Available online at www.sciencedirect.com

SCIENCE DIRECT

ELSEVIER

Agricultural Economics 30 (2004) 51–62

AGRICULTURAL ECONOMICS

www.elsevier.com/locate/agecon

Distributive leakages of agricultural support: some empirical evidence

Klaus Salhofer[a,*], Erwin Schmid[b]

[a] *Environmental Economics, Resource Economics and Agricultural Policy Research Group, Technical University of Munich, Alte Akademie 14, Freising-Weihenstephan 85354, Germany*

[b] *Department of Economics, Politics, and Law, University of Natural Resources and Applied Life Sciences, Vienna, Gregor Mendel Strasse 33, Vienna 1180, Austria*

Received 16 January 2001; received in revised form 17 June 2002; accepted 11 September 2002

Abstract

The paper evaluates the transfer efficiency of the Austrian bread grain policy taking into account distributive leakages, i.e. how much of the transfers officially intended to support farm income are finally realised in the upstream and downstream industries. Gardner's [Am. J. Agric. Econ. 65 (1983) 225] well-known measure of average transfer efficiency (ATE) is augmented for the case of more than two social groups and computer-intensive simulation procedures are utilised to deal with parameter uncertainty.

JEL classification: C15; H22; Q18

Keywords: Agricultural policy analysis; Transfer efficiency; Distributive leakages; Computer-intensive simulation techniques

1. Introduction

Assessing the efficiency of income redistribution through agricultural policies has been an important topic in agricultural policy analysis (e.g. Nerlove (1958); Josling (1969); Gardner (1983); Alston and Hurd (1990); Giannakas and Fulton (2000)). Moreover, assessing the transfer efficiency of agricultural policies has also become an important tool of the OECD (1995) (see also Blandford and Dewbre, 1994) to stimulate the discussion on how governments can achieve income support objectives at relatively low cost. While there have been many developments in this area of research in the last 40 years (see Bullock and Salhofer, 2003), important questions remain. One of these questions is that of distributive leakages, i.e. how many income gains accrue to groups other than the intended beneficiaries of support (OECD, 1995, p. 12). In other words, how much of the transfers intended to support farm income are finally realised in the upstream (agricultural input) and downstream (food) sectors.

The OECD (1995) discusses the problem of distributive leakages to farm input suppliers theoretically and also derives some stylised empirical results for simple policies, i.e. policies which use only one policy instrument at a time. The objective of our study is to scrutinise the existence and magnitude of distributive leakages to upstream and downstream industries for the Austrian bread grain sector. In particular,

* Corresponding author. Tel.: +49-8161-71-3406; fax: +49-8161-71-3408.
E-mail address: salhofer@wzw.tum.de (K. Salhofer).

0169-5150/$ – see front matter
doi:10.1016/S0169-5150(03)00080-X

the rather complex (multi-instrument) Austrian bread grain policy is investigated between 1991 and 1993 (prior to EU accession). Therefore, we estimate the benefits and costs of this policy compared to a situation without any intervention in the bread grain market.

Moreover, the study augments Gardner's (1983) well-known measure of average transfer efficiency (ATE). Gardner's ATE measure is defined as the benefits to farmers divided by the cost to non-farmers (typically consumers and taxpayers). Hence, Gardner like many successors, e.g. Alston and Hurd (1990) and Kola (1993), divide society into two social groups. This seems plausible given that in their single market models farmers are usually the only beneficiaries while consumers and taxpayers are in essence the same group of individuals. However, in multi-market models, more than two social groups can be identified, e.g. processors of agricultural products and input suppliers, with sometimes more than one group gaining from agricultural policy. To account for this, Gardner's intuitively appealing ATE measure is in our study augmented for the case of more than two social groups.

In addition, our study utilises a computer-intensive simulation technique (Davis and Espinoza, 1998; Salhofer, 1999; Zhao et al., 2000) to deal with parameter uncertainty. This technique is based on randomly choosing parameter values from a range of potential parameter values. By conducting this procedure repeatedly one can derive a probability distribution of transfer measures rather than point estimates.

The reminder of the study is organised as follow: The next section briefly reviews Austrian bread grain policy, represents the utilised model and welfare measures, and discusses parameter values. In Section 3, transfer efficiency measures are developed for more than two social groups. Section 4 presents empirical results and tests for their sensitivity. A final discussion is given in Section 5.

2. Modelling the Austrian agribusiness of bread grain

2.1. The Austrian bread grain policy

Government intervention in Austria's bread grain (wheat, rye) market is illustrated in Fig. 1. D_{fo} represents domestic demand for bread grain in food production only, while D represents total domestic demand for bread grain including demand for feeding purposes. Initial domestic supply is represented by S and supply including a fertiliser tax by S_t. The 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 that 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}

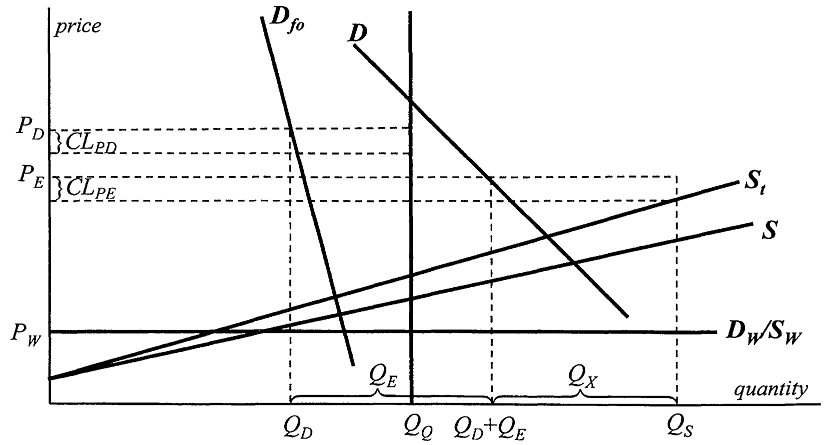

Fig. 1. Austrian bread grain policy.

