

Cost Pooling in the Australian Grain Handling and Transport Industries

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Cost pooling has been the most distinctive feature of the pricing policies of Australian grain handling authorities during the past 40 years. The grain handling system is characterized by extensive cost pooling in each state, both between receipt points and among users at a particular receipt point. The general principle is that all growers are charged the same amount per tonne, regardless of the actual cost of handling their grain. In addition, revenues are pooled across wheat lots differentiated by quality and by time and place of delivery¹. Since growers care only about net return, the effects of cost and revenue pooling are closely intertwined. Buccola has examined distributive equity issues in revenue pooling. Similar issues arise with the pooling of costs across growers.

Grain handling by statutory authorities permits the operation of a pooling system by which a uniform handling charge can be made for deliveries at any point in a given state. Several different interpretations of pooling will be examined with specific reference to its operation in the grain handling system.

The recent Australian economic policy debate has seen an increasing emphasis on micro-economic policy reform. In the agricultural sector, this has led to a shift in emphasis from policies focused on farm production to a concern with the processing sector, notably including the Royal Commission into Grain Storage, Handling and Transport. This concern has led to a reconsideration of the desirability of pooling and to

¹ Another type of revenue pooling, not considered here, arises in home consumption price schemes where the monopoly rent from a limited access domestic market is pooled with export returns. The main issues in this case concern the appropriate level of supply and the difference between average and marginal cost. This paper is concerned with issues of resource allocation and income distribution between producers.

proposals for its removal. The implications of removing pooling will be considered in the light of this discussion.

For the purposes of this paper, pooling may be defined as a situation where a firm producing a differentiated product charges a uniform price despite differences in production cost. The practice is most common among public utilities, but it is not confined to that sector. For example, supermarkets which offer free delivery are practising a form of pooling. Typically, products will be differentiated by place of delivery, as in the case where public utilities subsidize rural consumers at the expense of urban ones.

The services of grain handling authorities are differentiated geographically and it is likely that the cost of providing these services will vary from place to place. Hence the practice of making a uniform charge for all deliveries may be regarded as a form of pooling.

In this paper, a range of issues concerned with cost pooling are discussed. After a brief survey of the institutional setting, some analytical concepts associated with recent developments in the theory of industrial organization are introduced. These are used to analyze a number of possible explanations for the existence and persistence of cost pooling. The preferred explanation integrates common property notions (Buccola, Quiggin 1983, Zusman) with the analysis of policy reform developed by Rausser and Foster. Empirical estimates of the cost and benefits of various pooling practices are presented.

The institutional setting

Grain handling in Australia is dominated by statutory authorities. The statutory quasi-monopoly positions held by these authorities mean that they have considerable flexibility in the pricing structures that they adopt. In practice, all of these boards adopt some form of pooling. The pattern differs only slightly between states. The situation in New South Wales is typical: Wheat and other grains are delivered to a country receiver

point operated by the Grain Corporation, a statutory authority with grower representation. Grain is transported primarily by rail, under contractual arrangements between the Grain Corporation and the State Rail Authority. The marketing of wheat is mainly undertaken by the Australian Wheat Board, while coarse grains are handled mainly by state grain boards.

The AWB has total control over exported wheat, and maintains a major presence in the domestic market. The AWB pools all costs and revenues arising from marketing wheat: most storage and handling costs are pooled on a state basis, while most marketing costs and revenue are pooled on a national basis. Prior to 1989, revenue was pooled over time, location and quality, so that growers received an average return for sale of the season's wheat (differential rates for Australian Standard white and five other categories of wheat were introduced in 1984-85). Distribution costs, which include costs of storage, handling and transportation, were pooled across classes of wheat and time, and have been pooled on a state basis since 1978-79. No regard was given to differences in cost levels that exist among storage sites in different locations. Rail transportation is usually charged on a rail distance or radial distance basis. This method of charging does not discriminate between main lines and branch lines, although costs of servicing the latter are higher. Until 1985-86, port charges were pooled nationwide. Since that time, port costs have been partially disaggregated into Western Australia and 'eastern state' rates. The charge subtracted from grower revenue to cover pooled costs is aimed at covering average costs.

