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Was the Austrian Agricultural Policy Least Cost Efficient?

by

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Contents

Abstract

The study evaluates the efficiency of government intervention using a vertical structured model including imperfectly competitive agricultural input markets, the bread grain market, and the imperfectly competitive food industry. To test for policy efficiency the actually observed bread grain policy is compared to a hypothetical efficient policy. To account for the sensitivity of the results in regard to the model parameter values computer-intensive simulation procedures and surface response functions are utilized.

Keywords: agricultural policy, efficient combination of policy instruments, statistical welfare analysis

JEL: Q18, D61, H21

Kurzfassung

Die vorliegende Studie untersucht die Effizienz der Brotgetreidepolitik in Österreich. Dazu wird eine vertikal gegliedertes Model entwickelt, daß sowohl den Brotgetreidemarkt selbst, als auch unter unvollkommenen Wettbewerb agierende vorgelagerte Faktormärkte und den nachgelagerten Lebensmittelsektor berücksichtigt. Um die Brotgetreidepolitik auf ihre Effizienz hin zu testen, wird die tatsächlich beobachtete Politik mit einer hypothetischen optimalen Politik verglichen. Der Abhängigkeit der Ergebnisse von den gewählten Modelparameterwerten wird mit Hilfe von computerintensive Simulationstechniken und „surface response" Funktionen Rechnung getragen.

Schlüsselwörter: Agrarpolitik, effiziente Kombination von Politikinstrumenten, statistische Wohlfahrtsanalyse

1. Introduction

As a rule, governments defend their policy as efficiently meeting stated objectives. The aim of this study is to take this to an empirical test. In particular, it is analyzed if the market interventions into the Austrian bread grain market before the EU accession were designed to efficiently meet the main stated objectives. To do so, the actually observed policy is compared to a hypothetical optimal policy using the same instruments, but at optimal levels.

In the next section the official objectives relevant to the past bread gain policy in Austria and the policy instruments are reviewed. In Section 3 a vertically-structured model including imperfectly competitive agricultural input markets, the bread grain market, and the imperfectly competitive food industry is developed. Since the results crucially depend on the model parameters a range rather than (one or a few) specific values are derived for each model parameter in Section 4. In Section 5 the simulation model and assumed parameter ranges are used to test for the efficiency of the bread grain policy. Section 6 provides a sensitivity analysis of the results. Section 7 gives a summary and discussion.

2. Objectives and instruments of bread grain policy

Thus, official objectives of farm policy as stated in national agricultural legislation are manifold there also appears to be a high degree of unanimity about the goals of agricultural policy among developed countries. Following Winters (1987, 1990) in analyzing the objectives of agricultural support in OECD countries one may identify four categories of farm policy goals: i) support and stabilization of farm income; ii) self-sufficiency with agricultural (food) products; iii) regional, community and family farm aspects; iv) the environment. There is not much doubt among agricultural policy analysts that farm income support has been the most important goal over the last decades (Josling, 1974; Gardner, 1992).

In general, Austrian agricultural legislation is not different from other developed countries. The overall goals of agricultural policy are stated in paragraph 1 of the "Landwirtschaftsgesetz" (Agricultural Status) (see Gatterbauer et al. 1993, Ortner, 1997) and perfectly fit in the four categories mentioned above.

The particular objectives of bread grain market interventions are stated in the "Marktordnungsgesetz" and can be summarized as (Astl,1989, p. 88; Mannert, 1991, p. 74): i) safeguarding domestic production, ii) stabilizing flour and bread prices; and iii) securing a sufficient supply and quality of bread grain, bread grain products and animal feedstuffs.

Utilized policy instruments to meet stated policy objectives can be illustrated by means of Figure 1 with D_{fo} being the domestic demand for bread grain for food production and D being the total domestic demand for bread grain including demand for feeding purposes. Initial domestic supply is represented by S and supply including a fertilizer tax by S_t. World market price is assumed to be perfectly elastic at P_w. Farmers obtain a high floor price (P_D) for a specific contracted quantity (or quota) Q_Q. Since farmers have to pay a co-responsibility levy (CL_{PD}) the net producer price is P_D - CL_{PD}. Quantities, which exceed the quota can be delivered at a reduced price P_E. Again farmers' net floor price is P_E - CL_{PE}, with CL_{PE} being the co-responsibility levy for bread grain beyond the quota. Food processors have to buy bread grain at the high price P_D, while the price of bread grain for feeding purposes is P_E. Therefore, domestic demand for bread grain in food production is Q_D, domestic demand for feeding purposes is Q_E, total domestic demand is $Q_D + Q_E$, and exports are $Q_X = Q_S – (Q_D+ Q_E)$.

3. The model

Elaborating on Salhofer (1997) the Austrian agribusiness of bread grain is modeled by a log-linear, three-stage, vertically-structured model. The first stage includes four markets of input factors used for bread grain production: land, labor, durable investment goods (e.g. machinery and buildings), and operating inputs (e.g. fertilizer, seeds). Since 95% of farmland is owned by farmers and 86% of labor in the agricultural sector is self-employed, land (*A*) and labor (*B*) are assumed to be factors offered solely by farmers in perfectly competitive markets. On the contrary, investment goods (*G*), and operating inputs (*H*) are supplied by upstream industries, which are assumed to have some market power to set the prices above marginal cost. Assuming constant elasticity supply functions:

(1a) $Q_i = X_i P_i^{e_i}$, $(i = A, B)$, and

(1b) $Q_i = X_i \left((1 - L_i) P_i\right)^{e_i}$, $(i = G, H)$,

where Q_i denotes the quantity supplied, X_i is the shift parameter, P_i the price, e_i the supply elasticity of input factor *i*, and L_i is the Lerner index (defined as the ratio between the profit margin and the price) of input factor industry *i*.

Export and import of input factors are not considered. Hence, it is assumed that domestic consumption of input factors equals domestic production. This is certainly correct for land and agricultural labor and is also appropriate for important industrially produced input factors (e.g. tractors, fertilizer) before joining the EU.

At the second stage, input factors of the first stage are used to produce bread grain assuming a CES production technology:

(2) $Q_S = X_{QS} \left(\sum_i a_i Q_i^r \right)^{\frac{1}{r}}$, $(i = A, B, G, H)$, with $r = \dfrac{s_S - 1}{s_S}$ and, $\sum_{i=A,B,G,H} a_i = 1$,

where Q_S denotes the produced quantity of bread grain, X_{QS} the production function efficiency parameter, a_i the distribution parameter of factor i, r the substitution parameter, and s_S the elasticity of substitution between input factors at the farm level.

The first and the second stage are linked by the assumption that bread grain producers maximize their profits. Assuming a perfectly competitive bread grain market factor prices equal the value of marginal product:

$$\text{(3.a)} \quad P_i = X_{QS}^{r} a_i \left(\frac{Q_S}{Q_i} \right)^{1-r} \left(P_E - CL_{PE} \right), \quad (i = A, B, G), \text{ and}$$

$$\text{(3.b)} \quad P_H + T_F = X_{QS}^{r} a_H \left(\frac{Q_S}{Q_H} \right)^{1-r} \left(P_E - CL_{PE} \right),$$

where P_E is the gross price and CL_{PE} is the co-responsibility levy for bread grain that exceed the quota Q_Q (see Figure 1), and T_F is the fertilizer tax per unit.

The produced quantity of bread grain is used for food production (Q_D), animal feed (Q_E), and exports (Q_X):

$$\text{(4)} \quad Q_S = Q_D + Q_E + Q_X.$$

The third stage aggregates firms which process and distribute bread grain, such as wholesale buyers, mills, exporters, and foodstuffs' producers. Bread grain (*D*) along with other input factors of labor (*J*), and capital (K) (a residual of including all other inputs except *D* and *J*) are combined to produce food (bread grain products like flour, bread, noodles). Supplies of *J* and *K* are again modeled by constant elasticity functions:

$$\text{(5)} \quad Q_i = X_i P_i^{e_i}, \quad (i = J, K,),$$

and food production by a CES technology:

$$(6)\quad Q_{SF} = X_{QSF}\left(\sum_i a_i Q_i^{g}\right)^{\frac{1}{g}} \quad (i = J, K, D),\text{ with } g = \frac{s_F - 1}{s_F}, \quad \text{and} \sum_{i=J,K,D} a_i = 1\,,$$

where Q_{SF} represents the produced quantity of food (bread grain products), X_{QSF} the production function shift parameter, a_i the distribution parameter of factor i, g the substitution parameter, and s_F the elasticity of substitution between input factors at the food industry level.

Assuming some market power in the food sector input demand is represented by

$$(7)\quad P_i = (1 - L_F)\, X_{QSF}^{g} a_i \left(\frac{Q_{SF}}{Q_i}\right)^{1-g} P_F\,, \quad (i = J, K, D),$$

where P_F denotes the price of food, P_D the gross price of bread grain under the quota, and L_F the Lerner index of the downstream sector.

Food demand is modeled by a constant elasticity function:

$$(8)\quad Q_{DF} = X_{QDF} P_F^{h_F}\,,$$

where Q_{DF} represents the demanded quantity of food, X_{QDF} a shift parameter, and h_F the elasticity of demand.

Import and export of processed bread grain do not play an important role in Austria. According to Astl (1991), the ratio of imports to total consumption of bread and baker's ware is less than 7%. According to Raab (1994), exports of flour and flour products increased but were still only 20,000 t or 4% of domestically processed bread grain in 1993. Given these facts, we assume that domestic demand of bread grain products equals domestic supply:

$$(9)\quad Q_{DF} = Q_{SF}.$$

Bread grain demand for feeding purposes are also modeled by a constant elasticity demand function:

(10) $$Q_E = X_{QDE} P_E^{h_E},$$

where X_{QDE} and h_E are the shift parameter and the elasticity of animal feedstuffs demand, respectively.

Finally, we define the agricultural share of expenditures for bread grain products (l) as

(11) $$l = \frac{P_D Q_D}{P_F Q_{DF}}.$$

The model in Equations (1) through (11) is calibrated, in order to match the three year averages of prices and quantities over the period 1991 - 1993.

