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## Costly (Dis)Agreement: Optimal Intervention, Income Redistribution, and Transfer Efficiency of Output Quotas in the Presence of Cheating

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# Costly (Dis)Agreement: Optimal Intervention, Income Redistribution, and Transfer Efficiency of Output Quotas in the Presence of Cheating

Konstantinos Giannakas and Murray Fulton

## Abstract

This study builds on previous work by Giannakas and Fulton (2003, 2000) on the economics of output quotas in the presence of cheating by examining the efficiency of the policy in transferring income to producers as well as the optimal regulatory response to enforcement costs and farmer noncompliant behavior in a decentralized policy making environment. Analytical results show that enforcement costs and cheating change the transfer efficiency of output quotas, the level of intervention that transfers a given surplus to producers, the socially optimal income redistribution, and the social welfare from intervention. The incidence of the policy is shown to depend on the relative political preferences of the policy makers and the policy enforcers making the consideration of the decentralized policy making structure critical in analyzing output quotas in the presence of cheating.

**KEYWORDS:** quotas, cheating, agricultural policy, distribution, welfare

## 1. Introduction

In a recent article published in this *Journal*, Giannakas and Fulton (GF hereafter) examine the optimal enforcement of output quotas in the presence of enforcement costs and farmer noncompliance with the provisions of the quota program. In particular, GF (2003) analyze the optimal enforcement of supply restrictions in a *decentralized* policy making structure that considers separately the decisions of the policy maker and the policy enforcer. The key (and rather counter-intuitive) result of their study is that program enforcement increases with the weight placed by the enforcement agency on producer welfare. This result stems from their finding that, while violation of the quota limit might be optimal for the individual producer that holds competitive conjectures, above-quota production depresses market price and producer welfare. Thus, an enforcement agency operating with the interests of producers in mind will restrict the very actions these producers would prefer to undertake.

In this paper, we extend the work of GF (2003) to examine the efficiency of the policy in redistributing income to producers in the presence of cheating as well as the optimal regulatory responses to enforcement costs and producer noncompliant behavior. In particular, we examine the consequences of enforcement costs and cheating on the transfer efficiency of output quotas and on the level of the socially optimal policy intervention and income redistribution under the different policy enforcement scenarios analyzed in GF (2003).

The transfer efficiency of output quotas in the presence of cheating has also been examined in an earlier article by GF that introduced enforcement costs and cheating into the economic analysis of output quotas. In particular, GF (2000) examine the ramifications of enforcement costs and above-quota production for the transfer efficiency of the policy in a *centralized* policy making environment where policy design and implementation are the responsibility of a single agency.

In analyzing the transfer efficiency of the policy mechanism and the optimal regulatory responses to enforcement imperfections, this paper adopts the *decentralized* policy making environment introduced in GF (2003). This richer policy making structure, which considers separately the decisions of the policy maker and the policy enforcer, is required because differences in the political preferences of the two groups are shown to significantly affect the level of policy intervention and the incidence of output quotas.<sup>1</sup> Similar to the previous papers by GF, the economic consequences of enforcement costs and cheating are considered in the context of a static, partial equilibrium, closed economy model. Since this paper builds on the results of GF (2003), an understanding of this earlier paper will assist in delving into the present article.

The rest of the paper is organized as follows. The next section analyzes the effect of enforcement costs and cheating on the level of policy intervention (i.e., the level of output quota) that transfers a given surplus to producers of the regulated commodity. To do this, the next section looks at the problem of a regulator that desires to make a specific income transfer to agricultural producers under the different scenarios on policy enforcement (determined by the enforcement agency) considered in GF (2003). The section following links the surplus transfer to producers with the distortionary costs of market intervention to determine the efficiency of the policy in redistributing income in the economy under costly enforcement. Once the transfer efficiency of output quotas has been determined, the paper endogenizes the surplus transfer to producers – it considers the socially optimal income redistribution and the social welfare from intervention when enforcement is costly. While most of the analysis focuses on the case where penalties for quota violations are exogenous to the agency responsible for the enforcement of the farm program, for completeness of exposition, the implications of endogenizing penalties are discussed before moving to the concluding section of the paper.

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<sup>1</sup> As pointed out in GF (2003), by considering a centralized policy making structure, the analysis of GF (2000) implicitly assumes identical political preferences of the regulatory and enforcement agencies involved in agricultural policy making.

## 2. Regulator and Optimal Intervention

Consider first the case of a regulatory agency that desires to transfer a given surplus to producers of the regulated commodity. In the decentralized policy making environment considered in this paper, the regulator moves first and determines the quota level  $\bar{Q}$  that will achieve the desired income redistribution knowing the reaction functions of both the enforcement agency and the producers [given by equations (7)-(9) and equation (4) in GF (2003)]. In other words, this section analyzes the first stage of a three-stage game between the regulator, the enforcement agency and the farmers where the regulator decides on the level of  $\bar{Q}$  that transfers a given surplus to producers knowing exactly how this choice will affect the levels of enforcement and production. The optimal choices of the enforcement agency and the farmers (determined in the second and third stage of the game, respectively) are examined in GF (2003) and are known by the regulator.