A new Wheat Marketing Act of 1989 introduced a number of significant changes to the Australian grain transport and handling system, mostly arising out of the 1988 Royal Commission into Grain Storage, Handling and Transport. Under this Act, the Australian Wheat Board obtained the right to operate in all grains, not just wheat. Perhaps the most important change was deregulation of the domestic wheat market, so

that growers may chose whether to deliver directly to the Australian Wheat Board or to a trader for cash. The proportion of production handled by the wheat pool, although still high, has declined as the proportion held by private traders has increased: in 1984- 85, the AWB received 94 per cent of total production, compared with an estimated 88 per cent in 1990-91 and a forecast 80 per cent in 1991-92 (ABARE Crop Report 1991). With regard to pooling, grower payments are now made according to the protein content of the wheat and according to the port zone growers delivered into (all silos are assigned to specified ports). Growers may now freely decide where they wish to deliver their grain. Port zone differentials are to be assessed on rolling three year data base of the relative cost of port operations. A number of less efficient rail links were closed, two ports which were no longer used for grain shipping were closed and two new port facilities were opened.

Pooling, sustainability and barriers to entry

The issues involved may be clarified by consideration of the notion of stand-alone cost. Let the cost of producing a given bundle of outputs be given by $C = C(y_1, y_2, \dots, y_n)$. The stand-alone cost of producing output 1 separately is given by $C_1 = C(y_1, 0, 0, \dots)$. More generally the stand alone cost of producing any subset $I = \{I_1, I_2, \dots, I_m\}$ of the set of outputs may be denoted by C_I . The existence of economies of scope implies that

$$(1) \quad C \leq \sum_{i=1}^n C_i,$$

so that the costs of producing all goods in one bundle is less than the cost of producing them all separately. More precisely, the technology displays economies of scope if and only if, for any partition $\{I^1, I^2, \dots, I^K\}$ of the set of outputs,

$$(2) \quad C \leq \sum_{i=1}^K C^{I^k}.$$

This definition of economies of scope is insufficient for some purposes. Baumol, Bailey and Willig have developed the notion of trans-ray convexity, which, broadly speaking, means that C is convex over certain sets of multi-product outputs in which the 'total' output is held constant; that is, the different products are complements. If condition (2) holds without the restriction that the output sets $\{I^1, I^2 \dots I^k\}$ should be disjoint, the technology is said to be sub-additive in costs, and the industry is a natural monopoly.

A price vector \mathbf{p} covers average costs if

$$(3) \quad \mathbf{p} \bullet \mathbf{y} = \sum_{i=1}^n p_i y_i \geq C.$$

Assuming that all outputs are measured in comparable units, the cost-pooled price is given by

$$(4) \quad \bar{c} = C / \sum_{i=1}^n p_i y_i$$

A cost-pooled price vector is sustainable if the revenue from any subset of the output set is less than the stand-alone cost of producing that subset. Under these conditions, the cost-pooled price covers average costs and no entrant can profitably undercut the cost-pooled price on any subset of the output set. A natural monopoly will be referred to as sustainable if there exists a sustainable price vector.

It might be expected on the basis of intuition that, if production by a single firm minimizes total costs of production, then no new entrant could successfully 'raid' the market of an existing monopolist as long as prices were set so as to cover average costs but not to yield profits. For example, ACIL (1987, p.37) state:

If a "natural" monopolist claims that government intervention is needed to protect market share, then either the firm is not a genuine natural monopolist or the enterprise is so inefficient that it cancels out its economies of size. In both instances there is no reason for the government to limit competition.

In fact, as Baumol, Panzar and Willig show, this need not be the case. They give an example of a single-product firm which is a natural monopoly but for which no sustainable price exists. This condition is referred to as non-sustainable natural monopoly. More relevant to the problem are examples of multi-product firms where monopoly is the cheapest method of supplying all markets, but there is no sustainable price vector which covers average costs but is less than the stand-alone price for every market. Hence, there always appears to be cross-subsidization in that some market can be supplied more cheaply by an outside entrant. Defenders of limitations to entry in markets where pooling is practised have referred to this type of entry as 'cream-skimming'.

