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Agribusiness and the Efficiency of Agricultural Policy

Klaus Salhofer[*)]

Abstract:

A common finding in agricultural policy analysis is that agricultural policies fail to achieve their main objective of farm income support efficiently. Here it is argued that this might be the case because beside the explicit goal of supporting farm income government also pursues the implicit policy objective of supporting agribusiness. In particular, it is shown for the Austrian bread grains market that if we add agribusiness as a targeted group to government's objective function the actually observed policy turns out to be quite efficient. This stimulates the question of the influence of the dimensions on the efficiency of a policy observed.

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1. Introduction

According to Winters (1987) the stated goals of agricultural policies in OECD countries are manifold, such as "promoting agricultural efficiency and the optimum utilisation of production factors," "assuring a fair farm income," "maintaining vigorous and pleasant rural communities," or "conserving the natural environment." It is commonly accepted among agricultural economists that supporting farm income is the central purpose of most government interventions in agricultural markets (Josling, 1974; Gardner, 1992). However, agricultural programmes are commonly criticised for not achieving this main objective of income redistribution in an efficient way (Thomson and Harvey, 1981; Alston, 1986; Harvey and Hall, 1990; Kola, 1993; Salhofer, 1996). According to the political economy literature this outcome can be explained by the paradigm that implicit (not officially stated) objectives may dominate explicitly stated goals (Brooks, 1996).

Recently, some authors discussed the role of upstream and downstream industries (firms providing inputs for agricultural production as well as firms processing and distributing agricultural products) in agricultural policy formation (Alston, Carter and Wohlgenannt, 1989; Babcock, Carter and Schmitz, 1990; Ndayisenga and Kinsey, 1994; Salhofer, Hofreither and Sinabell, 1999). The purpose of this paper is to investigate if transferring income to upstream and downstream industries might have been an implicit (never officially stated) policy objective. The bread grains sector in Austria before the accession to the EC serves as the empirical basis for this study, because this segment of Austria's farm sector was highly subsidised and comparably input intensive.[1]

In section 2, a three-stage vertical-structured model is built consisting of agricultural input markets, the agricultural commodity market, and the food market, necessary model parameters are derived, and Austria's bread grains policy is reviewed. In section 3, two different government objective functions are assumed: (i) minimising social cost given a certain level of welfare transfer to farmers, and (ii) minimising social cost given a certain level of welfare transfer to farmers as well as a certain level of welfare transfer to upstream and downstream industries. Utilising the developed model social cost and optimal combinations of policy instruments are derived for these two

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[1] Bread grains is an aggregate comprised of common wheat, durum wheat, and rye.

hypothetical objective functions and compared with the actually observed situation. Section 4 presents the conclusions and discusses the results.

2. Modelling the Austrian Agribusiness of Bread Grains

The Model

As illustrated in Figure 1, the Austrian agribusiness of bread grains is modelled by a log-linear, three-stage vertically-structured model (Salhofer, 1997).[2] The first stage includes markets of agricultural input factors used for bread grains production. Since 95% of farmland is owned by farmers and 86% of labour in the agricultural sector is self-employed, these two resources are assumed to be offered solely by farmers. On the contrary, investment goods (mainly machinery and buildings), and operating inputs (mainly fertiliser, pesticides, and seed) are produced by industries. Export and import of input factors is not considered. Hence, it is assumed that domestic consumption of input factors equals domestic production. This is certainly correct for land and agricultural labour but might not be exactly accurate for industrially produced input factors. However, in both cases a big share of domestic consumption was produced domestically

At the second stage, input factors of the first stage are used to produce bread grains assuming a Cobb-Douglas technology. The first and the second stage are linked by the assumption that agricultural firms maximise their profits.

At the third stage the produced quantities of bread grains are used for food production, animal feed, and exports. Firms, which process food combine bread grains with other input factors of investment goods, and industrial labour assuming a Cobb-Douglas technology. Again, the second and the third stage are linked by the assumption that food industry firms maximise their profits. Import and export of processed bread grains do not play an important role (Raab, 1995). Hence, it is assumed that domestic demand of processed bread grains equals domestic supply. Quantities of bread grains which are neither used for food production nor for animal feed are exported.