Note that, since output quotas involve surplus transfers from consumers to producers, a necessary condition for the adoption of the farm program is that the weight attached by the regulator on producer surplus exceeds the weight placed on the welfare of the regulated commodity consumers. Suppose that the political preferences of the regulator result in the desire to increase producer surplus to the level represented by the area  $BCDE$  in Figure 1, and that this surplus is smaller than the producer surplus corresponding to the monopoly output. In a world where cheating is perfectly and costlessly deterred,  $\bar{Q}^{pce}$  in Figure 1 (where the superscript “pce” stands for “perfect and costless enforcement”) will be the quota level that achieves the regulator’s objective, i.e., it increases the producer surplus to the desired level  $BCDE$ .

When the monitoring of farmers is costly, however, GF (2003) show that the levels of enforcement and production depend on the political preferences of policy enforcers. In general, the greater is the relative weight  $\theta$  placed by the enforcement agency on producers, the greater is the level of enforcement, and the lower is the above-quota production  $Q_m$ . What we will show in this section of the paper is that, the greater is enforcement and the lower is cheating, the greater is the quota level that achieves the desired surplus transfer to producers.

To show this result, consider first the case where the enforcement agency places relatively high weight on producer well being [i.e.,  $\theta \geq \theta_c$  in GF (2003)]. In this case, the audit probability (denoted as  $\delta_0^{\theta \geq \theta_c}$  where the superscript stands for the weight placed by the enforcement agency on producer welfare) is set so that cheating is completely deterred [i.e.,  $\delta_0^{\theta \geq \theta_c} = \delta_0^{nc}$  (where the superscript “nc” stands for “no cheating”) and  $Q_m^{\theta \geq \theta_c} = 0$ , see GF (2003)]. The relevant effective supply curve of the regulated commodity is depicted as the kinked  $S + MP^{\theta \geq \theta_c}$  curve in Figure 1.

In such a case, an output quota set at  $\bar{Q}^{\theta \geq \theta_c}$  ( $\equiv \bar{Q}^{pce}$ ) will be the optimal choice of the regulator that desires the specific increase in producer surplus, i.e.,

$$\bar{Q}^{\theta \geq \theta_c} : p(\bar{Q}^{\theta \geq \theta_c})\bar{Q}^{\theta \geq \theta_c} - C(\bar{Q}^{\theta \geq \theta_c}) = BCDE \quad (1)$$

where  $p(\bullet)$  is the market price of the regulated commodity and  $C(\bullet)$  is the total cost of production.

When the enforcement agency places a positive but relatively low weight on producer surplus [i.e.,  $\theta \in (0, \theta_c)$ ], GF (2003) show that complete deterrence of cheating is not economically optimal and some cheating will always occur (i.e.,  $\delta_0^{\theta < \theta_c} < \delta_0^{nc}$  and  $Q_m^{\theta < \theta_c} > 0$ ). The relevant effective supply curve is shown as the  $S + MP^{\theta < \theta_c}$  curve in Figure 1. Under a quota set at  $\bar{Q}^{pce}$ ,

the above-quota production equals  $Q_m^{\theta < \theta_c}$  and total production equals  $Q^{*\theta < \theta_c} (= \bar{Q}^{pce} + Q_m^{\theta < \theta_c})$ . The corresponding market price is reduced and there is a surplus transfer from producers to taxpayers through the penalties paid on detected above-quota production (given by the shaded area  $G$ ). Because of the increased production and the expected penalty, producer welfare is reduced relative to the “perfect and costless enforcement” situation for a quota set at  $\bar{Q}^{pce} (= \bar{Q}^{\theta \geq \theta_c})$ . Thus, for the desired increase in producer welfare to occur, the optimal quota when  $\theta < \theta_c$ , denoted as  $\bar{Q}^{\theta < \theta_c}$ , should be less than  $\bar{Q}^{pce}$ . More specifically,  $\bar{Q}^{\theta < \theta_c}$  will be given by:

$$\bar{Q}^{\theta < \theta_c} : p(Q^{*\theta < \theta_c})Q^{*\theta < \theta_c} - C(Q^{*\theta < \theta_c}) - [(\delta_0^{\theta < \theta_c} + \delta_1' Q_m^{\theta < \theta_c})\rho]Q_m^{\theta < \theta_c} = BCDE \quad (2)$$

where  $\delta_1'$  is the exogenous component of the detection probability function and  $\rho$  is the penalty per unit of detected above-quota production [see GF (2003)].

