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The economics of coupled farm subsidies under costly and imperfect enforcement

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Abstract

This study relaxes the assumption of perfect and costless policy enforcement found in traditional agricultural policy analysis and introduces enforcement costs and cheating into the economic analysis of output subsidies. Policy design and implementation is modeled in this paper as a sequential game between the regulator who decides on the level of intervention, an enforcement agency that determines the level of policy enforcement, and the farmer who makes the production and cheating decisions. Analytical results show that farmer compliance is not the natural outcome of self-interest and complete deterrence of cheating is not economically efficient. The analysis also shows that enforcement costs and cheating change the welfare effects of output subsidies, the efficiency of the policy instrument in redistributing income, the level of government intervention that transfers a given surplus to agricultural producers, the socially optimal income redistribution, and the social welfare from intervention. ©2000 Elsevier Science B.V. All rights reserved.

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1. Introduction

The traditional analysis of production subsidies (per unit and ad valorem subsidies) and deficiency payments takes place under the assumption that either farmers comply completely with the provisions of these farm programs or policy enforcement is perfect and costless. If cheating on farm programs is profitable however, full compliance is by no means assured unless monitoring and enforcement are costlessly carried out. [1] Because of the cost associated with investigating farmers and punishing the detected cheaters, program enforcement is likely to be incom-

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[1] Monitoring refers to the actions taken by policy makers to determine whether a farmer complies with the provisions of the subsidy program and includes on-site inspections and reviewing the records of a farm. Enforcement refers to the process of moving violators into compliance through penalties and/or criminal prosecution for instance. In what follows, the terms monitoring and/or enforcement will be used interchangeably to denote the process of investigating farmers and punishing the detected cheaters.

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plete. Imperfect enforcement in turn creates economic incentives for farmers to cheat on the farm program.

In fact, cases of cheating on farm programs are often reported by the European Press (Moyer and Josling, 1990). Fraud is considered to be an integral part of the common agricultural policy (CAP) (Ockenden and Franklin, 1995; Gardner, 1996). Gardner argues that the manipulation of regulations "to milk the maximum in subsidies" from the European Union's (EU) farm budget, "is not only common, standard practice... but is also accepted as standard practice" (Gardner, 1996, pp. 44).

The possibility of cheating on subsidy programs in the EU arises from the fact that eligibility for most government payments usually requires farmers to make an application for the payment (Harvey, 1997).[2] By over-reporting the level of their production on the application, farmers can collect payments on quantities greater than those produced. A recent report on the extent of cheating on farm subsidies in the EU estimates the 'losses' through fraud and lax controls in the payment of farm subsidies and subsidy overpayments to $4 billion per year.[3] These cheating costs account for up to 10% of the 36 billion ECU a year laid out on agricultural support through the CAP (Gardner, 1996).

Cheating on farm programs is not an exclusive European characteristic however. In the United States, the existence of a United States Department of Agriculture (USDA) 'hotline', where cases of 'fraud' related to 'submission of false claims/statements' can be reported, indicates that the problem of cheating on farm programs is not unknown to US agricultural policy makers (USDA Office of Inspector General, 1999).

Very few studies have incorporated misrepresentation or cheating in theoretical agricultural policy analysis. Among the exceptions are Alston and Smith (1983) who raise the question of cheating and 'black market' activity in an examination of rationing in an industry with an effective minimum price policy in place and Giannakas (1998) who examines the incidence of output quotas, deficiency payments and decoupled area payments under costly and imperfect enforcement.[4]

The purpose of this study is to introduce enforcement costs into the economic analysis of output subsidies (production subsidies and deficiency payments) and to examine the causes and consequences of farmer misrepresentation. The consequences of cheating for the incidence of output subsidies are considered in the context of a static, partial equilibrium model of a closed economy. A key element of the subsidy policy modeled in this paper is that farmers report their own production. Therefore, the results of the analysis apply to cases where eligibility for government subsidies requires farmers to make an application for the payment.

Analytical results show that compliance with policy rules is not the expected producer behavior and complete deterrence of cheating is not economically efficient. The analysis also shows that enforcement costs and cheating change the welfare effects of output subsidies, the efficiency of the policy instrument in transferring income to agricultural producers, the level of government intervention that transfers a given surplus to producers, the socially optimal income redistribution, and the social welfare from intervention. The relevance of the analysis for a small open economy and the large country case is discussed throughout the text.

2. Agricultural policy making

The agricultural policy making structure in most countries, and certainly the EU and the US, is characterized by a separation of powers between the agencies responsible for policy design and policy enforcement. In the EU, the level of the transfer is decided by the Council of Ministers of Agriculture and the countries/members are assigned the implementation and

[2] There are complaints heard throughout Europe that farmers spend more time filling in forms than farming (Ockenden and Franklin, 1995).

[3] EU fraud and waste on farm subsidies, 117 Journal of Commerce, 22 December 1997.

[4] This paper is based on Chapter IV of Giannakas' Ph.D. Dissertation (Giannakas, 1998). Working papers currently in review examine the other policy instruments considered in the dissertation, namely output quotas and decoupled area payments. A fourth paper (Giannakas and Fulton, 1999) focuses on the efficiency of quotas and subsidies in an institutional structure in which a single agency determines both enforcement and policy intervention. The assumption of a single agency is in contrast to the institutional arrangement with separate regulatory and enforcement agencies examined in this paper.

enforcement of the policy (Runge and von Witzke, 1987; From and Stava, 1993; Swinbank, 1997). In the US, the legislative body of the government (i.e., the Congress) decides on the farm policy and the level of transfer to producers and the USDA is responsible for carrying out the programs (Gardner, 1987; Moyer and Josling, 1990). More specifically, the Secretary of Agriculture decides on the level of the policy instrument that achieves the policy objectives, and the Agricultural Stabilization and Conservation Service (now the Farm Services Agency) implements and enforces the commodity programs.

To capture this separation of activities, an institutional arrangement characterized by decentralized policy making is adopted in this paper. More specifically, policy design and implementation is modeled in this paper as a sequential game between the regulator who decides on the level of intervention, an enforcement agency that determines the level of policy enforcement, and the farmer who decides on the quantity to produce and the quantity to misrepresent. The payoff functions of all agents are assumed to be common knowledge. The regulator moves first and decides on the subsidy knowing exactly how her decisions will affect enforcement and misrepresentation. Optimal enforcement is determined next. Finally, the farmer makes his production and cheating decisions, observing both the policy variable and the enforcement parameters. Different scenarios concerning the political preferences of the enforcement agency and the decision variables it controls are examined within this framework.

All formulations of the sequential game developed in this paper are solved using backwards induction (Kreps, 1990; Gibbons, 1992). The problem of the farmer is considered first, the problem of the enforcement agency follows and, finally, the solution to the problem of the regulatory agency determines optimal intervention, enforcement and misrepresentation.

3. Output subsidies and optimal farmer misrepresentation

Production subsidies and deficiency payments have often been used by policy makers, alone or in conjunction with other policies like price supports, supply controls, and/or trade policies, to encourage production of a specific commodity and/or to transfer income to producers. Both producers and consumers have benefited from production subsidies and deficiency payments while taxpayers have incurred the costs. Fig. 1 depicts the traditional static, partial equilibrium welfare effects of a production subsidy scheme for a closed economy with linear approximations of supply and demand curves (Nerlove, 1958; Wallace, 1962). In this static context the production subsidy program is identically equivalent to a target price-deficiency payment scheme.[5] In what follows, the terms output subsidy and subsidy will be used to denote a production subsidy and/or a deficiency payment.