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 supply is Q_S, 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 $Q_X = Q_S - (Q_D + Q_E)$.

2.2. The model

The Austrian agribusiness of bread grain is modelled by a log-linear, three-stage, vertically-structured model. The first stage includes four markets of input factors used for bread grain production: land, labour, durable investment goods (machinery and buildings), and operating inputs (fertiliser, seeds, pesticides, etc.). Since farmers own 95% of the farmland and 86% of the labourers in the agricultural sector are self-employed, land (A) and labour (B) are assumed to be factors offered solely by farmers. Since many farmers supply land and labour and there are no substantial barriers to entry, a competitive market structure is chosen for the land and labour markets. Assuming constant elasticity supply functions:

$$Q_i = X_i P_i^{\varepsilon_i}, \quad i = A, B, \tag{1a}$$

where Q_i denotes the quantity supplied, X_i the shift parameter, P_i the price, and ε_i the supply elasticity of input factor i.

Investment goods (G), and operating inputs (H) are supplied by upstream industries. These inputs as defined in the model are conglomerates of separate industries in at least two vertical stages (production and trade). Investment goods are comprised of agricultural machinery and agricultural buildings, and operating inputs include fertiliser, pesticides, seeds, energy and insurance. For this reason, the market structure of these aggregations of industries is hard to define. While strong competition might be observed in the building industry, one clearly can see some concentration in the machinery industry. For example, according to BMLF (1997) the two Austrian tractor brands (Steyrer and Lindner) held 54% of the market share in 1996. Similar observations can be made with respect to some operating inputs. According to BMLF (1996), three firms (RWA, Saatbau Linz and Pioneer) had a share of 62% in the seed market in 1995. For commercial fertiliser, two Austrian firms (Agro Linz, and Donau Chemie AG) had at least 66% of the market. Moreover, there was a strong concentration in trade of agricultural machinery and operating inputs. One firm (RWA) traded about 75% of the pesticides, 70% of the fertiliser and 40% of the agricultural machinery. Given this, it is assumed that upstream industries are able to exert some market power and set the prices above marginal cost. Hence,

$$Q_i = X_i((1 - L_i)P_i)^{\varepsilon_i}, \quad i = G, H, \tag{1b}$$

where L_i is the Lerner index (defined as the ratio between the profit margin and the price) of input factor for industry i.

For simplicity, export and import of input factors are not considered. While this seems reasonable for land and agricultural labour it needs some further remarks in regard to industrially produced input factors. Defining the share of investment goods and operating inputs produced domestically is not an easy task. First, both input categories are conglomerates of separate industries. Second, Austria has simultaneously been an importer and exporter for most inputs. However, some remarks can be made: The value of imports of wheat and rye seeds was below 1% of farmer's expenditures for these inputs; however, there certainly have been some license fees paid to foreign seed firms. Austria was a net exporter of fertiliser with a self-sufficiency ratio (defined as the value produced divided by domestic consumption) of 1.3. The value of imports of commercial fertiliser and manufactured raw materials was about 30% of domestic expenditures for this input. Since we cannot classify how much of the imported raw materials have been manufactured and exported again, this 30% is an upper bound of the market share of imports. The self-sufficiency ratio of agricultural machinery was 0.92. Again, since Austria was an exporter and importer at the same time, the market share of domestically produced machinery is hard to define, but according to our calculations it was at least 60%. Clearly, for some input factors imports are negligible, e.g. agricultural buildings or hail insurance. Given these observations and considering the cost share of each input factor (e.g. fertiliser, seeds, machinery) within the two defined categories (operating inputs and durable investment goods), a very careful estimate of how much of the market value is produced domestically is about 75% for both.[1]

At the second stage, input from the first stage are used to produce bread grain. For simplicity, a constant-elasticity-of-substitution (CES) production technology with constant returns to scale is assumed:

$$Q_S = Z_{Q_S}\left(\sum_i \alpha_i Q_i^{\rho}\right)^{1/\rho}, \quad i = A, B, G, H,$$

$$\text{with } \rho = \frac{\sigma_S - 1}{\sigma_S}, \text{ and } \sum_{i=A,B,G,H} \alpha_i = 1, \tag{2}$$

where Q_S denotes the produced quantity of bread grain, Z_{Q_S} the production function efficiency parameter, α_i the distribution parameter of factor i, ρ the substitution parameter, and σ_S the elasticity of substitution between input factors at the farm level. The first and the second stages are linked by the assumption that bread grain producers maximise their profits.[2] Based on the observations of many suppliers, no substantial barriers to entry and farmers being price takers, we use the standard assumption of a perfectly competitive agricultural market. Hence, factor prices equal the corresponding values of marginal products. Thus,

$$P_i = Z_{Q_S}^{\rho}\alpha_i\left(\frac{Q_S}{Q_i}\right)^{1-\rho}(P_E - CL_{PE}), \quad i = A, B, G, \tag{3a}$$

and

$$P_H + T_F = Z_{Q_S}^{\rho}\alpha_H\left(\frac{Q_S}{Q_H}\right)^{1-\rho}(P_E - CL_{PE}), \tag{3b}$$

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

As depicted in Fig. 1, the produced quantity of bread grain is used for food production (Q_D), animal feed (Q_E), and exports (Q_X):

$$Q_S = Q_D + Q_E + Q_X. \tag{4}$$

The third stage represents firms which process and distribute bread grain, such as wholesale buyers, millers, exporters, and foodstuff producers. Bread grain (D) along with the other inputs labour (J) and capital (K)—which is a residual including all other inputs except D and J—are combined to produce food (products such as flour, bread and noodles). Supplies of J and K are again modelled by constant elasticity functions:

$$Q_i = X_i P_i^{\varepsilon_i}, \quad i = J, K. \tag{5}$$

For simplicity, food production is modelled by a constant returns to scale CES technology:

$$Q_{SF} = Z_{Q_{SF}}\left(\sum_i \alpha_i {Q_i}^{\gamma}\right)^{1/\gamma}, \quad i = J, K, D,$$

$$\text{with } \gamma = \frac{\sigma_F - 1}{\sigma_F}, \text{ and } \sum_{i=J,K,D} \alpha_i = 1, \tag{6}$$

where Q_{SF} represents the produced quantity of food (bread grain products), $Z_{Q_{SF}}$ the production function efficiency parameter, α_i the distribution parameter of factor i, γ the substitution parameter and σ_F the elasticity of substitution between input factors at the food industry level.