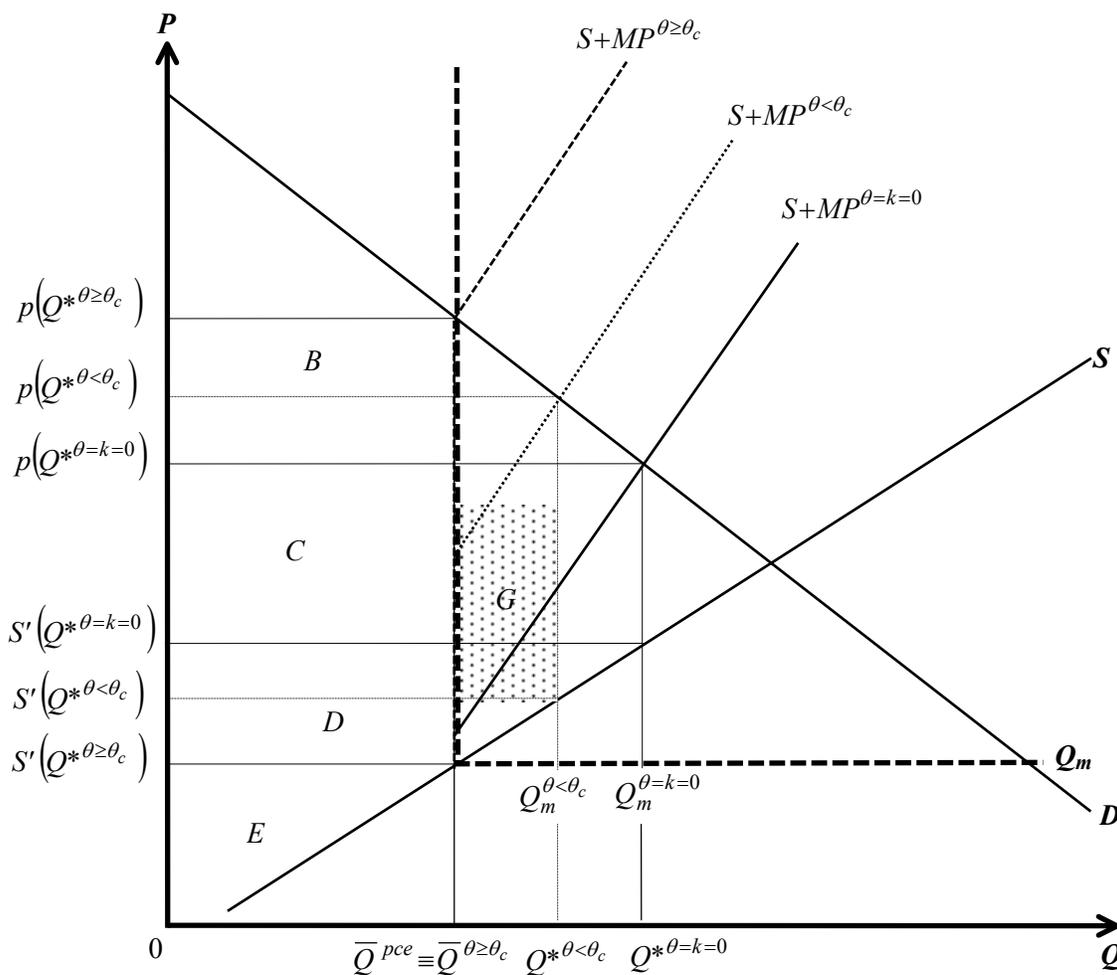


Figure 1. Welfare Effects of Output Quotas With Cheating

Similarly, when the enforcement agency places no weight on producers and consumers (i.e., when  $\theta=k=0$ ), enforcement is minimized and above-quota production is maximized for any given level of quota. The relevant effective supply curve is given by the  $S+MP^{\theta=k=0}$  curve in Figure 1. The quota level that would achieve the regulator's objective is given as:

$$\bar{Q}^{\theta=k=0} : p(Q^{*\theta=k=0})Q^{*\theta=k=0} - C(Q^{*\theta=k=0}) - \left[ (\delta_0^{\theta=k=0} + \delta_1 Q_m^{\theta=k=0}) \rho \right] Q_m^{\theta=k=0} = BCDE \quad (3)$$

Obviously, since  $\delta_0^{\theta=k=0} < \delta_0^{\theta < \theta_c} < \delta_0^{\theta \geq \theta_c} (= \delta_0^{nc})$  and  $Q_m^{\theta=k=0} > Q_m^{\theta < \theta_c} > Q_m^{\theta \geq \theta_c} = 0$  for any given  $\bar{Q}$ , it will always hold that  $\bar{Q}^{\theta=k=0} < \bar{Q}^{\theta < \theta_c} < \bar{Q}^{\theta \geq \theta_c} (= \bar{Q}^{pce})$  – i.e., the level of output quota that transfers a given surplus to producers increases with an increase in the level of enforcement (and a reduction in cheating).

Following these results, it is easy to determine the level of total production  $Q^*$  (i.e., output quota plus above-quota production) when the objective of the regulator is to transfer a given surplus to producers. Crucial in determining the level of total production is the transfer from producers to taxpayers through the penalties paid on detected above-quota production.

To show this, note that in a hypothetical case of no punishment for cheating, violation of the quota limit by farmers would only require the establishment of the quota such that the total production (output quota plus above-quota production) would be at the level that achieves the desired transfer to producers. When penalties are charged, however, there is surplus transferred from producers to taxpayers. Because of this transfer, the total quantity must be reduced further in order for the desired producer welfare increase to occur. In general, the greater is the transfer from producers to taxpayers, the lower is the total production of the regulated commodity. Since the expected penalty increases with an increase in cheating, it always holds that  $Q^{*\theta=k=0} < Q^{*\theta < \theta_c} < Q^{*\theta \geq \theta_c} (= Q^{*pce})$  – i.e., when the objective of the regulator is to transfer a given surplus to producers, total quantity produced increases with an increase in the level of enforcement (and a reduction in the level of cheating). A consequence of this is that consumer surplus falls with an increase in cheating when the objective of the regulator is to transfer a given surplus to producers.