In the case of grain handling, this analysis is not very plausible because the market appears to meet sustainability conditions. The existence of scale economies at each site implies that the requirement of declining ray average costs will be met (Quiggin and Fisher). Assuming that economies of scope do in fact exist (otherwise there would be no point in maintaining a single organization) it seems unlikely that sustainability is a problem because, in part, the economies of scope arise as a result of shared overheads. Sharkey shows that in the case where economies of scope arise from shared overheads a natural monopoly is always sustainable.

The analysis above indicates that there are two possible situations under which pooling may be feasible. First, the cost function for the relevant goods may display sufficient economies of scope and scale to make it a natural monopoly. In this case, it is possible that there may be a sustainable uniform price vector. The necessary condition is that the stand-alone price for every good should be greater than the pooled price given by (4). In essence, this implies that economies of scope and scale outweigh the extra charge imposed on lower-cost goods.

Alternatively, pooling may be made possible by legal or contractual barriers to entry, such as occur frequently in public utilities and, in particular, in various parts of

the grain handling system. Grain handling authorities have, until recently, been protected from competition by a range of statutory provisions (see Royal Commission into Grain Storage, Handling and Transport 1988b). However, if economies of scope associated with coordination of a number of different receival points are sufficiently extensive, it is possible that pooling may survive in the absence of these provisions. To be more precise, barriers to entry will be needed in the market from which the cross-subsidy is obtained unless economies of scale and scope are sufficient to outweigh the subsidy. The fact that barriers to entry exist suggests that at least some services have a stand-alone cost smaller than the pooled price.

Using the standard criterion of minimizing the loss of consumer surplus and assuming demands for the different products are independent, it may be shown (Sharkey 1982, p.51) that the optimal set of prices, subject to the requirement that revenue should cover average costs, is given by:

$$(5) \quad 1 - (\partial C / \partial y_i) / p_i = -k / \eta_i \quad i = 1, 2, \dots, n.$$

where:

p_i = the price of output i ;

η_i = the elasticity of demand for output i ; and

k = a proportionality constant which determines the proportion of total costs which are recovered.

These prices are referred to as 'Ramsey prices'. Ramsey's work was concerned with the setting of optimal taxes on commodities, but his analysis carries over to the question of socially optimal pricing for a multi-product monopolist. In essence, Ramsey pricing involves charging high prices for products with more inelastic demand. It is, therefore, analogous to the discriminating monopoly solution for the single-product case².

² The difference is that the objective in the Ramsey pricing problem is to maximize consumer welfare subject to the constraint that profit should be exactly zero. The discriminating monopoly outcome may be regarded as the solution to the dual problem of maximizing profit subject to the constraint that

Explanations of Pooling

A number of explanations of pooling have been offered. The simplest explanation is that based on a desire for income redistribution. On this interpretation, cost pooling is purely a means of redistributing income from low to high-cost customers. This may or may not involve lower efficiency costs than effecting similar redistribution through the tax system, either by taxpayer-funded subsidies of the high cost product or by direct income transfers. (See Thomson and Walsh for a comparison of the costs of cross-subsidy and taxpayer funded subsidies). An income distributional analysis of price pooling in the Canadian wheat industry has been offered by Groenewegen. However, Oleson and Brooks deny that the pooling scheme operated by the Canadian Wheat Board redistributes income between farmers in different locations.

This approach is not very plausible in the present case, simply because there is no obvious reason why grain handling authorities or governments would want to redistribute income in this way. Users of high-cost facilities are not, in any obvious way, either more deserving or more politically influential than users of low-cost facilities.

The second main approach which has been used in cases of this kind is based on the output-maximizing bureaucracy model (Niskanen). In the standard case, the bureaucracy receives its funding through the budget, and seeks to structure its program so as to maximize funding. Unlike the standard budget-funded bureaucracy, the grain handling authorities are required to sell their output and are subject to a break-even constraint. Assuming that the firm can capture all of the consumer surplus associated with infra-marginal customers, it can supply others at prices below marginal costs. For a single product firm, this would be undertaken by charging infra-marginal customers a higher price, as in the price discrimination model. In the corresponding multi-product case, a consumer surplus should be exactly zero

higher markup is charged for consumers with a less elastic demand for the good. The principle here is the same as that of Ramsey pricing. The difference is that some customers are provided with services at rates below marginal cost, thereby expanding total output. Whereas the usual Ramsey pricing problem is to maximize consumer surplus subject to a break-even constraint, in this case the maximand is the value of output (which is equal to the total expenditure for the authority).