Under a per unit output subsidy of v, producers receive an increase in producer surplus equal to the area $p^{t}BCp^{e}$, consumers gain area $p^{e}CDp^{c}$, while taxpayers lose area $(1+d)\ p^{t}BDp^{c}$, where d is the marginal deadweight loss from taxation (Ballard and Fullerton, 1992). Taxpayers' cost is given by the product of the market clearing quantity and the subsidy paid to farmers, adjusted to account for the positive deadweight losses from taxation. The distortionary costs of market intervention equal the area BCD plus $d(p^{t}BDp^{c})$ (Gardner, 1983,1987; Alston and Hurd, 1990). The implicit assumption in this analysis is that farmers do not misrepresent their production, i.e., farmers do not cheat.

Given the increased benefits from an output subsidy scheme, however, farmers may find it economically optimal to increase further their returns by over-reporting the level of their production and collecting government payments for phantom output. Assuming farmers know with certainty the subsidy for their production, the penalty in case they are caught cheating, and the probability of being investigated,

[5] The equivalence of deficiency payments and production subsidies (i.e., per unit subsidies and ad valorem subsidies) may break down when market conditions change. Since, by definition, deficiency payments make up the difference between some target price and the corresponding market clearing price, changes in supply and/or demand leave the price received by producers in the presence of the program unaffected; the deficiency payment is adjusted so that the (target) price is constant. On the other hand, when a per unit subsidy (or an ad valorem subsidy) is in effect, the price received by producers (and, thus, the quantity produced) changes as the market conditions change; production subsidies do not stabilize the price received by producers. Changes in the market conditions also change the per unit subsidy that is equivalent to a particular ad valorem subsidy (Gardner, 1987).

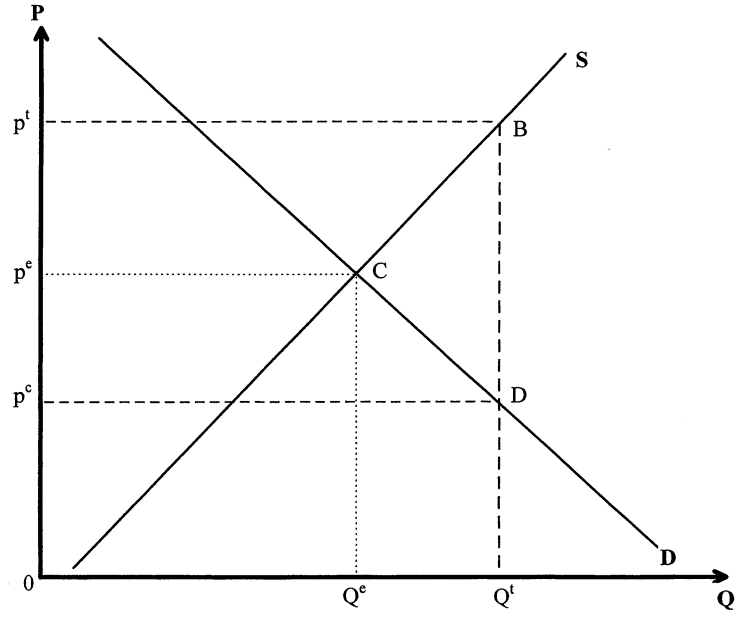

Fig. 1. The welfare effects of production subsidies and deficiency payments.

their decision on whether to cheat (and if so, by how much) can be modeled as decision-making under uncertainty. In this framework, the individual farmer's choice can be viewed as a choice between a certain outcome (profits if he does not cheat) and his profits in case he misrepresents his level of production. Assuming the representative farmer is risk neutral, his objective function can be written as:

$$\max_{q^t,q_m} E[\Pi] = (p^c + v)q^t - c(q^t) + [(1-\delta)v - \delta\rho]\, q_m \qquad (1)$$

where p^c is the market clearing price; v the output subsidy; q^t quantity produced; $c(q^t)$ cost function; q_m is the quantity reported as eligible for payments over and above q^t; ρ is the per unit penalty charged on detected misrepresentation; and δ is the probability that the farmer will be audited.[6] If the farmer is cheating on the farm program, δ reflects the probability he will be detected and punished. The probability of audit takes values between 0 and 1 (i.e., $\delta \in [0,1]$) and reflects the intensity with which agricultural policy is enforced and with which cheating is investigated.

The audit probability is assumed to be a linear function of the amount of cheating, i.e., $\delta = \delta_0 + \delta_1 q_m$, where δ_0 is a fixed base probability and $\delta_1 q_m$ is a component that depends on the misrepresented quantity. The parameter δ_0 is assumed to be dependent on the resources spent for policy enforcement. The parameter δ_1 depends on factors affecting the observability of farmers' actions (e.g., such as location and dispersion of the farms) and is assumed to be strictly positive and exogenous to both policy enforcers and producers.

[6] The model in Eq. (1) can be modified to include risk aversion of the representative farmer and/or private costs from cheating. The risk averse farmer will choose q_m that maximizes his expected utility (i.e., $\max_{q^t,q_m} E[U(\Pi)] = (1-\delta)U[(p^c+v)q^t - c(q^t) + vq_m] + \delta U[(p^c+v)q^t - c(q^t) - \rho q_m]$). In terms of output misrepresentation, risk aversion results in reduced cheating relative to the case where risk neutrality is assumed. Cheating also falls when the costs incurred by farmers in protecting themselves from detection (i.e., $k(q_m)$) are incorporated into the representative farmer's objective function. Even though both risk averse behavior and private costs from cheating change the results quantitatively, the qualitative nature of the results in this study remains unaffected. Notice that in cases where government payments are based on delivered product, cheating requires collusion between the agency responsible for the payments and the farmer. In such a case, the component kq_m would represent the bribes to the corrupt government official and/or the processor.

The first order conditions for the representative farmer's problem are

$$\frac{\partial E[\Pi]}{\partial q^{\mathrm{t}}} = 0 \Rightarrow p^{\mathrm{c}} + \mathrm{v} = c'(q^{\mathrm{t}}) \tag{2}$$

$$\frac{\partial E[\Pi]}{\partial q_{\mathrm{m}}} = 0 \Rightarrow \mathrm{v} - \delta_0(\mathrm{v}+\rho) - 2\delta_1(\mathrm{v}+\rho)q_{\mathrm{m}} = 0 \Rightarrow q_{\mathrm{m}} = \frac{\mathrm{v} - \delta_0(\mathrm{v}+\rho)}{2\delta_1(\mathrm{v}+\rho)} \tag{3}$$

Eq. (2) shows that the farmer will produce where the market price plus subsidy equals the marginal cost of production. Note that the optimal output level does not depend on any of the parameters associated with farmer misrepresentation.

Eq. (3) shows the optimal choice of the quantity misrepresented by the representative farmer as a function of subsidy payments, per unit penalty and audit probability parameters. Eq. (3), thus, reflects the best response of the farmer to the choices made by the regulatory and enforcing agencies. Consistent with a priori expectations, misrepresented quantity increases with the subsidy payment and decreases with an increase in the audit probability and per unit penalty parameters (i.e.,$\partial q_{\mathrm{m}}/\partial \mathrm{v} > 0$, $\partial q_{\mathrm{m}}/\partial \delta_0 < 0$ and $\partial q_{\mathrm{m}}/\partial \rho < 0$).

