About the Efficiency of Input vs. Output Quotas

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1 Introduction

Output quotas are known to be more efficient than input quotas in transferring surplus from consumers to producers. While both types of quotas entail a consumer loss arising from the increase in output price, an input quota also raises the shadow price of the restricted input and leads to inefficient production. As noted by Alston and James (2002), under an input quota, producers will distort the input mix to make the constraint on input use less binding. In the case of acreage restrictions, this distortion may lead to intensified use of non-land inputs, a phenomenon referred to as "slippage". Alston and James (2002) also mention that with inputs of varying quality, input quotas give producers an incentive to use the highest quality of the restricted input.

Floyd (1965) has studied the redistributive properties of alternative agricultural policies with an application to U.S. agriculture. Specifying a constant-elasticity partial equilibrium model with two inputs (land and an aggregate input representing labor and non-land capital) and one output, he compared the returns to these two inputs of an output subsidy scheme, a land quota scheme and an output quota scheme that have the same effect on output price. He did not compare those three policies in terms of their economy-wide deadweight losses. Using an equilibrium displacement model with constant-elasticity demand and supply schedules, Gardner (1987) has analyzed the welfare effects of output and input quotas. He showed that the surplus transformation curve for an input quota lies inside that for an output quota, meaning that the surplus transfer from consumers to producers is less efficient. He also noted that in the extreme case where the elasticity of substitution between inputs is zero, the two curves should coincide.

Despite their theoretical inefficiency, input quotas have been a ubiquitous element of agricultural policies, a common example being acreage reduction programs. Well-known land quota policies include the former US tobacco program, the former US acreage reduction program (repealed by the 1996 FAIR Act) or the EU wine common market organization rules. It has been argued that output quotas cannot be properly implemented when output heavily depends on weather conditions (Gisser, 1993; Alston and James, 2002). Output quotas may also be difficult to implement if the raw farm output is directly sold to consumers, as noted by Alston and James (2002) for the case of the Canadian and Australian egg industries.

While practicality considerations pertaining to the implementation and monitoring of quotas may partially explain the existence of input quotas, I argue in what follows that policymakers may also have efficiency reasons to choose them. The widely accepted view that input quotas create additional deadweight losses heavily rests on comparisons that take for granted that the regulator can perfectly (and at no cost) choose and monitor the quota level that transfers any given amount of surplus from consumers to producers. I show that relaxing this assumption may lead the regulator to prefer an input quota policy.

In the next section, I derive the welfare effects of an output quota and an input quota in the context of a 2-input, 1-output industry, and present numerical evidence of the relative inefficiency of input quotas, based on the assumption that the regulator has perfect information about the market fundamentals and can enforce the quota level at no cost. In section 3, I analytically derive the optimal quota levels from the point of view of the production sector under two alternative scenarios, and show that letting the industry choose its quota level always leads to a smaller deadweight loss under an input quota policy. Section 4 concludes.

2 Welfare effects of output and input quotas

Alston and James (2002) have suggested the use of a Muth model (Muth, 1964) in order to quantify the inefficiency of input quotas. Accordingly, I specify a Muth model with 2 inputs (X_1 and X_2) and 1 output (Q). The assumptions underlying the model are that the production technology displays constant returns to scale, and that the production sector is perfectly competitive. In addition, I will assume throughout the paper that whenever quotas are implemented, they are fully transferable.[1]

I specify the model as follows:

$$\begin{cases} E(Q) = -\eta E(P) - \delta_Q \\ E(P) = s_1 E(W_1) + s_2 E(W_2) \\ E(X_1) = -s_2\sigma E(W_1) + s_2\sigma E(W_2) + E(Q) \\ E(X_2) = s_1\sigma E(W_1) - s_1\sigma E(W_2) + E(Q) \\ E(X_1) = \epsilon_1 E(W_1) - \delta_1 \\ E(X_2) = \epsilon_2 E(W_2) \end{cases}, \tag{1}$$

where P, W_1 and W_2 are the prices of output Q and inputs X_1 and X_2, s_1 and s_2 denote the cost shares on inputs X_1 and X_2, η denotes the absolute value of the elasticity of output demand, ϵ_1 and ϵ_2 denote the elasticity of supply of inputs X_1 and X_2, σ denotes the elasticity of input substitution, and $E(.)$ denotes the percentage change in an equilibrium variable.[2] The perturbation δ_Q represents a relative shift of the output demand schedule along the quantity axis. Similarly, δ_1 represents a relative shift of the supply schedule of input X_1 along the quantity axis.