Not much information is available regarding whether the downstream industry is able to exert some market power to set the prices above marginal cost. To a great extent, the Austrian food manufacturing sector is made up of small enterprises. In 1993, about 93,000 employees worked in about 7,000 enterprises in the food and luxury food industries, which implies an average of about 14 employees per enterprise (Mazanek, 1995, 1996). However, about 70% of these had less than 20 employees and accounted for only for 8% of the output. While the concentration ratio in food manufacturing is unclear, there is some evidence of market concentration in food retailing. Aiginger et al. (1999) report a four-firm concentration ratio (CR-4)

[1] More details about the underlying calculations are available from the authors.

[2] Farmers' decision problems can be described as:

$$\max_{Q_A, Q_B, Q_G, Q_H} (P_E - CL_{PE})Q_S - P_G Q_H - \int S_A(Q_A)\,\mathrm{d}Q_A - \int S_B(Q_B)\,\mathrm{d}Q_B,$$

where $S_A()$, and $S_B()$ are inverse supply functions of land and labour, respectively. Though policy variables P_D, CL_{PD}, and Q_Q influence the profits of farmers, they do not influence farmers' production decisions. Moreover, since supplied by farmers, the costs of land and labour are not prices times quantities, but the opportunity costs of using these inputs for bread grain production, i.e. the areas beneath the corresponding marginal cost curves. Another way to look at farmers' decision problems is one of farmers maximizing their rents from supplying land and labour.

in the Austrian food-retailing sector of 58% in 1993. Given this, we assume some market power in the food sector and derived input demand is represented by:

$$P_i = (1 - L_F) Z_{Q_{SF}}^{\gamma} \alpha_i \left(\frac{Q_{SF}}{Q_i} \right)^{1-\gamma} P_F, \quad i = J, K, D, \tag{7}$$

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 in the downstream sector.

Food demand is modelled by a constant elasticity function:

$$Q_{DF} = X_{Q_{DF}} P_F^{\eta_F}, \tag{8}$$

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

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

$$Q_{DF} = Q_{SF}. \tag{9}$$

Bread grain demand for feeding purposes is also modelled by a constant elasticity demand function:

$$Q_E = X_{Q_{DE}} P_E^{\eta_E}, \tag{10}$$

where $X_{Q_{DE}}$ and η_E are the shift parameter and the elasticity of animal feedstuffs demand.

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

$$\lambda = \frac{P_D Q_D}{P_F Q_{DF}}. \tag{11}$$

The model is calibrated to fit the price and quantity averages of the period 1991–1993. Afterwards, the model is used to simulate the hypothetical situation without any government intervention in the bread grain market, keeping all other parameters constant. Hence, P_D and P_E are set to P_w, the world market price, CL_{PD}, CL_{PE} and T_F are set to zero and the quota restriction does not apply ($Q_Q = Q_S(P_w)$), while, for example, the assumption that domestic food supply equals domestic food demand or the magnitude of market power in upstream and downstream industries are kept constant.

2.3. Welfare measures

Welfare changes of bread grain farmers (ΔU_{BF}) are measured as the difference between the current situation (average 1991–1993) and a simulated non-intervention situation. Welfare in both situations is given by revenues (first term in (12)) minus both the costs of purchased inputs (second term in (12)) and the opportunity costs of owned inputs (last term in (12)).

$$\begin{aligned} \Delta U_{BF} = {} & [(P_E - CL_{PE} - P_w)(Q_S - Q_{Sw}) \\ & + (P_D - CL_{PD} - P_E + CL_{PE}) Q_Q] \\ & - [(P_G - P_{Gw})(Q_G - Q_{Gw}) \\ & + (P_H + T_F - P_{Hw})(Q_H - Q_{Hw})] \\ & - \Bigg[\frac{X_A}{\varepsilon_A + 1} (P_A^{\varepsilon_A+1} - P_{Aw}^{\varepsilon_A+1}) \\ & - (P_A - P_{Aw})(Q_A - Q_{Aw}) \\ & + \frac{X_B}{\varepsilon_B + 1} (P_B^{\varepsilon_B+1} - P_{Bw}^{\varepsilon_B+1}) \\ & - (P_B - P_{Bw})(Q_B - Q_{Bw}) \Bigg], \end{aligned} \tag{12}$$

where P_w is the world market price of bread grain and CL_{PD} the co-responsibility levy of bread grain under the quota. The subscript 'w' indicates prices and quantities in the non-intervention situation. For example, Q_{S_w} is the quantity of bread grain that would be produced without government intervention.