Based on Equations (1) through (11) welfare levels for different social groups and policy scenarios can be calculated: Welfare of bread grain farmers (U_{BF}) is measured as the sum of Marshallian producer surpluses from supplying land and labor:

(12) $$U_{BF} = \frac{X_A P_A^{e_A+1}}{e_A+1} + \frac{X_B P_B^{e_B+1}}{e_B+1}.$$

Welfare of upstream industries (U_{UI}) is measured as the sum of producer surpluses from supplying investment goods and operating inputs (first term in Equation (13)) and oligopoly rents in these industries (second term),

(13) $$U_{UI} = \left[\sum_{i=G,H} \frac{X_i (1-L_i)^{e_i+1} P_i^{e_i+1}}{e_i+1} \right] + \left[L_i P_i Q_i \right].$$

Similar, welfare of downstream industry (U_{DI}) is measured as producer surpluses from supplying capital and labor to food industry (first term) and food industries oligopoly rent (second term):

$$(14)\quad U_{DI} = \sum_{i=J,K} \left[\frac{X_i P_i^{e_i+1}}{e_i + 1} \right] + \left[L_F P_F Q_{DF} \right].$$

Welfare of food consumers (U_{CS}) is calculated as Marshallian consumer surplus:

$$(15)\quad U_{CS} = -\frac{X_{QDF} P_F^{h_{F+1}}}{h_F + 1}.$$

Similar, welfare of buyers of bread grain for animal feed (U_{BS}) is calculated as

$$(16)\quad U_{BS} = -\frac{X_{QDE} P_E^{h_{E+1}}}{h_E + 1}.$$

This buyers surplus includes the welfare of consumers of the final product (e.g. meat) as well as the welfare of all suppliers of factors necessary to produce this final good (Just, Huth and Schmitz, 1982).

Taxpayers' welfare (U_{TX}) is measured by budget revenues minus expenditures times marginal cost of public funds (MCF):[1]

$$(17)\quad \Delta U_{TX} = MCF \left\{ \begin{bmatrix} -(Q_Q - Q_D)(P_D - CL_{PD} - P_E) - Q_X (P_E - CL_{PE} - P_w) \\ -Q_X AEC - Q_Q ST + CL_{PD} Q_D + CL_{PE} (Q_E - Q_Q + Q_D) \end{bmatrix} + [T_F Q_H] \right\},$$

where CL_{PD} refers to the co-responsibility levy of bread grain under the quota, AEC refers to export cost in addition to the difference between the domestic price and the world market price, like transportation cost and the wholesalers' markup, and ST refers to the premium wholesale buyers get for storing bread grain under the quota. The first term in Equation (17) describes expenditures for exports and revenues from the co-responsibility levy, and the second term describes revenues from fertilizer taxation.

4. Model parameters

To run the model including Equations (1) through (11) and to calculate the welfare of social groups including Equations (12) through (17), 32 parameter values are necessary (e_A, e_B, e_G, e_H, e_J, e_K, a_A, a_B, a_G, a_H, a_J, a_K, a_D, s_S, s_F, h_E, h_F, L_G, L_H, L_F, X_A, X_B, X_G, X_H, X_J, X_K, X_{QS}, X_{QSF}, X_{QDF}, X_{QE}, l, MCF). While 13 values (X_A, X_B, X_G, X_H, X_J, X_K, X_{QS}, X_{QSF}, X_{QDF}, X_{QE}, a_D, a_H, a_K) of these 32 parameters are endogenously derived in the calibration process, 19 specific parameter values (e_A, e_B, e_G, e_H, e_J, e_K, a_A, a_B, a_G, a_J, s_S, s_F, h_E, h_F, L_G, L_H, L_F, l, MCF) have to be assumed.

Instead of one (ore a few) specific value(s) for each parameter, here we assume more conservatively each parameter to be in a plausible range. The upper and lower bound of this range are identified based on own estimations, results from recent empirical studies for Austria, and an extensive literature review on parameter values for European countries.

Afterwards, two times 10,000 parameter sets are created by assuming two alternative distributions between the upper and lower boundary of each parameter: i) a normal distribution N(μ, σ,) with $\mu = (\alpha+\beta)/2$ and $\sigma = (\mu-\alpha)/1.96$, where α and β are the upper and lower parameter values and the normal distribution is truncated at α and β, the boundaries of the 95% confidence interval. ii) a uniform distribution U(α, β).

These two parameter distributions characterize two alternative assumptions: While the normal distribution assumes that values in the middle of the parameter interval are more likely, the uniform distribution assumes that each value within the upper and lower boundary is equally likely. In both cases the parameter values are assumed to be symmetrically distributed.

4.1. Land supply elasticity

Elasticities of a change in land area given a change in land prices, as needed for the model, are not directly available from the literature. However, following Abler (2000) one can derive such elasticities indirectly from elasticities of land supply with respect to product prices by assuming that changes in product prices and hence returns are to some degree capitalized in land prices. Based on an extensive literature review Abler (2000) suggest a plausible range to be between 0.2 and 0.6 for the US. In a similar attempt Salhofer (2000) suggest a plausible range to be between 0.1 and 0.4 for Europe. Hence, here we follow Salhofer (2000).

4.2. Labor supply elasticities

According to Salhofer (2000) most studies on farm labor supply in Europe report rather low estimates at the household level between 0.2 and 0.3. However, labor supply elasticities derived from household models cover only the effect of a change in the wage rate on the hours worked and not the effect of labor force moving into (out of) the sector. Hence, the aggregated (sector wide) labor supply elasticity can be expected to be higher than the individual supply elasticities based on household models. For example, Kimmel and Kniesner (1998) found for a large random sample of US (not farm) households that a 1% increase in wage rates will reduce the hours worked by each employee by 0.5%, but will also reduce the number of employees by 1.5%. While the first number is comparable to the elasticities estimated in most cross section studies, the second number refers to the sectoral effect of a wage change.

More aggregated farm labor supply elasticities can be derived from studies using time series data on farm labor supply and wage rates. However, as reviewed in Salhofer (1999) most of these studies on aggregated farm labor supply in developed countries date back to the sixties and seventies using simple estimation procedures (e.g. Tyrchniewicz and Schuh, 1969; Bhati, 1978; Gallasch and Gardner, 1978). Estimated elasticities are in a wide range between 0.03 and 2.84 with a tendency of being larger in the long run and for hired labor, while Cowling, Metcalf and Rayner (1970) only report such an aggregated elasticity of 0.5 for an European country, the UK.

In addition, as explicitly shown in Barkley (1990) the labor supply elasticity is sensitive to the length of run. In the long run, everyone in agriculture is a potential migrant and the elasticity of labor supply is the same as the elasticity of migration.

Therefore, given the high percentage of family labor in Austria and the medium run orientation of our analysis the supply elasticity of farm labor is assumed to be between 0.2 and 1.

The same arguments can be made for the case of labor supply at the food industry level. Numerous microeconomic household studies of labor supply report low or even negative own-wage elasticities for nonfarm sectors. For example Hansson and Stuart (1985) surveyed 28 studies on labor supply and calculated a median uncompensated wage elasticity of labor supply of 0.10 and a compensated wage elasticity of 0.25. In a comparable effort Fullerton (1982) derived an uncompensated wage elasticity of 0.15. However, using aggregated data of 22 OECD countries and simulation techniques Hansson and Stuart (1993) derive aggregated uncompensated wage elasticities of labor supply between 0.2 and 1.4 as well as of 0.8 for Austria. Hence, we assume the labor supply elasticity at the food industry level to be between 0.2 and 1.4.

4.3. Operating inputs and investment goods supply elasticities

Estimates of supply elasticities of operating inputs as well as investment goods at the farm level are virtually absent from the literature. The only exceptions for Europe are to our knowledge Dryburgh and Doyle (1995) who estimate the supply elasticity of farm machinery to be 1.9 for the UK and Salhofer (1997) who estimates the supply of fertilizer to be 1.2 for Austria. Some studies assume elasticity values rather than estimating them. While some of these studies argue that in the long run these supply elasticities can be assumed to be infinite (e.g. Hertel, 1989; Abler and Shortle 1992; Shortle and Laughland, 1994), short and medium run oriented studies assume supply elasticities typically between 1 and 5 (e.g. Trail 1979; Gardner, 1987; Sawar and Fox, 1992). Based on the medium run orientation of this analysis we follow the later and assume that the elasticity of supply of operating inputs as well as of investment goods are in a wide and elastic (but not perfectly elastic) range between 1 and 5.

The same arguments can be made for the supply elasticity of investment goods at the food industry. Because of the absence of empirical values we assume a broad elastic range between 1 and 5.

4.4. Elasticity of substitution at the farm level

Since the elasticity of substitution is assumed to be an important parameter of the model, a CES production function including four inputs (land, labor, durable investments, and operating inputs) is estimated for the bread grain sector in Austria and reported in the Appendix. The elasticity of substitution derived from estimations is 0.46 with a standard deviation of 0.01.

Based on an extensive literature review, Salhofer (2000) estimated average elasticities of substitution for Europe between all possible pairs of land, labor, capital and operating inputs. In particular he derived an average elasticity of substitution between land an labor of 0.5, between land and capital of 0.2. between land and operating inputs of 1.4, between labor and capital of 0.5, between labor and operating inputs of 1, and between capital and operating inputs of 0.4 (Salhofer, 2000, Table 3). Based on these results and using cost shares (as discussed below) as weights we derive an average elasticity of substitution between all four inputs of 0. 65 with a standard deviation of 1.09. Given this, we assume the elasticity of substitution at the farm level is between 0.1 and 0.9.

4.5. Elasticity of substitution at the food industry level

Econometric estimations of a CES production function at the food industry level are reported in the Appendix. Results of a three input (labor, capital, agricultural input) CES production function are not very convincing. Better results are derive for a CES production function with labor and capital per unit of agricultural input. For this case the elasticity of substitution is estimated to be 0.57 with a standard deviation of 0.07.

Humphrey and Moroney (1975) estimated elasticities of substitution between capital, labor and natural resource products for the U.S manufacturing sector. For the food sector they derived that the estimates of the elasticities of substitution between each pair of these three inputs are not significantly different from each other and range between 1.34 and 1.51. The elasticities of substitution not being very different from each other for every pair of these three factors is also confirmed by a study for Germany. Rutner (1984) found for 15 different econometric models that the elasticity of substitution between capital and labor is ranging from 0.7 to 1 (and on average 0.9), between capital and the natural resource product from 1.0 to 1.2 (average 1), and between labor and the natural resource product from 0.5 to 1.1 (0.9) sector. Hence, we assume the elasticity of substitution in the food sector is between 0.5 and 1.5.

4.6. Distribution Parameters at the farm and food industry level

Distribution parameters of the underlying CES production technology can be calculated from cost (factor) shares. For the simple case of a CES function with two inputs one can derive from the first order conditions of the profit maximization problem that

(18) $$a_1 = \left(\frac{X_1}{X_2}\right)^{\frac{s-1}{s}} \frac{W_1 X_1}{W_1 X_1 + W_2 X_2}, \text{ and } a_2 = 1 - a_1$$

where a_1, X_1 and W_1 are the distribution parameter, the quantity, and the price of factor 1 and s is the elasticity of substitution. Since in our model the quantities of all inputs are standardized to 100 the distribution parameter of factor one is equal to its cost share. The same result is derived for more than two inputs.