Manipulation of the expression for q_{m} indicates that the over-reported quantity is positive when δ_0 is less than $v/(v+\rho)$, when v is greater than $\delta_0\rho/(1-\delta_0)$, or when ρ is less than$(1-\delta_0)\mathrm{v}/(\delta_0)$. These critical values for δ_0, v and are denoted δ_0^{nc}, v^{nc} and ρ^{nc}, respectively, where the superscript nc stands for no cheating.

A manipulation of Eq. (3) shows that the optimal level of misrepresentation is given by equating $v/(v+\rho)$ and $\delta_0 + 2\delta_1 q_{\mathrm{m}}$. Fig. 2 shows this relationship graphically. The horizontal line $v/(v+\rho)$ shows the ratio of the marginal benefits in case cheating goes undetected, over the opportunity cost in case the farmer is caught cheating. The line $\delta_0 + 2\delta_1 q_{\mathrm{m}}$ shows the change in the output that is expected to be penalized for a change in the quantity misrepresented, or the marginal penalized output (MPO). Finally, line delta in Fig. 2 graphs the audit probability, δ.

Fig. 3 graphs the determination of optimal misrepresentation at the industry level. The lines DELTA and MPO are the horizontal summation of individual farmers' delta and MPO curves, respectively. Both curves have an intercept of δ_0 when they are graphed relative to the origin of D in Fig. 3. The slopes of DELTA and MPO curves are δ_1/N and $2\delta_1/N$, respectively, where N is the number of representative farmers producing the subsidized commodity. The intersection of $v/(v+\rho)$ and MPO gives the aggregate quantity misrepresented at equilibrium which can be written as

$$Q_{\mathrm{m}} = Nq_{\mathrm{m}} = \frac{\mathrm{v} - \delta_0(\mathrm{v}+\rho)}{2\delta_1'(\mathrm{v}+\rho)} \quad \text{where} \quad \delta_1' = \frac{\delta_1}{N} \tag{4}$$

When the combination of policy variable and enforcement parameters are such that farmers misrepresent their production, traditional analysis fails to consider the area BEGH. This area represents farmers' expected benefits from cheating, $E[B_{\mathrm{c}}] = [\mathrm{v} - \delta(\mathrm{v}+\rho)]Q_{\mathrm{m}}$. The benefits from cheating constitute a decoupled income transfer from taxpayers to producers, since the transfer does not affect farmers' production decisions. [7]

Even though not present in the stylized Fig. 3, monitoring and enforcement costs should be included in both the taxpayers' costs and the welfare losses from market intervention. The resource costs of enforcing the program by investigating the farmers and convicting the detected cheaters, denoted as $\Phi(\delta_0)$, are assumed to be a non-decreasing function of the base audit probability (i.e., $\Phi'(\delta_0) \geq 0$, $\Phi''(\delta_0) \geq 0$).

There are also fixed costs associated with the operation of the enforcement agency. These costs are not incorporated into the model. The reason for the exclusion of these fixed costs lies in the presumption that the existence of the agency responsible for policy enforcement depends on government intervention in agriculture rather than the presence of any commodity program in particular.

[7] Due to the decoupled nature of the surplus transfer through output misrepresentation, the analysis of cheating on output subsidies presented in this section of the paper is not affected by any assumption about trade consideration. Consider the case of an output subsidy adopted by a country that exports the regulated commodity. When the country faces a perfectly elastic demand curve (i.e., case of a small open economy), p^{c} in Eq. (1) will account for the (unaffected) world price. In the large country case, the market price (p^{c} in Eq. (1)) would reflect the (distorted) world price after intervention. In either case, the subsidy v equals the difference between the price received by producers and the relevant world price and the best response function of the farmers is the one given by Eq. (4).

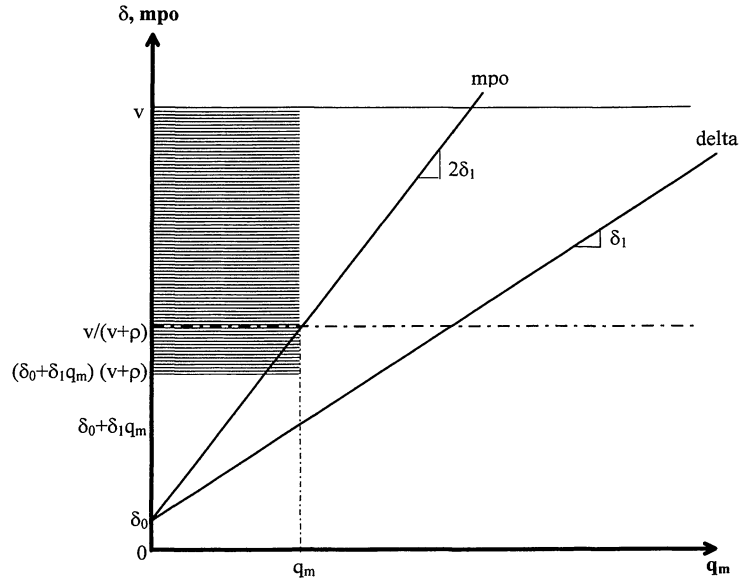

Fig. 2. Optimal farmer misrepresentation on output subsidies (cheating equilibrium).

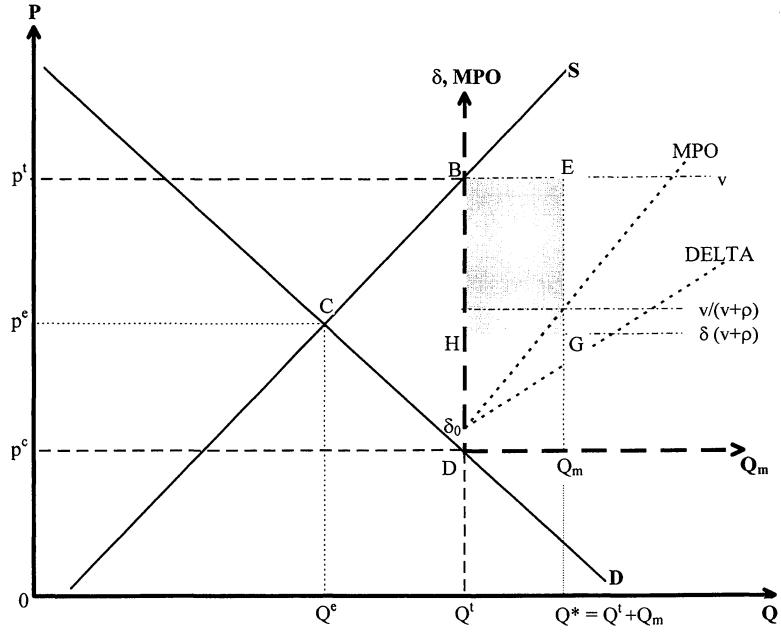

Fig. 3. The welfare effects of output subsidies under costly enforcement and misrepresentation.

4. Optimal enforcement by the enforcement agency

Eq. (4) indicates that farmer misrepresentation under a subsidy scheme depends on the level of the payment and the enforcement parameters. Since, however, the enforcement parameters and the policy variable are endogenous to agricultural policy makers, the question that arises is whether complete deterrence of cheating is the optimal response of regulatory and enforcement

agencies to the (optimizing) behavior of the farmers (which has been shown to include cheating when allowed by the circumstances).

This section of the paper examines the problem of policy enforcers. The problem of the enforcement agency is to determine the degree to which the subsidy scheme designed by the regulator is enforced. In making this decision, the enforcement agency knows exactly how its decisions will affect the (optimizing) behavior and welfare of farmers.

