compensation of inflation.

$$(4) \qquad \dot{P}_i = \dot{P}_p + \dot{Q}$$

It is proper for Q to be defined as the GNP-deflator for the non-agricultural incomes.

If it is the objective of the agricultural policy to eliminate the sectoral income disparity emerging in the process of economic growth, the price proposal for agricultural products is to be made to the level determined by equation (3). If moreover the compensation of inflation is to be taken into consideration in the price setting, it is necessary to apply a formula like (4) above.

3. Comparison of the actual agricultural price with the normative ones

These normative prices can be compared with the actual one to make sure if the agricultural price policies were satisfactory from the standpoint of farmers, or if the income disparity was eliminated with success. The data required for the comparison are available from the statistics published by Statistical Office of the European Communities.[3]

[3] Statistical Office of the European Communities: National Accounts Yearbook, General Statistics - Monthly Statistics, Yearbook of Agricultural Statistics.

The list of variables used in the estimation is the following:

X : Gross national product at market prices in the agriculture, forestry and fishery at 1963 prices.

Y : Gross national product at market prices outside the agriculture, forestry and fishery at 1963 prices.

a : The share of employment in the agriculture, forestry and fishery to the total.

P : Index of the producers' price for agricultural products.

Q : GNP-deflator for Y calculated as the ratio of nominal to real gross national product outside the agriculture, forestry and fishery.

Pp : The normative agricultural price 1, which is defined as in equation (3) and represents the parity maintaining or disparity eliminating price.

P_i : The normative agricultural price 2, which is defined as in equation (4) and represents the inflation compensating price.

Because of the availability of relevant data the following five countries were selected for the estimation: Germany (FR), France, Italy, Netherlands and Belgium. All variables are expressed in terms of the annual rate of change for the decade 1961-1970. Each of the time-series was cyclically adjusted in use of the five year moving average, so that the long-run tendency would appear more clearly.

The results of calculation are summarized in Table 1 and Table 2. The following factfindings are obtained for each country:

a) Germany (FR)

In Germany (FR) the rate of change in the actual price for agricultural products was only 0.51 percent in average, which was the lowest among the five countries. It was even negative in the latter half of the decade.[4] The normative price 1 (PP) have the average change rate of -1.91 percent, the negative value being obtained chiefly because the rate of decrease in agricultural employment was higher than the growth rate of nonagricultural income. The average rate of change in the normative price 2 (P_i) was 1.75 percent, so that the actual rate of change lay between those of the two normative prices. This implies that the actual price was indeed set high enough to eliminate the income disparity due to the growth of nonagricultural income, but not so high as to improve the unfavorable income situation caused by inflation.

[4]It is to be noted that German agriculture experienced twice the institutional price reduction, once in 1967 about 10 percent in order to harmonize the cereal prices in six EC-member countries and once in 1969 8.5 percent because of the evaluation of German mark. Cf. O.E.C.D.: Agricultural policy of Germany, pp. 18-19 of the German version.

b) France

The actual rate of change recorded 3.40 percent in average and it was higher than the average rates of change in both of normative prices. It can be concluded therefore that the agricultural price in France was set so high as to compensate the income disparity due to inflation.

c) Italy

The highest average (3.64 percent) was obtained in Italy for the actual price. The difference between this rate and that of the second normative price was 0.77 percent and the price set so high was likely to contribute much to eliminate the sectoral income disparity. Measured by the ratio of real gross national product per employment in the non-agricultural and the agricultural sector the disparity of 3.31 in 1960 tended to reach 2.38 in 1970.

d) Netherlands

The highest rate of increase in production among the member countries contributed to make the normative price 1 lower to the rate of -2.34 percent. In face of the highest inflation rate this contribution did not reflect in the normative price 2, whose average rate of change was 2.75 percent. The difference between P and P_i was only 0.16 percent in average, the least among the five. This could imply that the agricultural price policy in Netherlands might have been carried out satisfactorily for the population in both sectors.

e) Belgium

The difference between the actual and the second normative price was highest (0.94) percent). The elimination of income disparity was realized most markedly in Belgium. With the same measure of disparity as for Italy the ratio moved from 1.26 in 1960 to 1.05 in 1970 and became less than unity after 1970. It can be argued consequently that the income situation would be more favorable in the agricultural sector in Belgium.