This explanation is open to two major objections. First, the total demand for grain handling services is fairly inelastic. Once the wheat is grown it must be handled. Handling charges affect the demand for handling services only to the extent that they reduce the net returns from grain production and hence the supply of wheat. As is shown below, the resulting elasticity of demand for grain handling services is of the order of 0.1. Furthermore, there is not likely to be a particularly close relationship between the group of farmers who face high handling costs and the group with a highly elastic grain supply. The elasticity of grain supply will be determined primarily by the attractiveness of alternatives to cropping. Thus, an output-maximizing bureaucracy would do better to subsidize regions with extensive scope for substitution between grain and livestock at the expense of those which are naturally specialized in crops. (This criticism is not applicable if pooling is used to prevent substitution of alternative grain handling services. For example, it is not surprising to see subsidization of farmers operating near state borders.) Second, Ramsey pricing is likely to reinforce, rather than mitigate, differences in average costs. Hence, the output-maximizing bureaucracy would be unlikely to practice pooling.

A third group of explanations is based on concerns relating to distributive equity and entitlements in common property systems, of which marketing cooperatives are an important example (Zusman). Buccola and Subaie argue that the revenue pooling practices of US cooperative marketing pools must be understood in relation to members'

ex ante contributions to the pool rather than the *ex post* realized sale price in a random environment.

This point may be developed further using a common property framework (Quiggin 1983), which has been applied to a range of problems including dryland and irrigation-related salinity. In this analysis, it is assumed that the industry has technical characteristics of natural monopoly, and that consumers have more or less effective ownership rights over the firm which provides the service. This assumption is particularly apposite in the case of grain handling authorities because all of them have extensive grower representation on their boards and two are grower cooperatives. This will alter the firm's objective function. In particular, the boards of such organizations will not maximize profits or returns to employees as in the models considered previously. Their actions will depend on the decision procedure through which consumers of the service (with divergent interests) determine policy. A particularly important case is that of a 'conservative' decision rule where unanimous or near-unanimous agreement is required for policy changes.

If costs are pooled through a uniform pricing rule, this decision procedure implies that the firm will be technically efficient, since there will be unanimous agreement for the adoption of the cost-minimizing production technique. However, the vector of goods supplied will not satisfy allocative efficiency conditions.

Consider, for example, the case of a grain handling authority deciding where to make an investment in expanding or modernizing receival point facilities. If the grain handling authority followed a Ramsey pricing rule, then the decision to make the investment at a particular site would benefit farmers delivering to that site and harm others, since marginal cost would be likely to decline relative to average cost. The lowest average operating costs are likely to be found at the newest receival points and these are most likely to have spare capacity. Marginal cost will be particularly low in

relation to average cost at these sites. Hence, the Ramsey pricing rule is likely to imply a sharper divergence from the current system of cost pooling than the system that would arise if all receival points charged average cost plus a fixed unit allowance for system overheads. As has been noted in other contexts, such as peak-load pricing for bridges, Ramsey pricing is likely to offend popular notions of equity since those who get the worst service are frequently required to pay the highest prices. Hence, such a decision would be likely to be vetoed by the losers. In practice, this might result in a policy of spreading investment funds around on an 'equitable', but technically inefficient, basis. By contrast, given pooling, everyone would favor the investment being directed wherever it would secure the greatest possible reduction in system costs.

In this analysis, gains in efficiency could be made if the veto power of losers could be over-ridden by institutional changes, since the vector of services supplied could then be brought into line with allocative efficiency conditions. The crucial question is the size of the net efficiency cost of pooling relative to the transfers associated with its existence or removal. If the transfers are large relative to the efficiency costs, then the survival or removal of pooling will largely depend on social decisions about income distribution. It is particularly important to note, in this context, that pooling tends to counteract the transfers which would otherwise arise as a result of particular location decisions by grain handling and transport authorities. For example, pooling of freight costs may be seen as resulting in a transfer to growers on branch lines from those near main lines. From the perspective of the common property analysis presented above, it may be more appropriate to see pooling as compensation to growers who would otherwise have lost from the original decision to route main lines well away from their property.