Wealth transfers to upstream industries (ΔU_{UI}) are measured as the sum of changes in Marshallian producer surpluses from supplying investment goods and operating inputs to farmers (first term in (13)) and oligopoly rents in these industries (second term in (13)):

$$\begin{aligned} \Delta U_{UI} = {} & \left[\sum_{i=G,H} \frac{X_i (1 - L_i)^{\varepsilon_i+1}}{\varepsilon_i + 1} (P_i^{\varepsilon_i+1} - P_{i,w}^{\varepsilon_i+1}) \right] \\ & + \left[L_i (P_i Q_i - P_{i,w} Q_{i,w}) \right], \quad i = G, H. \end{aligned} \tag{13}$$

Wealth transfers to the downstream industry (ΔU_{DI}) are measured as changes in producer surplus from supplying capital and labour to the food industry (first term in (14)) and the food industry's oligopoly rent (second term in (14)):

$$\Delta U_{DI} = \sum_{i=J,K} \left[\frac{X_i}{\varepsilon_i + 1} (P_i^{\varepsilon_i+1} - P_{i,w}^{\varepsilon_i+1}) \right] + [L_F(P_F Q_{DF} - P_{Fw} Q_{DFw})]. \quad (14)$$

The change in the welfare of food consumers (ΔU_{CS}) is calculated as the change in consumer surplus:

$$\Delta U_{CS} = \frac{X_{Q_{DF}}}{\eta_F + 1} (P_{Fw}^{\eta_F+1} - P_F^{\eta_F+1}). \quad (15)$$

Similarly, the change in the welfare of buyers of bread grain for animal feed (ΔU_{BS}) is calculated as:

$$\Delta U_{BS} = \frac{X_{Q_{DE}}}{\eta_E + 1} (P_{Ew}^{\eta_E+1} - P_E^{\eta_E+1}). \quad (16)$$

The change in the welfare of taxpayers (ΔU_{TX}) is measured by budget revenues minus expenditures times marginal cost of public funds (*MCF*):

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

where *AEC* refers to export cost in addition to the difference between the domestic price and the world market price, such as 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 (17) describes expenditures for exports and revenues from the co-responsibility levy, and the second term describes revenues from fertiliser taxation.

2.4. Parameters and simulation technique

To run the model and calculate welfare changes described above, 32 parameter values are necessary (ε_A, ε_B, ε_G, ε_H, ε_J, ε_K, α_A, α_B, α_G, α_H, α_J, α_K, α_D, σ_S, σ_F, η_E, η_F, L_G, L_H, L_F, X_A, X_B, X_G, X_H, X_J, X_K, Z_{Q_S}, $Z_{Q_{SF}}$, $X_{Q_{DF}}$, X_{Q_E}, λ, *MCF*). While values for 13 ($X_A, X_B, X_G, X_H, X_J, X_K, Z_{Q_S}, Z_{Q_{SF}}, X_{Q_{DF}}, X_{Q_E}$, $\alpha_D, \alpha_H, \alpha_K$) of these 32 parameters are endogenously derived in the calibration process, 19 (ε_A, ε_B, ε_G, ε_H, ε_J, ε_K, α_A, α_B, α_G, α_J, σ_S, σ_F, η_E, η_F, L_G, L_H, L_F, λ, *MCF*) specific parameter values are exogenously given.

In contrast to most empirical studies of this kind, we do not assume one (or a few) specific value(s) for each parameter, but rather assume a plausible range for each parameter. The upper (a) and lower (b) bounds of these ranges are based on extensive literature and data analysis (described in detail in Salhofer, 2001; Salhofer et al., 2001) and are presented in Table A.1 in Appendix A. Two alternative distributions are assumed between the upper and lower bounds: (i) a uniform distribution $U(a, b)$, and (ii) a symmetric normal distribution $N(\mu, \sigma)$ with $\mu = (a + b)/2$ and $\sigma = (\mu - a)/1.96$, which is truncated at a and b.

On the basis of these parameter ranges, 10,000 independent draws are taken for each parameter and each alternative distribution. Separately, we derive 10,000 parameter sets of 19 elements for each alternative distribution. These parameter sets are used to derive 10,000 welfare measures for each defined group and each alternative parameter distribution.

3. Transfer efficiency measures

The most common measure to express the efficiency of agricultural programs in redistributing welfare to farmers is Gardner's (1983) ATE measure, defined as the negative ratio between the welfare gains of farmers (ΔU_{BF}) and the expenses of non-farmers (commonly measured as welfare cost to consumers (ΔU_{CS}) and taxpayers (ΔU_{TX})), $ATE = -\Delta U_{BF}/(\Delta U_{CS} + \Delta U_{TX})$. Therefore, an *ATE* of 0.6 reveals that from every € of cost borne by non-farmers 60 cents are realised as benefits by farmers, while 40 cents are socially wasted.[3] However, in this study society is differentiated into more than two social groups, with more than one group gaining (as we will see later on) from agricultural policy. Therefore, more differentiated efficiency measures are desirable and necessary.

[3] One can show that $1 - ATE = SC/-(\Delta U_{CS} + \Delta U_{TX})$, with SC being deadweight losses or social cost, defined as $SC = -(\Delta U_{CS} + \Delta U_{TX} + \Delta U_F)$.

Table 1
Benefit/cost and cost/cost ratios of bread grain policy in Austria under the assumption of normal distributed parameter values

	Mean	Standard deviation	Coeffecient of variance	95% CI		75% CI	
				Maximum	Minimum	Maximum	Minimum
Benefit/cost ratios							
BC_{BF}	0.33	0.04	0.12	0.41	0.26	0.38	0.28
BC_{UI}	0.12	0.02	0.18	0.16	0.08	0.14	0.09
BC_{DI}	0.15	0.05	0.37	0.26	0.05	0.22	0.09
BC_{SC}	0.40	0.04	0.09	0.47	0.32	0.45	0.35
Cost/cost ratios							
CC_{Consumer}	0.53	0.05	0.09	0.62	0.43	0.59	0.47
CC_{BS}	0.28	0.02	0.08	0.33	0.24	0.31	0.26
CC_{TX}	0.22	0.02	0.11	0.27	0.18	0.25	0.19

Own calculations.