[2] A full description of the model is given in the Appendix.

The farm sector is assumed to be competitive. This assumption is justified by the large number of firms producing bread grains and by the fact that farmers take prices given by government. Input industries and food industry as defined in the model are conglomerates of separate industries. Investment goods include all kind of agricultural machinery as well as agricultural buildings. Operating inputs include fertiliser, pesticides, seeds, fuel, lubricants, etc. The food sector comprises wholesale buyers, mills, as well as the bread, noodle and baker's ware industries. For this reason, the market structure of these aggregations of industries is hard to define and is therefore described by a variable oligopoly. Since the model is log-linear, oligopoly-pricing behaviour can be described by a mark-up over marginal cost. This mark-up (ψ) is defined by a conjectural variation model (Salhofer, Hofreither and Sinabell, 1999):

(1) $\psi_i = 1+(1+\lambda_i)/(M_i\eta_i)$, with i = food industry, operating input industry, agricultural investment goods industry,

where λ is the conjectural variation term describing expectations about competitors' behaviour, M is the number of identical firms in the industry, and η is the elasticity of demand. Different λ's correspond to different oligopoly theories (Maier, 1993). Assuming $\lambda = 0$ corresponds to the Cournot conjecture. The mark-up is determined by the number of firms, and ranges between the monopoly mark-up (if $M = 1$, $\psi = 1+1/\eta$) and the zero mark-up in the competitive situation (if $M = \infty$, $\psi_i = 1$). Assuming $\lambda = -1$ corresponds to the Bertrand conjecture and hence also implies the competitive outcome. If $\lambda = M-1$, the outcome is collusion and is hence equal to a monopoly outcome. Given a negative demand elasticity, in order to derive a market equilibrium at positive prices it is necessary that $|M\eta| \geq 1$ in the case of $\lambda = 0$ and $|\eta| \geq 1$ in the case of $\lambda = M-1$. Hence, ψ is a number between zero and one. If for example $\psi = 0.5$, the price for a unit of food is twice as high as the marginal cost of producing this unit.

The analysis below is conducted for two alternative assumptions: perfect competition in agricultural input and food industries ($\psi_i = 1$) and imperfect competition ($\psi_i < 1$), where mark-up parameter ψ_i for the latter case is derived in the following way: Since rather precise information about the price of one ton of bread grains at the farm-gate as well as at the final consumer level is available, the mark-up for the food processing sector can derived in the calibration process. Hence, the mark-up is set at a level which fits the observed data best, given the assumed supply and demand relations. However, no such information is available to derive the oligopoly structure of the upstream industries. Hence, the most imperfect situation (lowest ψ_i) possible for each industry given the demand elasticities, as well as the three possible values of λ are calculated.[3] The derived ψ's are 0.414 for the food industry, 0.764 for the investment goods producing industry, and 0.865 for the operating inputs producing industry.

Estimation of Model Parameters

Since land for producing high quality bread grains is limited to favoured areas, it is assumed to be a fixed factor. In order to estimate all other supply elasticities, single-equation structural regression models are combined with time-series analysis (Salhofer, 1997). The supplied quantity (e.g. of operating inputs) is assumed to be a log-linear function of the price (of operating inputs) and other observed influence variables (e.g. labour costs in the operating inputs industry). Time series with at least 28 observations are used to estimate the parameters utilising OLS procedures. In an attempt to avoid possible misspecification problems, different combinations of shift variables are tested, and the error term is modelled as an autoregressive moving average (ARMA) process. For simplicity, only first and second order ARMA processes are inspected. The parameters of the structural model and the parameters of the time series model have to be estimated simultaneously to prevent a loss of efficiency (Pindyck and Rubinfeld, 1991). The "best" ARMA process is selected using the Akaike information criterion and the Schwartz criterion. The estimation procedure used can be viewed as a specific type of a transfer function model with restrictions on the lags of the exogenous and endogenous variables.