Overall, the analysis shows that both the quota level that transfers a given surplus to producers and the total output produced are greatest when both the regulator and the agency responsible for the enforcement of the quota program have a high weight attached to producer welfare. Both  $\bar{Q}$  and  $Q^*$  fall with a divergence in the political preferences of the policy maker and the policy enforcer.

Implicit in the above analysis is the assumption that the total surplus  $BCDE$  can be achieved by an appropriate quota under all scenarios concerning the enforcement agency's political preferences and prevailing enforcement. However, this is not generally true; not all income transfers can be achieved under cheating. Consider the case where the government has a very high political weight attached to producer welfare and the targeted producer surplus corresponds to the monopoly one. When enforcement is perfect, this requires nothing but the establishment of the quota at the output level determined by the equality of marginal revenue with marginal costs.

Under imperfect enforcement and cheating, however, this targeted level of producer surplus is not feasible. The reason is the transfer from producers to taxpayers through the penalties on detected cheating whenever above-quota production occurs. Thus, even if the quota was set such that the total, after-cheating production would equal the monopoly output, the producer surplus would be less than the one under perfect enforcement of the quota program. The difference would be the expected penalties on above-quota production. This constraint on the maximum possible surplus transfer under cheating could result in either the adjustment of the desires of the regulator,

or in the use of subsidy payments that would make up the difference between the desired and the feasible transfer under imperfect enforcement of output quotas [for a policy mix that combines supply restrictions with output subsidies in the presence of cheating see GF (2000)].

### 3. Efficiency in Redistribution

The previous section examined the ramifications of enforcement issues and the political preferences of policy makers and policy enforcers for the case in which the purpose of government intervention is to transfer a given surplus to producers of the regulated commodity. In this part of the paper the welfare losses from the program are explicitly linked to the surplus transferred to producers.

In the interest group surplus space, the surplus transformation curve (*STC*) shows the trade-off between producer surplus (*PS*) and consumer plus taxpayer surplus (*CS+TS*) for various levels of policy intervention. The slope of the *STC*, denoted as  $s = \partial PS / \partial (CS + TS)$ , is the marginal rate of surplus transformation. It shows the efficiency of output quotas in redistributing income to producers at the margin; how much of an extra dollar “taken” by consumers and taxpayers is received by producers. The inverse of  $s$  gives the marginal cost to consumers and taxpayers for transferring an extra dollar to producers, while one minus the absolute value of  $s$  shows the marginal welfare losses associated with the specific transfer. The closer is  $s$  to -1, the smaller are the welfare losses, and the greater is the transfer efficiency of the policy instrument.

In a world where program enforcement is perfect and costless, the *STC* of output quotas is shown as  $STC^{pce}$  in Figure 2. The  $STC^{pce}$  is equivalent to the *STC* proposed in the traditional analysis of this policy instrument (Gardner, 1983; Josling, 1974). Point *E* in Figure 2 corresponds to the competitive output; the point of nonintervention. The  $STC^{pce}$  is concave and reaches its maximum (slope of zero) at the level of quota that equals the monopoly output. Producer surplus increases at the expense of consumer surplus for output quotas set between the competitive and the monopoly output. Further restrictions on production result in losses for both producers and consumers. Since taxpayers are not involved in the surplus trade-off when enforcement is perfect and costless, the slope of  $STC^{pce}$  can be written as  $s^{pce} = \partial PS / \partial CS^{pce}$ .

Consider now the case where monitoring producers’ actions requires resources. Recall that when the weight placed by the enforcement agency on producer welfare is relatively high (i.e.,  $\theta \geq \theta_c$ ), cheating is completely deterred by an audit probability that equals  $\delta_0^{nc}$ . Producer and consumer welfare are the same as in the “perfect and costless enforcement” case while the taxpayer costs are increased by the monitoring costs associated with  $\delta_0^{nc}$ , i.e.,  $(1+d)\Phi(\delta_0^{nc})$  where  $(1+d)$  is the marginal cost of public funds. The slope of the relevant *STC*,  $STC^{\theta \geq \theta_c}$ , equals:

$$s^{\theta \geq \theta_c} = \frac{\partial PS}{\partial (CS^{\theta \geq \theta_c} + TS^{\theta \geq \theta_c})} = \frac{\partial PS}{\partial [CS^{\theta \geq \theta_c} + (1+d)\Phi(\delta_0^{nc})]} \quad (4)$$

where  $\partial CS^{\theta \geq \theta_c} = \partial CS^{pce}$ .

The monitoring and enforcement costs result in reduced transfer efficiency of the policy instrument relative to the “perfect and costless enforcement” case. Since  $\delta_0^{nc}$  is a decreasing function of  $\bar{Q}$  [i.e.,  $\delta_0^{nc} = (b_1 - a_1)(Q^e - \bar{Q})/\rho$ ], the greater is the level of intervention (i.e., the

smaller is  $\bar{Q}$  and the further left from  $E$  we move), the greater is the audit probability that deters cheating. Increased  $\delta_0$  results in increased resource costs of monitoring and enforcement and reduced efficiency of the policy in transferring income to producers of the regulated commodity.