To derive cost shares of inputs for bread grain production in Austria farm accounting data (LBG, 1993, 1994) and gross margin calculations (BMLF, 1991, 1992, 1993) are utilized. The cost shares derived for land, labor, investment goods and operating inputs are 0.08, 0.34, 0.15, and 0.43, respectively. Using SPEL (production and income model for the agricultural sector of the European Community) data (Kniepert, 1998) a cost share for operating inputs of 0.46 is calculated. In addition, 16 studies for Western European countries are reviewed (Table 1). The average cost shares (and their standard deviations) derived from these studies are 0.10 (0.04) for land, 0.34 (0.10) for labor, 0.14 (0.08) for investment goods, and 0.41 (0.13) for operating inputs. Given this, we assume the cost share of land, labor, and investment goods to be in ranges of 0.06 to 0.10, of 0.29 to 0.39, and of 0.11 to 0.19, respectively. Given the assumption of constant returns to scale the cost share of operating inputs is calculated as a residual and hence is between 0.32 and 0.54.

Cost shares at the food industry level are calculated in the following way: Utilizing food industry and business statistics (Mazanek, 1994a, 1994b, 1995a, 1995b, 1995c, 1996) one derives the cost share of labor in the food manufacturing sector to be 0.16. Based on ÖSTAT (1997, 1998) the cost share of labor for wholesale and retail trade with grain products are calculated to be 0.66 and 0.73, respectively. Weighting these numbers by the production value of each stage (see Aiginger et al. 1990, p. 84) we derive the cost share of labor for the whole downstream industry to be in the range of 0.27 to 0.37. The cost share of bread grain as an input at the food industry level is implicitly given in the model and varies between 0.07 and 0.11. Given the assumption of constant returns to scale the cost share of capital is calculated as a residual and hence is between 0.52 and 0.66.

4.7. Agricultural share of expenditures for bread grain products

Based on the Agricultural Balances for Austria one can derive an average agricultural share of expenditures for bread grain products of 9.1% for the period 1991 to 1993. Schneider (1986) calculated agricultural shares of cereal product expenditures for the years 1973 to 1984. Using this time series and applying dynamic forecasting tools as implemented in EVIEWS 3.1 for different models (linear and log-linear, with and without constant term, with and without ARMA processes) the best guess of the agricultural share of expenditures for cereal products between 1991 and 1993 is 6.8%. Utilizing these two calculations and weighting the first more since it is based on actual data (rather than forecasts) and for bread grain (rather than cereals) we assume the agricultural share of expenditures for bread grain products is between 0.7 and 0.10.

4.8. Lerner Index of upstream and downstream industries

Not much information is available if upstream and downstream industries are able to exert some market power to set the prices above marginal cost. The Austrian food manufacturing sector is to a great extend small structured. In 1993, about 93,000 employees worked in about 7,000 enterprises of the food and luxury food industry and business what implies an average of about 14 employees (Mazanek, 1995a, 1996). However, about 70% of these enterprises had less than 20 employees and accounted only for 8% of the output.

Trail and Gilpin (1998) calculate for the food and drink manufacturing industry in the EU that 0.3% of the enterprises classified as large (>500 employees) account for 40% of the output, what might point to some market concentration. However, a quite different picture is conceived for the grain milling sector in particular with small (<10) and medium firms accounting for 72% and 25% of output, respectively. Similar numbers are given for the industrial baking sector with 56% of output produced by small firms and 29% by medium firms.

In an extensive review and evaluation of recent research on market concentration in food processing Sexton and Lavoie (1998, p. 45) conclude that though many studies tend to find some evidence of market power, the measured departures from competition have mostly been small.

While the concentration ratio in food manufacturing is unclear there is some evidence of market concentration in food retailing. Aiginger, Wieser and Wüger (1999) report a four-firm concentration ratio (CR-4) of the food retailing sector in Austria of 58% in 1993.

Given this we assume the Lerner index to be in a wide but moderate range between 0 and 0.2 implying that the product price is set between 0 and 25% above marginal cost.

There has been little detailed study of industries that supply manufactured inputs to agriculture. Notable exceptions for Europe are McCorrsiton and Sheldon (1986, 1989) and

McCorriston (1993). According to McCorriston (1993) the actual observed behavior of input industries (fertilizer, tractor) in the UK was significantly more competitive than the Cournot outcome. Hence we again assume the Lerner index to be in a wide but moderate range between 0 and 0.2 as for the upstream industries.

4.9. Food demand elasticity

For Austria Wüger (1988) estimated demand elasticities for food and beverages utilizing single equations as well as complete demand systems. He reports demand elasticities for cereal products between –0.1 and –0.6. Schneider and Wüger (1989) report as best estimates of several econometric models a demand elasticity for wheat flour of –0.3 and of rye floor of –0.2. Based on these estimates and in accordance with multiple recent studies for other European countries which all estimate values within this range (Karagiannis and Velentzas, 1997; Fulponi, 1989; Molina, 1994; Rickertsen, 1998; Michalek and Keyzer, 1992) we assume that the demand elasticity of bread grain products is in the range of –0.1 to –0.6.

4.10. Feed demand elasticity

For Austria Neunteufel (1997) estimates an own-price elasticity of wheat within a group of different cereals of –0.93 and an own-price elasticity of rye of –1.43.

Peeters and Surry (1997) reviewed the arts of estimating price-responsiveness of feed demand in the European Union and distinguished three commonly used approaches: i) linear programming; ii) econometrics, and iii) synthetic modeling. They discussed that due to these different approaches derived elasticity values vary over a wide range. Moreover, they give some arguments for the superiority of the econometric approach. Given this, we reviewed nine studies using a modern econometric dual approach (neglecting older linear single-equation models) (Table 2). The mean value of all elasticities for cereals and wheat given in this ten studies is -0.88, with a standard deviation of 0.48. Hence we assume the elasticity of feed demand to be in the range of 0.5 to 1.5.

4.11. Marginal cost of public funds

The actual magnitude of the MCF depends on the initial tax structure, the specific tax that is changed, and the responsiveness of economic agents. According to Hagemann, Jones and Montador (1988) many published studies on this subject report estimates in the range 1.07 – 1.47. Here we assume the MCF to be in a range from 1.1 to 1.4.

5. Empirical analysis

As discussed above, the main objective of agricultural policy in Austria, as in most developed countries, in general was to support farm income. Beside income redistribution, securing a sufficient supply and quality of bread grain products and animal feedstuffs was the most important goal of Austria's bread grain policy in particular (Mannert, 1991). Given this, we may simplify government's decision problem as trying to maximize social welfare given a socially demanded level of farmer's welfare and self-sufficiency.[2] Assuming that the socially demanded transfer level is reflected in the actually observed transfer level, that self-sufficiency is given when domestic supply is greater or equal domestic demand, and that the policy instruments available to government are the actually used instruments, government's decision problem can be formalized as:

$$
\text{(19)} \qquad \begin{aligned}
&\max_{P_{QD}, P_E, CL_{PQD}, CL_{PE}, QQ} && W = \left(U_{BF} + U_{UI} + U_{DI} + U_{CS} + U_{BS} + U_{TA}\right) \\
&\text{s.t.} && U_{BF} \geq U_{BF}^{A} \\
& && Q_X \geq 0
\end{aligned} \quad ,
$$

where U_{BF}^{A} is the actually observed welfare level of farmers, and Q_x are bread grain exports.

The official goal of introducing a tax on fertilizer was soil protection and hence environmentally motivated. For simplicity it is assumed that this environmental goal is separable from other goals and optimally met by the current level of fertilizer tax. Hence, government can freely choose the levels of five policy instruments (P_E, CL_{PE}, P_{QD}, CL_{PQD}, Q_Q) to maximize welfare under given constraints.

Utilizing the described simulation model, assumed distributions of parameter values, and welfare measures optimization problem (19) is solved numerically for 2 times 10,000 alternative parameter sets utilizing GAMS software (Brooke et al. 1988). As a result two alternative distributions of the optimal welfare levels as well as the optimal policy instrument levels are derived.

Utilizing the same model, parameter sets, and welfare measures, but taking the world market price of bread grain one can simulate a hypothetical nonintervention scenarios. Thus, the social cost of the optimal policy are measured as $SC^* = W^* - W^W$ where W^* and W^W are the welfare level in the optimal situation and in the world market price situation, respectively. Similarly, assuming plugging in the actually observed prices into the simulation model one could calculate the social cost of the actual observed policy $SC^A = W^A - W^W$ where W^A is the actual welfare level. Finally, the relative social cost (RSC) give the share by which the social cost could have been reduced, if the government would have used an optimal combination of policy instruments RSC = $(SC^A - SC^*)/SC^A$. This gives a measure of how close the actual policy is to the optimal policy.

This is illustrated in Figure 1 with the welfare of farmers U_{BF} and non-farmers, as an aggregate of all other groups $(U_{UI} + U_{DI} + U_{CS} + U_{BS} + U_{TA})$, on the axes. Point E describes the welfare distribution between these two groups without government intervention. If lump-sum transfers as well as lump-sum taxes would be possible, government could redistribute welfare from non-farmers to farmers along a 45° line through point E. However, here with the assumption of no lump-sum policy instruments the best government can do is described by a concave utility possibility curve. If U_{BF}^{A} is the socially demanded welfare level of farmers and point *A* is the actually observed welfare distribution, distance *AB* are the social cost of the actual policy (Bullock and Salhofer, 1998). The policy derived by the optimization problem (19) would be point *O*. The social cost of this optimal policy are *OB* and $(SC^{A} - SC^{*})/SC^{A} = AO/BO$.

The empirical results for the assumption of normally distributed parameters are summarized in Table 3. At the mean the social cost of the actually policy are measured to be € 159 million (about 42% of the value of bread grain production) with a standard deviation of € 23 million. In 95% (9,500 cases) of our 10,000 simulations the social cost are in a range of € 116 million to € 206 million. The 75% probability interval is between € 131 million € 188 million. In the case of the optimal policy the social cost are significantly smaller with a mean of € 91 million, a standard deviation of € 24 million, a 95% probability interval between € 45 million and € 139 million, and a 75% interval between € 62 million and € 121 million. Therefore, by using the same instruments at different levels government could have reduced the social cost on average by € 68 million, about 44% of the actual social cost, and with a 95% (75%) probability between 32% (35%) and 63% (53%).

Assuming a uniform distribution of the parameter values between the upper and lower boundary does not change the mean and median significantly (Table 4), but certainly causes higher standard deviations and hence wider probability intervals.

6. Sensitivity Analysis

To analyze the sensitivity of the RSC with respect to the model parameters, surface response functions are utilized (Zhao, Griffiths, Griffith, Mullen, 2000). The nonlinear relationships between RSC and model parameters are described by its second order approximation, i.e. a quadratic polynomial, comprising a constant, the 19 parameters par_i, (α_A, α_B, α_G, α_J, λ, ε_A, ε_B, ε_G, ε_H, ε_K, ε_J, η_F, η_E, σ_S, σ_F, L_F, L_G, L_H, MCF) and the permutations par_i par_j of the products of all 19 parameters.