[1] Although this assumption is not realistic for most agricultural quotas, I am not interested in modeling inefficiencies arising from misallocation of quotas between heterogeneous producers.

[2] All elasticities are evaluated at the undistorted equilibrium.

2.1 Welfare effects of an output quota

The system of equations (1) can be solved to express the relative changes in equilibrium variables due to the perturbations δ_Q and δ_1. To analyze the effect of an output quota, I set $\delta_1 = 0$ and let $\eta \to \infty$. The exogenous relative decrease in output is then represented by parameter δ_Q, and the relative changes in X_1, X_2, W_1 and W_2, can be expressed as functions of δ_Q. To calculate the change in output price, I let η take on its real value and use the fact that $E(P) = -\frac{1}{\eta}E(Q)$. The changes in equilibrium prices and quantities can then be used to derive the following welfare effects:[3]

$$\begin{cases} QR & = & PQ(1-\delta_Q)\left[\frac{\delta_Q}{\eta} + \frac{(\sigma+s_2\epsilon_1+s_1\epsilon_2)\delta_Q}{D'}\right] \\ \Delta CS & = & -PQ\left(\frac{\delta_Q}{\eta}\right)\left(1-\frac{\delta_Q}{2}\right) \\ \Delta PS_1 & = & -PQs_1\left[\frac{(\sigma+\epsilon_2)\delta_Q}{D'}\right]\left[1-\frac{(\sigma+\epsilon_2)\epsilon_1\delta_Q}{2D'}\right] \\ \Delta PS_2 & = & -PQs_2\left[\frac{(\sigma+\epsilon_1)\delta_Q}{D'}\right]\left[1-\frac{(\sigma+\epsilon_1)\epsilon_2\delta_Q}{2D'}\right] \end{cases},$$

where $D' = \sigma(s_1\epsilon_1 + s_2\epsilon_2) + \epsilon_1\epsilon_2 > 0$, QR represents the quota rent, and ΔCS, ΔPS_1 and ΔPS_2 are the changes in consumer surplus and the quasi-rents to suppliers of inputs X_1 and X_2, respectively. The resulting deadweight loss for the economy, defined as the sum of those surplus changes, is:

$$\begin{aligned} DWL^o &= -PQ\frac{1}{2\eta D'^2}[D'^2 - s_1\epsilon_1\eta(\sigma+\epsilon_2)^2 - s_2\epsilon_2\eta(\sigma+\epsilon_1)^2 \\ &\quad +2\eta(\sigma+s_2\epsilon_1+s_1\epsilon_2)D']\delta_Q{}^2. \end{aligned} \tag{2}$$

It is easy to show that DWL^o is always negative. It is proportional to $\delta_Q{}^2$, which implies that a marginal output quota, in the absence of any preexisting distortion, will entail no deadweight loss, a well-known result in public finance.

[3] All derivations and proofs are available from the author upon request.

2.2 Welfare effects of an input quota

The effect of an input quota can be inferred by setting $\delta_Q = 0$ and letting $\epsilon_1 \to \infty$. The relative reduction in input X_1 is then represented by parameter δ_1, and the relative changes in X_2, W_2, Q and P can be expressed as functions of δ_1. The change in W_1 is calculated using the fact that $E(W_1) = \frac{1}{\epsilon_1}E(X_1)$, with ϵ_1 now denoting the real elasticity of input supply. The welfare effects of the input quota can then be derived as:

