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Efficient income redistribution for a small country using optimal combined instruments

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Abstract

In this paper I improve Gardner's surplus transformation curve framework by assuming that governments are able to vary many policy instruments simultaneously instead of only one. I use my framework to find the combination of the currently used instruments which provides the most efficient income redistribution for the Austrian bread grains market. Comparing the most efficient policy with the actual policy reveals that 464×10^6 Austrian shillings were wasted. I theoretically compare for a small country the transfer efficiency of every possible pair of the four major agricultural policy instruments: floor price, (production) quota, co-responsibility levy, and deficiency payments. Without considering the marginal cost of public funds (MCF), deficiency payments *cum* quota (equal to a fully decoupled direct income support) is the most efficient policy, succeeded by floor price *cum* quota, and floor price *cum* deficiency payments. If the MCF is taken into account, the ranking crucially depends on the market parameters, the transfer level, and the value of the MCF. For the Austrian bread grains market, I empirically demonstrate that given the present support level, a fully decoupled direct income support redistributes income most efficiently as long as the MCF is lower than 1.17. Beyond this value a floor price *cum* quota policy becomes more efficient. A floor price *cum* deficiency payments policy is never superior to the floor price *cum* quota.

1. Introduction

The surplus transformation curve (STC) framework of Gardner (1983) has been used in several studies to analyze theoretically (Alston and Hurd, 1990; Gardner, 1991; Maier, 1993a) and empirically (Gardner, 1985; Bullock, 1992; Kola, 1993; Maier, 1993b) the efficiency of agricultural policy. An STC similar to a utility feasibility frontier (Samuelson, 1950; Graaff, 1957) demonstrates government's potential to redistribute economic surplus (or income) between social groups through an agricultural program. By delineating STCs for different support programs it is possible to compare their redistribution efficiency at various transfer levels. As shown by Von Cramon-Taubadel (1992), Bullock (1994), Bullock and Jeong (1994), Bullock (1995) and Bullock (1996) STCs also indirectly play an important role in political preference function studies.

However, all STCs in the literature, except in Bullock (1994) and Bullock (1996), suffer from the weakness of assuming that government can change only one policy instrument at a time. Hence, they illustrate government's redistribution feasibilities only under this very restrictive assumption. To conquer this deficiency, in this study I introduce the more realistic assumption that

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policymakers are able to vary many policy instruments simultaneously. I generate an 'augmented' STC by optimally combining all currently used policy instruments, where 'optimal' means that along this STC instruments are combined in a way which minimizes social costs at every single support level. Therefore, this frontier illustrates government's redistribution feasibilities, given that it can freely choose the levels of all currently used instruments. The theory employed has been developed independently (Salhofer, 1993; Salhofer, 1994) but is similar to that demonstrated by Bullock (1994) and Bullock (1996). The paper in hand provides the first empirical application of the theory. In particular, I use my framework to determine the most efficient policy of the currently used instruments, floor price, (production) quota, and co-responsibility levy for the Austrian bread grains market, given that present producer support is at the socially desired level and neglecting the general equilibrium retroactive effects from related markets. Comparing the optimal combination with the actual policy reveals the social cost of a suboptimal implementation of the present instruments (Bullock and Salhofer, 1995b).

Furthermore, I am in search of the most efficient support policy for a small country given the four frequently used instruments of floor price, quota, co-responsibility levy, deficiency payments, and any possible combination of two of these instruments. By systematizing the results of previous studies (De Gorter and Meilke, 1989; Alston and Hurd, 1990; Maier, 1993a; Bullock, 1994), I am able to conclude that the efficiency ranking is as follows (italicized '*cum*' indicates an optimal combination of two instruments): deficiency payments *cum* quota (equal to a fully decoupled direct income support), floor price *cum* quota followed by floor price *cum* deficiency payments. This clear ranking only holds as long as the costs of raising public funds (MCF) are not taken into consideration. Empirically, I investigate the efficiency ranking for the Austrian bread grains market for different values of MCF.