(20) $$RSC = c_0 + \sum_{i=1}^{19} c_i par_i + \sum_{i=1}^{19} \sum_{j=1}^{i} d_{ij} par_i par_j + e,$$

with c_0, c_i, and d_{ij} being regression coefficients, and e an error term.

Equation (20) is estimated using the 10,000 parameter sets drawn from the uniform distributions and the implied RSC-values. However, to exclude extreme parameter combinations the lowest and highest 2.5% of RSC-values are omitted, leaving 9,500 observations.

OLS-estimation of the response function exhibits an extremely good fit (R^2 = 0.993) as well as medium to high levels of significance for a majority of coefficients. About 57% of the coefficients are significant at the 99%, level, 3% at the 95% level, and 12% at the 90% level (Table 5 and Table 6).

The elasticity of the Relative Social Costs with respect to the 19 parameters was calculated performing the following Monte Carlo experiment: First, the 9,500 parameter sets and the estimated response function were used to calculate 9,500 RSC "base"-values. Second, the parameter sets were slightly changed by increasing all 9,500 values of the first parameter, e.g. α_A, by 1% and calculating 9,500 RSC "new"-values. Third, subtracting the 9,500 new RSC values from the 9,500 base-values and dividing the difference by the base value leads to 9,500 elasticity values, i.e. the percentage change of the RSC with respect to a 1% change in the first parameter. The left block of Table 7 reveals that at the mean (median) of all 9,500 calculated elasticity values a 1% change in the parameter α_A decreases the RSC by 0.007% (0.005%) with a standard deviation of 1.8%, a maximum value of 0.055% and a minimum value of –0.092%. The same procedures lead to elasticities for all other parameters.

The fact that the minimum elasticities are negative and the maximum elasticities are positive for all parameters reveals how the effect of a change in one parameter depends on the levels of all other parameters. Only four elasticities are significant different from zero at the 90% level or higher: the agricultural share of expenditures for bread grain products (λ), the Lerner index of the downstream industry (L_F), the elasticity of substitution at the food industry level (σ_F), and the marginal cost of public funds (MCF).

Alternatively to the mean value in the left block of Table 7, the first column represents the percentage change in RSC, when one parameter is changed by 1% and all other parameters are kept unchanged at their mean values. The results in the first columns of the left and the right block do not differ significantly from each other. The second and third columns of the right block, RSC_{min} and RSC_{max}, do not denote percentage changes, but the values of Relative Social Cost, when one parameter is set respectively at the lower and upper bound of its associated range, and all other parameters are set at their mean values. The last column, $\Delta(RSC)$, simply indicates the difference in the absolute Relative Social Costs ($\Delta(RSC) = RSC_{max} - RSC_{min}$). This can be interpreted as the „imprecision" in RSC due to the fact that in the model, the parameters used are range estimates rather than point estimates. The higher the absolute value of this last column, the greater the gain in the precision of the estimated RSC associated with a narrower parameter range. The parameters λ, σ_F and L_F exhibit the widest ranges. Hence, additional information on their actual values would be most beneficiary to the simulation model.

7. Discussion

As a rule, governments defend their policy as efficient in common political statements. Utilizing a three-stage vertically structured model including upstream and downstream industries it was shown over a wide range of possible model parameter values that the

Austrian bread grain policy was quite inefficient in meeting its two main objectives, namely supporting farm income and self-sufficiency. In fact, the social cost could on average have been reduced by more than 40% by using the same policy instruments, but at efficient levels.

Observing that government was very inefficient in achieving the main explicitly stated objectives desires some rationalization. Five rationales are given below: 1) Uncertainty about demand and supply: Demand, but especially supply of agricultural products are influenced by changes in exogenous factors government can not influence and/or not anticipate. Best known examples are weather, technological progress (a good example might be the rapid adoption of genetically modified seeds in the US in the last years) and changes in consumer preferences (e.g. a drastically change in demand for meat due to the BSE crises). However, in the case of the Austrian bread grain market before EU accession no such extreme exogenous shift in demand or supply appeared and changing weather conditions are controlled to some extent by taking three year averages.

2.) Uncertainty about policy effects: Government can not perfectly anticipate how a change in policy will influences the behavior of individuals and firms. With for example an increase in floor price consumers might substitute bread grain products for meat of soybean products and farmers might increase investments in land or agricultural machinery. The exact magnitudes of these changes are not known and sometimes difficult to anticipate.[3] Given this it is not surprising to observe that the actual observed policy will never exactly match with the ex-post algebraically optimal policy. However, the large estimated difference in social cost between the actual and the optimal policy outcome raises the question if this rational is the only (main) sources of observed inefficiencies. It was quite obvious that a (the) main source of inefficiency was the high level of surplus production and the implied expensive export subsidies. The self-sufficiency rate (domestic supply divided by domestic demand) during the period the examined bread grain policy was in place (1989 – 1994) was on average 136%

with a standard deviation of 8%, and therefore, much higher than actually needed to guarantee self sufficiency.

3) Policy inertia: The static analysis carried out in this study neglects that government can not only choose the type and levels of policy instruments, but also the point in time at which a policy is changed. Therefore, at each point in time government has to decide if the cost of changing a policy are higher or lower as the cost of having a suboptimal policy in place. Only if the latter is true government will change its policy. The cost of changing a policy can be grouped into compliance and transaction cost. Compliance cost evolve from the fact that economic agents (have to) align to a change in policy. An example are investments in machinery and buildings during a high floor price regime that are no longer used to full capacity after a drastically price drop. Transaction cost include cost of necessary changes in the administration and enforcement of the policy as well as political cost policy acceptance.

4.) Path dependency: Since smaller reforms are usually easier realized than large ones, today's policy (type as well as level of instruments) clearly depends to some extent on yesterday's policy (Koester, 1997). The floor price policy observed in many agricultural markets in developed countries were born and breed from food shortage after World War II. High producer prices stimulated investments and production and a supply shift. The same is true for the case of bread grain in Austria. From the end of the 70's supply exceeded demand and production surplus and expenses for export subsidies increased. However, at that time producers were used to and consumers no longer aware of the high prices of agricultural products and government tried to tame the increasing surplus production by minor adjustments like the introduction of the co-responsibility levy in 1979 or the change to a two-price plan (a higher floor price for a certain amount of bread grain under a quota and a lower floor price for the rest) rather than a radical change in the support system.

5.) Implicit policy objectives: From a political economy point of view government does not act like a benevolent dictator, but rather tries to maximize its probability to stay in power. Hence, instead of (or in addition to) following the explicit (official) objectives, it also has implicit (not officially mentioned) policy objectives. For example, Salhofer, Hofreither and Sinabell (2000) discuss that beside farmers upstream and downstream industries had considerable formal (institutionalized) and informal influence the agricultural policy decision-making process in Austria. Moreover, they confirm that upstream and downstream industries clearly benefited from the existing policy. Therefore, from a political economy point of view one could argue that though support of upstream and downstream industries never was an explicit official goal of farm policy, following political pressure from this group it was an implicit (not officially mentioned) policy objective.

The results derived in this study are based on computer intensive simulation and sensitivity-analysis techniques. Therefore, ranges of parameter values, rather than a few specific values are assumed. This has several advantages: First, instead of producing one (or a few) specific but highly uncertain number(s) about the effect of a policy, we are able to give a plausible range as well as a mean. Second, the results of the sensitivity analysis clearly reveal how a change in one parameter influences the results as well as what parameters are especially sensitive to the results. Hence, this gives a hint in which direction additional research effort (time) is invested efficiently.

Footnotes:

[1] In multiplying budget expenditures times marginal cost of public funds it is taken into account that raising money to support the agricultural sector causes distortions in other sectors. Given the small share of the cost of agricultural programmes in the total budget the marginal cost of public funds (MCF) might be a good measure of these additional cost.

[2] Note, that equally one could describe government's decision problem as minimizing social cost, given a certain amount of wealth transfers to farmers and self-sufficiency.

[3] An alternative way to think about this problem is in terms of information cost. The degree to which government can anticipate the effects of a policy change depends on how much information it has about individuals and firms. Clearly there is a trade off between the cost of collecting this information (e.g. by doing surveys) and the cost of implementing a suboptimal policy.

Appendix: Estimation of bread grain and food industry production functions

The model

Production is assumed to follow a Constant Elasticity of Supply (CES) technology.[1] Allowing for technical progress, a four-input CES production function can be defined as

$$\text{(A1)} \quad q = \exp(rt)\left[b_0 + b_1 x_1^{\ z} + b_2 x_2^{\ z} + b_3 x_3^{\ z} + b_4 x_4^{\ z}\right]^{\frac{1}{z}}$$

where t is a variable which increases linearly over time, and $r, z, b_0, b_1, b_2, b_3,$ and b_4 are coefficients to be estimated.

In this definition, the CES is non-linear in the coefficients and can either be estimated utilizing nonlinear estimation procedures as for example implemented in the econometric package EVIEWS or by using first order conditions of profit maximization (Arrow et al. 1961). Nonlinear estimation procedures showed convergence problems and dependency of the results from the starting values. Using first order conditions requires data on input prices which ware not available in this case. Hence, rewriting (A1) as

$$\text{(A2)} \quad \left[\frac{q}{\exp(rt)}\right]^z = \left[b_0 + b_1 x_1^{\ z} + b_2 x_2^{\ z} + b_3 x_3^{\ z} + b_4 x_4^{\ z}\right],$$

and defining $\tilde{q} = \left[\frac{q}{\exp(rt)}\right]^z$ and $\tilde{x}_i = x_i^{\ z}$ yields

$$\text{(A3)} \quad \tilde{q} = b_0 + b_1 \tilde{x}_1 + b_2 \tilde{x}_2 + b_3 \tilde{x}_3 + b_4 \tilde{x}_4 .$$

If we can assume the error term to be additive to the inputs (the error term acts like an additional input factor),

$$\text{(A4)} \quad \tilde{q} = b_0 + b_1\tilde{x}_1 + b_2\tilde{x}_2 + b_3\tilde{x}_3 + b_4\tilde{x}_4 + u\,,$$

which can be estimated using OLS.[2]

The problem with (A4) is that in order to perform this transformation we need the values of *z* and *r*, which we do not know. We can, however, estimate them using a kind of „two stage“ Maximum Likelihood approach.