The factor shares for producing bread grains as well as food are obtained by estimating Cobb-Douglas production functions with constant neutral growth rates. Since for both estimated production functions increasing returns to scale are detected, a Wald test on coefficient restric-

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3 Note that input demand elasticities for operating inputs (η_N = -7.4) and agricultural investment goods (η_N = -4.2) are derived from the bread grains production function.

tions is applied. The null hypothesis of constant returns to scale is not rejected for the food industry but rejected in the case of bread grains production.

Economic theory predicts that demand for a commodity is a function of all prices and income. Therefore, estimating demand in a complete system has clear advantages compared to estimating a demand equation in which own price appears as the only price variable (Young, 1982). Since estimation of a complete demand system would exceed the scope of this research, the elasticity of demand for bread grains products is taken from a recent, elaborated study by Wüger (1989) who estimated the demand of food and beverages by single equations and complete demand systems. Similarly, bread grains demand for feeding purposes ideally would be estimated in a system including the own price and prices of all substitutes and complements. Based on duality theory and weak separability, Neunteufel and Ortner (1993) derive own-price and cross-price elasticities of feed cereals from cost functions.

Table 1 summarises the parameters derived from estimations and taken from the literature. Using these elasticities the model is calibrated, in order to match the three year averages of the prices and quantities over the period 1991 - 1993.

Bread Grains Policy

Government intervention in Austria's bread grains market is illustrated in Figure 2; D_{fo} is the domestic demand for bread grains for food production, D is the total domestic demand for bread grains including demand for feeding purposes, S is the domestic supply, S_t is the domestic supply including fertiliser tax, and D_w/S_w is the foreign demand/supply line, both perfectly elastic at the prevailing world-market price because of the small-country assumption. Farmers obtain a high floor price (P_{QD}) for a specific quota Q_Q. Since farmers have to pay a co-responsibility levy (CL_{PQD}) the net producer price is P_{QD} - CL_{PQD}. Quantities, which exceed the quota, can be delivered at a reduced net floor price P_E - CL_{PE}. Food processors have to buy bread grains at the high price P_{QD}, while the price of bread grains for feeding purposes is P_E. Therefore, domestic demand for bread grains for food production is Q_D, domestic demand for feeding purposes is Q_E and exports are $Q_X = Q_S - Q_D - Q_E$.

3. Empirical Results

Efficiency of Agricultural Policy when Only Farmers' Welfare Matters

It is commonly accepted among agricultural economists that assisting farm income has been the central purpose of government intervention in agricultural markets (Josling, 1974; Gardner, 1992). For Austria, the country under investigation, the objective of redistributing income to farmers is stated directly and indirectly several times in article 1 of the "Landwirtschaftsgesetz" (Agricultural Act) (Gatterbauer et al., 1993). In accordance with this explicitly stated central purpose of agricultural policy, government's decision problem may be modelled as trying to minimise social cost (SC) of intervention given a socially (politically) demanded level of transfer to farmers. Assuming that this socially demanded transfer level is reflected in the actually observed transfer level, and that the policy instruments available to government are the actually used instruments, government’s decision problem can be formalised as:

$$(2) \quad \min_{(P_{QD}, P_E, CL_{PQD}, CL_{PE}, Q_Q)} SC \quad \text{s.t. } \Delta U_f = \Delta U_f^A$$

where ΔU_f is the wealth transfer to bread grains farmers and ΔU_f^A is the actually observed wealth transfer. Equation (2) is solved numerically using the model described in the previous section, standard Marshallian welfare measures, and GAMS software (Brooke et al. 1988).

Beside income redistribution, "securing a sufficient supply and quality of bread grains products and animal feedstuffs" was an important explicit goal of Austria's bread grains policy (Mannert, 1991). In accordance with this objective a self-sufficiency constraint is introduced which requires that total domestic demand never be greater than domestic supply. Since the official goal of introducing a tax on fertiliser was soil protection rather than income redistribution, this policy instrument is kept at the current intervention level. Hence, government can freely choose the levels of five policy instruments (P_E, CL_{PE}, P_{QD}, CL_{PQD}, Q_Q) to redistribute income at the lowest possible social cost.

Results of a calculated optimal policy are represented in Figure 3 and Table 2. The least cost policy that continues to transfer the current amount of welfare to farmers would guarantee a single floor price under a strict production quota. The quota is increased to the self-sufficiency level in order to avoid expensive exports, and the floor price is 22 % lower than actually observed. The co-responsibility levy is not used.