$$\begin{cases} QR & = & PQs_1(1-\delta_1)\left[\frac{\delta_1}{\epsilon_1} + \frac{(s_1\sigma+s_2\eta+\epsilon_2)\delta_1}{D''}\right] \\ \Delta CS & = & -PQ\left[\frac{s_1(\sigma+\epsilon_2)\delta_1}{D''}\right]\left[1 - \frac{s_1\eta(\sigma+\epsilon_2)\delta_1}{2D''}\right] \\ \Delta PS_1 & = & -PQs_1\left(\frac{\delta_1}{\epsilon_1}\right)\left(1-\frac{\delta_1}{2}\right) \\ \Delta PS_2 & = & PQs_2\left[\frac{s_1(\sigma-\eta)\delta_1}{D''}\right]\left[1 + \frac{s_1(\sigma-\eta)\epsilon_2\delta_1}{2D''}\right] \end{cases},$$

where $D'' = \eta\sigma + (s_1\eta + s_2\sigma)\epsilon_2 > 0$. The corresponding deadweight loss is:

$$\begin{aligned} DWL^i &= -PQ\frac{s_1}{2\epsilon_1 {D''}^2}[{D''}^2 - s_1\epsilon_1\eta(\sigma+\epsilon_2)^2 - s_1s_2\epsilon_1\epsilon_2(\sigma-\eta)^2 \\ &\quad +2(s_1\sigma + s_2\eta + \epsilon_2)\epsilon_1 D'']{\delta_1}^2. \end{aligned} \quad (3)$$

It can easily be shown that DWL^i is always negative. It is proportional to ${\delta_1}^2$, which implies that a marginal quota on input X_1, in the absence of any preexisting distortion, will entail no deadweight loss. This finding generalizes the public finance result that marginal quotas do not create deadweight losses to the case of an input quota in a multi-product setting.

Expressions (2) and (3) can be used to compare the deadweight losses from an input quota and an output quota. Figure 1 represents the deadweight losses of output and input quota policies, as functions of the transfer to the production sector. The transfer is defined as the sum of the quota rent and the quasi-rents to suppliers of inputs X_1 and X_2. The fact that the curve for the input quota lies inside that for the output quota implies that the input quota policy is less efficient, because for any given transfer of surplus to producers, the social cost of the transfer will be larger for the input quota. Although the two curves were derived for a given set of parameter values, changing these values does not modify the overall shape of the curves or their relative position. Making the elasticity of substitution smaller brings the two curves closer to one another, though even for small values of σ they can be made further apart by decreasing s_1. Note that because the input quota is less efficient, there exists a set of transfers that are achievable through an output quota but not through an input quota. For the case shown in figure 1, surplus transfers ranging approximately from 20 to 35% of the value of output are only attainable through an output quota.

Table 1 shows the deadweight losses associated with the transfer of a given amount of surplus to the production sector, for an output and an input quota and for various parameter settings. As noted above, although the input quota is always less efficient, the two policies converge for small enough values of σ or large enough values of s_1.

3 Optimal output and input quotas

In this section, I assume that the regulator, instead of choosing the quota level itself, chooses which type of quota to implement (output or input quota) but lets the industry choose and monitor the quota level. I carry out this analysis under two scenarios, reflecting two levels of representation of the suppliers of input X_2 in the industry. First, I assume that the quota is chosen so as to maximize the sum of the rents to suppliers of both inputs. Then, I assume it is chosen so as to maximize the rents to suppliers of input X_1 only. In both scenarios, I assume that the quota rent accrues to the suppliers of X_1.

3.1 Scenario 1

Under this scenario, suppliers of input X_1 and X_2 are equally represented in the industry. This is the case, in particular, if one entity supplies both inputs and produces the output. A farm sector where farmers supply family labor and own farm land would satisfy this assumption (neglecting other agricultural inputs). The optimal output quota ${\delta_Q}^*$ chosen by the industry then solves

$$\max_{\delta_Q} \quad TR + \Delta PS_1 + \Delta PS_2.$$

It can be shown that the solution to this program is given by

$${\delta_Q}^* = \frac{D'^2}{2D'D - s_1\epsilon_1\eta(\sigma+\epsilon_2)^2 - s_2\epsilon_2\eta(\sigma+\epsilon_1)^2}, \tag{4}$$

where $D = \sigma(\eta + s_1\epsilon_1 + s_2\epsilon_2) + \eta(s_2\epsilon_1 + s_1\epsilon_2) + \epsilon_1\epsilon_2 > 0$.