If we can assume the errors to be additive and normally distributed, the probability of observation *i*, given parameters *z* and *r*, is

$$\text{(A5)} \quad P(q_i \mid r, z) = \frac{1}{\sqrt{2\pi\sigma^2}} \exp\left[-\frac{res_i^{\;2}}{2\sigma^2}\right]\left|\frac{d\tilde{q}_i}{dq_i}\right|,$$

with res_i the *i*th residual from and • the standard error of the OLS-estimation of (A.4) and

$$\text{(A6)} \quad \left|\frac{d\tilde{q}_i}{dq_i}\right| = \left|\frac{z}{\exp(rt)}\left[\frac{q_i}{\exp(rt)}\right]^{z-1}\right| = \left|\frac{zq_i^{\;z-1}}{\exp(zrt)}\right|,$$

the transformation of the probability density function due to the transformation of q_i to $\tilde{q}_i$.[3]

---

1 The more general translog function is not chosen since a four-input translog function, even without allowing for technical progress, requires the estimation of 14 coefficients. Our set of annual data covers the years 1962-1994 –33 data points.

2 A similar approach can be found in Boyes and Kavanough (1978).

If the errors are independent, the joint probability (the likelihood) of all observations is simply the product of all the observations' probabilities (or, after taking logs, the sum of all log-probabilities)

(A7) $$logL(\mathbf{q} \mid r, z) = \sum_{i=1}^{n} \log\{P(q_i \mid r, z)\}$$

Maximization of the Likelihood function can then be performed by numerical methods. Furthermore, utilizing the Cramer-Rao theorem (see, e.g. Johnston, 1984), we can assign confidence intervals to our coefficients.[4]

For the present purpose, we need to estimate two production functions: production of bread grain, and production of food.

Production of Bread Grains

Primary production of bread grain Q_S is modeled with four inputs: land *B*, labor *L*, capital *K*, and fertilizer *N*.[5] Moreover, to allow for technical progress we include an exponential term.

Thus, the CES can be written as[6]

---

3 If we transform a variable *u* with a probability density function of *p(u)*, the transformed variable $y = f(u)$ has a probability density function of $p(y) = p(u)\left|\frac{du}{dy}\right|$ (Johnston, 1984, 535f).

4 For a more complete treatment concerning the estimation of and inference in the Maximum Likelihood function, see Streicher (2000).

5 The time series for *B*, *L*, *K*, and *N* span the years 1962 – 1994 and are scaled in a way that ∅(1991-93) = 100 (Salhofer, 1997).

(A8) $$Q_S = \exp(rt)\left[b_1 B^z + b_2 L^z + b_3 K^z + b_4 N^z \right]^{\frac{1}{z}}.$$

After performing the transformations described above, we obtain

(A9) $$\tilde{Q}_S = b_1\tilde{B} + b_2\tilde{L} + b_3\tilde{K} + b_4\tilde{N} \text{ . with } \tilde{Q}_S = \left[\frac{Q_S}{\exp(rt)}\right]^z \text{ and } \tilde{x}_i = x_i^{\ z} \text{ for } x_i = B, L, K, N.$$

Estimation results are represented in Table A1. With one exception, the estimated values are significant, the exception being the value of the fertilizer parameter, which exhibits the wrong sign (implying that an increase in fertilizer would actually decrease output, if not by much). The result might be explained by the fact that our fertilizer series consists of traded nitrogen fertilizer only and does not include manure. Since data on the usage of manure are not available it was tried to estimate manure quantities from head numbers of cattle, hog and chicken. The inclusion of this estimate of organic fertilizer did not improve the econometric results. This is not really surprising since the numbers found in the agricultural literature to estimate annual quantities of manure were extremely rough rules of thumb along the line of 20-80 kg of pure nitrogen per year per dairy cow. The elasticity of substitution implied by z = -1.186 is 0.46 and the growth rate is 2.74% per year.

The estimated coefficients imply marginal productivities, the rise in output after a 1% rise in the respective input. AS depicted in Figure A1 total productivity, i.e. the rise in output if all inputs are increased by 1%, is 1% as we have estimated the CES without a constant and therefore subject to constant returns to scale. Marginal productivity of land remained fairly

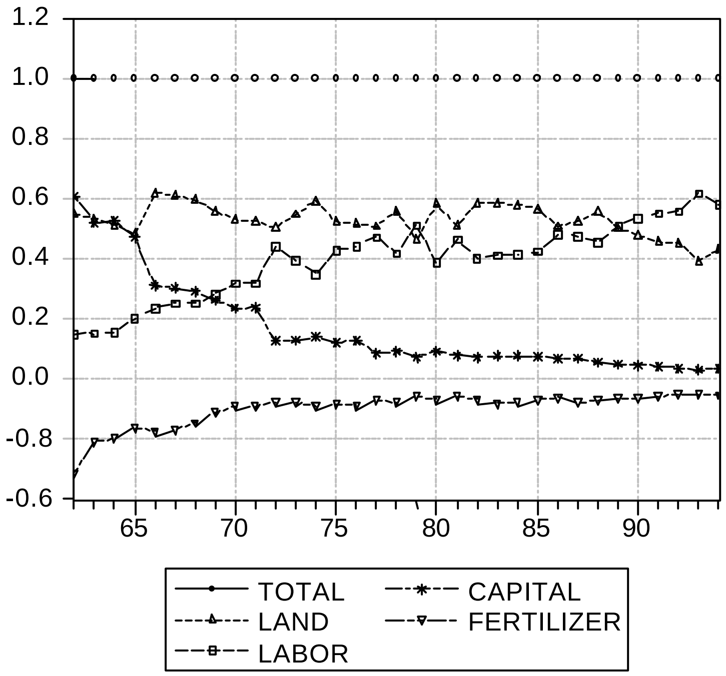
[6] We also tried including a constant term to allow for variable returns to scale. The constant turned out to be highly insignificant, allowing us to reformulate the function with constant returns to scale.

constant over time. Labor exhibits rising and capital falling marginal productivity, reflecting the trend towards increased mechanization.

Table A1: Estimation results of bread grain production function

Coeff.	Est. value	Std. error
z	-1.18600	0.04739
r	0.02740	0.00347
b_1	1.23959	0.19115
b_2	1.62642	0.45838
b_3	0.10496	0.03964
b_4	-0.14980	0.14370
R^2	0.90	
DW	1.80	

Figure A1: Total and marginal elasticities of productivities of bread grain production function inputs



Production of Food

Production of food Q_{SF} is modeled with three inputs: labor L, capital K, and agricultural inputs (including bread grain) Q_D. Again, to allow for technical progress we include an exponential term. Thus, the CES can be written as

$$\text{(A10)} \quad Q_{SF} = \exp(rt)\left[b_0 + b_1 L^z + b_2 K^z + b_3 Q_D{}^z\right]^{\frac{1}{z}}$$

Direct estimation of (A3) resulted in convergence problems; therefore, a CES was formulated for the production of food per unit of agricultural inputs:

$$\text{(A11)} \quad \left(\frac{Q_{SF}}{Q_D}\right) = \exp(rt)\left[b_0 + b_1\left(\frac{L}{Q_D}\right)^z + b_2\left(\frac{K}{Q_D}\right)^z\right]^{\frac{1}{z}}$$

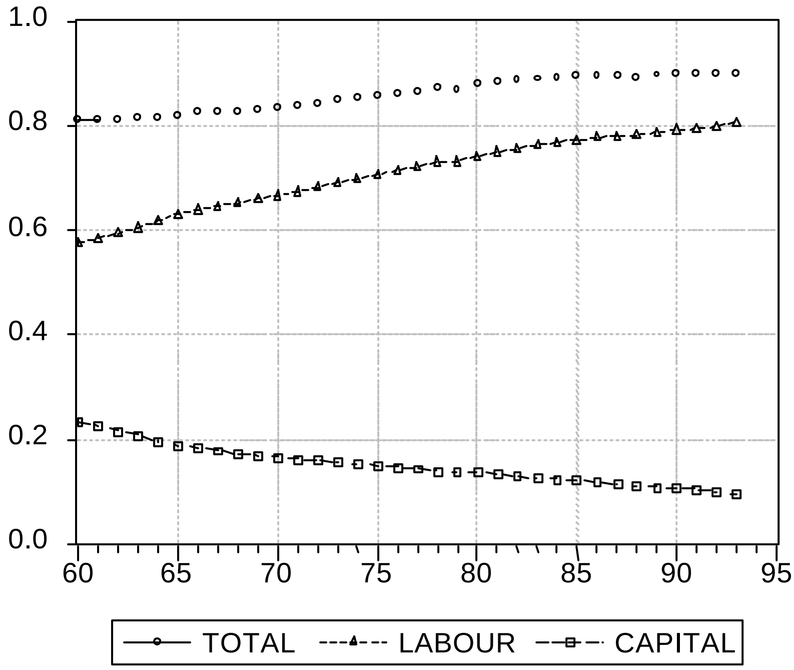
As depicted in TableA2 all coefficients are significant and have the expected sign. The elasticity of substitution implied by z = 0.0253 is 1.103.

Table A2: Estimation results of food production function

Coeff.	Est. value	Std. error
z	-0.76600	0.18615
r	0.02530	0.00048
b_0	0.18835	0.06878
b_1	1.52529	0.27921
b_2	0.18987	0.05822
R^2	0.99	
DW	1.42	

The marginal productivities implied by estimated coefficients are illustrated in Figure A2. Capital exhibits falling and labor rising marginal productivities, again reflecting increasing mechanization of the production process. Total productivity is no longer constant , but slightly increasing over time

Figure A2: Total and marginal elasticities of productivities of food production function inputs



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References

Abler, D. G. (2000). *Elasticities of Substitution and Factor Supply in Canadian, Mexican and US Agriculture.* Report to the Policy Evaluation Matrix (PEM) Project Group, OECD, Paris.

Abler, D. G., and Shortle, J. S. (1992). Environmental and Farm Commodity Policy Linkages in the US and the EC. *European Review of Agricultural Economics*, **19**, 197-217.

Aiginger, K., Bayer, K., Hutschenreiter, G. et al. (1990): *Perspektiven der Nahrungs- und Genußmittelerzeugung*. Studie des Österreichischen Instituts für Wirtschaftsforschung im Auftrag des Bundesministeriums für wirtschaftliche Angelegenheiten und der Raiffeisenzentralbank Österreich, Vienna.

Aiginger, K., Wieser, R., and Wüger, M. (1999). Marktmacht im Lebensmitteleinzelhandel. *WIFO-Monatsberichte*, **12,** 797-809.

Arrow, K. J., Chenery, H. B., Minhas, B. S. and Solow, R. M. (1961). Capital-Labor Substitution and Economic Efficiency. *Review of Economics and Statistics,* Vol. 43, 225-250.

Astl, A. (1989). "Getreidemarkt in den 90er Jahren". Österreichische Gesellschaft für Land- und Forstwirtschaftspolitik (ed.). *Wintertagung 1989.* Vienna, 84-97.

Astl, A. (1991). "Markt für Getreide und Mahlprodukte". Breuer, G., Gattermayer, F., Hohenecker, J. et al. (eds.). *Agrarvermarktung in Österreich: Von der Marktordnung zum Marketing.* Service Fachverlag, Vienna, 240-252.