The optimal policy instrument levels are calculated to be the same no matter if we assume perfect or imperfect competition in the upstream and downstream industries. Utilising this optimal policy instead of the current policy would considerably decrease social cost by ATS 1.679 billion (or 26%) in the case of perfect competition and ATS 1.375 billion (27%) in the case of imperfect competition.

Efficiency of Agricultural Policy when Not Only Farmers' Welfare Matters

Now, let’s assume that beside the explicitly stated goal of income transfer to farmers government also pursues the implicit objective of transferring income to upstream and downstream industries. In this case we may formalise government’s decision problem by

$$(3) \quad \min_{(P_{QD}, P_E, CL_{PQD}, CL_{PE}, Q_Q)} SC \qquad \text{s.t. } \Delta U_f = \Delta U_f^A \text{ and } \Delta U_A = \Delta U_A^A$$

where ΔU_A is the change in upstream and downstream industries' welfare level and ΔU_A^A is the actually observed welfare transfer to this sector.

The policy instrument levels which solve the optimisation problem (3) are in many aspects similar to the actually observed policy. In order to redistribute efficiently welfare to farmers as well as upstream and downstream industries government would use a higher floor price for a specific quota and a lower floor price for quantities which exceed the quota. Compared to the actually observed policy the higher floor price P_{QD} would be 9% lower (2%), the reduced floor price P_E would be 3% (6%) lower and Q_Q would be 33% higher (18% lower) in the case of perfect (im-perfect) competition (Table 3 and Table 4). The co-responsibility levy is not used. This result is in line with de Gorter and Meilke (1989) who discussed why a co-responsibility levy only results in higher economic cost without increasing the efficiency of income redistribution. Despite these small differences in policy instrument levels, utilising this optimal policy instead of the current policy would not considerably decrease social cost - ATS 217 million (3,4%) in the case of perfect competition and ATS 153 million (3%) in the case of imperfect competition.

4. Conclusions and Discussion

As a rule, governments defend their policy as efficiently achieving its objectives. A frequently stated objective of agricultural policy is to support farm income. However, during the last decades many studies have evaluated inefficiencies of agricultural programmes in redistributing welfare from consumers and taxpayers to farmers. This result is also confirmed by this study. By using the same instruments but different instrument levels government could have transferred an equal amount to farmers while decreasing social cost considerably by more than a quarter.[4]

This observation of highly inefficient income redistribution mechanisms seems to be in strict contrast to the "Efficient Redistribution Hypothesis" (Becker, 1983; Gardner, 1983, 1987). According to this hypothesis government tries to redistribute efficiently welfare among social groups in a Pareto sense, since if there were a policy change that could make at least one social group better of without harming any other social group, government would clearly enact said change. Therefore, the observation of inefficient redistribution policies can either lead to the rejection of the Efficient Redistribution Hypothesis or to the conclusion that these studies did not consider all government objectives (pertinent social groups).

In this study, it is hypothesised that upstream and downstream industries is such a pertinent social group and that supporting these industries is an implicit (never officially stated) objective of agricultural policy in Austria. Though the interest of agribusiness in agricultural policy is apparent, their potential role in agricultural policy formation is virtually absent in the literature (Brooks, 1996). Here, it is shown that if government's objective is to redistribute welfare to farmers as well

[4] A formal approach of how to measure the social cost of suboptimal combination of policy instruments is given in Bullock and Salhofer (1998a).

as to upstream and downstream industries, then the actually observed policy is close to the optimal policy and hence quite efficient.

Obviously, there is a dimensionality problem included in this finding. As Bullock (1994) pointed out whether policies are observed to redistribute welfare Pareto efficiently depends on the assumed number of policy instruments and policy objectives (or interest groups). In fact, if the number of interest groups equals the number of instruments plus one, we will observe only Pareto efficient policies. Bullock and Salhofer (1998b) followed Bullock (1994) and showed that no matter what kind of government objective function one assumes, making an additional policy instrument available to government can never decrease efficiency, since it makes the underlying maximisation problem less constraint. So, given the number of objectives and constraints adding a policy instrument will increase the degrees of freedom. Similarly one could argue here that adding a constraint to government's maximisation problem will decrease the degrees of freedom and hence imply that the optimal policy is closer to the actually observed policy. Though, once seen, this dimensionality problem of policy efficiency is quite obvious its importance is commonly overlooked in the literature discussing policy efficiency.