2. Efficiency of the present support policy and Gardner's surplus transformation curve

Structure and support of the Austrian bread grains market (wheat, durum, rye) are illustrated in Fig. 1, where D is the domestic demand, S the domestic supply, and W the foreign demand/supply line, both perfectly elastic at the prevailing world-market price because of the small-country assumption. Farmers obtain a high floor price P of 3699 Austrian shillings per metric tonne (ATS t^{-1}) for a specific quota Q_c (961 619 t). (In an effort to mitigate the year-to-year price and quantity fluctuations, 3 year price and quantity averages over the period 1991–1993 were used. For the world market price, the aver-

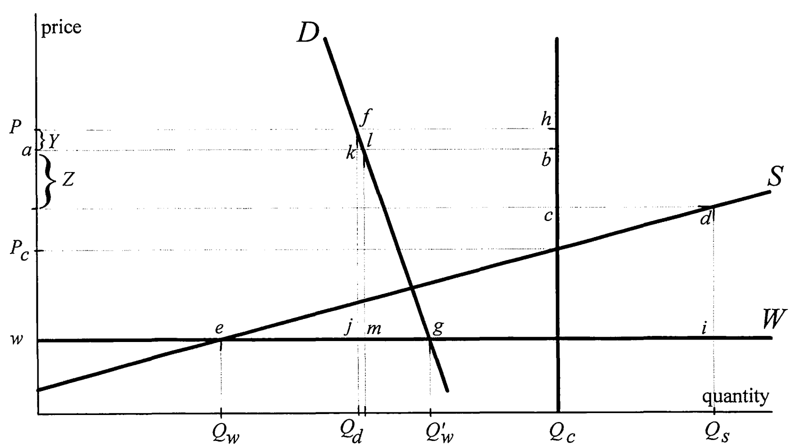

Fig. 1. Austrian bread grains market.

age export price is used. In 1992, 100 ATS = 9.1 $US.) Since farmers have to pay a co-responsibility levy (Y) the net producer price is ($P - Y =$ 3444 ATS t^{-1}). Quantities which exceed the quota can be delivered at a reduced floor price ($P - Y - Z = 2662$ ATS t^{-1}). This leads to a domestic demand (Q_d) of 601 668 t and supply (Q_s) of 1 182 892 t.

To compute the transfers and costs of various social groups caused by the policy, linear demand and supply curves and elasticities developed in some recent studies are employed. Schneider and Wüger (1988) estimated the demand for wheat and rye flours with single equations and systems of equations. Using statistical criteria, they selected as best parameters their (uncompensated) own-price elasticities for wheat and rye flours of −0.2 and −0.4, respectively. Using these results for the computations, I chose a demand elasticity of $\eta = -0.3$.

Neunteufel and Ortner (1989) estimated a supply elasticity of 1.13 for wheat in Austria using a simultaneous static model for agricultural products. The multiple regression is based on time series data from 1961 to 1987. Fischer et al. (1988) in a 'Food and Agricultural Model of Austria', first estimated parameters based on data from 1961 to 1976 and subsequently conducted an ex-ante simulation. This yielded a supply elasticity of 1.28 for wheat in Austria in 1991. However, I prefer the more recent result because of the greater number of observations and assume a supply elasticity of $\epsilon = 1.13$.

Since the elasticity on a linear curve is not constant, the quoted elasticities are reached at present prices and quantities of demand (P, Q_d) and supply ($P - Y - Z$, Q_s). Analytically, demand and supply are given by

$$Q_d = \alpha + \beta P = 782\,168 - 48.797P \quad (1)$$

and

$$Q_s = \gamma + \delta(P - Y - Z) = -153\,776 + 502.129(P - Y - Z) \quad (2)$$

where α and γ are the intercept and β and δ the slope of the demand and supply functions, respectively. The values of these parameters are derived by substituting the observed prices and quantities into Eqs. (1 NO TRANSLATION 2) and the definitions of the price elasticities ($\eta = \beta P / Q_d$; $\epsilon = \delta(P - Y - Z)/Q_s$).

Without government intervention the world-market price w (1120 ATS t^{-1}) would apply. Austrian farmers would produce quantity Q_w instead of Q_s. Hence, the income redistributed to farmers (ΔPS), i.e. the economic surplus achieved by producers due to the policy intervention, is *abcdew* in Fig. 1, or mathematically

$$\Delta PS = \int_w^{(P-Y-Z)} [\gamma + \delta x] \mathrm{d}x + ZQ_c = \gamma(P - Y - Z - w) + \frac{\delta}{2}\left((P - Y - Z)^2 - w^2\right) + ZQ_c \quad (3)$$

Because of the floor price policy, consumers have to pay P instead of w. Consumption is therefore Q_d instead of Q'_w, and consumers' surplus lost (ΔCS) is *Pfgw*, or

$$\Delta CS = \int_P^w [\alpha + \beta x] \mathrm{d}x = \alpha(w - P) + \frac{\beta}{2}(w^2 - P^2) \quad (4)$$