Barkley, A. P. (1990). The Determination of the Migration of Labor out of Agriculture in the United States, 1940-85. *American Journal of Agricultural Economics*, **72,** 567-573.

Becker, H. und Guyomard, H., (1991). Messung technischer Fortschritte und globaler Faktorproduktivitäten für die Agrarsektoren Frankreichs und der Bundesrepublik Deutschland, *Berichte über Landwirtschaft*, **69**, 223-244.

Behrens, R. and De Haen, H. (1980). Aggregate Factor Input and Productivity in Agriculture: A Comparison for the EC-Member Countries, 1963-76, , *European Review of Agricultural Economics*, **7,** 109-146.

Bhati, U. N. (1978). Analysis of Aggregate Labour Demand and Supply Relationships for Australian Agriculture, *Quarterly Review of Agricultural Economics,* **31,** 107-123.

BMLF (Bundesministerium für Land- und Forstwirtschaft) (1991). *Standarddeckungsbeiträge und Daten für die Betriebsberatung 1991/92, Ausgabe Ostösterreich.* Editor's edition, Vienna.

BMLF (Bundesministerium für Land- und Forstwirtschaft) (1992). *Standarddeckungsbeiträge und Daten für die Betriebsberatung 1992/93, Ausgabe Ostösterreich.* Editor's edition, Vienna.

BMLF (Bundesministerium für Land- und Forstwirtschaft) (1993). *Standarddeckungsbeiträge und Daten für die Betriebsberatung 1993/94, Ausgabe Ostösterreich.* Editor's edition, Vienna.

Bonnieux, F., (1989). Estimating Regional-Level Input Demand for French Agriculture Using a Translog Production Function, *European Review of Agricultural Economics,* **16**, 229-241.

Boyes, William J. and David C. Kavanough (1978). Money and the Production Function: A Test for Specification Errors. *The Review of Economics and Statistics*, Vol. ??? 442-446

Brooke, A., Kendrick, D. and Meeraus, A. (1988). *GAMS: A User's Guide, Release 2.25,* The Scientific Press, South San Francisco.

Bullock, D. S. and Salhofer, K. (1998). Measuring the Social Costs of Suboptimal Combination of Policy Instruments - A General Framework and an Example, *Agricultural Economics*, **18,** 249-259.

Bureau, J.-C., and Danechvar-Kakhki, M. (1991). Les substitutions entre les céréales et les autres concentrés en alimentation animale. *Cahiers d'économie et sociologie rurales*, **18-19**, 181-221.

Cowling, K., Metcalf, D. and Rayner, A. J. (1970). *Resource Structure of Agriculture: An Economic Analysis*, Pergamon Press, Oxford.

Dawson, P. J.; and Lingard, J. (1982). Management Bias and Returns to Scale in a Cobb-Douglas Production Function for Agriculture. *European Review of Agricultural Economics*, **9**, 7-24.

Dryburgh, C. R. and Doyle, C. J. (1995). Distribution of Research Gains under Different Market Structures: The Impact of Technological Change within the UK Dairy Industry, *Journal of Agricultural Economics*, **46**, 80-96.

Fullerton, D., (1982). On the Possibility of an Inverse Relationship between Tax Rates and Government Revenues, *Journal of Public Economics*, **19**, 3-22.

Fulponi, L. (1989). The Almost Ideal Demand System: An Application to Food and Meat Groups for France. *Journal of Agricultural Economics*, **40**, 82-92.

Gallasch, H. F. and Gardner, B. L (1978). Schooling and Agricultural Minimum Wage. *American of Agricultural Economics*, **60,** 264-268.

Gardner, B. L. (1987). *The Economics of Agricultural Policies.* New York: McGraw-Hill.

Gardner, B. L. (1992). Changing Economic Perspectives on the Farm Problem. *Journal of Economic Literature*, **30,** 62-101.

Gatterbauer, H., Holzer, G. and Welan, M. (1993). *Agrarpolitik und Agrarrecht in Österreich - ein Überblick*. Discussion Paper 21-R-93, Department of Economics, Politics, and Law, University of Agricultural Sciences Vienna.

Guyomard, H. and Vermersch, D. (1989a). Derivation of Long-Run Factor Demands from Short-run Responses, *Agricultural Economics*, **3**, 213-230.

Hagemann, R. P., Jones, B. R. and Mantador, R. B. (1988). Tax Reform in OECD Countries: Motives, Constraints and Practice, *OECD Economic Studies,* **10,** 185-226.

Hansson, I. and Stuart, C. (1993). The Effects of Taxes on Aggregate Labor: A Cross-Country General-Equilibrium Study, *Scandinavian Journal of Economics*, **95**, 311-326.

Hansson, I. and Stuart, C., (1985). Tax Revenue and the Marginal Cost of Public Funds in Sweden, *Journal of Public Economics*, **27***,* 331-353.

Henrichsmeyer, W. and Ostermeyer-Schlöder, A. (1988). Productivity Growth and Factor Adjustment in EC Agriculture, *European Review of Agricultural Economics*, **15**, 137-154.

Hertel, Th. W. (1989). Negotiating Reductions in Agricultural Support: Implications of Technology and Factor Mobility. *American Journal of Agricultural Economics*, **71**, 559-573.

Heshmati, A. and Kumbhakar, S. C. (1997). Estimation of Technical Efficiency in Swedish Crop Farms: A Pseudo Panel Data Approach, *Journal of Agricultural Economics,* **48**, 22-37.

Hockmann, H. (1988). Niveau und Entwicklung der Produktivität in der Landwirtschaft der Mitgliedsländer der EG und der Vereinigten Staaten von 1975-1984, *Berichte über Landwirtschaft*, **66**, 393-415.

Humphrey, D. B., and Moroney, J. R. (1975). Substitution among Capital, Labor, and Natural Resource Products in American Manufacturing. *Journal of Political Economy, 83*, 57-82.

Johnston, John (1984). *Econometric Methods*, McGraw-Hill

Josling, T. (1974). Agricultural Policies in Developed Countries: A Review. *Journal of Agricultural Economics,* **25,** 229-264.

Just, R. E., Hueth, D. L. and Schmitz, A. (1982). *Applied Welfare Economics and Public Policy*. Englewood Cliffs: Prentice-Hall.

Karagiannis, G., and Velentzas, K. (1997). Explaining Food Consumption Patterns in Greece. *Journal of Agricultural Economics*, **48**, 83-92.

Karagiannis, G., Katranidis, S. and Velentzas, K. (1996). Decomposition Analysis of Factor Cost Shares: The Case of Greek Agriculture, *Journal of Agricultural and Applied Economics*, **28**, 369-379.

Kimmel, J. and Kniesner, T. J. (1998). New Evidence on Labor Supply: Employment Versus Hours Elasticities by Sex and Marital Status, *Journal of Monetary Economics*, **42**, 289-301.

Kniepert, M (1998). *Gross Margin Calculations based on the SPEL data basis*. Computer Program in EXEL. Department of Economics, Politics, and Law, University of Agricultural Sciences Vienna.

Koester, U. (1997). "Agrarpolitik im Dauerkonflikt mit Prinzipien der Sozialen Marktwirtschaft." Lenel, H. O., Gröner, H., Hamm, W. et al. *Jahrbuch für die Ordnung der Wirtschaft und Gesellschaft*. Band 48, Lucius & Lucius, Stuttgart.

Kontos, A., and Young, T. (1983). An Analysis of Technical Efficiency on a sample of Greek farms. . *European Review of Agricultural Economics*, **10**, 271-280.

LBG (Wirtschaftstreuhand- und Beratungsgesellschaft) (1993). *Die Buchführungsergebnisse aus der österreichischen Landwirtschaft im Jahre 1992*. Editor's edition, Vienna.

LBG (Wirtschaftstreuhand- und Beratungsgesellschaft) (1994). *Die Buchführungsergebnisse aus der österreichischen Landwirtschaft im Jahre 1993*. Editor's edition, Vienna.

Mannert, J. (1991). *Agrarpolitik in Österreich*. Vienna: Wirtschaftsbetriebe der Universität für Bodenkultur.

Mazanek R. (1994a). Industriestatistik - Jahreserhebung 1992. *Statistische Nachrichten,* **49,** 935-941.

Mazanek R. (1994b). Gewerbestatistik - Jahreserhebung 1992. *Statistische Nachrichten,* **49,** 1024-1031.

Mazanek R. (1995a). Gewerbestatistik - Jahreserhebung 1993. *Statistische Nachrichten,* **50,** 543-549.

Mazanek R. (1995b). Industriestatistik - Jahreserhebung 1993. *Statistische Nachrichten,* **51,** 725-731.

Mazanek R. (1995c). Industriestatistik - Jahreserhebung 1994. *Statistische Nachrichten,* **51,** 760-766.

Mazanek R. (1996). Gewerbestatistik - Jahreserhebung 1994. *Statistische Nachrichten,* **51,** 892-898.

McCorriston, S. (1993). The Welfare Implications of Oligopoly In Agricultural Input Markets, *European Review of Agricultural Economics,* **20,** 1-17.

McCorriston, S. and Sheldon, I. M (1986). EC Integration and Agricultural Supply Industries, in Macmillan, M., Mayes, D. G. and van Veen, P. (eds). *European Integration and Industry,* Tilburg University Press, Tilburg.

McCorriston, S. and Sheldon, I. M (1989). Trade and Welfare Effects of the EC Accession in the UK Agricultural Supply Industries, *Journal of Agricultural Economics,* **40,** 320-313.

Mergos, G. J. and Yotopoulos, P. A. (1988). Demand for Feed Inputs in the Greek Livestock Sector, *European Review of Agricultural Economics,* **15**, 1-17.

Mergos, G. J. and Yotopoulos, P. A. (1988). Demand for Feed Inputs in the Greek Livestock Sector, *European Review of Agricultural Economics,* **15**, 1-17.

Michalek, J. and Keyzer, M. A. (1992). Estimation of a two-stage LES-AIDS Consumer Demand System for Eight EC Countries *European Review of Agricultural Economics,* **19,** 137-163.

Millan, J. A. (1993). Demanda de Factores de Produccion y Cambio Tecnico en la Agricultura Española, *Investigacion Agraria Economia,* **8**, 185-196.

Molina, J. A. (1994). Food Demand in Spain: An Application of the Almost Ideal System. *Journal of Agricultural Economics,* **45**, 252-258.

Neunteufel, M. (1992). Faktornachfrage und technischer Fortschritt im österreichischen Agrarsektor, *Der Förderungsdienst*, **40**, 273-277.

Neunteufel, M. (1997). Das EKG-Modell der österreichischen Landwirtschaft, in: Sektorales Prognosemodell für die österreichische Land- und Forstwirtschaft. Abschlußbericht zum Projekt Nr. AW/8/71 der Bundesanstalt für Agrarwirtschaft, Vienna.