Given the importance of the number of instruments and the number of pertinent groups to how efficient a policy may look like, it becomes essential to carefully choose what we assume that government is maximising and what policy instruments are available to it. At least in the case of Austria before the accession to the EC adding upstream and downstream industries as a group in government's maximisation problem is strongly supported by Hand Salhofer, Hofreither and Sinabell (1999) who show utilising expert interviews that beside farmers agribusiness had very strong formal and informal influence channels in the agricultural policy decision making process in Austria.

Adding agribusiness in models of political economy may also add interesting aspects to many other observed phenomena like the difference in support between countries or agricultural subsectors.

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Appendix: Formal structure of the model

Supply of farm-owned input factors:

(1a) $i = X_i P_i^{\kappa_i}$, i = B, L.

Supply of industrially produced input factors:

(1) $i = \psi_i X_i P_i^{\kappa_i}$, i = K, N.

Conditional demand for agricultural input factors:

(2a) $P_i = \alpha_i \frac{Q_S}{i} (P_E - CL_{PE})$, i = B, K, L, and

(2b) $P_i + T_F = \alpha_i \frac{Q_S}{i} (P_E - CL_{PE})$, i = N.

Production of bread grains:

(3) $Q_S = X_{QS} \prod_i i^{\alpha_i}$, i = B, K, L, N.

Supply of food industry input factors:

(4) $i = X_i P_i^{\kappa_i}$, i = M, A.

Note that supply of bread grains for food production is implicitly given by equation (3).

Conditional demand for food industry input factors:

(5) $P_i = \psi_F \alpha_i \frac{Q_{SF}}{i} P_F$, i = M, A, Q_D.

Production of food:

(6) $Q_F = X_{QSF} \prod_i i^{\alpha_i}$, i = M, A, Q_D,

Demand for bread grains for food production and feeding:

(7) $Q_i = X_{QDi} P_i^{\eta_i}$, i = F, E.

Exports:

(8) $Q_X = Q_S - Q_D - Q_E$.

α_i	factor share of input i
η_i	elasticity of demand for bread grains for food production (F) and feeding (E)
κ_i	supply elasticity of input i
ψ_i	mark-up parameter of input industry i
ψ_F	mark-up parameter of food industry
A	quantity of food industry investment goods
B	quantity of land
CL_{P_E}	co-responsibility levy of surplus bread grains
$CL_{P_{Q_D}}$	co-responsibility levy of contracted bread grains
K	quantity of agricultural investment goods
L	quantity of agricultural labour
M	quantity of food industry labour
N	quantity of operating inputs
P_E	gross supply price of surplus bread grains
P_F	price of processed bread grains (food)
P_i	price of input factor i
Q_D	quantity of bread grains used for food production
Q_F	quantity of bread grains products (food)
Q_E	quantity of bread grains used for animal feed
Q_s	produced quantity of bread grains
Q_X	quantity of exported bread grains
T_F	fertiliser tax
X_i	shift parameters

Table 1 Summary of Derived Parameters

Parameter	Value	Parameter	Value
Factor share of land	0.756	Supply elasticity of land	0.000
Factor share of agricultural investment goods	0.194	Supply elasticity of agricultural investment goods	0.959
Factor share of agricultural labour	0.362	Supply elasticity of agricultural labour	3.186
Factor share of operating inputs	0.384	Supply elasticity of operating inputs	1.157
Factor share of food industry investment goods	0.393	Supply elasticity of food industry investment goods	0.959
Factor share of food industry labour	0.388	Supply elasticity of food industry labour	0.603
Factor share of bread grains	0.219	Supply elasticity of bread grains	implicitly given
Demand elasticity of food	-0.600	Demand elasticity of feed	-1.041

Table 2 Policy Instrument Levels Induced by an Optimal Policy when Only Bread Grains Farmers Welfare Matters