To express how much each group gains or loses, we suggest the following set of measures: First, benefit/cost ratios:

$$BC_i = \frac{\Delta U_i}{-\sum_{j=1}^{m} \Delta U_j}, \quad i = 1, \dots, n, \tag{18}$$

where ΔU_i is the welfare change of one of n benefiting groups, ΔU_j the welfare change of one of m loosing groups, and $-\sum_{j=1}^{m} \Delta U_j$ the negative sum of the welfare changes of all loosing groups and hence total program cost. BC_i times 100 measures what percentage of the total cost caused by agricultural policy is realised as benefits by group i. That part of total program cost that is not attributable to any winning group is socially wasted. Therefore, with dead weight losses or social cost (SC) defined as the negative of the sum of welfare changes over all social groups, $SC = -[\sum_{j=1}^{m} \Delta U_j + \sum_{i=1}^{n} \Delta U_i]$:

$$1 - BC_1 - \dots - BC_n = BC_{SC}$$

$$\text{with } BC_{SC} = \frac{SC}{-\sum_{j=1}^{m} \Delta U_j}. \tag{19}$$

Hence, $BC_1 = 0.3$ reveals that 30% of the sum of cost of all groups that lose from the policy are realised as benefits by group 1. $BC_{SC} = 0.2$ means that 20% of the sum of cost of all loosing groups not realised as benefits by any group and hence socially wasted.

Second, cost/cost ratios:

$$CC_j = \frac{\Delta U_j}{\sum_{j=1}^{m} \Delta U_j}, \quad j = 1, \dots, m, \tag{20}$$

with ΔU_j being the welfare change of one of m loosing groups and hence $-\sum_{j=1}^{m} \Delta U_j$ equal to total program cost. Therefore, $CC_j = 0.3$ measures that 30% of total program cost (sum of welfare changes over all loosing groups) are borne by group j.

4. Empirical results

The 2 × 10,000 calculated welfare measures for each social group are utilised to derive distributions of efficiency measures. The results are summarised in Table 1 for the case of normally distributed parameter values and in Table 2 for the case of uniform distributed parameter values. Bread grain farmers, upstream industries and downstream industries benefit from agricultural policy and hence their shares (as well as the share of social cost) are expressed as benefit/cost ratios. Consumers, buyers of bread grains for feeding purposes and taxpayers lose, and their shares are expressed as cost/cost ratios.

At the mean, 33% of total program cost are realised as benefits by bread grain producers.[4] In 95% of our 10,000 simulations, this value is between 26 and 41%, and in 75% of the total simulation runs the value is

[4] Like other studies of the transfer efficiency of agricultural policy, we do not consider that some of these rents are not realized by operators but rather by landowners. For Austria, this problem seems smaller than for most other developed countries. According to Wytrzens (1991) in 1990 about 95% of farm land was owner operated in Austria.

Table 2
Benefit/cost and cost/cost ratios of bread grain policy in Austria under the assumption of uniform distributed parameter values

	Mean	Standard deviation	Coefficient of variance	95% CI		75% CI	
				Maximum	Minimum	Maximum	Minimum
Benefit/cost ratios							
BC_{BF}	0.33	0.05	0.16	0.44	0.24	0.40	0.27
BC_{UI}	0.12	0.03	0.24	0.18	0.07	0.15	0.08
BC_{DI}	0.15	0.07	0.49	0.31	0.03	0.25	0.06
BC_{SC}	0.40	0.05	0.13	0.49	0.29	0.46	0.33
Cost/cost ratios							
CC_{Consumer}	0.53	0.06	0.12	0.64	0.41	0.61	0.45
CC_{BS}	0.29	0.03	0.10	0.34	0.23	0.32	0.25
CC_{TX}	0.22	0.03	0.15	0.29	0.16	0.26	0.18

Own calculations.

between 28 and 38%. This is also illustrated by the kernel density function in Fig. 2.

Beside farmers, upstream industries benefit about 12% and downstream industries about 15% of total program cost. While it is obvious that upstream industries benefit from higher agricultural prices through higher input demand, the benefits for downstream industries are less obvious. Since imports of bread grain products are restricted, downstream industries are able to benefit from supported agricultural prices. As mentioned, the ratio of imports to total consumption of bread and baker's wares is less than 7%. Therefore, the high prices of agricultural products are, to a great extent, transmitted to consumers. This is especially true

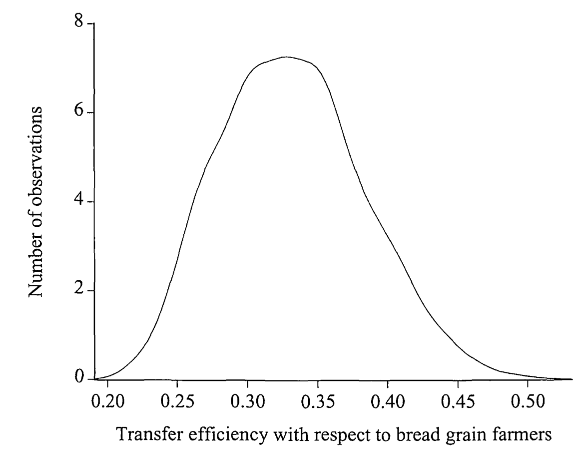

Fig. 2. Kernel density function of the ratio between bread grain farmers' benefits and the total cost of the policy.

given the inelastic demand for bread grain products and the market power of the downstream industry.[5] The high coefficient of variation of the downstream industry's benefits illustrates that this result heavily depends on the assumed parameter values.

Adding up the average of all winning groups' benefits (33 + 12 + 15 = 60%) reveals that only 60% of the total program cost is transformed into benefits while 40% are socially wasted, i.e. dissipated through inefficient resource allocation.