The analysis here is closely related to the work of Rausser and Foster, who divide public policies into two classes — PERTs which enhance efficiency and PESTs which yield income redistribution at some efficiency cost. The central point made by Rausser

and Foster is that a given PERT may be politically acceptable only if it is accompanied by a PEST designed to counteract some of its distributional effects. For example, the provision of a productivity-enhancing public good (a PERT) may enhance total welfare, but, under conditions of inelastic demand, may imply a transfer from producers to consumers. If the initial distribution of income was a political equilibrium reflecting the relative political power of the two groups, it is likely that public good provision will be rejected because of its distributional effects. If however, the PERT policy is combined with a PEST, such as a minimum price policy, which transfers some rent from consumers to producers, the combined policy may be Pareto-improving³.

The common property analysis presented above suggests an extension of this model. It may be possible to design institutions in such a way that PERTs (in this case, optimal investment decisions) are automatically accompanied by the appropriate PESTs (those associated with cost pooling). The introduction of PEST policies normally involves some dissipation of rent (Bhagwati). The use of an automatic mechanism for countering the unintended distributional effects of PERTs has the potential to eliminate, or at least to minimize this dissipation.

The discussion thus far has been based on the assumption that the grain handling system may be regarded as the common property of graingrowers. It is important to consider the roles of other actors in the system, most notably employees of the grain handling system and the unions which represent them. The interest of employees in maximizing their returns from wages and working conditions will be opposed in many respects to the grower objective of minimizing total costs. In a complete common property analysis, it would be natural to treat the employees as 'stakeholders' having some effective property rights in the system. However, it seems unlikely that employees

³ The achievement of a Pareto-improvement is not a necessary condition for political equilibrium. under some circumstances, the PERT may be acceptable even though producers are only partially compensated. This issue is beyond the scope of the present paper.

or unions will have much influence over pricing policy decisions. The problem of pooling may be analyzed by treating the actions of employees and unions as an exogenous constraint. Hence the conclusion that pooling will lead to the adoption of the cost-minimizing production technique should be interpreted in terms of the cost-minimizing production technique which growers can achieve given the constraints imposed by employees and unions.

An illustration

The way in which cost pooling may serve to facilitate efficient investment decisions may be illustrated using the example of decisions concerning the type of storage to create. In order to assess the possible impacts of a move away from pooling, it will be assumed that the alternative is to levy charges which differ according to variations in average operating costs across sites.⁴ Piggott, Coelli and Fleming estimate the following average cost function for receival sites in NSW.

$$(6) \quad AOC = 5.2 + 0.12/Q - 3.8(Q/C) + 0.89(Q/C)^2 + 2.7D$$

(0.77) (0.008) (1.1) (0.32) (0.59)

$R^2 = .60$ Standard errors in parentheses

where:

AOC = average operating cost (1985-86 dollars/tonne);

Q = throughput (100 000 tonnes);

C = permanent capacity (100 000 tonnes);

D = dummy variable having the value 1 when bunker storages are in use and zero otherwise.

⁴ As has already been noted, the Ramsey pricing formula is based on differences in marginal costs. However, estimates of marginal costs are highly sensitive to the choice of estimation technique and functional form, and the estimates obtained with any given functional form may vary greatly with small changes in the level of throughput.