Policy instrument	Policy instrument level induced by current policy	Policy instrument level induced by optimal policy	Percentage change in policy instrument level
	ATS/t or 1000t	ATS/t or 1000t	%
P_{QD}	3,698	2,884	-22
P_E	2,853	2,884	1
CL_{PQD}	255	0	-100
CL_{PE}	191	0	-100
Q_Q	962	1,242	29

Table 3 Policy Instrument Levels Induced by an Optimal Policy when Not Only Bread Grains Farmers Welfare Matters - Perfect Competition

Policy instrument	Policy instrument level induced by current policy	Policy instrument level induced by optimal policy	Percentage change in policy instrument level
	ATS/t or 1000t	ATS/t or 1000t	%
P_{QD}	3,698	3,352	-9
P_E	2,853	2,764	-3
CL_{PQD}	255	0	-100
CL_{PE}	191	0	-100
Q_Q	962	1,280	33

Table 4 Policy Instrument Levels Induced by an Optimal Policy when Not Only Bread Grains Farmers Welfare Matters - Imperfect Competition

Policy instrument	Policy instrument level induced by current policy	Policy instrument level induced by optimal policy	Percentage change in policy instrument level
	ATS/t or 1000t	ATS/t or 1000t	%
P_{QD}	3,698	3,638	-2
P_E	2,853	2,685	-6
CL_{PQD}	255	0	-100
CL_{PE}	191	0	-100
Q_Q	962	1242	-18

