A Note on the Effects of Non-Transferable Quotas on Supply Functions

Julian M. Alston*

Marketing systems using non-transferable or imperfectly transferable quotas induce shifts in supply as well as shifts along supply functions. There are social costs associated with these shifts which are additional to those normally recognised in the literature. To reduce the size of the shifts in supply and the social costs, quotas should be efficiently transferable.

1 Introduction

In conventional analysis the effects of quotas are illustrated, and occasionally estimated, by comparing the free market equilibrium of supply, demand and price, with that which applies or would apply under quotas. The consequences of quotas are treated as shifts along static supply and demand schedules, assuming no change in the positions of the schedules.

The hypothesis of this note is that frequently where quotas cause shifts along supply functions there are simultaneous shifts of the functions. This is not a new notion; there have been piece-meal applications in some form for example by Alston and Quilkey (1979). Beck (1974), Harris and Candler (1960), Parish (1963) and Parish and Kerdpibule (1968).

The purpose of the note is to draw together these piece-meal applications and focus attention on the effects of marketing quotas on the position of the supply schedule, drawing on examples in Australian agriculture. Modifying the analysis to allow for shifts both in and along functions due to interference will alter the conclusions, and will have implications for the prescriptions for policy-makers, arising from such work.

2 Conventional Analysis

In conventional analyses of the economic effects of marketing quotas, the position of the commodity supply function is assumed to be unaffected by the quota system. This approach, as used for example by Beck (1974) in his analysis of hen quotas and by Parish (1963) for fluid milk marketing quotas, is demonstrated in the general model shown in Figure 1. In the absence of quotas the free equilibrium is at E, where the supply function SS' intersects the demand function DD'. At the equilibrium price P, quantities supplied and demanded are equal at Q. If supply is restricted by a quota system to Q', the market clearing price is higher at P'. The net social cost of this quota system is shown as the triangle aEb which represents the sum of the net loss of producers' and consumers' surpluses.

This model takes only limited account of some real-world aspects of quota systems. 1 Closed quota systems can result in changes in uncertainty and the rate of

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*Research Economist, Division of Economics and Marketing, Department of Agriculture, Victoria, currently on study leave at North Carolina State University. The author is indebted to Geoff Edwards, John Freebairn, John Quilkey, Timothy J. Ryan, Michael Taylor, and three anonymous referees, for comments on earlier drafts. The usual caveat applies.

1 The administrative arrangements for quota systems are mostly overlooked in analyses of this type. Social costs can arise from the bureaucracy associated with quota systems. For example Godden and Drane (1978) have discussed "inefficiency" which arises from "... regulations imposed... for bureaucratic convenience." Further inefficiencies can arise if the quota administering authority cannot accurately fix both prices and quantities of the product in accord with demand. To deal with this problem in part, the administering authority can set the total quota in excess of anticipated requirements, as a form of insurance. It is believed that the New South Wales Dairy Industry Authority had a standard safety margin of 10 percent of fresh milk sales. It is likely there are social costs associated with such behaviour. The analysis of this paper does not account for the social costs due to arrangements adopted in the administration of quota schemes, for bureaucratic convenience.
technical change, are barriers to entry for economically efficient producers, can prevent the achievement of economies in production, and can result in externalities. All of these effects cause structural changes in supply. The structural changes in supply can be represented as shifts in supply which occur simultaneously with the shifts along supply functions when quota systems are introduced. In the following analysis, the nature of the shifts in supply due to a theoretical closed quota system are demonstrated; the social and private costs and benefits of quotas are represented schematically; in this context closed quota systems are compared with open quota systems; and the implications for empirical work are discussed.

![Diagram of supply shifts under a closed quota system](image)

*Figure 1: Some Effects of Closed Quota Systems*

3 Supply Shifts Under a Closed Quota System

3.1 Imperfect Quota Allocation

Much of the literature concerning marketing quotas has related to quota allocation in particular, a great deal of which discusses the relative merits of open (transferable) quota systems and closed (non-transferable) quota systems (see, for example, Beck 1974, Jarrett 1971, Lloyd 1971, Neutze 1961, Parish and Kerdpibule 1968, and Powell 1972). Explicit attention has not been paid to the complete effects of quota allocation on the position of the supply function.