Graphically, the increased enforcement costs result in a leftward elongation of  $STC^{\theta \geq \theta_c}$  relative to the  $STC^{pce}$  with the horizontal distance between the two  $STCs$  reflecting the monitoring costs associated with  $\delta_0^{nc}$ . Both curves reach a maximum at the same level of producer surplus i.e., the same level of surplus can be transferred to producers under both situations.

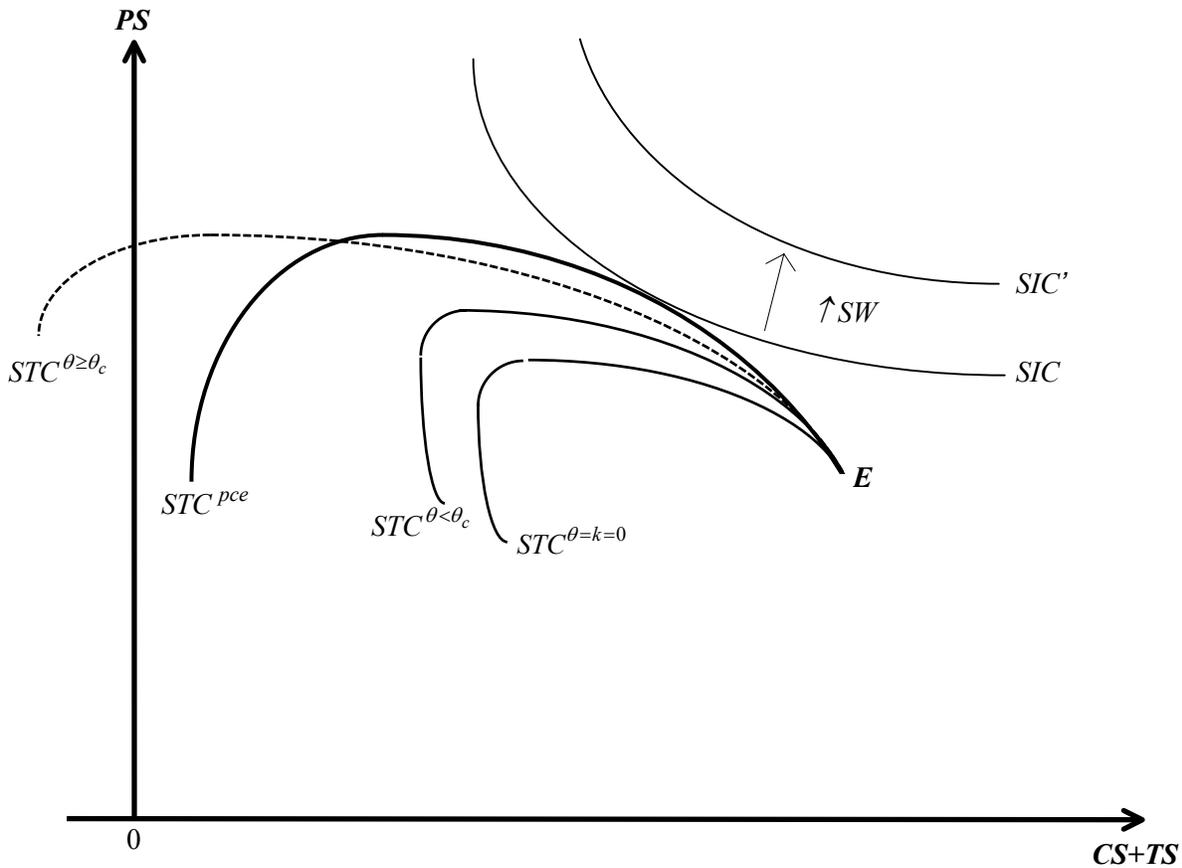


Figure 2. STCs of Output Quotas Under Costly Enforcement [Low  $\Phi(\delta_0)$ ]

When, however, the weight placed on  $PS$  is relatively low [i.e.,  $\theta \in [0, \theta_c]$ ], complete deterrence of cheating is not economically optimal. Above-quota production occurs and some part of producer surplus ( $R_\rho$ ) is transferred to taxpayers through the penalties paid on detected over-production [i.e.,  $R_\rho^{\theta < \theta_c} = (\delta_0^{\theta < \theta_c} + \delta_1' Q_m^{\theta < \theta_c}) \rho Q_m^{\theta < \theta_c}$  when  $\theta \in (0, \theta_c)$ , and  $R_\rho^{\theta = k = 0} = (\delta_0^{\theta = k = 0} + \delta_1' Q_m^{\theta = k = 0}) \rho Q_m^{\theta = k = 0}$  when  $\theta = k = 0$ ]. The slope of the  $STC^{\theta < \theta_c}$  can be written as:

$$s^{\theta < \theta_c} = \frac{\partial PS}{\partial (CS^{\theta < \theta_c} + TS^{\theta < \theta_c})} = \frac{\partial PS}{\partial \left\{ CS^{\theta < \theta_c} + (1+d) \left[ \Phi(\delta_0^{\theta < \theta_c}) - R_\rho^{\theta < \theta_c} \right] \right\}} \quad (5)$$

while the slope of  $STC^{\theta=k=0}$  equals:

$$s^{\theta=k=0} = \frac{\partial PS}{\partial (CS^{\theta=k=0} + TS^{\theta=k=0})} = \frac{\partial PS}{\partial \left\{ CS^{\theta=k=0} + (1+d) \left[ \Phi(\delta_0^{\theta=k=0}) - R_\rho^{\theta=k=0} \right] \right\}} \quad (6)$$

where  $|\partial CS^{\theta=k=0}| > |\partial CS^{\theta < \theta_c}| > |\partial CS^{\theta \geq \theta_c}|$ .