Similarly, the optimal input quota ${\delta_1}^*$ is given by

$${\delta_1}^* = \frac{(\sigma+\epsilon_2)\epsilon_1 D''}{D''(D + (s_1\sigma + s_2\eta + \epsilon_2)\epsilon_1) - s_1 s_2(\sigma-\eta)^2\epsilon_1\epsilon_2}. \tag{5}$$

Plugging expressions (4) and (5) into expressions (2) and (3), respectively, it can be shown that the deadweight loss resulting from the optimal output quota is always larger than that resulting from the optimal input quota.[4] For tractability purposes, I present a proof of this result in the special case where $\epsilon_1 \to \infty$ and $\epsilon_2 \to \infty$, that is, when the gain to producers is only comprised of the quota rent. The deadweight loss expressions then simplify to

$$\begin{cases} DWL^o({\delta_Q}^*) = -PQ\frac{1}{8\eta} \\ DWL^i({\delta_1}^*) = -PQ\frac{s_1}{8}\frac{s_1\eta+2s_2\sigma}{(s_1\eta+s_2\sigma)^2} \end{cases},$$

[4]This result was shown, in the general case, with the aid of the "Simplify" command in MATHEMATICA. The proof is available upon request.

so that $|DWL^i(\delta_1{}^*)| < |DWL^o(\delta_Q{}^*)|$ iff $s_1\eta(s_1\eta + 2s_2\sigma) < (s_1\eta + s_2\sigma)^2$, which is always true. As a result, the deadweight loss generated by an input quota policy where producers freely choose the quota level is always smaller than that generated by an output quota policy where producers freely choose the quota level. This can be seen in figure 1, where the deadweight loss corresponding to the largest attainable transfer is clearly smaller for the input quota.

This result is far from being obvious. Even if one expects the output price to be lower under an optimal input quota policy (because the production inefficiency deters the producer group from distorting output too much), which would make consumers better off, the surplus transferred to producers is necessarily smaller under an input quota because of the waste due to inefficient production. Therefore, it would have been hard to predict that the resulting deadweight loss was lower for an input quota policy. In fact, the production inefficiency has two opposing effects on this deadweight loss: it creates waste because producers depart from cost-minimizing behavior, but at the same time it restricts the ability of the industry to effectively increase output price, therefore benefiting consumers. The above derivation shows that the latter effect dominates.

3.2 Scenario 2

Under this scenario, suppliers of input X_2 are not represented in the industry. This would be the case if landowners (suppliers of land) and farm managers (owners of the output quotas) are equally represented in the industry, but suppliers of hired labor (input X_2) are not. In this situation, the group comprised of landowners and farm managers collects the quota rents, while farm workers are hurt by an output quota and either benefit or lose from an input quota, depending on the relative magnitudes of σ and η.[5]

[5]More precisely, farm workers benefit from an input quota iff $\sigma > \eta$, i.e., inputs are gross substitutes.

The optimal output quota $\hat{\delta_Q}$ then maximizes $TR + \Delta PS_1$ and is equal to

$$\hat{\delta_Q} = \frac{(D' + s_2\eta(\sigma + \epsilon_1))D'}{2D'D - s_1\epsilon_1\eta(\sigma + \epsilon_2)^2}. \tag{6}$$

Similarly, the optimal input quota $\hat{\delta_1}$ is given by

$$\hat{\delta_1} = \frac{(s_1\sigma + s_2\eta + \epsilon_2)\epsilon_1 D''}{D''(D + (s_1\sigma + s_2\eta + \epsilon_2)\epsilon_1)}. \tag{7}$$

As for scenario 1, it can be shown that the deadweight loss generated by the optimal input quota is always smaller than that generated by the optimal output quota.