In the absence of quotas the supply function (the no-quota supply function) is the horizontal sum of the individual supply functions of all producers. When quotas are applied the supply function (the quota supply function) is the horizontal sum of the supply functions of producers who have quotas.

If quotas are allocated between producers to achieve minimum marginal cost for any quantity, the supply function will be the same with or without quotas. However, if quotas are not allocated to the most economically efficient producers in appropriate quantities so that each producer can fully capture any available economies of size or scale, the quota supply function will be to the left of the no-quota supply function. Optimal size will differ between producers, and the larger are the differences between
quota levels and optimal sizes, and the larger are the potential economies, the greater will be the supply shift.

3.2 Technical Change

Quotas also may affect producers' incentives to pursue and adopt innovations and technical improvements, especially where the changes involve lumpy capital items with large size economies. Thus over time under quotas the supply curve may shift to the right at a slower rate than in their absence. At a point in time the consequence of not having adopted technical innovations is a supply curve to the left of where it would be if the innovations had been adopted. In the static model this can be represented as an additional leftwards shift of the quota supply function relative to the no-quota supply function. The additional social costs of this type of shift in supply may be thought of as the opportunity costs of technical change which would have occurred but has not occurred because of quotas.

In Figure 1 the no-quota supply function is $SS^*$ and the quota supply function is higher at $SS^*$ because quota is not allocated to the most efficient producers in the appropriate quantities and because quotas retard technical change. The net social cost of quotas is augmented by the area $bSdc$ which is both a loss in producers' surplus and a net loss to society because the cost of resources used to produce $Q'$ could be lower by that amount.

3.3 Input Quotas

Digressing away from market share quotas per se, shifts in supply are caused also by input quota schemes (such as acreage or hen quotas or irrigation water rights). Where the use of one input is restricted it is profitable to increase the relative levels of other inputs. This will cause the supply function to shift to the left over the range where the input is restricted. As pointed out by Beck (1974) in relation to hen quotas, the magnitude and nature of this shift will depend on the elasticities of substitution of other inputs for the restricted input; it also depends on the type of quota and the type of input. The shift can be represented schematically. In Figure 2, $SS^*$, is the marginal cost curve of producers with hen quotas if quota were not limiting and did not cause distortions in input use. The total hen quota is such that $Q^*$ would be the minimum cost level of output and $Q^*$ is the technical maximum production of eggs from that number of hens. The supply function beyond $Q^*$ approaches the vertical $Q^*$ asymptotically as higher prices call forth increased substitution of other inputs for additional hens to produce greater output. Actual output is $Q'$ given by the intersection of the supply function $SaS^m$ with the demand function $DD'$. The additional social costs are represented by the shaded area $abc$ in Figure 2.

Another complicating factor is that input quotas stimulate research into, and the adoption of, innovations which increase the productivity of the restricted input. This acts to shift the vertical $Q^*$ in Figure 2 to the right. An example is selection of hens for higher egg production under hen quotas. This selection could be at the expense of other hen characteristics and may involve a leftwards shift of $SS^*$ to achieve a rightwards shift of $Q^*$.

Irrigation water rights are an example of a closed input quota system used widely in Australia. Non-transferable water rights have consequences for the supply functions of many farm products, causing shifts in supply as shown in Figure 2.

3.4 Quotas and Uncertainty

Under most quota systems a producer faces two potential opportunity costs of an unplanned shortfall of production from his potential share of the market to which quotas apply. There is the opportunity cost of revenue losses from foregone sales in the current period, and in some instances quota shares may be permanently reduced as a result of a shortfall, resulting in a loss of revenue in the current year and in all future years.
Figure 2: Effects of Input Quotas

Where these opportunity costs exist is pays producers to adopt strategies to reduce the risk of a shortfall. The strategies may involve aiming for excess production as 'insurance' against a shortfall, increased storage capacity and stock holdings for storables, formal insurance policies, arbitrage arrangements, or the adoption of more costly input combinations and production techniques which reduce the uncertainty of yields. A risk neutral producer aiming to maximise profit would combine the various forms of insurance to equate the marginal benefits of the last dollar spent on each. A risk averse producer would equate the marginal benefits in terms of utility from expenditure on different forms of insurance.