Similar to the previous cases, when total production falls below the monopoly output producer surplus falls when  $\theta \in [0, \theta_c)$ . The consumer/taxpayer surplus is reduced initially but rises after the point is reached where the penalties collected on detected cheating exceed the resource costs of monitoring and the loss in consumer surplus. The result is the backward bending portion of the  $STC^{\theta < \theta_c}$  and  $STC^{\theta=k=0}$  curves in Figure 2.

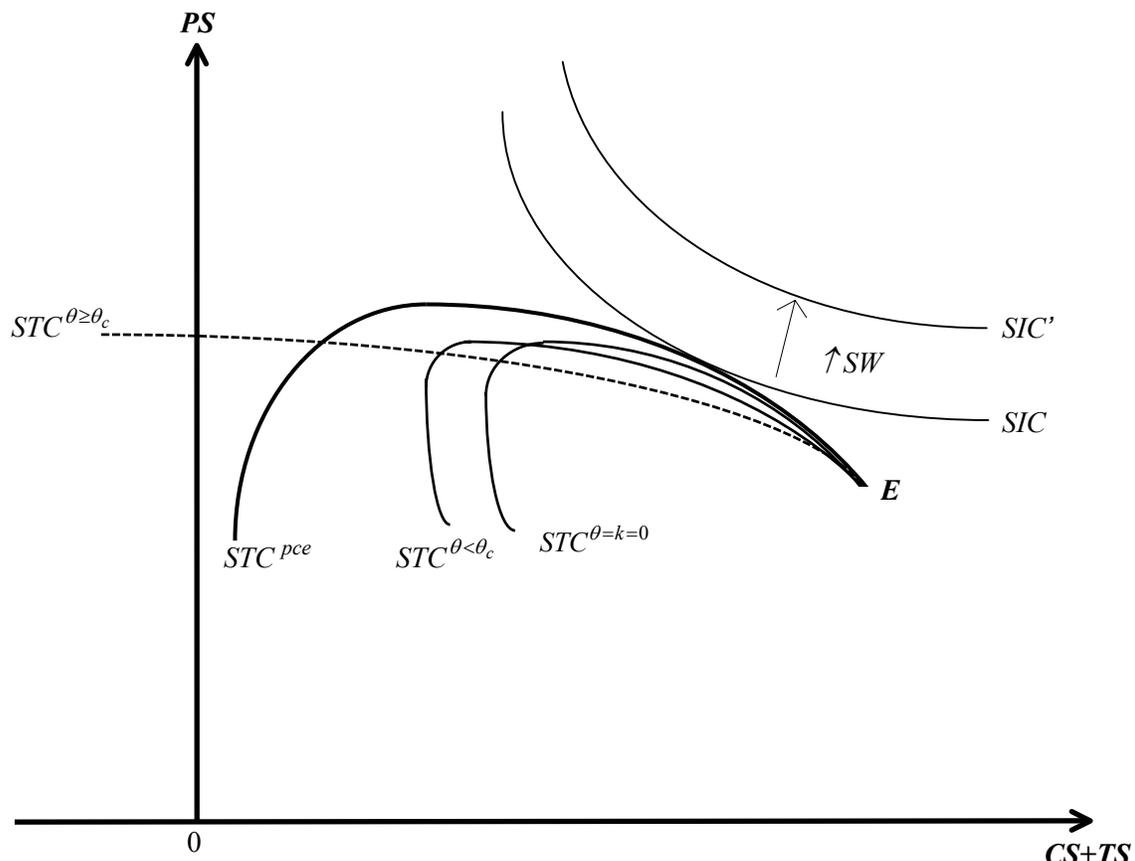
As was pointed out in the previous section, the transfer  $R_\rho$  from producers to taxpayers under imperfect enforcement implies that in order for a given surplus to be transferred to producers, the output level has to be reduced more than would otherwise be required. This reduction in total output results in increased distortionary costs of market intervention relative to the “perfect and costless enforcement” case. Moreover, the positive  $\delta_0$  that occurs when  $\theta \in [0, \theta_c)$  means positive monitoring and enforcement costs.

Because of the increased resource costs associated with a given transfer to producers the  $STC^{\theta < \theta_c}$  and  $STC^{\theta=k=0}$  will lie underneath  $STC^{pce}$  everywhere to the left of  $E$ . Hence, the most efficient income redistribution through output restrictions occurs in a world where policy enforcement is perfect and costless. The implication of this result [which is consistent with the findings of GF (2000) for the centralized policy making case] is that the traditional analysis of output quotas overestimates the transfer efficiency of this policy instrument by ignoring the costs associated with program enforcement.