The level of enforcement is determined by the enforcement parameters, the audit probability and the penalties. Penalties for producers detected cheating on farm programs are generally set elsewhere in the legal system and are, therefore, exogenous to agricultural policy makers. With ρ exogenous to agricultural policy makers, the problem of the enforcement agency is the determination of the δ_0 that maximizes its objective function. The general form of the enforcement agency's problem can be written as:

$$\max_{\delta_0} W = \theta\,\mathrm{PS} + \mathrm{TS}$$
$$= \theta\left\{S(Q^{\mathrm{t}})Q^{\mathrm{t}} - \int_0^{Q^{\mathrm{t}}} S(Q)\,\mathrm{d}Q + [(1-\delta)(S(Q^{\mathrm{t}}) - D(Q^{\mathrm{t}})) - \delta\rho]Q_{\mathrm{m}}\right\} - (1+d)\left\{[S(Q^{\mathrm{t}}) - D(Q^{\mathrm{t}})]Q^{\mathrm{t}} + [(1-\delta)(S(Q^{\mathrm{t}}) - D(Q^{\mathrm{t}})) - \delta\rho]Q_{\mathrm{m}} + \Phi(\delta_0)\right\} \quad (5)$$

$$\text{s.t.} \quad Q_{\mathrm{m}} = \frac{\mathrm{v}\text{-}\delta_0(\mathrm{v}+\rho)}{2\delta_1'(\mathrm{v}+\rho)}$$

where $D(Q)$ and $S(Q)$ are the inverse demand and supply functions, respectively, and θ is the weight placed by the enforcement agency on producer welfare. All other variables are as previously defined. The consumer surplus is not included in the objective function of policy enforcers since, for any output subsidy v, cheating involves direct transfers from taxpayers to producers. Thus, consumer welfare is not affected by the amount of enforcement and farmer misrepresentation.

Assuming the enforcement costs $\Phi(\delta_0)$ equal $1/2\psi\delta_0^2$ (where ψ is a strictly positive scalar that depends on things like the agrarian structure and the number of representative farmers), the first order condition for the problem specified in Eq. (5) is

$$\frac{\partial W}{\partial \delta_0} = 0 \Rightarrow (1+d)\psi\delta_0 = [(1+d)-\theta] \cdot \left[\frac{S(Q^{\mathrm{t}}) - D(Q^{\mathrm{t}})}{2\delta_1'} \cdot \frac{[S(Q^{\mathrm{t}}) - D(Q^{\mathrm{t}}) + \rho]}{2\delta_1'}\delta_0\right] \quad (6)$$

Eq. (6) indicates that the optimal audit probability is determined by equating the marginal resource costs of enforcement ($\mathrm{MC_e} = (1+d)\psi\delta_0$), with the marginal benefits from investigation ($\mathrm{MB_e} = [(1+d)-\theta]((\mathrm{v}-\delta_0(\mathrm{v}+\rho)))/2\delta_1'$). The marginal benefits from enforcement include benefits from penalties on the current level of misrepresentation and the benefits from increased enforcement and reduced cheating.

The effect of policy enforcement on farmers' well-being may or may not be taken into account by policy enforcers. For various reasons, the enforcement agency might place a relatively high weight ($\theta = \theta^{\mathrm{H}}$, where $\theta^{\mathrm{H}} \geq 1+d$), a low weight ($\theta = \theta^{\mathrm{L}}$, where $\theta^{\mathrm{L}} \in (0,\ 1+d)$), or no weight ($\theta = \theta^0 = 0$) on producer surplus. Substituting these values into Eq. (6) and solving for δ_0 generates the best response function of the enforcement agency to the output subsidy chosen by the regulator and farmers' optimizing behavior for the three values of θ.

More specifically, when the enforcement agency does not consider the effect of its choices on producers' welfare (i.e., $\theta = \theta^0 = 0$), but its objective, instead, is to minimize taxpayer costs from cheating, [8] the base audit probability will equal

$$\delta_0^{\theta^0} = \frac{S(Q^{\mathrm{t}}) - D(Q^{\mathrm{t}})}{S(Q^{\mathrm{t}}) - D(Q^{\mathrm{t}}) + \rho + 2\delta_1'\psi} = \frac{\mathrm{v}}{\mathrm{v}+\rho+2\delta_1'\psi} \quad (7)$$

where the superscript denotes the weight placed by policy enforcers on producer surplus. Similarly, when the enforcement agency places a positive but relatively low weight on producer surplus (i.e., θ is lower than the marginal cost of public funds, $1+d$), the optimal δ_0, $\delta_0^{\theta^{\mathrm{L}}}$, will equal

[8] Substituting θ^0 into Eq. (5) shows that enforcement agency's payoff function is measured by the addition to the regulator's revenue net of enforcement costs. Alternatively, the enforcement agency can be viewed as seeking the δ_0 that minimizes total budgetary costs from cheating, i.e., the resource costs of enforcement plus the payments on quantity misrepresented minus the penalties collected from those detected cheating.

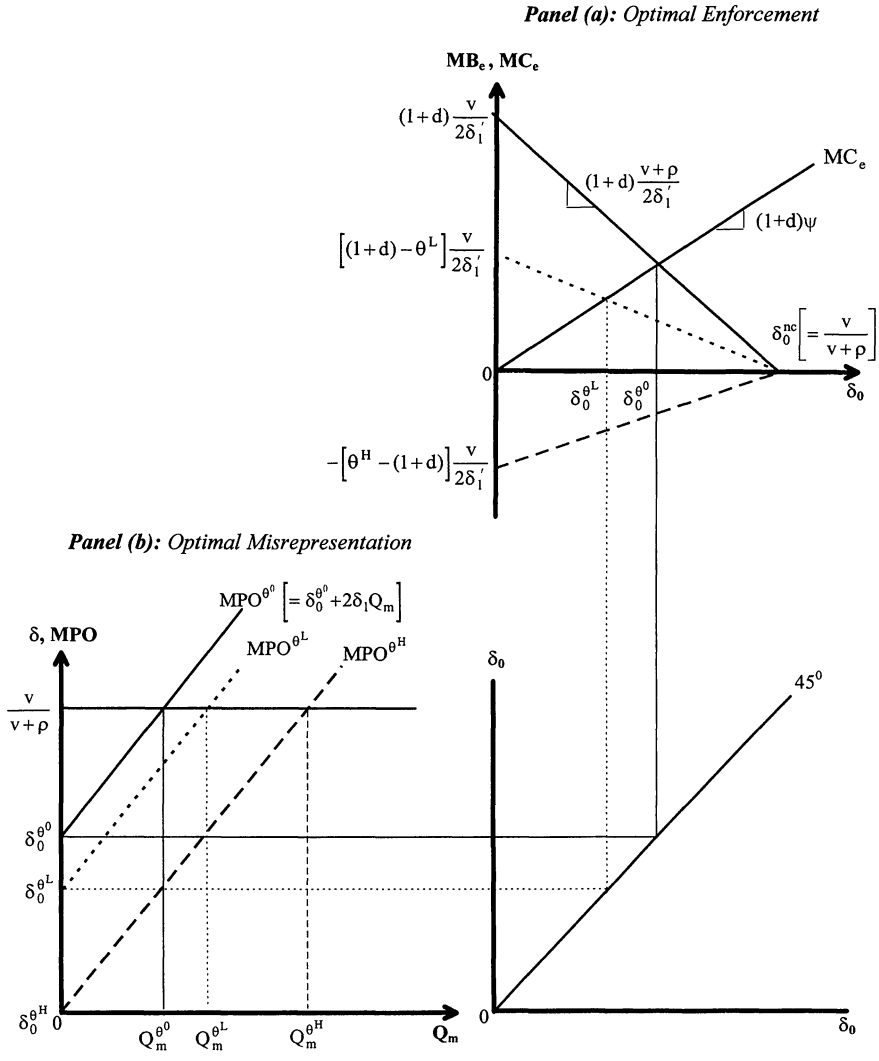

Fig. 4. Optimal enforcement and strategic interdependence between the enforcement agency and the farmers.