The intervention influences the budget (or taxpayers) in two ways. On the one hand, there are expenditures due to export restitution payments (*fhcdij*); on the other hand, revenues result from the co-responsibility levy (*Phba*). After subtracting the overlapping area (*fhbk*), the budgetary expenditure (T) equals *kbcdij* − *Pfka*, or

$$T = (P - Y - w)(\alpha + \beta P - Q_c) + (P - Y - Z - w) \times (Q_c - \gamma - \delta(P - Y - Z)) + (\alpha + \beta P)Y \quad (5)$$

Government's potential to redistribute economic surplus from one group to another can be illustrated using Gardner's surplus transformation curve framework. To date, all STCs in the literature, except in Bullock (1994) and Bullock (1996), have been computed as follows. Economic surplus redistributed to farmers (ΔPS) and the economic surplus lost by consumers/taxpayers (ΔCT), measured as

$$\Delta CT = \Delta CS + T \quad (6)$$

are both functions of some constant market parameters, which characterize supply and demand curves, and of policy instruments. Some studies assume ΔCT and ΔPS are functions of multiple policy instruments (Alston and Hurd, 1990; Bullock, 1992; Kola, 1993), one of which is variable and the others constant; and other studies assume only one policy instrument, which is variable (Gardner, 1983; Gardner, 1985; Hofreither, 1992). By changing the variable instrument, one obtains different pairs of ΔPS and ΔCT and, therefore, a surplus transformation curve.

Applying this framework to the Austrian bread grains market, it is possible to derive such standard STCs by continuously varying one of the four policy instruments (P, Y, Z, Q_c) in Eqs. (3)–(6) while holding the other three instruments constant, given the market parameters ($\alpha,\beta,\gamma,\delta,w$). For example, STC^P in Fig. 2 is computed by increasing the price P continuously, starting at the world-market price w while retaining Y, Q_c, and Z at present levels. (Sometimes STCs are represented using absolute values of PS and CT (Gardner, 1983). The diagram used here, with axes of ΔPS and ΔCT, is credited to Gardner (1985).) The origin represents the situation with no intervention. As government increases the floor price above the nonintervention price level, farmers gain and consumers/taxpayers lose, moving 'northwest' along STC^P. The first kink appears when $(P-Y)$ is increased beyond P_c, and the quota becomes effective. The second kink appears when $(P-Y-Z)$ exceeds P_c, the point from which it makes economic sense to produce more than the quota. The policy then becomes less efficient and the curve flattens out again. All three parts of this curve are slightly concave. To be able to calculate the surplus changes of these three different situations using Eqs. (3)–(6), one has to assume that if $(P-Y) \leq P_c = -\gamma/\delta + 1/\delta Q_c$ then $Z=0$ and $Q_c = Q_s = \gamma + \delta(P-Y)$; if $(P-Y) > P_c$ and $(P-Y-Z) \leq P_c$ then $Z = P - Y - P_c$.

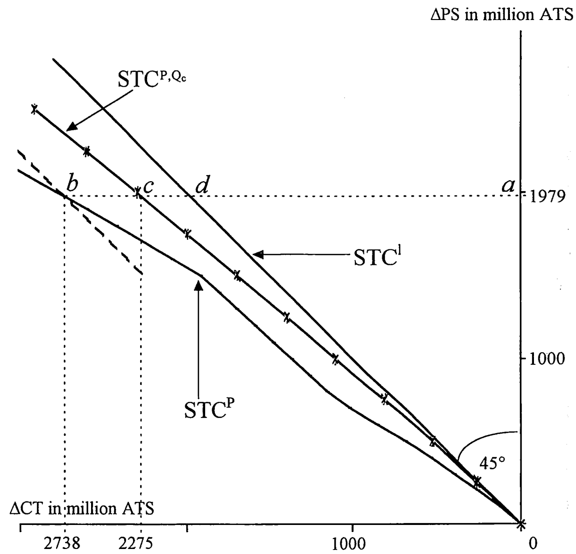

Fig. 2. Surplus transformation curves for alternative support policies.

Under the actual floor price the transferred producers' surplus is estimated to be 1979 million ATS ($0a$ in Fig. 2). The cost to consumers/taxpayers amounts to 2738 million ATS (ab). This means that the average transfer efficiency ($0a/ab$) equals −72%, which represents a social cost ($\Delta PS + \Delta CT$) of about 28% (759 million ATS) (Table 1). In this graphical representation, a redistribution policy becomes increasingly efficient, the further the STC lies to the 'northeast'.