Excess production as a means of insurance of quota shares has been analysed in detail by Alston and Quilkey (1979). The analysis will not be duplicated here. The adoption of otherwise suboptimal input combinations and production techniques, or any of the other possible forms of insurance, results in a leftwards shift of the supply function in addition to those shifts arising from imperfect quota allocation between producers and the effects of quotas on technical change.

Quotas in association with uncertainty do not work entirely to shift supply to the left. By giving greater stability in the price of the product than in their absence, quotas reduce uncertainty. This is an implicit, often explicit, objective of quota schemes. Where producers are risk averse, and price risk is incorporated into the supply function as a cost, greater stability in prices over time will cause the supply function to shift downwards to the right. This will offset to some extent, and could eliminate entirely, the shifts to the left from the various causes outlined above.

3.5 Externalities

There may be external economies or diseconomies due to quota schemes. For example, in the Victorian tobacco industry, quotas have led to a concentration of production in the Myrtleford area. There may be externalities due to this concentration. In a more striking example, the combination of non-transferable water inputs and very low prices for irrigation water has been held responsible for high water tables and salinity problems in irrigation areas in Victoria. These problems affect not

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2 There is plenty of literature on the benefits of price stabilization and their incidence. In a useful summary of the literature, Edwards (1979) suggests a shift in supply due to stabilization and discusses the additional social costs of resource misallocation due to this shift.
only those people who have water rights but other farmers in or near irrigation areas and other people who use the water in the Murray River.

It is not possible to generalise about the nature of the effects of externalities due to quota schemes on the positions of supply functions, but it is important to recognise the potential for externalities in any analysis of quota schemes.

3.6 Incidence of Benefits and Costs

The incidence of benefits and costs of quotas is important as well as the net social costs. The net social cost of quotas is borne mainly by consumers and partly by producers. Producers who obtain quota freely are net beneficiaries. The costs and benefits of quotas are distributed as follows and in Figure 3.

![Figure 3: Overall Effects of Closed Quota Systems](image_url)

**Consumers**

The imposition of supply control and supported prices involves a loss of consumers' surplus represented by the area $P'cEP$.

**Producers**

There is a loss of producers' surplus represented by the area $feE$. As a result of the price increase from $P$ to $P'$ producers would gain additional surplus of the area $P'ceP$, making a total surplus represented by the area $P'cS$. Of this surplus the area $aS'$ is foregone as a result of the supply shift from $SS'$ to $aS'$, induced by the quota system. This leaves a total producers' surplus represented by $P'cda$. This surplus is distributed between producers depending on the ways they obtained their quotas and depending on their costs of owning quota.

**Distribution Between Producers**

At the margin there is a benefit to each producer from quota ownership equal to the difference between his marginal cost of producing his quota quantity and the product price. This benefit differs between producers as their marginal costs and quota sizes differ. The value of quota, which is capitalized into the value of the business, is the present value of all future benefits of quota ownership. Those who obtain quota gratis, as has happened on the establishment of many quota systems, obtain a windfall gain of the capital value of quota.
For all producers the ownership of quota involves opportunity costs except where quota is attached to individuals and is not transferable in any way. The costs of owning quota are the returns from activities foregone by retaining quota.

This is an imputed cost for producers who do not have to buy quota but is a more apparent cost for new entrants and those producers who wish to increase quota size. From the producers' viewpoint the cost of producing the product to which quotas apply is increased by the cost of owning quota in order to do so.

Adding the cost of quota ownership into the supply function, the segment ad shifts upwards to bc which represents the industry marginal cost including the opportunity cost of owning quota. Where quota is allocated efficiently between producers so that marginal costs are equal for all producers, bc will be parallel to ad.