Figure 1 Model structure

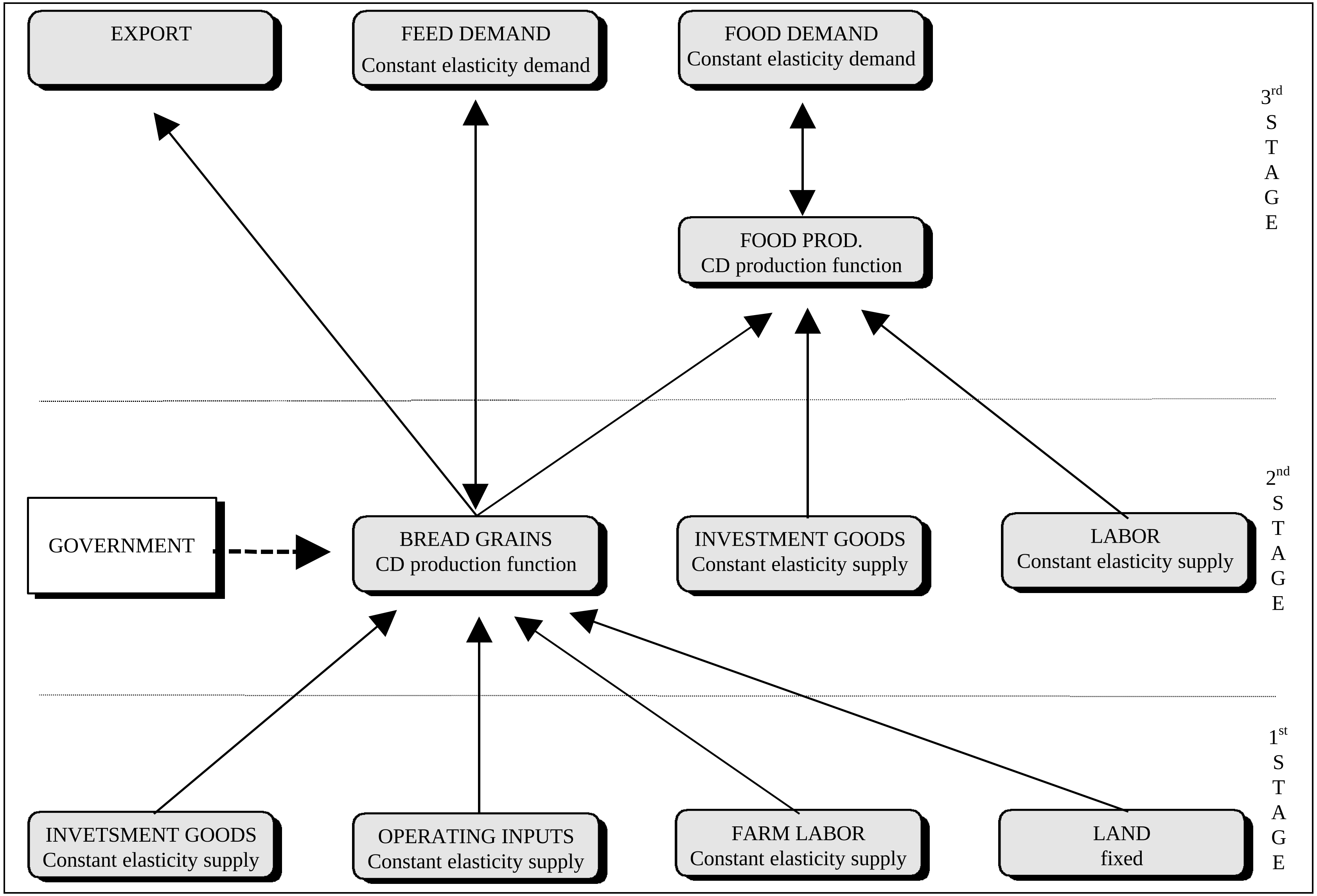

Figure 2 Bread grains policy

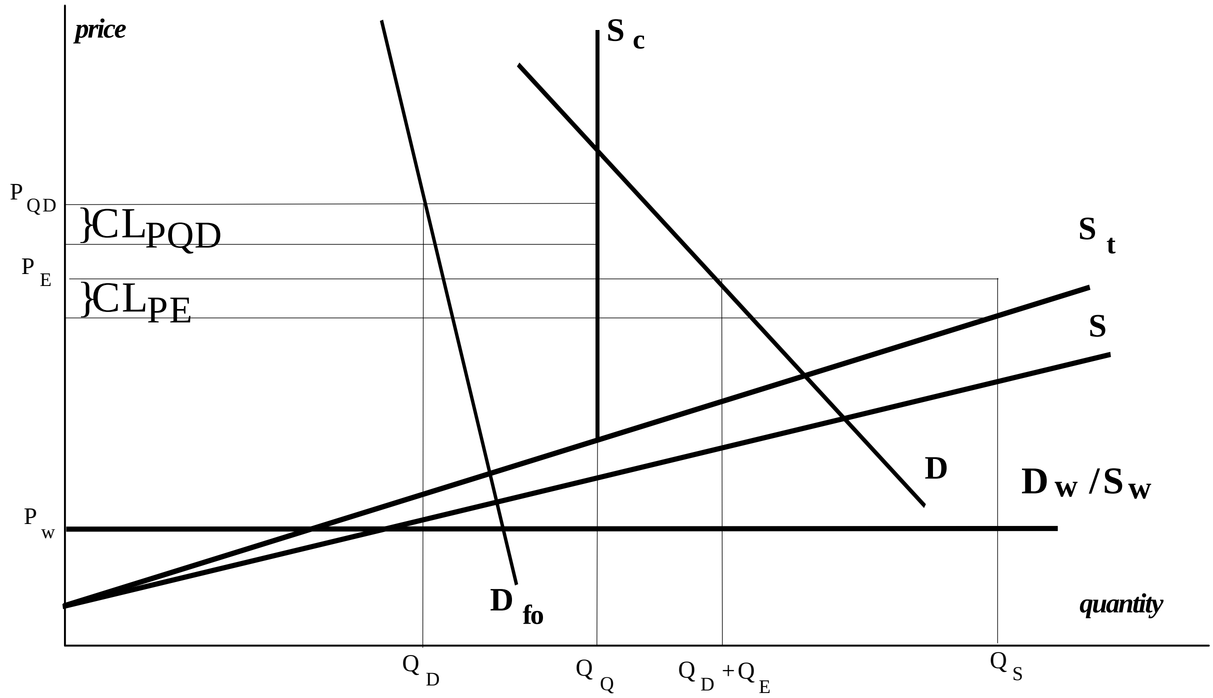

Figure 3 Optimal Policy when Only Bread Grains Farmers Welfare Matters