Table 1
Implications of the present policy and the optimal support policy

	Average transfer efficiency (%)	Floor price P (ATS t^{-1})	Co-respons. levy Y (ATS t^{-1})	Price difference Z (ATS t^{-1})	Quota Q_c (1000 t)	Output Q_s (1000 t)	ΔPS (million ATS)	ΔCS (million ATS)	T (million ATS)	ΔCT (million ATS)
Present support	−72	3699	255	782	961.619	1182.892	1979	−1714	−1024	−2738
Optimal support	−87	4141	0	2482	679.175	679.175	1979	−1975	−299	−2275
Difference	20 [a]	422	−255	1700	−282.444	−503.717	0	−261	725	464

[a] $100 \times (-87+72)/(-72) = 20$.

Similarly, one could exemplify three other standard STCs by varying the co-responsibility levy Y or the difference between the high and the reduced floor price Z or the quota Q_c while maintaining the other instruments constant at the present level. All four STCs would intersect at point b with different slopes (Bullock, 1994). For example, the dotted line through point b intimates the STC derived by varying only the quota keeping all other instruments constant. While STC^P and all other possible standard STCs are able to provide information on the average transfer efficiency of the actual policy, they can illustrate government's redistribution feasibilities only under the very restrictive assumption that government can change just one instrument at a time.

3. Optimal combination of policy instruments and 'augmented' surplus transformation curve

3.1. Optimal combination of present intervention instruments

To give a more realistic picture of government's redistribution feasibilities it will now be assumed that government can vary all currently used instruments simultaneously. Because efficient redistribution feasibilities are of interest above all, one has to solve the optimization problem

min.

$$\begin{aligned} &-\Big[\alpha(w-P)+\frac{\beta}{2}(w^2-P^2) \\ &+(P-Y-w)(\alpha+\beta P-Q_c) \\ &+(P-Y-Z-w)(Q_c-\gamma-\delta(P-Y-Z)) \\ &+(\alpha+\beta P)Y\Big] \\ &\text{s.t.}\,\Delta \overline{PS}=\gamma(P-Y-Z-w) \\ &+\frac{\delta}{2}\left((P-Y-Z)^2-w^2\right)+ZQ_c \end{aligned} \tag{7}$$

Minimize consumers/taxpayers' costs subject to a fixed producer surplus. This nonlinear optimization problem was solved using GAMS software (Brooke et al., 1988). (GAMS programs are available on request.)

The above method can be explained by reference to Fig. 2. First, ΔPS is fixed at some level of $\Delta \overline{PS}$, for example at the present support level of 1979 million ATS while looking for the combination of policy instruments that ensures an outcome for consumers/taxpayers which lies as far as possible to the right on the line ba. By solving the minimization problem we obtain point c. By changing the fixed value of $\Delta \overline{PS}$, and repeatedly solving Eq. (7) we are able to trace out STC^{P,Q_c}. This augmented STC illustrates government's redistribution feasibilities, given that the four actually applied instruments (P, Y, Z, Q_c) are freely available to government, while along STC^P it is only P. Since the outcome of the actual policy (b) is not a point on STC^{P,Q_c}, government has not combined policy instruments optimally.

The optimal policy instrument combination for the present producer support level is summarized in Table 1. Firstly, it would be optimal to abandon the co-responsibility levy. This result is in accordance with De Gorter and Meilke (1989, pp. 597–598) who argued that a co-responsibility levy can be viewed as a floor price policy in combination with a domestic consumption tax and is therefore never more efficient than a pure floor price policy. Their argument can be reviewed with the help of Fig. 1. Abolishing the co-responsibility levy and fixing floor prices at $(P-Y)$ keeps producers' surplus at the same level but reduces the consumer price and therefore increases consumers' surplus by *Pfla*. On the one hand, the budget is disburdened by a higher domestic demand (*klmj*) while, on the other hand, the net revenues from the levy (*Pfka*) are lost. On the whole, by abolishing the levy there are welfare gains of *flmj*. Secondly, supply of bread grains beyond quota should be not supported since the optimal value of Z is 2482 ATS t^{-1} which implies that $(P-Y-Z)=P_c$. Thirdly, the current quota is 20% too high and the price 12% too low to be optimal for the support provided to producers. This is in accordance with the finding of Gardner (1983, p. 230) that a low demand and a high supply elasticity tend to make production control more effective.