On average, about 53% of the total program cost is paid by consumers, 28% by buyers of bread grain for feeding purposes, and 22% by taxpayers. While consumers and taxpayers are a relatively well-defined social group, it is not as obvious whose change in wealth is measured by the welfare of buyers of bread grain for feeding purposes. According to Just et al. (1982), this measure includes the welfare change of end consumers as well as the changes in the rents of all suppliers of factors necessary to produce the final good (i.e. animal farmers, meat processors, etc.). To fully clarify the magnitudes of the welfare changes for each of these groups a model for the meat sector, similar to the one developed here for the bread grain sector, would be necessary. However, the qualitative results of this meat sector model might be

[5] While it is difficult to prove formally for our expanded empirical model, including vertical relations from the agricultural input sector to the food sector, that downstream industries lose from eliminating the floor price policy, we provide a formal proof in Appendix B for a simpler model, that only depicts the downstream sector.

expected to be similar to those derived for bread grain. As long as import of meat is restricted, high prices for agricultural products can to a great extent be transmitted to final consumers. Suppliers of inputs at every stage of production will gain from the agricultural policy as long as their supply curve is not perfectly elastic and/or they are able to exert market power. Therefore, what is measured here as the costs to buyers of bread grain for feeding purposes might actually measure costs to final consumers and even underestimate these costs since it also includes benefits to suppliers of inputs for meat production at several stages.

The results for the case of uniformly distributed parameter values do not vary significantly as regards their means but, as expected, have higher variances.

To analyse how sensitive the transfer efficiency measures are with respect to the model parameters, surface response functions are utilised (Zhao et al., 2000). In particular, we first describe the underlying non-linear relationships by estimating their second order approximations, i.e. quadratic polynomials:

$$BC_i = c_0 + \sum_{k=1}^{19} c_k Y_k + \sum_{k=1}^{19}\sum_{l=1}^{k} d_{kl} Y_k Y_l + e,$$
$$i = BF, UI, DI, SC;\ k, l = 1, \dots, 19, \tag{21a}$$

$$CC_j = c_0 + \sum_{k=1}^{19} c_k Y_k + \sum_{k=1}^{19}\sum_{l=1}^{k} d_{kl} Y_k Y_l + e_j,$$
$$j = CS, BS, TX;\ k, l = 1, \dots, 19, \tag{21b}$$

where Y_k and Y_l are the 19 model parameters, c_0, c_k, and d_{kl} are regression coefficients, and e_i are error terms. Details of the 210 estimated coefficients for each of the seven regressions are available upon request. The adjusted R^2 is in all cases very high, at least 0.995.

Second, the elasticities of transfer efficiency measures (here for the case of benefit/cost ratios) with respect to model parameters ($E_{i,k}$) are calculated through partial differentiation of the quadratic surface response functions (Zhao et al., 2000):[6]

[6] Alternative means of deriving elasticity measures from surface response functions are discussed in Salhofer et al. (2001).

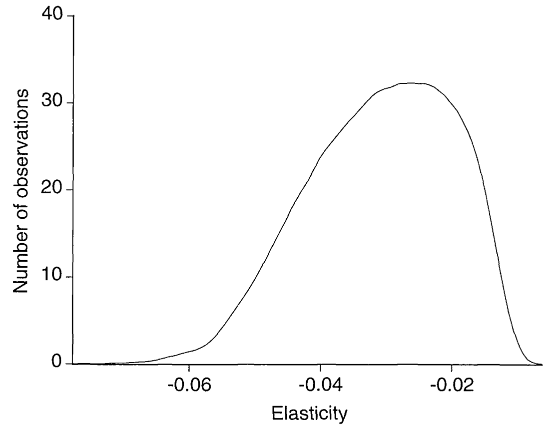

Fig. 3. Kernel density function of the elasticity E_{BF,ε_A}, i.e. the percentage change in the ratio between bread grain farmers' benefits and total cost of the program with respect to a 1% change in the supply elasticity of land.

$$E_{i,k} = \left(\frac{\partial BC_i}{\partial Y_k}\frac{Y_k}{BC_i} = c_k + 2d_{kk}Y_k + \sum_{\substack{l=1\\ k\neq l}}^{19} d_{kl}Y_l \right) \frac{Y_k}{BC_i},$$
$$i = BF, UI, DI, SC;\ k, l = 1, \dots, 19. \tag{22}$$

Plugging the 19 × 10,000 uniformly distributed parameter values, the implied BC measures, and the estimated regression coefficients into (22), distributions of elasticities are derived. For example, the kernel density function in Fig. 3 describes the distribution of the elasticity E_{BF,ε_A}, i.e. how much a one percentage change in the supply elasticity of land alters the ratio between bread grain farmers' benefits and total cost of the program.

The mean value of E_{BF,ε_A} (−0.03) and all other elasticities are presented in Table 3. Hence, if the supply of agricultural land would become more elastic by 1%, the ratio between bread grain farmers' benefits and the total cost of the program would decrease by 0.03%. Most measures are quite inelastic to most model parameters. This is especially true for the BC_{BF} as well as all the cost/cost ratios. In the case of BC_{UI} and BC_{DI} there are some quite influential parameters including Lerner indices, the demand elasticity for food, and the elasticity of substitution at the farm level.