3.3 Robustness check

The results presented in the last two sections were derived assuming that changes in equilibrium prices and quantities can be approximated using a first-order approximation around the undistorted equilibrium. Although this approximation will be exact for linear demand and input supply schedules, its accuracy may become questionable for other specifications, especially for large departures from the undistorted equilibrium. Since I am interested in comparing the deadweight losses of quotas that are by nature far from the undistorted quantities, it is relevant to ask whether the result would hold with other model specifications.

In the following, I derive the deadweight losses from optimal quotas using constant-elasticity demand and supply schedules, and a Cobb-Douglas production technology.[6] In order to simplify the analysis, I assume that the supply of input X_2 is infinitely elastic, at price w_2. Hence, industry profits are equal to the quasi-rent of suppliers of input X_1 plus the quota rent. Using the same

[6] Note that the Cobb-Douglas assumption implies that the elasticity of substitution between inputs, σ, is constant and equal to 1.

notation as before, the model equations read:

$$\begin{cases} Q = P^{-\eta} \\ X_1 = W_1^{\epsilon_1} \\ Q = X_1^{s_1} X_2^{s_2} \end{cases} .$$

The derived industry supply schedule can be shown to be equal to:

$$Q(P; w_2) = {s_1}^{\epsilon_1} \left(\frac{s_2}{w_2}\right)^{\frac{(1+\epsilon_1)s_2}{s_1}} P^{\frac{\epsilon_1+s_2}{s_1}}. \tag{8}$$

Similarly, the derived demand for input X_1 is equal to:

$$X_1(W_1; w_2) = s_1^{s_1\eta+s_2} \left(\frac{s_2}{w_2}\right)^{s_2(\eta-1)} W_1^{-(s_1\eta+s_2)}. \tag{9}$$

From expressions (8) and (9), it is apparent that the industry's derived supply and demand schedules are of the constant-elasticity form. It is then straightforward to derive the profit-maximizing output and input quota levels, using the monopolist's pricing rule stating that the relative price-cost margin must equal the inverse elasticity of demand. For the output quota, this pricing rule implies that[7]

$$\frac{Q^*}{Q} = \left(\frac{\eta-1}{\eta}\right)^{\frac{\eta(\epsilon_1+s_2)}{s_1\eta+s_2+\epsilon_1}} \tag{10}$$

Similarly, the optimal input quota is given by

$$\frac{X_1^*}{X_1} = \left(\frac{s_1(\eta-1)}{s_1\eta+s_2}\right)^{\frac{\epsilon_1(s_1\eta+s_2)}{s_1\eta+s_2+\epsilon_1}} \tag{11}$$

Gardner (1987) derives an expression for the deadweight loss resulting from a given reduction in quantity, for the constant-elasticity case. Applying this

[7] Q^* denotes the monopoly quantity and Q the undistorted quantity.

formula to the optimal output and input quotas, we obtain:

$$\left|\frac{DWL^o}{PQ}\right| = \frac{\eta}{\eta-1}\left[1-\left(\frac{\eta-1}{\eta}\right)^{\frac{(\eta-1)(\epsilon_1+s_2)}{s_1\eta+s_2+\epsilon_1}}\right] - \frac{\epsilon_1+s_2}{\epsilon_1+1}\left[1-\left(\frac{\eta-1}{\eta}\right)^{\frac{\eta(\epsilon_1+1)}{(s_1\eta+s_2+\epsilon_1)}}\right]$$

and

$$\left|\frac{DWL^i}{W_1X_1}\right| = \frac{s_1\eta+s_2}{s_1(\eta-1)}\left[1-\left(\frac{s_1(\eta-1)}{s_1\eta+s_2}\right)^{\frac{\epsilon_1 s_1(\eta-1)}{s_1\eta+s_2+\epsilon_1}}\right] - \frac{\epsilon_1}{\epsilon_1+1}\left[1-\left(\frac{s_1(\eta-1)}{s_1\eta+s_2}\right)^{\frac{(\epsilon_1+1)(s_1\eta+s_2)}{s_1\eta+s_2+\epsilon_1}}\right].$$

Although an analytical demonstration that $|DWL^o| > |DWL^i|$ would be beyond the scope of this paper, it can easily be checked through simulation that the result still holds. Table 2 compares these two measures for a wide range of parameter values.[8] Without constituting by itself an irrefutable proof of the robustness of the deadweight loss comparison, this derivation adds credence to the view that it should be valid in many situations.