Niendieker, V. (1992). Die Faktoreinkommensverteilung im Agrarsektor der BR Deutschland, *Agrarwirtschaft,* **41**, 2-12.

Ortner, K. M. (1997). "Österreichische Agrarpolitik bis zum EU-Beitritt", Österreichischer Agrarverlag (ed.). *Österreichs Landwirtschaft im EU-Agrarsystem.* Editor's edition, Klosterneuburg.

ÖSTAT (Österreichisches Statistisches Zentralamt) (1997). *Statistisches Jahrbuch der Republik Österreich 1998.* Editor's edition, Vienna

ÖSTAT (Österreichisches Statistisches Zentralamt) (1998). *Statistisches Jahrbuch der Republik Österreich 1998.* Editor's edition, Vienna

Peeters, L. (1995). Measuring Biases of Technical Change: The Case of Cereals Displacement in Livestock Ration Formulation in Belgium, *European Review of Agricultural Economics*, **22**, 137-156.

Peeters, L. and Surry, Y. (1993a). “An Econometric Model for Measuring Substitution and Allocation of Marketable Feed Inputs.” European Association of Agricultural Economists (ed.). *VIIth EAAE Congress, Stresa Italy 6th – 10th September 1993, Contributed Papers, Volume B, Methodology*. 126-140.

Peeters, L. and Surry, Y. (1993c). Estimating Feed Utilisation Matrices Using a Cost Function Approach, *Agricultural Economics*, **9**, 109-126.

Peeters, L. and Surry, Y. (1994). Un modèle d’agrégation pour le secteur de l’alimentation animale du Benelux, *Cahiers d’economie et sociologie rurales*, **30**, 49-78.

Peeters, L., and Surry, Y. (1993b). Un Modelo Economometrico de Medicion de las Relaciones de Sustitucion Entre Materias Primas Compradas Para la Produccion de Piensos Compuestots y su Asignacion. *Revista de Estudios Agro-Sociales*, **166**, 113-141.

Peeters, L., and Surry, Y. (1997). A Review of the Arts of Estimating Price-Responsiveness of Feed Demand in the European Union, *Journal of Agricultural Economics*, **48**, 379-392.

Raab, F. (1994). "Getreide und Mahlprodukte". Gattermayer, F., Hohenecker, J., Schiebel, W. et al. (eds.). *Agrarvermarktung in Österreich.* 2. Aufl., Service Fachverlag, Vienna, 325-342.

Rickertsen, K. (1997). The Demand for Food and Beverages in Norway. *Agricultural Economics*, **18**, 89-100.

Rutner, D. (1984). *Faktorsubstitution in den Produktionssektoren der Bundesrepublik Deutschland – Eine ökonometrische Analyse anhand des Translog-Modells, 1961-1980,* Haag + Herchen Verlag.

Salhofer, K. (1997). *Efficiency of Income Redistribution through Agricultural Policy: A Welfare Economic Analysis.* Peter Lang Verlag, Frankfurt.

Salhofer, K. (1999). *Distributive Leakages from Agricultural Support: Some Empirical Evidence from Austria.* Unpublished Manuscript, Department of Economics, Politics, and Law. University of Agricultural Sciences Vienna.

Salhofer, K. (2000). *Elasticities of Substitution and Factor Supply Elasticities in European Agriculture: A Review of Past Studies.* Report to the Policy Evaluation Matrix (PEM) Project Group, OECD, Paris.

Sarwar, G. and Fox, G. (1992). An Evaluation of the Redistributive Efficiency of Alternative Crow Benefit Payment Policies in Western Canada, *Review of Agricultural Economics*, **14,** 187-204.

Schneider, M. (1986). Wettbewerbsposition der österreichischen Landwirtschaft und Marktspannen auf dem inländischen Nahrungsmittelmarkt. *WIFO-Monatsberichte*, **5,** 329-335.

Sexton, R. J. and Lavoie, N. (1998). Food Processing and Distribution: An Industrial Organization Approach, in Gardner, B. L. and Rausser, G. C. (eds). Handbook of Agricultural Economics. forthcoming.

Shortle, J. S., and Laughland, A. (1994). Impacts of Taxes to Reduce Agrichemical Use When Farm Policy is Endogenous. *Journal of Agricultural Economics*, **45**, 3-14.

Streicher, G (2000). *Estimation of CES Production Functions*, Unpublished Manuscript, Department of Economics, Politics, and Law. University of Agricultural Sciences Vienna.

Surry, Y. (1990). Economic Modelling of the European Community Compound Feed Sector: An Application to France, *Journal of Agricultural Economics*, **41**, 404-421.

Surry, Y. (1993). The „Constant Difference of Elasticities“ Function with Applications to the EC Animal Feed Sector, *Journal of Agricultural Economics*, **47**, 110-125.

Surry, Y. and Moschini, G. (1984). Input Substitutability in the EC Compound Feed Industry, *European Review of Agricultural Economics*, **11**, 455-464.

Trail, B. (1979). An Empirical Model of the U.K. Land Market and the Impact of Price Policy on Land Values and Rents, *European Review of Agricultural Economics*, **6**, 209-232.

Traill, B., and Gilpin, J. (1998). Changes in Size Distribution of EU Food and Drink Manufacturers: 1980 to 1992. *Agribusiness*, **14**, 321-329.

Tyrchniewicz, E. W. and Schuh, G. E. (1969). Econometric Analysis of the Agricultural Labor Market, *American Journal of Agricultural Economics*, **51,** 770-787.

Varian, Hal R. (19??).

Von Witzke, H. (1979). Prices, Common Agricultural Price Policy and Personal Distribution of Income in West German Agriculture, *European Review of Agricultural Economics*, **6,** 61-80.

Walo, A. (1994). *Größen- und Verbundvorteil bei Mehrprodukteunternehmen. Eine empirische Untersuchung der schweizerischen landwirtschaftlichen Talbetriebe.* Verlag Rüegger AG, Chur/Zürich.

Winters, A. L. (1987). The Political Economy of the Agricultural Policy of Industrial Countries, *European Review of Agricultural Economics*, **14,** 285-304.

Winters, L. A. (1990). The So-called „Non-Economic" Objectives of Agricultural Support, *OECD Economic Studies*, **13,** 237-266.

Wüger, M. (1989). *Einkommens- und Preiselastizitäten für Nahrungsmittel in Österreich. Ein Vergleich verschiedener Schätzansätze*, WIFO Working Paper 28, Austrian Institute of Economic Research, Vienna.

Table 1: Estimates of cost shares for Western European countries

	Country	Year	Product	Land	Labor	Durab. invest.	Oper. inp.
Becker and Guyomard (1991)	Germ./France	ϕ 1961-84	agriculture	0.09	0.43	0.14	0.35
Behrens and De Haen (1980)	EU	ϕ 1970-76	agriculture	0.09	0.50	0.09	0.32
Bonnieux (1989)	France	ϕ 1959.83	agriculture	0.10	0.32	0.11	0.47
Dawson and Lingard (1982)	UK	ϕ 1974-77	dairy	0.16	0.20	0.16	0.48
Guyomard & Vermersch (1989)	France	1981	cereals	0.19	0.31	0.18	0.33
Henrichsmeyer et al. (1988)	EU	ϕ 1980-85	agriculture	0.05	0.31	0.10	0.54
Heshmati (1997)	Sweden	1988	crops	0.09	0.25	0.06	0.59
Hockmann (1988)	EU	ϕ 1980-84	agriculture	0.09	0.38	0.13	0.40
Karagiannis et al. (1996)	Greece	1980	agriculture	0.14	0.38	0.24	0.24
Kontos and Young (1983)	Greece	1980	agriculture	0.13	0.29	0.29	0.29
Mergos and Yotopoulos (1988)	Greece	1970	livestock	0.13	0.34	0.09	0.44
Millan (1993)	Spain	ϕ 1962-85	agriculture	0.13	0.55	0.07	0.25
Neunteufel (1992)	Austria	1986	agriculture	0.06	0.19	0.20	0.56
Niendecker (1991, 1992)	Germany	1987	agriculture	0.09	0.37	0.06	0.48
von Witzke (1979)	Germany	N.A.	agriculture	0.08	0.24	0.08	0.59
Walo (1994)	Switzerland	1991	agriculture	0.06	0.42	0.32	0.20
Mean				0.10	0.34	0.14	0.41
Standard deviations				0.04	0.10	0.08	0.13

Table 2: Estimates of feed demand elasticities for Western European countries

Study	parameter value	country	product	year	optimizing agent
Bureau and Danechvar-Khaki (1995)	-1.65	France	cereals	1986	livestock producer
Peeters (1995)	-0.67	Belgium	cereals	ϕ 1961-1990	feed compounder
Peeters and Surry (1993a,b)	-0.93	Belgium	cereals	1988	livestock producer + feed compounder
	-0.76	NL	cereals	1988	livestock producer + feed compounder
Peeters and Surry (1993c)	-0.79	Belgium	cereals	1988	feed compounder
Peeters and Surry (1994)	-0.65	Belgium	wheat	1988	feed compounder
	-0.69	Belgium	cereals	1988	feed compounder
Mergos and Yotopoulos (1988)	-0.66	Greece	cereals	1970	livestock producer
Surry and Moschini (1984)	-0.63	Belgium	cereals	ϕ1961-1978	feed compounder
	-0.80	NL	cereals	ϕ 1961-1978	feed compounder
Surry (1990)	-2.03	France	wheat	1980	livestock producer + feed compounder
Surry (1993)	-0.25	Den., UK, Ir.	wheat	1984	livestock producer
Mean	-0.88				
Standard deviation	0.48				

Table 3: Social cost of actual and optimal policy given a normal distribution of parameter values

	Mean	Median	Std. Dev.	95% Probability interval from	95% Probability interval to	75% Probability interval from	75% Probability interval to
Social cost of actual policy	159.3	158.6	23.2	116.3	206.2	131.4	188.4
Social cost of optimal policy	91.2	91.1	24.0	45.0	138.7	61.7	120.9
Percentage improvement	0.44	0.42	0.08	0.32	0.63	0.35	0.53

Table 4: Social cost of actual and optimal policy given a uniform distribution of parameter values

	Mean	Median	Std. Dev.	95% Probability interval from	95% Probability interval to	75% Probability interval from	75% Probability interval to
Social cost of actual policy	158.9	157.2	30.4	104.3	221.5	122.2	197.5
Social cost of optimal policy	90.2	89.3	31.6	31.4	152.8	51.5	129.7
Percentage improvement	0.45	0.43	0.11	0.30	0.72	0.33	0.59