Table 3
Mean values of elasticites of transfer efficiency measures with respect to model parameters

	Benefit/cost ratios				Cost/cost ratios		
	BC_{BF}	BC_{UI}	BC_{DI}	BC_{SC}	CC_{Consumer}	CC_{BS}	CC_{TX}
ε_A	−0.03	0.02	0.01	0.02	0.00	−0.01	0.00
ε_B	−0.21	0.16	0.00	0.12	0.00	−0.06	0.00
ε_G	0.03	−0.22	0.00	0.04	0.00	−0.02	0.00
ε_H	0.07	−0.55	0.00	0.09	0.00	−0.04	0.00
ε_J	0.05	0.05	−0.39	0.06	−0.04	−0.01	0.05
ε_K	0.09	0.09	−0.76	0.12	−0.08	−0.01	0.09
α_A	0.11	−0.20	0.03	−0.04	−0.01	0.01	0.03
α_B	0.41	−0.94	0.06	−0.08	−0.02	−0.02	0.10
α_G	−0.01	0.03	0.01	0.01	−0.01	−0.02	0.05
α_J	−0.06	−0.04	0.27	−0.04	0.04	−0.01	−0.05
σ_S	−0.04	0.06	0.00	0.02	0.00	−0.01	0.00
σ_F	−0.51	−0.52	1.85	0.03	0.42	−0.20	−0.51
η_E	−0.10	−0.09	−0.10	0.15	−0.10	0.19	−0.10
η_F	0.07	0.07	−1.25	0.17	−0.06	−0.05	0.07
λ	−0.76	−0.78	0.89	0.62	0.68	−0.61	−0.77
L_F	−0.05	−0.09	−2.55	0.81	0.05	−0.56	−0.05
L_G	0.01	−1.45	−0.02	0.41	−0.01	−0.18	0.01
L_H	−0.01	−3.73	−0.05	1.08	0.00	−0.55	0.00
MCF	−0.05	−0.05	−0.05	0.07	−0.05	−0.11	0.16

Own calculations.

5. Summary and discussion

Agricultural programs in developed countries commonly redistribute income from consumers and taxpayers to farmers. Many studies have measured the economic costs of such transfers stemming from inefficiencies in the use of production resources and distortions in consumption patterns (e.g. Babcock et al., 1990; Cramer et al., 1990; Gisser, 1993; Kola, 1993). Much less is known about distributive leakages due to income gains accruing to groups other than the intended beneficiaries of support. This study gives some empirical evidence of distributive leakages for the case of bread grain policy in Austria prior to EU accession. It is shown that the welfare gains of upstream and downstream industries are almost as large as those of bread grain farmers.

To account for the transfer effects in a multi-group analysis we have augmented Gardner's (1983) two-group (farmer and non-farmer) measure of average transfer efficiency. Utilising these new measures, we estimate that 33% of total program cost (the sum of welfare changes of all losing groups) are realised as benefits by bread grain farmers, 12% by upstream industries, and 15% by downstream industries. Adding up all winning groups' benefits ($33+12+15=60\%$) reveals that only 60% of the total program cost are transformed into benefits. Therefore, 40% are not realised as benefits by any group, but rather dissipated due to inefficient resource allocation. Hence, social costs (the sum of welfare change over all groups) divided by total program costs (the sum of welfare changes of all losing groups) is 0.4. This study therefore confirms a low transfer efficiency for agricultural programs, and reveals that this is not only due to inefficient resource use, but also to distributive leakages.

Utilising computer-intensive simulation techniques, we are able to show that most of our results are quite stable over a wide range of parameters. Moreover, utilising regression analysis, we are able to identify the parameters with the most important influence on model outcomes.

While the techniques used expose the effects of changes in parameters, the results still rest on assumptions that are not varied in the simulations, including constant returns to scale, constant elasticity of substitution or log-linear demand, and supply functions.

Acknowledgements

The authors would like to thank Patrick Westhoff, Kay Maas and two anonymous reviewers for helpful comments. Research was started while Klaus Salhofer was a Visiting Scholar at the University of California, Davis. He wishes to thank the Department of Agricultural and Resource Economics for its hospitality and also gratefully acknowledges support from the Austrian Science Fund, project no. J1479-OEK.

Appendix A

Table A.1 presents the summary of the parameter ranges.

Table A.1
Summary of the parameter ranges

Parameter	Range	Parameter	Range
ε_A	0.1–0.4	α_A	0.06–0.10
ε_B	0.2–1.0	α_B	0.29–0.39
ε_G	1.0–5.0	α_G	0.11–0.19
ε_H	1.0–5.0	α_J	0.27–0.37
ε_J	0.2–1.4	λ	0.07–0.10
ε_K	1.0–5.0	L_G	0–0.2
σ_S	0.1–0.9	L_H	0–0.2
σ_F	0.5–1.5	L_F	0–0.2
η_E	−0.1 to −0.6	MCF	0.1–0.4
η_F	−0.5 to −1.5		

Source: Salhofer (2001).

Appendix B

While it is difficult to prove formally in the context of our model the empirical result that the downstream industry gains from introducing a floor price above the world market price in the bread grain market, we provide a formal proof for a simpler model, depicting the downstream sector only.

As in our empirical model, assume a simple log-linear food (bread grain product) demand curve:

$$P = aQ^n, \quad \text{with } n = \frac{1}{\eta}, \tag{B.1}$$

where P is the price, Q the quantity, a the scale parameter and η the demand elasticity. Assume also that food supply is described by a simple log-linear function:

$$P = bQ^e, \quad \text{with } e = \frac{1}{\varepsilon}, \tag{B.2}$$

where b is a scale parameter and ε the supply elasticity. Note, that the food supply curve in our empirical model, implicit in the assumed CES production technology, is also log-linear.