If the co-responsibility levy and the reduced floor price instruments were not applied, and P and Q_c were fixed at their optimal values, the average transfer efficiency would increase by about 20% and bring gains for consumers/taxpayers of 464 million ATS (*bc* in Fig. 2), while maintaining producers' assistance at the present level. In other words, by not implementing the applied instruments optimally a social cost of 464 million ATS was induced.

3.2. Alternative support policy

Beside quotas, floor price, and co-responsibility levy, deficiency payments are the most often discussed instrument. Therefore, I will attempt to answer the question of whether adding deficiency payments to the presently used instruments could increase the efficiency of redistribution. Bullock (1994; see also Bullock and Salhofer, 1995a) shows that an optimal combination of two policy instruments is at least as efficient as each of these two policy instruments are on a separate basis. Given this fact and the earlier finding that co-responsibility levy is always inferior to a pure floor price policy, one of the following three pairs should be the most efficient for a small country: (i) floor price *cum* quota; (ii) deficiency payments *cum* quota; (iii) floor price *cum* deficiency payments.

Maier (1993a) demonstrated that for any combination of floor price and deficiency payments one can find a more efficient combination of floor price and quota. His argument is briefly retraced in Fig. 3. A combination of floor price and deficiency payments policy means that producers obtain a price P for the domestic demanded quantity Q_d, financed by domestic consumers and a lower price P' for the quantity that exceeds domestic demand, financed by taxpayers. By imposing a quota equal to Q_c it is possible to transfer additional income to farmers at the same deadweight loss.

Alston and Hurd (1990) have demonstrated graphically that an optimal combination of deficiency payments and quota is to fix output at the nonintervention level Q_w and redistribute the desired support level by lump sum transfers. Obviously, this support policy is equal to a fully decoupled direct income support policy. As long as the marginal costs of public funds are neglected this policy has no deadweight loss and is illustrated by the 45° line STC[1] in Fig. 2. Given the above, the transfer efficiency ranking is (i), succeeded by (ii), and (iii).

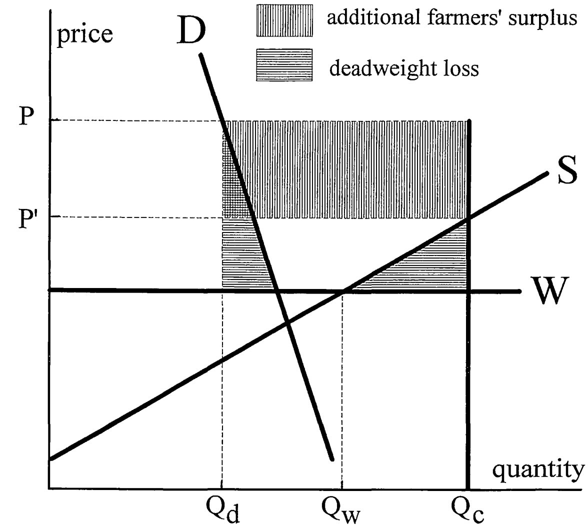

Fig. 3. Floor price *cum* quota vs. floor price *cum* deficiency payments.

4. Considering the cost of public funds

Alston and Hurd (1990), Chambers (1993) and Alston et al. (1993) pointed out that it is important to take into account the welfare costs of distortions caused by the collection of taxes to finance government spending for the evaluation of farm programs. To this purpose we have to multiply the budgetary burden (T) by the marginal cost of public funds (MCF). (I use the marginal value because agricultural expenditures accounted for only 1.6% of the total budget in Austria in 1991 (OECD, 1992, p. 350.) As soon as the MCF is greater than 1, any of the three optimal combinations (i), (ii), and (iii) might be the most efficient. The market parameters, the