In summary the actual agricultural price would have been higher than what was sufficient to compensate inflation except in Germany.[5] With respect to the effect on the price reduction the rural exodus played the most important role. The increase in production shared one fourth in the price reduction effects. Not only the attempt to stimulate the rural exodus by means of all possible structural policies will be desired to set the agricultural price at the acceptable level. But the stress should also be put on the attempt to stabilize the inflation which gives causes to the price rise in the agricultural sector.

[5]It is to be considered here that the government expenditures amounted to 4.36 billion DM to compensate the price reductions in 1967 and 1969. Cf. O.E.C.D. op. cit., p. 33.

4. Optimal combination of the agricultural price and structural policies

The relation (3) between P_p and a can be thought of as optimal in the sense that it was derived from the maximization of the objective function of the government. Of the variables which appear in this relation the growth (Y) may be regarded to be given exogenously outside the agriculture. If it is assumed in addition that the level of production or its change rate ($\dot{X}$) can also be determined exogenously, for example as a planned value, we get a linear relation between $\dot{P}_p$ and $\dot{a}$ as follows:[6]

$$(5) \quad \dot{P}_p - \frac{\dot{a}}{1-a} = b \quad \text{(constant)}$$

Here $b = (\dot{Y} - \dot{X})$.

An infinite number of combinations of $\dot{P}_p$ and $\dot{a}$ can be chosen out of the equation (5). Another relations is required to fix the specific one from them.

To obtain one more relation we take account of the government expenditures relevant to the agricultural policy. The agricultural structural policy aims at the reduction of labor input in the farmyard. Let the expenditures for this aim be designated as G_a. Remarking that $\dot{a}$ is negative in general, we suppose a functional relation between $-\dot{a}$ and G_a whose marginal productivity is decreasing.

$$(6) \quad -\dot{a} = f(G_a)$$

To a given amount of G_a corresponds a certain value of $\dot{a}$, which determines an optimal change rate $\dot{P}_p$ through (5). An amount of price-political expenditures (G_p) will be fixed corresponding to this change rate. Assuming a linear relation between G_p and $\dot{P}_p$ we get

$$(7) \quad G_p = c\,\dot{P}_p.$$

If we minimize the sum of outlays for the agricultural policies

$$(8) \quad G = G_a + G_p$$

under the restraints (5), (6) and (7), we can get a unique optimal combination of $\dot{P}_p$ and $\dot{a}$.

A graphical presentation will follow in use of Figure 1. In the first quadrant is shown the relation (6). The linear relations (5) and

[6]The share of agricultural employment is supposed to be given at the beginning of each period.

(7) appear in the second and the third quadrant respectively. To a given amount of G_a corresponds a value of G_p and the relation between G_a and G_p is depicted in the fourth quadrant. The relation (8) gives a set of linear contours with a slope of unity in the fourth quadrant. The minimum value of G will be established by the contour which is tangential to the curve for G_a and G_p. The coordinates of the tangential point will afford the unique optimal combination of G_a and G_p.

5. Concluding remark

A formula to determine the agricultural price was derived from an objective function of the government. It was applied with empirical data to judge the performance of agricultural price policy in the EC member countries. It is well recognized that the agricultural price policy should be carried out within a limit and harmonized with the agricultural structural policy. A tentative approach to get an optimal combination of the two policies was presented in section 4. An empirical background would be desirable to support the functional relation (6) between the rural exodus and the government expenditures for the improvement of agricultural structure. A quantitative study is planned to estimate the relation.