$$\delta_0^{\theta^L} = \frac{[(1+d)-\theta][S(Q^t)-D(Q^t)]}{[(1+d)-\theta][S(Q^t)-D(Q^t)+\rho]+(1+d)2\delta_1\psi}$$

$$= \frac{[(1+d)-\theta]\mathrm{v}}{[(1+d)-\theta](\mathrm{v}+\rho)+(1+d)\,2\delta_1\psi} \tag{8}$$

When the weight placed on producers exceeds the marginal cost of misrepresentation to taxpayers (i.e., $\theta \geq 1+d$), the best response of policy enforcers is complete allowance of cheating, i.e.,

$$\delta_0^{\theta^H} = 0 \tag{9}$$

A zero base audit probability does not mean that cheating goes undetected. Since δ_1 is assumed to be strictly positive, a zero δ_0 means that policy enforcers will not actively spend resources to deter misrepresentation over and above that which would occur otherwise.The reaction functions of policy enforcers under the different θ's indicate that δ_0 decreases with the increased weight placed on producers (i.e., $\delta_0^{\theta^0} > \delta_0^{\theta^L} > \delta_0^{\theta^H}$). Maximum enforcement occurs when policy enforcers place zero weight on producer welfare. Enforcement, however, is always incomplete due to the

positive resource costs of investigation (i.e., $\psi > 0$); δ_0 will be smaller than the base audit probability that completely deters cheating (i.e., $\delta_0 < \delta_0^{nc} = v/(v + \rho)$).

The optimal δ_0 under the alternative political preferences of the enforcement agency is determined graphically by the intersection of the MC_e curve with the relevant MB_e curve in Fig. 4, Panel (a). When θ equals zero, the relevant marginal benefit function is shown as the downward sloping solid MB_e curve. The MB_e curve is downward sloping due to the decrease in misrepresentation caused by increases in δ_0. The intersection of the MB_e curve with the horizontal axis determines the base audit probability that completely deters cheating, δ_0^{nc}. Obviously, δ_0^{nc}would be the optimal choice of policy enforcers if enforcement was costless (i.e., $\psi = 0$). In this case, the MC_e curve would coincide with the horizontal axis. However, investigating farmers and convicting the detected cheaters is costly. The greater are the enforcement costs (i.e., the larger is ψ), the greater is the slope of the MC_e curve, and the lower is the base audit probability.[9]

An increase in the weight policy enforcers place on producer surplus reduces both the intercept and the absolute value of the slope of the marginal benefit function. More specifically, increases in θ cause a leftward rotation of the MB_e curve through δ_0^{nc}. *Ceteris paribus*, this results in a reduced base audit probability. Under θ^L, the relevant MB_e curve (shown as the downward sloping dashed MB_e curve in Fig. 4, Panel (a)) will always fall between the MB_e curve under θ^0 and the horizontal axis; $\delta_0^{\theta^L}$ is always positive.

When $\theta = 1 + d$, the weight placed by policy enforcers on producers equals the marginal cost of public funds, i.e. the implicit weight placed by the enforcement agency on taxpayer surplus. Since taxpayer gains from increased enforcement constitute producer losses (in a one-to-one correspondence) and since equal weight is attached to the welfare of producers and taxpayers, the marginal benefits from enforcement are zero. Hence, when $\theta = 1 + d$, the MB_e curve coincides with the horizontal axis, and both the slope and the intercept equal zero. The only point where the MC_e curve meets the horizontal axis is at the origin. Thus, the optimal δ_0 equals zero.

Finally, values of θ greater than $1 + d$ result in a further leftward rotation of the MB_e curve. The relevant MB_e curve is shown as the upward sloping dashed line in Fig. 4, Panel (a). Since the weight placed on producers exceeds the marginal cost of public funds, the benefits from investigating farmers are never positive. Thus, when policy enforcement is costly (i.e., whenever $\psi > 0$), the best response of policy enforcers that place relatively high weight on producers is to choose a zero base audit probability.

Fig. 4 also graphs the strategic interdependence between the enforcement agency and farmers; it shows the effect enforcement decisions have on output misrepresentation. Panel (b) of Fig. 4 depicts the cheating equilibrium for the N representative farmers. Changes in δ_0 result in parallel shifts of the MPO curve faced by the farmers. More specifically, reductions in δ_0 caused by increases in θ translate into downward parallel shifts of the MPO curve and increased output misrepresentation for a given subsidy and penalty. Mathematically, Q_m under the different political preferences of policy enforcers is derived by substituting the appropriate δ_0 into the farmers' reaction function in Eq. (4). Hence, when $\theta = \theta^0$ output misrepresentation will equal

$$Q_m^{\theta^0} = \frac{\psi v}{(v + \rho)(v + \rho + 2\delta_1 \psi)} \tag{10}$$

Similarly, the equilibrium Q_m under θ^L and θ^H, $Q_m^{\theta^L}$ and $Q_m^{\theta^H}$, respectively, will equal

$$Q_m^{\theta^L} = \frac{(1 + d)\psi v}{(v + \rho)[(1 + d)\,(v+\rho+2\delta_1'\psi) - \theta\,(v + \rho)]} \tag{11}$$

and

$$Q_m^{\theta^H} = \frac{v}{2\delta_1'(v + \rho)} \tag{12}$$

Fig. 4 is well suited for comparative static's analyses. For instance, an increase in the penalty results in a parallel downward shift of the $v/(v + \rho)$ line in Panel (b) and a reduction in Q_m (direct effect). An increased ρ also results in a clockwise rotation of the relevant

[9] Although Panel (a) of Fig. 4 illustrates the case of increasing marginal enforcement costs, the marginal costs from enforcement can in fact be constant, i.e. the case of constant returns to government spending on program enforcement. In such a case, the relevant Mce curve would be a horizontal line that would meet the vertical axis in Panel (a) of Fig. 4 at ψ', the level of the constant marginal costs.

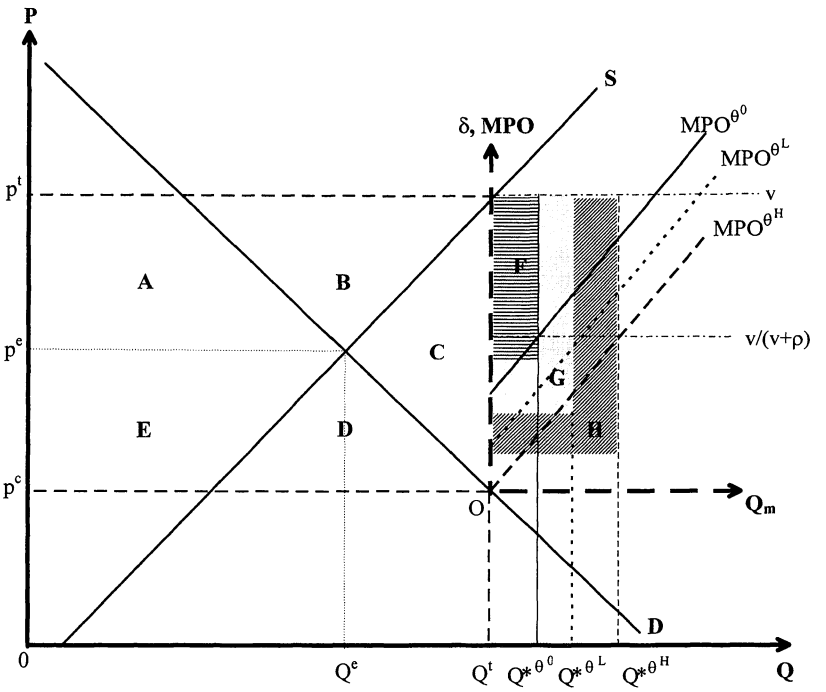

Fig. 5. The welfare effects of output subsidies under various levels of enforcement and cheating.