Utilising a standard conjectural variation model (e.g. Bhuyan and Lopez, 1998), industry-wide pricing behaviour can be described as:

$$MC = P\left(1 + \frac{\theta}{\eta}\right), \quad \text{with } L = -\frac{\theta}{\eta}, \tag{B.3}$$

where MC is marginal cost, θ the conjectural variation elasticity, and L the Lerner index. Using (B.1)–(B.3) we can derive the quantity supplied:

$$Q = \left(\frac{a(1-L)}{b}\right)^{1/(e-n)}. \tag{B.4}$$

Rents (R) to food suppliers are given by revenues minus marginal cost:

$$R = PQ - \int_0^Q S(Q)\,\mathrm{d}Q. \tag{B.5}$$

Using Eq. (B.4) one can derive:

$$R = (A - B)b^{(n+1)/(n-e)},$$
$$\text{with } A = a(a(1-L))^{(n+1)/(e-n)}, \text{ and } B = \frac{(a(1-L))^{(e+1)/(e-n)}}{e+1}. \tag{B.6}$$

Introducing a floor price for bread grain, one of several inputs used to produce food, implies an increase in the cost of producing food. In our simple model this might be captured by an increase in the scale parameter b of the food supply function. An increase in costs will increase rents if $\partial R/\partial b > 0$. The first derivative of Eq. (B.6) with respect to b is:

$$\frac{\partial R}{\partial b} = [A - B]\frac{n+1}{n-e}b^{((n+1)/(e-n)-1)}. \tag{B.7}$$

Following standard assumptions that $a, b > 0$, $\varepsilon \geq 0$, $0 \leq L \leq 1$, and $\eta \leq 0$, A and B are positive. Hence, if the elasticity of demand $|\eta| < 1$, then $\partial R/\partial b > 0$, i.e. downstream industries gain from higher bread grain prices. Note that in our empirical model the demand for food is assumed to be quite inelastic ($-0.1 > \eta > -0.6$).

References

Aiginger, K., Wieser, R., Wüger, M., 1999. Marktmacht im Lebensmitteleinzelhandel. WIFO-Monatsberichte 12, 797–809.

Alston, J.M., Hurd, B.H., 1990. Some neglected social costs of government spending in farm programs. Am. J. Agric. Econ. 72, 149–156.

Astl, A., 1991. Markt für Getreide und Mahlprodukte. In: Breuer, G., Gattermayer, F., Hohenecker, J., Schneeberger, W., Steidl, A., Wöber, G., Wytrzens, H. (Eds.), Agrarvermarktung in Österreich: Von der Marktordnung zum Marketing. Service Fachverlag, Vienna, pp. 240–252.

Babcock, B.A., Carter, C.A., Schmitz, A., 1990. The political economy of U.S. wheat legislation. Econ. Inquiry 28, 335–353.

Bhuyan, S., Lopez, R.A., 1998. Oligopoly power and allocative efficiency in US food and tobacco industries. J. Agric. Econ. 49, 434–442.

Blandford, D., Dewbre, J., 1994. Structural adjustment and learning to live without subsidies in OECD countries. Am. J. Agric. Econ. 76, 1047–1052.

BMLF (Bundesministerium für Land und Forstwirtschaft), 1996. Grüner Bericht, Vienna, 1995.

BMLF (Bundesministerium für Land und Forstwirtschaft), 1997. Grüner Bericht, Vienna, 1996.

Bullock, D.S., Salhofer, K., 2003. Judging agricultural policies: a survey. Agric. Econ. 28, 225–243.

Cramer, G.L., Wailes, E.J., Gardner, B.L., Lin, W., 1990. Regulation in the U.S. rice industry, 1956–1989. Am. J. Agric. Econ. 72, 1056–1065.

Davis, G.C., Espinoza, M.C., 1998. A unified approach to sensitivity analysis in equilibrium displacement models. Am. J. Agric. Econ. 80, 868–879.

Gardner, B.L., 1983. Efficient redistribution through commodity markets. Am. J. Agric. Econ. 65, 225–234.

Giannakas, K., Fulton, M., 2000. Efficient redistribution using quotas and subsidies in the presence of misrepresentation and cheating. Am. J. Agric. Econ. 82, 347–359.

Gisser, M., 1993. Price support, acreage controls, and efficient redistribution. J. Polit. Econ. 101, 584–611.

Josling, T., 1969. A formal approach to agricultural policy. J. Agric. Econ. 20, 175–195.

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

Kola, J., 1993. Efficiency of supply control programmes in income redistribution. Eur. Rev. Agric. Econ. 20, 183–198.

Mazanek, R., 1995. Gewerbestatistik—Jahreserhebung 1993. Statistische Nachrichten 50, 543–549.

Mazanek, R., 1996. Industriestatistik—Jahreserhebung 1993. Statistische Nachrichten 51, 725–731.

Nerlove, M., 1958. The Dynamic of Supply. John Hopkins Press, Baltimore.

OECD, 1995. Adjustment in OECD agriculture, Paris.

Raab, F., 1994. Getreide und Mahlprodukte. In: Gattermayer, F., Hohenecker, J., Schiebel, W., et al. (Eds.), Agrarvermarktung in Österreich, second ed. Service Fachverlag, Vienna, pp. 325–342.

Salhofer, K., 1999. Distributive leakages of agricultural support: some empirical evidence from Austria. In: Proceedings of the Paper presented at the 1999 Annual Meeting of the Southern Agricultural Economics Association, Memphis.

Salhofer, K., 2001. Elasticities of substitution and factor supply elasticities in European agriculture: a review of past studies. In: OECD (Ed.), Market Effects of Crop Support Measures, Paris, pp. 89–119.

Salhofer, K., Schmid, E., Schneider, F., Streicher, G., 2001. Testing for efficiency: a policy analysis with probability distributions. Discussion Paper No. 87-W-01, Department of Economics, Politics and Law, University of Agricultural Sciences Vienna.

Wytrzens, H.K., 1991. Landwirtschaftlich genutzter Boden. In: Gattermayer, F., Hohenecker, J., Schiebel, W., Schneeberger, W., Steidl, A., Wöber, G., Wytrzens, H. K., Breuer, G. (Eds.), Agrarvermarktung in Österreich: Von der Marktordnung zum Marketing, second ed. (Revised and extended). Service Fachverlag, Vienna, pp. 185–194.

Zhao, X., Griffiths, W.E., Griffith, G.R., Mullen, J.D., 2000. Probability distributions for economic surplus changes: the case of technical change in the Australian wool industry. Aust. J. Agric. Resour. Econ. 44, 83–106.