Consider next the relative transfer efficiency of output restrictions under the different political preferences of the enforcement agency when program enforcement is costly. The analysis in GF (2003) and the results in the previous section of this paper show that both enforcement and total production increase with an increase in the weight placed by the enforcement agency on producers (i.e.,  $\delta_0^{\theta=k=0} < \delta_0^{\theta < \theta_c} < \delta_0^{\theta \geq \theta_c}$  and  $Q^{*\theta=k=0} < Q^{*\theta < \theta_c} < Q^{*\theta \geq \theta_c}$ ). This finding implies that an increase in  $\theta$  will increase the transfer efficiency of quotas (i.e.,  $|s^{\theta=k=0}| < |s^{\theta < \theta_c}| < |s^{\theta \geq \theta_c}|$ ) as long as the increase in monitoring costs (associated with the higher  $\delta_0$ ) is smaller than the reduction in the welfare losses from misallocation of resources (due to higher production). Thus, for any given market conditions, relatively low enforcement costs result in a  $STC^{\theta=k=0}$  that lies under  $STC^{\theta < \theta_c}$  which, in turn, lies under  $STC^{\theta \geq \theta_c}$  everywhere to the left of  $E$  (Figure 2). More generally, the lower are the enforcement costs, the greater is the likelihood that the transfer efficiency of the policy instrument increases with an increase in  $\theta$  for any level of market intervention.

If enforcement costs are high, however, this result no longer holds. Since smaller values of  $\theta$  mean less enforcement and smaller output levels,  $STC^{\theta=k=0}$  lies above  $STC^{\theta < \theta_c}$  which, in turn, lies above  $STC^{\theta \geq \theta_c}$ . The reason for this ranking is that as  $\theta$  increases, the increase in monitoring costs is greater than the reduction in welfare losses that result from an increase in production. In

this case, the most efficient outcome emerges under allowance of cheating and its attendant decrease in total production. This is true for the range of intervention where the reduction in enforcement costs (due to reduced enforcement) outweigh the relevant increase in deadweight welfare losses. As long as the increase in the deadweight loss is greater than the reduction in monitoring costs,  $STC^{\theta \geq \theta_c}$  will eventually cross  $STC^{\theta < \theta_c}$  and  $STC^{\theta = k = 0}$  from below (Figure 3). Note also, that because of the transfers from producers to taxpayers through penalties on detected quota violations, the maximum transfer that can be achieved when some cheating is allowed is always smaller than the maximum feasible transfer when cheating is completely deterred. Thus,  $STC^{\theta = k = 0}$  and  $STC^{\theta < \theta_c}$  reach their maximum at a lower level of producer surplus than  $STC^{\theta \geq \theta_c}$  (and  $STC^{pce}$ ).



**Figure 3. STCs of Output Quotas Under Costly Enforcement [High  $\Phi(\delta_0)$ ]**

With this background, the relationship between transfer efficiency and the political preferences of the regulator and the enforcement agency can be summarized. When enforcement costs are low, the efficiency of output quotas in transferring income to producers is maximized when both the enforcement agency and the regulator place a relatively high weight on producer welfare.<sup>2</sup> Interestingly, the transfer efficiency of the policy mechanism is minimized when the

<sup>2</sup> Recall that, since output quotas involve surplus transfers to producers, a necessary condition for the adoption of the farm program is a relatively high weight attached by the regulator to producer surplus.

enforcement agency is not concerned with the welfare of producers and consumers but its objective instead is to minimize the taxpayer costs from cheating. The reason is the relatively low level of enforcement that results when the enforcement agency attaches zero weight to producer welfare. Since the costs of enforcement are less than the benefits obtained by having greater production, the most efficient outcome emerges under increased enforcement.

While a disagreement in the political preferences of the policy maker and the policy enforcer is costly in terms of the transfer efficiency of output quotas when enforcement costs are low, this is not the case if monitoring costs are high. When enforcement costs are high, the costs of enforcement are greater than the benefits obtained by having greater production – thus the most efficient outcome emerges under relatively low enforcement. Since reduced enforcement occurs when the enforcement agency places a relatively low weight on producer welfare relative to that of the policy maker, the implication is that a lack of agreement in political weighting yields a more efficient outcome.

Overall, the efficiency of output quotas in redistributing income to producers of the regulated commodity depends on the level of enforcement and the associated monitoring costs. When enforcement costs are low, the efficiency of output quotas increases with an increase in enforcement and the reduction in cheating. When, on the other hand, enforcement costs are high, the transfer efficiency of the instrument depends on the desired transfer to producers. For relatively small transfers, the transfer efficiency increases with a reduction in monitoring. Because there is a limit on the maximum income redistribution that can be achieved under imperfect enforcement, the transfer of a large amount to producers can only be achieved under complete deterrence of cheating.

#### 4. Optimal Income Redistribution

In addition to determining the consequences of cheating for the transfer efficiency of output quotas, the *STC* framework developed above can be used to determine the socially optimal income redistribution when enforcement of the quota program is costly. Consider the case where the objective of the regulatory agency is the determination of the surplus transfer to producers that maximizes some weighted social welfare function (*SWF*) (rather than the determination of the quota level that transfers a *given* surplus to producers). Assume that the political preferences of the regulator result in social indifference curves (*SICs*) similar to those graphed in Figures 2 and 3, with the *SWF* value increasing with the northeast shift of the *SIC* [for the specifics of the *SWF* that gives rise to the *SICs* used in this paper see Gardner (1987)].