downward sloping MB_e curve through the intercept in Panel (a). The optimal δ_0 is reduced and Q_m increases (indirect effect). A change in the subsidy results in parallel shifts of the $v/(v+\rho)$ line in Panel (b) (direct effect on Q_m), and also changes both the intercept and slope of the MB_e function in Panel (a) (indirect effect).

Overall, when program enforcement is costly, complete deterrence of cheating on output subsidies is never optimal from an economic perspective. The optimal enforcement and, therefore, the optimal output misrepresentation depend on the weight placed by policy enforcers on producer surplus. Enforcement is maximized and cheating is minimized when the enforcement agency minimizes total taxpayer costs from cheating. When farmer welfare is weighted highly, complete allowance of cheating is the optimal choice of the enforcement agency and maximum misrepresentation the best response of the farmers.

5. Regulator and optimal intervention

Consider next the case of a regulatory agency in a decentralized policy making environment that desires to transfer a given surplus to producers of the regulated commodity. Implicit in this formulation is the assumption that the regulator is not concerned with the distribution of resources within the farm sector; the purpose of government intervention is to transfer income to the farmers. This assumption is consistent with the assumption of homogeneity of producers adopted in this paper.

The regulator's problem can be seen as the determination of the subsidy level that achieves the desired income redistribution. Since the reaction functions of all parties involved in agricultural policy design and implementation are assumed to be common knowledge, the regulator knows exactly whether and how her decision will affect the level of enforcement and output misrepresentation.

Assume that the political preferences of the regulator result in a desire for an income transfer to producers given by the areas $A+B$ in Fig. 5. When policy enforcement is perfect and costless, the quantity reported as eligible for government payments equals the actual production level. In such a case, the optimal choice of the regulator in terms of v that transfers areas $A+B(=[(p^c+v)Q^t-C(Q^t)]-[p^eQ^e-C(Q^e)])$

to producers will equal the difference between p^t and p^c shown in Fig. 5. The optimal subsidy under perfect and costless enforcement is denoted as v^{pce}.

When, however, enforcement of output subsidies is costly, it will be incomplete and some output misrepresentation will always occur. The extent of misrepresentation depends on the weight policy enforcers place on producer surplus. Because of this misrepresentation, there is always more than the desired surplus transferred to producers under a subsidy payment set at v^{pce}. The excess transfer increases with the increase in misrepresentation.

Fig. 5 shows output misrepresentation and the welfare effects of a given subsidy under the alternative political preferences of the enforcement agency. The greater is θ, the lower is δ_0, and the greater is Q_m. The lower is enforcement and the greater is misrepresentation, the greater is the *total* transfer to producers (i.e., payments for output produced plus benefits from misrepresentation) for any given subsidy level. Thus, for the equivalent of area $A+B$ to be transferred to producers, the regulator has to reduce the unit payment to the level at which the total transfer to producers will equal $A+B$. Therefore, the optimal subsidy that transfers a *given* surplus to producers falls with the increase in misrepresentation, i.e., $v^{\theta^H} < v^{\theta^L} < v^{\theta^0} < v^{pce}$.

A consequence of this is that consumer surplus falls with an increase in cheating when the objective of the regulatory agency is to transfer a given surplus to producers. The taxpayer costs associated with the specific income redistribution are reduced by the amount foregone by consumers plus the change in the deadweight welfare loss triangle, adjusted to account for the distortionary costs from taxation. Furthermore, the reduced enforcement associated with increased weight on producers (and increased cheating) results in reduced enforcement costs incurred by taxpayers. [10]

6. Transfer efficiency and optimal income redistribution

Assuming that the sole purpose of market intervention is income transfer, the trade off between producer surplus and consumer plus taxpayer surplus under an output subsidy scheme is reflected by the surplus transformation curve (STC) (Josling, 1974; Gardner, 1983; Bullock, 1992). The slope of the STC, denoted as $s = \partial PS/\partial(CS + TS)$, is the marginal rate of surplus transformation. It reflects the efficiency of the policy mechanism in redistributing income to producers at the margin, or how much of an extra dollar raised by consumers and taxpayers is received by producers. One minus the absolute value of s shows the deadweight loss per dollar transfer. The efficiency in redistribution links the resource costs of market intervention to the surplus transferred to producers. The closer is s to -1, the smaller are the welfare losses, and the more efficient is the income redistributional mechanism.

The analysis in the previous sections shows that the levels of intervention and enforcement vary with the political preferences of the enforcement agency. The same is also true for the welfare loss associated with a given transfer to producers. Variation in the social cost of a transfer implies variation in the transfer efficiency of output subsidies. In general, less auditing means lower resource costs of monitoring and enforcement associated with the specific transfer to producers. At the same time, the lower is the subsidy level that achieves the desired transfer, the lower are the distortionary costs of market intervention (i.e., the Harberger triangle and the deadweight losses from taxation). And the lower are the welfare losses from a given transfer to producers, the greater is the transfer efficiency of output subsidies.

Recall that when policy enforcement is costly, both enforcement and the subsidy decrease with an increase in the weight placed by policy enforcers on producer

[10] The effects of the reduction in the subsidy when cheating occurs in an open economy framework are quite straight forward. When farmer misrepresentation occurs in a small open economy, the welfare of consumers remains unaffected. The reason is that the domestic policy has no effect on the world price. However, the change in the subsidy will affect the terms of trade for the country. More specifically, the reduction in the quantity produced will reduce (increase) exports (imports) for the small open economy that exports (imports) the supported commodity. For the large country case, the reduction in domestic production (due to the fall in output subsidy) will increase the world price. Increased world price means reduced surplus for domestic consumers. When the large country is an exporter of the commodity, reduced production means also reduced exports and therefore, reduced transfer from domestic taxpayers to foreign consumers while the same surplus is transferred to domestic producers. Similarly, when the large country imports the subsidized commodity, the reduced subsidy results in increased imports and reduced transfer from foreign producers to domestic consumers.