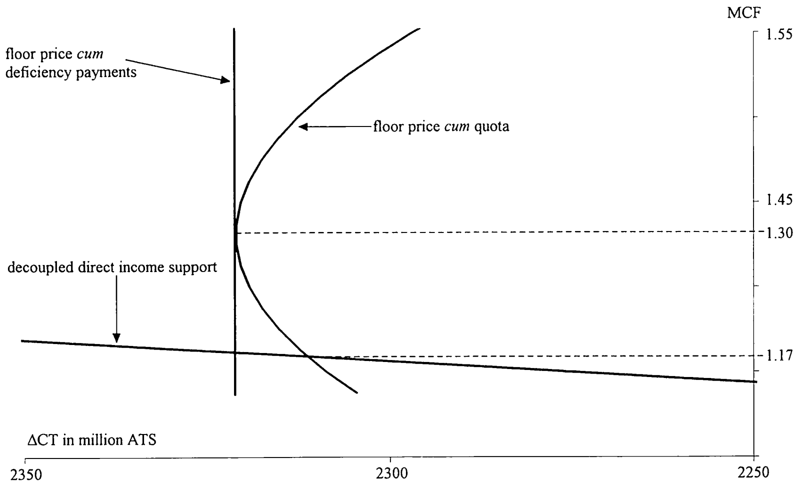

Fig. 4. Efficiency ranking and marginal costs of public funds.

MCF as well as the amount of transfer determine which one is superior. The magnitude as well as the exact theoretical foundation of the MCF are still subjects of discussion (Ballard, 1990; Fullerton, 1991; Ballard and Fullerton, 1992; OECD, 1994, pp. 30–34). Various studies have developed estimates that lie in the range 1.17–1.55 (Hagemann et al., 1988).

To obtain empirical results for the Austrian bread grains market, I fix the transfer at the present level of 1979 million ATS and vary the MCF between 1.17 and 1.55. Fig. 4 reveals that as long as the MCF is lower than about 1.17 a fully decoupled direct income support has the lowest costs to consumers/taxpayers and is hence most efficient. Beyond this value a floor price *cum* quota policy is superior. As the MCF increases, exports become more costly and therefore the optimal quota decreases. At an MCF of 1.3 the optimal policy is to limit output at the domestic demanded quantity and have no exports. As the MCF increases beyond 1.3 the costs of consumers/taxpayers can be decreased by setting the quota below the self-sufficiency level, hence levying the imports.

Because of the inelastic demand, elastic supply, and low world-market price, the optimal combination of floor price and deficiency payments should redistribute all income by floor price instead of deficiency payments for the whole range of MCF values investigated. This means that it is optimal to have no exports, whereby the curve for floor price *cum* deficiency payments is therefore tangent to the curve for floor price *cum* quota if the MCF equals 1.3.

5. Discussion

The efficiency of agricultural programs is often discussed using Gardner's STC which illustrates the trade-off between consumers/taxpayers' and producers' surpluses. As discussed here, such 'conventional' STCs only represent government's feasibilities to redistribute economic surplus (or income) under the very restrictive assumption that government can change just one instrument at a time. In this study, I overcome the above limitation by assuming that government is able to change more than one policy instrument simultaneously. The 'augmented' STC thus illustrates the optimal redistribution feasibilities, given that all currently applied instruments are freely available to government. With this augmented STC it becomes possible to compare not only simple policies like floor price to quota but combined policies like floor price *cum* quota to deficiency payments *cum* quota. In addition, this method makes it possible to discuss whether government has combined instruments efficiently and to determine the social costs of inefficient instrument combination. For a formal approach to measure the social costs of an inefficient combination of policy instruments, see Bullock and Salhofer (1995b).

Given the four commonly used agricultural policy instruments (floor price, quota, co-responsibility levy, deficiency payments), not considering the cost of raising public funds, the efficiency ranking was found to be deficiency payments *cum* quota (= fully decoupled direct income support), succeeded by floor price *cum* quota, and floor price *cum* deficiency payments. As soon as the costs of public funds are considered the ranking becomes indeterminate and subject to empirical investigations as shown for the Austrian bread grains market. It was revealed that optimally combining the actual employed instruments could decrease social costs considerably. Perhaps adding other policy instruments (e.g. input subsidy) could further improve transfer efficiency.

The major limitations of the study are common in the literature, and are well known and inherent in static, single-market analyses. Substitution effects in related markets, as well as income leakages to input and intermediary sectors have not been taken into consideration in this paper (Thurman and Wohlgenannt, 1989). Because of the static framework, it is not possible to analyze structural changes. But quota programs can lead to structural changes that depend on the arrangements for quota transfer, and can therefore lead to additional social costs not observed in this study (Burrell, 1991; OECD, 1990, pp. 13–37). Direct income support, however, is rarely decoupled and can hence be accompanied by many distortions (OECD, 1990, pp. 33–53; Kjeldahl, 1993). As Munk (1989) and Hofreither (1992) have stated, administrative and enforcement costs must also be considered when drawing final conclusions. Finally, the environmental impact of the different policy options have not been taken into account (Gardner, 1991).

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