4 Interpretation

Let us summarize the results derived in sections 2 and 3. The regulator will prefer an output quota policy if he solves

$$\min_{\mathcal{P},\lambda} \quad DWL(\mathcal{P}(\lambda)) \quad \textit{sub. to} \quad T(\mathcal{P}(\lambda)) \geq \tau,$$

where $\mathcal{P}$ represents the policy choice (an output or input quota policy), λ represents the quota level, T represents the realized transfer to producers and τ is

[8]Table 2 also shows that $\frac{X_1^*}{X_1} > \frac{Q^*}{Q}$, meaning that the optimal reduction in input use is smaller than the optimal reduction in output.

a policy objective. However, he will prefer an input quota policy if he solves

$$\min_{\mathcal{P}} \quad DWL(\mathcal{P}(\lambda^*)) \quad sub.\ to \quad \begin{cases} \lambda^* = \max\limits_{\lambda} \quad T(\mathcal{P}(\lambda)) \\ T(\mathcal{P}(\lambda^*)) \geq \tau \end{cases} .$$

In this case, the regulator chooses the policy but lets the industry regulate itself in its choice and implementation of the quota level. This program assumes that the objective τ is achievable through both policy alternatives. This clearly puts an upper bound on the value of τ, as we saw in section 2 that large transfers can only be achieved through output quotas.

This provides a new argument as to why policymakers may favor input quotas over output quotas. The superiority of output quotas over input quotas, as described in section 2, is dependent upon the assumptions that the regulator either seeks to increase output price by a given amount or to transfer a given amount of surplus to producers, and that he knows which quota level to implement in order to achieve either of these objectives. It also assumes implicitly that the cost of enforcing the quota is negligible.[9]

However, the regulator rarely has perfect information about the market fundamentals, i.e., the supply and demand elasticities. Producers may have a better knowledge of their cost and demand conditions than regulators. The producer association has no incentive to reveal these elements to the regulator, but rather to lie about them so that the regulator ends up choosing the quota level that maximizes producers' surplus. Even if the regulator could design a revelation mechanism that would lead the industry to truthfully reveal its cost, this mechanism would certainly generate information rents for the producer association, and thus the regulator would only be able to obtain the desired information at

[9]Here, enforcement costs are the costs the regulator incurs when ensuring that producers do not restrict input or output below the regulated quota level. Those must be distinguished from the costs of ensuring that each producer does not exceed its allocated quota.

a positive cost. Even though the design of such a revelation mechanism lies beyond the scope of the present paper, it is not unreasonable to think that the cost of obtaining information from the producer group would be larger the larger the amount of surplus at stake for the industry. Since the optimal transfer is always larger for an output quota, the industry would lose more by revealing its cost under an output quota policy than under an input quota policy. Therefore, if the regulator chose to implement an output quota, it would probably cost him more to obtain truthful information from the industry. This information rent could potentially reverse the ranking of the two policies.

Sometimes, although the type of quota is given and not negotiable (it could be set up in the legislation), the quota level itself is revised annually through an administrative procedure that involves the producer association. In some French cheese markets for instance, quota levels are adopted upon proposition by the producer association (Conseil de la Concurrence, 1998). In such cases, it is not unreasonable to think that the quota level adopted will be close to the one maximizing industry profits. The results from section 3 then indicate that the deadweight loss is likely to be smaller for an input quota policy.