The area abed represents the windfall gain; the surplus accruing to the original owners of quota who retain this benefit whether they remain in production or sell their businesses including quota and invest the funds elsewhere. The triangle P'cb represents the surplus accruing to resources other than quota which are used in production and is the only 'true' surplus obtained from producing the product to which quotas apply.

Society

The net social costs of a closed quota system are given by the sum of costs and benefits to producers and consumers. In Figure 3, producers' surplus under quotas is represented by the area P'cda which is distributed as P'cb accruing to producers per se and bcda accruing to the original owners of quota. Compared with the no-quota equilibrium at E, producers have lost surplus of PES and consumers have lost surplus of P'cEP.

Summing up these losses and gains, there is a net social cost of the sum of the areas adS and cEf.

3.7 Consequences for Empirical Work

As well as the consequences for the measurement of net social costs and for transfers from consumers to a select group — the original recipients of quota — there are consequences for empirical work on supply functions for products to which marketing quotas are applied. Once quotas are operating, positive approaches to estimating supply functions will be confounded because the position of the industry marginal cost function under quotas depends on the product price and the total quota. Under these conditions it is difficult to identify the supply function using positive methods such as regression analysis of aggregate time series data or constructive methods based on cost data relating to individual firms. Synthetic methods such as programming or simulation models may be used to estimate the quota supply function. With more difficulty, and with appropriate adjustments for the costs of quota ownership, it may be possible to derive estimates of the no-quota supply function. Alternatively, the no-quota supply function may be estimated from data prior to the introduction of quotas as per Beck (1974). The difficulty here is to incorporate structural changes in the no-quota supply function, such as those due to technical change over time, and the problem of estimating the quota supply function remains.

Attempts to estimate supply functions, for commodities under quotas, which do not account for either the shifts in supply due to quotas or the empirical problems

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1 The position of the industry marginal cost curve (bc) depends jointly on the total quota quantity and the product price. These determine the value and cost of quota which, along with the other costs, determine the marginal cost. Unlike the static model, the marginal cost curve is separated from the supply (response) curve aS. This is an explanation of the spiral of costs or production and prices when cost of production is used as a basis for pricing products under quotas and is a reason for rejecting that method.

2 The original owners of quota may not be producers at all as in the case of the motor car industry where import quotas are auctioned and the windfall benefits go to government.
raised above, will suffer from specification bias \(^5\). Estimates derived from functions which suffer from mis-specification, from this or any other source, can result in inappropriate policy prescriptions if used for that purpose.

### 3.8 Perfect Transferability

A perfect open quota system would allow quota to be transferable, free of transactions costs, in continuously divisible units of quantities and time, to enable all producers at any point in time to achieve the levels of quota which would equate marginal costs between them. The time domain is important for those commodities where seasonal variation in supply is important (e.g. fresh market milk) because comparative advantage can vary between producers within and between seasons. Arbitrage may be a partial substitute for short period transferability but as pointed out by Lloyd (1971) "...it is cheaper to transport the quota certificate than the product itself."

A perfect open quota system would remove the problem of imperfect allocation of quota between producers: it would neutralize the potential effects of quotas on producers' incentives to pursue technical change and would allow the achievement of economies of size. Also, the costs of owning perfectly transferable quotas eliminate any excess profits other than the windfall gains and losses when demand shifts, described by Edwards (1979). Open quotas remove the incentive to insure against shortfalls because in the event of a shortfall, surplus quota can be sold avoiding any potential loss of capital. However an open quota scheme retains the advantage of reduced price uncertainty and the net effect may be a quota supply function below the no-quota supply function.

### 3.9 Imperfect Transferability

In reality any open quota system will be less than perfect. The imperfections can take the form of non-zero transactions costs, imperfect information and uncertainty in the market for quota, and physical constraints on the transferability of quota.

Transactions costs associated with quota transfers are likely to be small but these costs may be a significant barrier to frequent transfers of small amounts of quota, especially where the price of quota is comparatively small. The other sources of imperfections are likely to be more important overall.

Imperfections in the marketing system for quotas, especially poor market information, will reduce the efficiency with which the price for quota is determined and the efficiency of quota transfers.