The socially optimal transfer to producers under the various levels of program enforcement is determined by the tangency of the *SIC* with the relevant *STC* (Gardner, 1987). In the relevant area for policy intervention through output restrictions (i.e., the area to the right of the point corresponding to monopoly output), the level of optimal total transfer to producers increases with an increase in the efficiency of the policy instrument in redistributing income.

For any given set of *SICs*, the maximum transfer to producers will take place in an environment where cheating is perfectly and costlessly deterred. Since the transfer to producers under an output quota occurs through the market effects of the policy instrument, there will be less output produced under perfect and costless enforcement than when program enforcement is costly (i.e., the level of production under perfect and costless enforcement will be closer to the monopoly output). This finding implies that the traditional analysis of output quotas, by assuming perfect and costless enforcement of the farm program, inflates the socially optimal total transfer to producers, as well as the social welfare value from intervention.

When program enforcement is costly, both the socially optimal total transfer to producers and the social welfare from intervention increase with an increase in enforcement when enforcement costs are low. Put in a different way, when enforcement costs are low both the optimal transfer to producers and social welfare are maximized when the political preferences of the enforcement agency and the regulator coincide, i.e., when producer welfare is valued highly by those responsible for policy design and enforcement. On the other hand, when enforcement costs are high, the socially optimal transfer to producers and the value of *SWF* fall with an increase in the level of monitoring (Figure 3). Thus, when enforcement is relatively costly, both producers and the society would be better off in a policy making environment characterized by a divergence in the political preferences of the agencies involved in policy design and policy enforcement.

## 5. Extension of the Model - Endogenous Penalties

To complete the analysis of the transfer efficiency of output quotas and the optimal regulatory responses to enforcement costs and farmer noncompliant behavior, it is useful to consider the policy outcomes in the limiting case where penalties are endogenous to the agency responsible for the enforcement of the program. Given the results of GF (2003) on the optimal enforcement of the policy when the enforcement agency has control over both audits and penalties charged on detected above-quota production, the implications of endogenous penalties for our analysis are straightforward.

In particular, GF (2003) show that when penalties are endogenous to the enforcement agency, the optimal choice of an enforcement agency that places a relatively high weight on producer surplus will be the complete deterrence of cheating through the establishment of enormous fines for those caught violating their quota limit (and no monitoring). Since, in this case, enforcement of output quotas is perfect and costless, the quota level that transfers the desired surplus to producers, the transfer efficiency of the policy instrument, and the socially optimal income redistribution are those derived by the traditional analysis of the policy mechanism. This finding bolsters GF's assertion that, "one interpretation of the assumption of 'perfect and costless policy enforcement' that is implicit in the traditional quota analysis is that enormous fines can be costlessly levied on producers that violate their quota limit" [GF (2003), p.13].

When, on the other hand, the enforcement agency places a relatively low weight on producer welfare, above-quota production occurs and the quota level that achieves the desired transfer to producers is reduced relative to the "perfect and costless enforcement" case. Total production is also reduced. Reduced production results in increased welfare losses from the misallocation of resources associated with a given transfer to producers and, thus in a reduced transfer efficiency of the policy instrument relative to the "perfect and costless enforcement" case.

## 6. Concluding Remarks

This paper extends the study of Giannakas and Fulton (2003) on the optimal enforcement of output quotas in the presence of cheating by examining the efficiency of the policy in transferring income to agricultural producers as well as the optimal regulatory responses under the different enforcement policy scenarios considered in GF (2003). In particular, the paper examines the economic consequences of enforcement costs and producer noncompliant behavior on the transfer efficiency of output quotas and the level of the socially optimal policy intervention and income redistribution in a *decentralized* policy making environment.

Analytical results show that the introduction of enforcement costs and cheating changes the incidence of the quota program. By operating under the assumption of perfect and costless enforcement of quotas, the traditional analysis of the farm program overestimates the quota level that transfers a given surplus to producers, the transfer efficiency of the policy instrument, the socially optimal total transfer to producers, and the social welfare value from intervention. The magnitude of the changes due to cheating (and, thus, the incidence of output quotas) depends on the level of program enforcement which is determined, in turn, by the resource costs of monitoring producer compliance and the relative weights placed by policy enforcers on the welfare of the interest groups. On this latter point, when monitoring costs are high, a divergence between the political preferences of the policy maker and those of the policy enforcer results in larger and more efficient transfers to producers than would occur if the preferences were similar. When monitoring costs are low, this result is reversed and the larger and more efficient transfer occurs if both policy makers and policy enforcers have a relatively high weight attached to producer welfare.

The results of this paper demonstrate that enforcement issues relating to output quota schemes have significant effects on income redistribution. They also bolster our previous arguments that enforcement costs and farmer noncompliant behavior cannot be a matter of indifference and need to be included into the economic analysis of the policy.

Finally, it should be noted that, while our study provides insights on the economic causes and consequences of farmer noncompliant behavior, an empirical analysis of cheating on output quotas could make the analysis of the policy instrument under costly enforcement more useful in practical policy settings. Being constrained by data limitations, we leave this query open to future research.

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