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Figures and tables

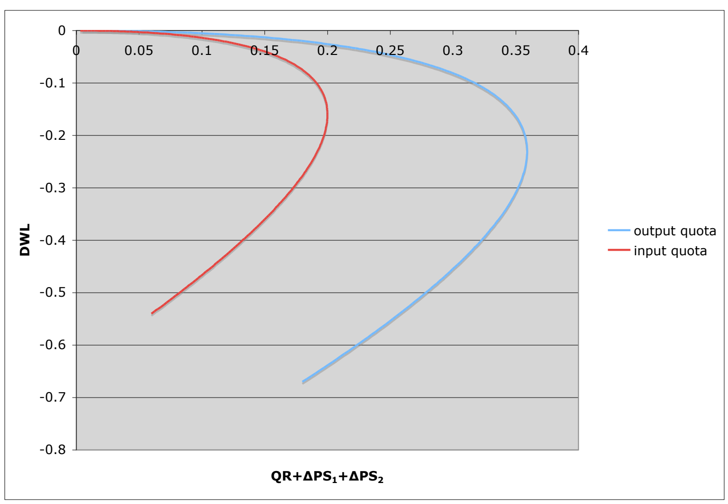

Figure 1: Deadweight losses of output and input quota policies as functions of the transfer to the production sector. The baseline parameter values are $\eta = 0.5$, $\epsilon_1 = 0.5$, $\epsilon_2 = 1$, $s_1 = 0.6$ and $\sigma = 0.5$.

1	2	3	4	5	6	7	8	9
η	ϵ_1	ϵ_2	s_1	s_2	σ	T	$\lvert DWL^o \rvert$	$\lvert DWL^i \rvert$
1	0.5	0.5	0.5	0.5	0.5	0.05	0.005	0.014
0.5	0.5	0.5	0.5	0.5	0.5	0.05	0.001	0.004
1.5	0.5	0.5	0.5	0.5	0.5	0.02*	0.001	0.004
1	1	0.5	0.5	0.5	0.5	0.05	0.003	0.008
1	0.1	0.5	0.5	0.5	0.5	0.02*	0.001	0.007
1	0.5	1	0.5	0.5	0.5	0.05	0.004	0.011
1	0.5	0.1	0.5	0.5	0.5	0.05	0.012	0.023
1	0.5	0.5	0.2	0.8	0.5	0.02*	0.001	0.006
1	0.5	0.5	0.8	0.2	0.5	0.05	0.005	0.005
1	0.5	0.5	0.5	0.5	0.1	0.05	0.005	0.008
1	0.5	0.5	0.5	0.5	0.01	0.05	0.005	0.005
1	0.5	0.5	0.05	0.95	0.01	0.05	0.005	0.014
1	0.5	0.5	0.5	0.5	1	0.05	0.005	0.017

Table 1: Deadweight losses of output and input quota policies. Column 7 indicates the surplus transfer to producers in terms of the value of output. Stars identify situations where a transfer of 5% was achievable through an output quota, but not an input quota. Columns 8 and 9 show the deadweight loss of the transfer for the output and input quota policies, respectively.

1	2	3	4	5	6	7	8	9
η	ϵ_1	s_1	s_2	$s_1\eta + s_2$	$\frac{Q^*}{Q}$	$\frac{X_1^*}{X_1}$	$\lvert DWL^o \rvert$	$\lvert DWL^i \rvert$
1.1	0.5	0.5	0.5	1.05	0.182	0.357	0.962	0.344
1.5	0.5	0.5	0.5	1.25	0.390	0.563	0.304	0.135
2.5	0.5	0.5	0.5	1.75	0.567	0.719	0.099	0.049
1.1	0.1	0.5	0.5	1.05	0.253	0.757	0.792	0.095
1.1	1	0.5	0.5	1.05	0.145	0.210	1.077	0.513
1.5	0.1	0.5	0.5	1.25	0.481	0.862	0.247	0.037
1.5	1	0.5	0.5	1.25	0.333	0.409	0.343	0.201
1.1	0.5	0.9	0.1	1.09	0.370	0.425	0.585	0.466
1.1	0.5	0.1	0.9	1.01	0.087	0.214	1.327	0.120

Table 2: Optimal output and input quotas and corresponding deadweight losses in the constant-elasticity case. Note that for the monopoly solution to be defined, demand elasticities have to be greater than 1 in absolute value. The elasticity of the derived demand for input X_1 is reported in column 5.