Table 1. Comparison of the actual agricultural price with the normative ones in terms of the annual rate of change (%)

a) Germany (FR)

year	actual price	normative 1	normative 2	non-ag. income	labor share	agric. income	GNP-deflat.
	$\dot{P}$	$\dot{P}_p$	$\dot{P}_i$	$\dot{Y}$	$\frac{\dot{a}}{1-a}$	$\dot{X}$	$\dot{Q}$
1961	0.84	- 1.74	1.48	7.09	- 6.09	2.74	3.22
1962	1.22	- 2.25	1.23	6.97	- 6.00	3.22	3.48
1963	1.46	- 1.06	2.59	5.28	- 5.52	0.82	3.65
1964	3.72	0.04	3.44	4.76	- 4.79	-0.06	3.40
1965	1.93	- 3.65	- 0.71	3.61	- 4.30	2.96	2.94
1966	- 0.19	- 2.23	0.42	4.43	- 4.13	2.54	2.65
1967	- 0.17	0.19	2.92	4.96	- 4.54	0.22	2.73
1968	- 0.19	- 2.78	0.83	4.95	- 4.94	2.79	3.61
1969	- 3.01	- 4.22	0.36	4.79	- 5.57	3.44	4.58
1970	- 0.54	- 1.41	4.91	5.69	- 6.03	1.07	6.32
average	0.51	- 1.91	1.75	5.25	- 5.19	1.97	3.66

b) France and Italy

year	France			Italy		
	$\dot{P}$	$\dot{P}_p$	$\dot{P}_i$	$\dot{P}$	$\dot{P}_p$	$\dot{P}_i$
1961	3.71	- 2.60	2.18	1.33	- 3.00	1.35
1962	4.22	- 1.81	2.32	3.44	- 5.06	0.58
1963	3.36	- 1.76	2.16	4.55	- 5.45	0.27
1964	3.88	- 1.32	2.64	5.37	- 1.41	3.76
1965	3.31	- 1.78	1.92	4.74	- 0.63	3.98
1966	1.90	- 2.62	0.90	1.81	- 0.46	2.99
1967	1.76	- 0.90	3.38	4.02	2.22	5.00
1968	3.59	- 0.72	4.12	3.33	- 0.28	3.25
1969	3.51	- 1.64	3.64	3.07	- 0.94	3.64
1970	4.75	1.21	7.29	4.74	- 1.96	3.86
average	3.40	- 1.39	3.06	3.64	- 1.70	2.87

c) Netherlands and Belgium

year	Netherlands			Belgium		
	$\dot{P}$	$\dot{P}_p$	$\dot{P}_i$	$\dot{P}$	$\dot{P}_p$	$\dot{P}_i$
1961	1.94	- 0.13	2.75	3.22	0.33	1.51
1962	2.82	- 4.88	- 0.54	2.58	- 1.77	0.46
1963	4.70	- 1.23	3.66	4.22	0.56	3.50
1964	5.08	- 1.60	4.15	4.20	1.97	5.65
1965	4.08	- 3.25	2.65	3.47	- 2.06	2.02
1966	2.12	- 4.68	0.94	1.73	- 2.89	1.14
1967	2.79	- 2.47	2.63	2.07	- 2.36	1.40
1968	2.06	- 2.36	2.62	0.88	- 3.36	0.63
1969	0.68	- 2.65	2.69	- 0.06	- 6.14	- 1.83
1970	2.88	- 0.18	5.91	2.41	- 4.20	0.83
average	2.91	- 2.34	2.75	2.47	- 1.99	1.53

Table 2. The average rates of change in variables for 1961-1970

Variable	Germany	France	Italy	NL	Belgium
$\dot{P}$	0.51	3.40	3.64	2.91	2.47
$\dot{P}_p$	- 1.91	- 1.39	- 1.70	- 2.34	- 1.99
$\dot{P}-\dot{P}_p$	2.42	4.79	5.34	5.21	4.46
$\dot{P}_i$	1.75	3.06	2.87	2.75	1.53
$\dot{P}-\dot{P}_i$	- 1.24	0.34	0.77	0.16	0.94
$\dot{Y}$	5.25	5.95	5.79	5.78	5.08
$\frac{\dot{a}}{1-a}$	- 5.19	- 5.36	- 6.20	- 4.95	- 6.14
$\dot{X}$	1.97	1.98	1.29	3.16	0.92
$\dot{Q}$	3.66	4.45	4.56	5.09	3.52

Fig. 1. The optimal combination of government expenditures for agricultural policy.