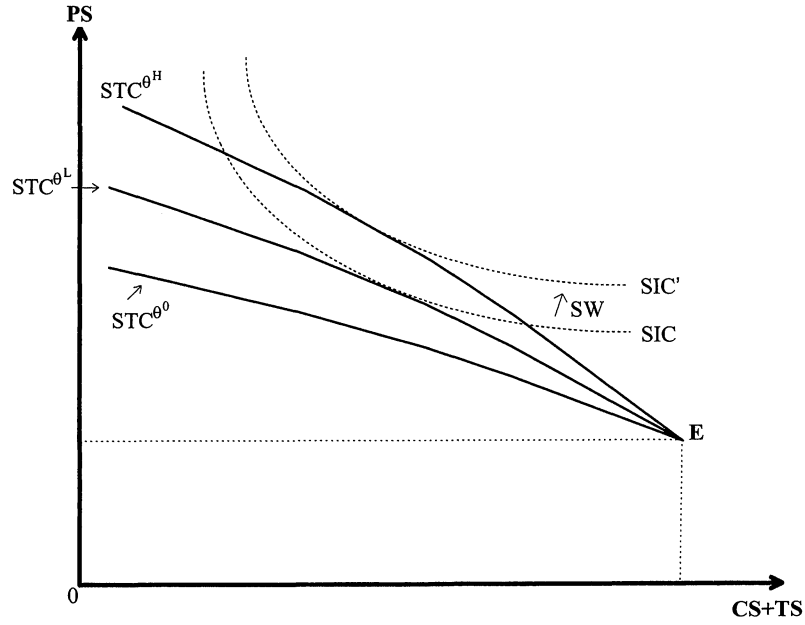

Fig. 6. Surplus transformation curves for output subsidies under costly enforcement.

surplus (i.e., $\delta_0^{\theta^0} > \delta_0^{\theta^L} > \delta_0^{\theta^H}$ and $v^{\theta^0} > v^{\theta^L} > v^{\theta^H}$). Since both enforcement costs and distortionary costs of intervention decrease with an increase in θ, the greater is θ, the greater is the marginal efficiency of output subsidies in transferring income to producers, i.e. $\left|s^{\theta^H}\right| > \left|s^{\theta^L}\right| > \left|s^{\theta^0}\right|$.

Put in a different way, the efficiency of a transfer to producers increases with cheating since output misrepresentation allows the regulator to substitute distortionary transfers through the market with more efficient decoupled transfers through cheating. Since enforcement falls as the weight placed by the enforcement agency on producer welfare increases, the greater is θ, the greater is the decoupled transfer through cheating, and the more closely output subsidies approximate a lump-sum transfer program.The relevant STCs are depicted as the (concave) STC$^{\theta^H}$, STC$^{\theta^L}$ and STC$^{\theta^0}$ in Fig. 6. The STCs originate from point E which is the locus of the interest group surpluses at the competitive equilibrium.[11] STC$^{\theta^0}$ lies underneath STC$^{\theta^L}$ which, in turn, lies underneath STC$^{\theta^H}$ everywhere to the left of E.[12] The vertical distance between the STCs reflects the difference in the welfare losses associated with the specific transfer to producers under the different θs. Since $\delta_0^{\theta^0}$, $\delta_0^{\theta^L}$ and the distortionary costs of market intervention increase with an increase in the level of intervention, the vertical distance between the STCs increases with a leftward move from E.

It is worth noting that the efficiency of the policy mechanism in transferring income to producers increases when the political preferences of the enforcement agency and the regulator coincide (i.e., when both agents place a relatively high weight on producer welfare). Paradoxically, the transfer efficiency of output subsidies falls when the objective of the enforcement agency is to minimize total taxpayer costs from cheating. The reason is the rela-

[11] As long as there is government intervention in any other commodity market, the taxpayer surplus corresponding to point E incorporates the costs associated with the operation of the enforcement agency. When non-intervention in the specific market also means non-intervention in the whole agricultural sector, taxpayer surplus at point E would shift to the right by an amount equal to the fixed costs associated with the existence of the enforcement agency.

[12] Obviously for zero subsidy (no intervention), neither enforcement nor misrepresentation will emerge.

tively high enforcement and intervention that occur when policy enforcers place zero weight on producer welfare.

The relative position of the STC for output subsidies in a world where program enforcement is perfect and costless (i.e., STC^{pce}) is determined solely by the distortionary costs of market intervention (i.e., the relevant Harberger triangle and the deadweight losses from taxation to finance the transfer). The marginal efficiency of redistribution of output subsidies, $|s^{pce}|$, will always be less than $\left|s^{\theta^H}\right|$, and STC^{pce} will always lie underneath STC^{θ^H} everywhere to the left of E. The reasoning goes as follows. Because of misrepresentation that occurs under θ^H, the subsidy that achieves the desired transfer to producers will be smaller than the subsidy under perfect and costless enforcement, i.e. $v^{pce} > v^{\theta^H}$. Reduced subsidy implies reduced distortionary costs of intervention. Reduced welfare losses associated with a given transfer to producers mean increased transfer efficiency of output subsidies.

The position of STC^{pce} relative to STC^{θ^L} and STC^{θ^0} is case specific and depends on market conditions and the resource costs of enforcement. Even though the distortionary costs of market intervention are lower under θ^L and θ^0 (since v^{θ^L} and v^{θ^0} are smaller than v^{pce}), the enforcement costs are greater than those under perfect and costless enforcement of the program. The relative position of the STCs depends on the relative size of the total costs. For given market conditions, the greater is $\Phi(\delta_0)$, the greater is the likelihood that STC^{pce} will lie above STC^{θ^L} and STC^{θ^0}. Alternatively, for relatively low enforcement costs, STC^{pce} will lie underneath STC^{θ^L} and STC^{θ^0}.

The STC framework developed above can be used to determine the socially optimal total transfer to producers. Suppose the problem faced by the regulatory agency is the determination of income redistribution that maximizes some social welfare function (SWF) that weights producer, consumer, and taxpayer welfare, rather than the determination of the subsidy level that transfers a given surplus to producers. Assume that the political preferences of the regulator result in the social indifference curves (SIC) shown in Fig. 6, with the SWF value increasing with a northeast shift of the SIC.

The socially optimal total transfer to producers under the different scenarios considered in this study is determined by the tangency of the SIC to the relevant STC (Gardner, 1987). Fig. 6 shows that the level of total transfer to producers is directly related to the efficiency of output subsidies in transferring income to producers. More specifically, the greater is the transfer efficiency of the policy instrument, the larger is the socially optimal total transfer. Furthermore, since the SWF value increases with movements to the northeast, increases in transfer efficiency also imply increases in social welfare. Both the socially optimal total transfer to producers and the social welfare from intervention are maximized when the political preferences of the enforcement agency and the regulator coincide.

7. Extension of the model – endogenous penalties

Crucial for the previous analysis and results is the assumption that penalties are exogenous to agricultural policy makers. Consider now the case of an enforcement agency that controls both enforcement parameters – δ_0 and ρ. Endogeneity of penalties calls for an additional first order condition to the enforcing agency's problem specified in Eq. (5), i.e.,

$$\frac{\partial W}{\partial \rho} = 0 \Rightarrow [(1+d)-\theta] \cdot \left[\frac{\delta_0^2}{4\delta_1'} - \frac{[S(Q^t)-D(Q^t)]^2}{[S(Q^t)-D(Q^t)+\rho]^2 4\delta_1}\right] = 0 \Rightarrow \rho = \frac{(1-\delta_0)}{\delta_0}[S(Q^t)-D(Q^t)] = \frac{(1-\delta_0)}{\delta_0}\mathrm{v} \tag{13}$$

The optimal ρ in Eq. (13) is the penalty structure required to completely deter farmer misrepresentation, ρ^{nc}. Interestingly enough, the best response function of the enforcement agency does not depend on the weight it places on producer surplus. Solving Eqs. (7)–(9) simultaneously with Eq. (13) indicates that when penalties are endogenous to agricultural policy makers, cheating will be completely deterred by a zero base audit probability and a huge penalty on detected

misrepresentation.[13] This is true no matter the weight placed on producers, i.e.,

$$\delta_0^{\theta(\rho)} = 0 \quad \text{and} \quad \rho = \infty \, \forall \theta \tag{14}$$

where $\delta_0^{\theta(\rho)}$ denotes the optimal δ_0 under all θs when penalties are endogenous.