Table 5: Values of the coefficients of the surface response function

Const.	$Par_{i\backslash j}$	1	α_A	α_B	α_G	α_J	λ	ε_A	ε_B	ε_G	ε_H	ε_K	ε_J	η_F	η_E	σ_S	σ_F	L_F	L_G	L_H	MCF
	α_A	0.305	-0.445	-0.030	-0.155	0.053	-0.105	0.080	-0.114	0.048	0.011	-0.002	0.045	0.003	0.119	-0.051	-1.334	-0.010	-0.294	-0.205	-0.738
	α_B	-0.388		-0.392	0.233	0.068	0.026	-0.050	0.023	-0.100	0.020	0.002	-0.003	0.035	0.005	0.045	0.049	-0.332	0.096	-0.033	-0.061
	α_G	-0.162			-0.041	0.077	0.002	0.004	0.027	0.046	-0.007	-0.010	0.020	-0.001	0.030	-0.026	-0.008	0.034	0.888	0.005	-0.115
	α_J	0.036				-0.002	0.015	0.072	-0.181	0.009	-0.020	-0.002	0.127	-0.026	0.003	0.001	0.001	-0.016	-0.017	-0.262	0.192
	λ	-48.461					-3.706	2.371	0.837	10.275	8.301	0.186	-2.188	-2.788	0.171	0.062	0.165	0.054	0.825	0.139	111.352
	ε_A	-0.020						0.038	-0.036	0.030	0.015	0.011	-0.019	0.009	-0.009	-0.001	0.000	0.000	0.000	-0.013	-0.013
	ε_B	-0.105							0.097	-0.031	-0.016	0.053	0.044	-0.014	0.026	-0.016	0.001	0.000	-0.003	-0.001	-0.017
	ε_G	-0.021								-0.001	0.001	-0.001	0.006	0.002	0.000	-0.001	-0.002	0.000	0.000	0.000	0.001
	ε_H	-0.073									-0.003	-0.010	-0.001	0.015	0.006	-0.002	-0.003	-0.004	0.000	0.000	0.003
7.058	ε_K	-0.042										-0.002	0.000	-0.003	0.029	-0.003	0.000	-0.001	-0.015	0.001	0.001
	ε_J	-0.109											-0.009	0.000	0.001	0.079	-0.002	0.000	-0.001	-0.034	0.005
	η_F	1.994												0.117	-0.041	-0.006	-1.429	-0.110	-0.003	0.052	0.141
	η_E	0.493													-0.046	0.024	0.003	-0.182	-0.093	0.013	-0.028
	σ_S	-0.052														0.054	0.047	0.003	0.004	0.010	-0.010
	σ_F	-1.886															-0.296	0.091	0.044	0.391	0.196
	L_F	-4.096																-0.303	0.138	0.065	0.754
	L_G	-0.278																	0.003	0.031	0.030
	L_H	-0.579																		-0.023	0.047
	MCF	1.162																			0.043

Table 6: Significance of the coefficients of the surface response function

Const.	$Par_{i\backslash j}$	1	α_A	α_B	α_G	α_J	λ	ε_A	ε_B	ε_G	ε_H	ε_K	ε_J	η_F	η_E	σ_S	σ_F	L_F	L_G	L_H	MCF
	α_A	+	+++		+		+++	+++	+++	+			+++		+++		+				+
	α_B	+++		+++	+++	+		+++	++	+++	+		+	+++	++	+++	+		+		
	α_G	+			+	+			+++	+++			+++		+++	+++			+		
	α_J							+	+++		++		+++	+++	+			+			++
	λ	+++					+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++		+++
	ε_A							+++	+++	++		+++	+++	+++	+					+++	+
	ε_B	+++							+++	+++	+++	+++	+++	+++	+++	+++	+		+++	+++	+++
	ε_G	+++								+		+	+++	+++		+++	+++			+++	+++
	ε_H	+++									+++	+++		+++	+++	+++	+++	+++		+++	+++
+++	ε_K	+++										+++		+++	+++	+++	+	+++	+++	+++	+++
	ε_J	+++											+++			+++	+++		++	+++	+++
	η_F	+++												+++	+++		+++	+++	+	+++	+++
	η_E	+++													+++	+++		+++	+++	+++	+++
	σ_S	+++														+++	+++			+++	+++
	σ_F	+++															+++	+++	+++	+++	+++
	L_F	+++																+++	+++	+++	+++
	L_G	+++																		+	+
	L_H	+++																		+	++
	MCF	+++																			+++

+++ represents a 99% significance level, ++ represents a 95% significance level, + represents a 90% significance level,

Table 7: Sensitivity Analysis

	Monte Carlo-results (n=9500)					Evaluation at parameter means			
Par.	**Mean**	**Median**	**S.E.**	**Min**	**Max**	**Avg.**	**RSC_{min}**	**RSC_{max}**	**Δ(RSC)**
α_A	-0.007	-0.005	0.018	-0.092	0.055	-0.006	0.418	0.417	-0.001
α_B	-0.035	-0.033	0.055	-0.245	0.168	-0.036	0.420	0.415	-0.004
α_G	-0.001	-0.002	0.018	-0.064	0.087	-0.002	0.418	0.417	0.000
α_J	0.015	0.015	0.021	-0.059	0.105	0.015	0.417	0.419	0.002
λ	-1.106***	-1.187	0.277	-1.588	0.118	-1.232	0.494	0.364	-0.130
ε_A	0.000	0.000	0.005	-0.028	0.027	0.000	0.418	0.417	0.000
ε_B	-0.016	-0.012	0.032	-0.153	0.094	-0.015	0.419	0.411	-0.008
ε_G	-0.019	-0.023	0.015	-0.049	0.059	-0.029	0.431	0.415	-0.016
ε_H	-0.054	-0.064	0.034	-0.129	0.136	-0.078	0.453	0.409	-0.044
ε_K	-0.016	-0.018	0.024	-0.080	0.102	-0.023	0.428	0.415	-0.013
ε_J	-0.011	-0.011	0.014	-0.061	0.055	-0.015	0.424	0.415	-0.009
η_F	-0.109	-0.098	0.078	-0.366	0.225	-0.132	0.388	0.466	0.079
η_E	-0.176	-0.158	0.108	-0.539	0.076	-0.177	0.374	0.448	0.074
σ_S	0.005	0.005	0.012	-0.069	0.073	0.007	0.414	0.419	0.005
σ_F	-0.538***	-0.543	0.138	-1.028	0.123	-0.644	0.603	0.332	-0.271
L_F	-1.023**	-1.058	0.417	-2.116	0.604	-1.124	0.478	0.372	-0.106
L_G	-0.007	-0.012	0.032	-0.088	0.125	-0.013	0.419	0.417	-0.001
L_H	-0.019	-0.029	0.074	-0.225	0.317	-0.031	0.420	0.417	-0.003
MCF	0.107**	0.101	0.054	-0.068	0.287	0.118	0.389	0.448	0.059

*, **, *** indicate a significance level of 90%, 95%, and 99%, respectively.

Figure 1: Bread grain market and policy

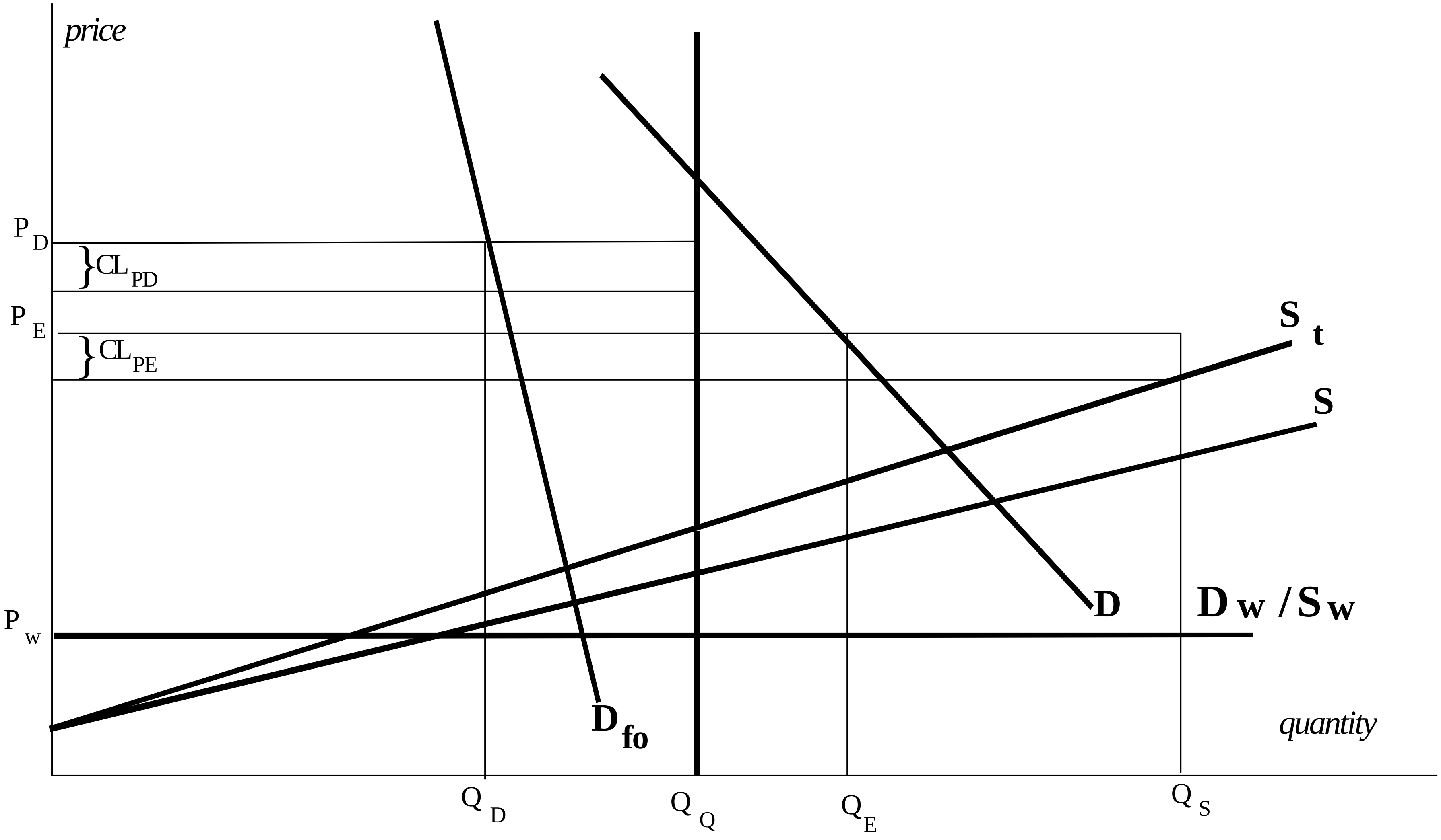

Figure 2: Social cost of actual and optimal policy