Limits on the total amount of quota which individuals can acquire may be an explicit barrier to the achievement of economies of size or scale. For example in the egg industry there are maximum total hen quotas ranging from 25,000 birds in Queensland up to 250,000 birds in New South Wales. It is likely that there are potential size economies between 25,000 and 250,000 birds and possibly even beyond that size of flock.

Indiscretions in the quantities in which quota may be transferred may be restrictive and constraints on the intervals at which quotas can be transferred will be costly where comparative advantage varies between producers over shorter time periods.

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\(^5\) A cursory examination of the literature on empirical supply analysis has yielded few examples. Chen et al. (1972) estimated a supply model for fluid milk in California, where production and prices are determined institutionally, ignoring potential supply shifts due to regulation. Also in the U.S., a great deal of work has been done aiming to incorporate the effects of Government programs in acreage response models. Much of this work has been reported in Houck et al. (1976), covering supply models for corn, grain sorghum, barley, oats, wheat, soybeans and cotton. The general model reported in Houck et al. incorporates acreage control programs as a change in the effective price for the product. This model implicitly ignores the shifts in supply which may have occurred as outlined in this paper due to institutional pricing and supply control. The model may be a good predictor but the potential mis-specification casts doubt on this. For some policy purposes the model is inappropriate.
Most Australian quota schemes are bound to suffer from spatial limits on the transferability of quota. In the egg industry, for example, it is not possible to transfer hen quota between States and in Victoria transfers of quota from country areas to the Melbourne metropolitan area are not allowed although transfers in the opposite way are. This can be a major source of imperfections in an open quota system, preventing the most efficient producers from achieving optimal production levels and causing production to be located suboptimally.

4 Conclusion

Open quota systems are likely to be imperfect. The more imperfect is the system of quota transferability the closer is the resemblance of an open quota system to the limiting case where quotas are not separately transferable at all. Even where quotas are transferable the quota supply function will most likely be above the no-quota supply function, with the difference and the incumbent social costs depending on the degree of the imperfections, and the magnitude of price support in the quota system.

The costs of marketing quotas are borne mainly by consumers but also by producers, especially those who have to pay for quotas. The only beneficiaries, who receive a windfall benefit, are producers when quotas are initially allocated gratis, or government when quotas are sold in the first instance. The benefits are less than the costs and marketing quotas involve net social costs.

The magnitude of the net costs depends jointly on the efficiency with which quota is transferred between producers, in quantities, space, and time, and on the discrepancy between the price and production level under quotas and the price and production level which would prevail in their absence.

The conclusion that transferable quotas are preferable to non-transferable quotas is not an original one. The contribution of this note is to clarify the nature of the various effects and social costs of imperfectly transferable quotas. It adds force to the conclusion that transferable quotas are preferable to non-transferable quotas. Any real world quota system will not be perfect, and any appraisal of a quota system should therefore take account of the effects of the quotas on the position of the supply function.

It is likely that quotas will be a continuing feature of agriculture in Australia. The Industries Assistance Commission (1976a, 1976b) has recommended two price quota systems to replace the existing equalisation arrangements for both the Australian dairy and dried vine fruits industries. The merit of these recommendations has been questioned (see, for example, Godden and Drane 1978), and they have not been adopted. Nevertheless it is politically easier to introduce quota systems than to discard them. Where quota systems prevail, the social costs can be reduced by having an efficient system of transferability.

The social costs can be further reduced by keeping the product price under quotas as close as possible to the free market price, so that the price of quota is as close as possible to zero. The difficulty with this prescription is that the lower are the prices of the product and the quota, the less likely is the achievement of the objectives of the authority imposing the quota.

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*Discussion of the relative merits of equalization and two price quota schemes is likely to continue. Any analysis of these alternatives which does not consider the issues raised in this paper will be lacking. Equalization, too, may affect the position of the supply function. A change from equalization to quotas will have consequences for social costs and income distribution different from the consequences of a change from free competition to quotas, as analysed in this paper. A complete appraisal of equalization versus quotas is beyond the scope of this paper.*
References


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