Graphically, the huge per unit penalty makes the slope of all MB_e curves in Fig. 4, Panel (a) infinite. The MB_e curves coincide with the vertical axis and meet the MC_e curve at the origin. The resulting zero δ_0 means that the MPO curve comes out from the origin, while the huge penalty shifts the $v/(v+\rho)$ line downwards so that it coincides with the horizontal axis in Fig. 4, Panel (b). The optimal response of the farmer is then a zero level of misrepresentation.

Assuming there are no costs associated with the establishment of huge penalties on detected output misrepresentation, and since no (costly) auditing prevails at equilibrium, the perfect enforcement of the program (i.e., Eq. (13)) is also costless. Since output misrepresentation is perfectly and costlessly deterred when penalties are endogenous to the enforcement agency, the output subsidy that transfers a given surplus to producers, the transfer efficiency of the policy instrument, and the socially optimal total transfer to producers are those derived by the traditional analysis of output subsidies. Thus, one interpretation of 'perfect and costless enforcement' is the costless establishment of infinite per unit penalties for farmers who are detected misrepresenting the level of their production.

Infinite per unit penalties for farmers cheating on farm subsidies is not what is observed in most of today's world however. In most countries legal penalties cannot be set far in excess of the material damage caused by the illegal activity; in lay terms, the punishment has to fit the crime. In the EU for instance, detected farmer misrepresentation on compensatory payments results in a scaling-back of payments by the same percentage (i.e., the percentage of cheating) plus an additional uncompensated set-aside requirement for the following year (Swinbank and Tanner, 1996, pp. 97).[14] Even in the US where detection of cheating on farm income transfer programs causes punitive fines and exclusion from future program benefits (usually for 3 years), the penalty is not of the magnitude that results in costless policy enforcement, i.e., the per unit penalty is not infinite.

One reason why the severe punishment of law violators is not the norm is that institutionalized infinite per unit penalties are neither credible nor just. For instance, in his work on income tax evasion Cowell (1990, pp. 150) argues that enormous fines for small amounts of cheating would violate 'the public's sense of what is fair and reasonable.' Similar views can be found in Becker (1968); Stigler (1970); Polinsky and Shavell (1979); Shavell (1987).

8. Summary and discussion

Agricultural policy analysis, in general and the analysis of output subsidies in particular, traditionally take place under the assumption that: (i) either farmers do not cheat; or (ii) enforcement of agricultural policies is perfect and costless. However, enforcement requires resources and is, therefore, costly. The resource costs of enforcing an output subsidy scheme result in policy enforcement that is incomplete. Imperfect enforcement generates economic incentives for farmers to misrepresent their production and to collect subsidies on production that never took place. The lower is the level of enforcement, the higher is the equilibrium amount of farmer misrepresentation.

The analysis in this paper shows that the level of enforcement depends on the political preferences of policy enforcers. Since cheating on subsidies results in a direct income transfer from taxpayers to produc-

[13] This result is altered when agricultural policy making is centralized and penalties are endogenous to agricultural policy makers. Giannakas (1998); Giannakas and Fulton (1999) show that when a single agency determines both the level of intervention (i.e., the subsidy) and the level of enforcement, policy makers will find it economically optimal to completely allow cheating. The reason is that the increased producer benefits from misrepresentation enable the singe agency's policy makers to reduce the subsidy that transfers a given surplus to producers, thereby increasing the transfer efficiency of the policy.

[14] In 1993 Germany successfully resisted the enforcement of the rules when in parts of Eastern Germany the areas reported as eligible for payments exceeded the base areas by up to 15%. Not only were producers not penalized, but Germany also managed to exclude these areas from the penalty scheme for the following 3 years. The decision of the European Council to not punish the German producers created a precedent in the EU and resulted in detected cheating being unpunished in other parts of the Union as well (e.g., Spain and Scotland) (Swinbank and Tanner, 1996).

ers, enforcement decreases as policy enforcers place increasing weight on producer welfare. The political preferences of policy enforcers are also crucial in determining the subsidy that transfers a given surplus to producers, the transfer efficiency of the policy mechanism, and the socially optimal total transfer to producers. The causation goes as follows. The greater is the weight placed by policy enforcers on producer surplus, the lower is the program enforcement, and the lower is the subsidy level that achieves a desired transfer to producers. Lower enforcement and intervention means lower welfare losses associated with a given transfer to producers, and greater transfer efficiency of output subsidies. The greater is the marginal efficiency of output subsidies in redistributing income to producers, the greater is the socially optimal income redistribution. Overall, the transfer efficiency of output subsidies, the socially optimal total transfer to producers and the social welfare from intervention are maximized when the political preferences of the enforcement agency and the regulator coincide.

When both the enforcement agency and the regulator attach a relatively high weight to the welfare of producers, the economically efficient outcome includes a reduced subsidy and a minimum amount of monitoring and enforcement. The conclusion that a limiting case of the analysis approximates a lump-sum transfer highlights at least two issues in the literature on lump-sum payments. First, even though lump-sum transfers are more efficient means of income redistribution than coupled farm subsidies, they are viewed as 'hypothetical ideals' that 'are operationally irrelevant' (Williamson, 1996, pp. 210). Second, lump-sum transfers are not only impossible, but they are perceived to be unfair to the extent that they involve arbitrary exclusions from the program (Gardner, 1987, pp. 190).

Lump-sum transfers that are linked to cheating obviously involve highly arbitrary exclusions. Farmers that comply with program provisions and truthfully report their production receive less benefits than do the farmers that cheat. While the focus on the representative farmer in this paper precludes the formal consideration of this outcome, the principle is nevertheless clearly illustrated.

The impossibility of lump-sum transfers is also highlighted by the analysis in this paper. While conceptually interesting, the idea that cheating would be made the basis of policy seems far-fetched. One reason is that morality and culture, although significant determinants of an individual's propensity to cheat (Grasmick and Green, 1980), have not been incorporated into the analysis. Not only are some farmers expected not to cheat, but wide spread cheating is likely to create a culture of dishonesty in the society and a public disrespect for both the government and community rules (Lea et al., 1987; Cowell, 1990). As a consequence, governments would be unlikely to base policy on something that would ultimately undermine policy. The key point here is that any lump-sum transfer program that could be devised is predicated on a set of behavioral assumptions that make it operationally impractical.

The above discussion sheds light on the government's use of mixed policy instruments such as subsidies and supply restrictions (i.e., the so-called stop-and-go policies). Linking subsidy payments to an arbitrary chosen level of output (or input) does two things. First, it provides a way of making operational a program that now has many of the characteristics of a lump-sum transfer. Second, it may reduce the possibility of cheating, thus limiting the exclusion of honest farmers and lessening the general propensity for cheating. The possibility of cheating may be reduced because the enforcement issues in this case are confined to compliance with supply restrictions which may be easier to monitor than output (on the economics of a stop-and-go policy mix under costly enforcement see Giannakas and Fulton (1999)).

In addition to providing an understanding of the causes and consequences of cheating on output subsidies, the results of this study might assist in explaining potential differences in compliance with policy rules observed in different areas/countries. For instance, the varying significance of agriculture in different countries, and the different weights being placed by Ministries of Agriculture or agricultural policy enforcement agencies on producer welfare, might account for the variable levels of enforcement and cheating seen around the world. More research, however, is required to analyze and better understand these issues and to determine the empirical importance of cheating on output subsidies.

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