A noteworthy feature of these estimates is that average operating costs are higher by about $\$2.70 / t$ at sites where bunker storage is used. Consider a site with $Q = C = 100\,000\ t$, operated on a 'fill-and-close' basis. Now suppose that there is a stochastic increase in deliveries such that, in 1 out of 2 years, Q rises to $150\,000\ t$. This increase may be dealt with by building additional fixed capacity or by using bunker storage in years of high deliveries. If the additional fixed storage is built substitution in (6) indicates that average operating costs will be $\$3.19/t$ in years of low deliveries and $\$2.37/t$ in years of high deliveries. If bunker storage is used, average operating costs will be $\$2.41/t$ in years of low deliveries and $\$5.07/t$ in years of high deliveries. The long-run average cost per tonne will be $\$2.98$ for the fixed capacity solution and $\$4.01$ for the bunker storage solution. Hence, growers served by the site in question will prefer the construction of additional capacity. However, the costs for the system as a whole include the capital costs of constructing the additional storage facilities. Quiggin and Fisher estimate these costs at $\$51/t$ for storage facilities of the type used in the Piggott and Coelli equation. Amortized at a rate of 10 per cent and averaged over total throughput, the associated annual capital charge is $\$2.04$. The total cost of the solution based on constructing extra capacity is $\$5.02$. Capital costs for bunkers are small, so the solution favored by growers under the average operating cost pricing formula will increase system costs by an amount on the order of $\$1/t$.

Thus, a situation where pricing is based on average operating costs is likely to generate pressure for excessive capital investment, particularly in the form of vertical storage. A pooling rule reduces this pressure⁵. In order for the pooling rule to be beneficial, it is necessary that the efficiency costs of pooling should be less than the benefits associated with optimal investment costs.

⁵ There is some evidence of excessive fixed capacity even under the prevailing rule (Royal Commission). Pressure for the construction of fixed capacity could arise either because of lower queuing costs at facilities of this kind or as insurance against a move away from pooling.

Costs of Pooling

In order to assess the efficiency costs of pooling it is necessary to examine specific causes of cost divergence between receival points and between users of a particular receival point. These issues are addressed below.

Pooling Among Sites

As has already been noted, the costs associated with pooling among sites will depend on the variations in marginal costs among sites and the elasticity of the demand for grain handling services at each site. As an initial simplifying assumption, it may be supposed that all grain must be processed by the grain handling system and that transport cost differentials always outweigh processing cost differentials so that it is always cheapest to deliver to the nearest receival point. This is the situation modelled by Spriggs, Geldard, Gerardi and Treadwell and would apply, in particular, to pooling between widely separated regions (for example, Western Australia and the eastern states).

Further, in order to provide a simple basis for comparison, it will be assumed that the cost function takes the linear form.

$$(7) \quad C = \sum_{i=1}^n c_i y_i$$

The fact that C is additive in the y_i means that there are no economies of scope. The fact that C is linear means that there are no economies of scale. In this simple case, the only sustainable price vector is that satisfying $p_i = c_i \forall i$. Any other price vector, such as the pooled price can be maintained only by barriers to entry. The assumption of a linear cost function seems plausible for the case of pooling between large, widely separated regions.

Given these assumptions, the elasticity of demand for the services of a particular site will depend solely on the elasticity of supply of wheat. It may be shown that:

$$(8) \quad |e_h| = (c_h/p_g) e_g$$

where: e_h = elasticity of demand for grain handling; e_g = elasticity of supply of wheat; c_h = grain handling charge; and p_g = price of wheat at the farm gate. (Demand elasticities have been normalized to be positive).

Given an estimate of the elasticity of supply of wheat of the order of 0.8 (Vincent, Powell and Dixon, *p.223*; Wall and Fisher, *p.123*) and grain handling charges of about 15 per cent of the wheat price, this procedure yields an estimated elasticity own-price elasticity of demand for grain handling of 0.12. Using the standard welfare triangle method (Figure 1), the deadweight loss associated with a tax (or subsidy) t is

$$(9) \quad \Delta = 1/2 e_h t^2.$$

The welfare triangle method may be applied to the analysis of pooling across sites. At each site (9) may be estimated with $t_i = |c_i - \bar{c}|$. Consider, for illustrative purposes, a distortion of 10 per cent, that is, pooling across two sites one of which has costs 10 per cent above the average and the other 10 per cent below, implying a difference of about \$3 per tonne. The same analysis could be applied to a large group of sites with a 10 per cent coefficient of variation in costs. The coefficient of variation observed in NSW is around 10 per cent implying typical pairwise differences between sites of the order of \$2 to \$5 per tonne (see Royal Commission into Grain Storage, Handling and Transport 1988b).

The total loss for a 10 per cent distortion in grain handling charges may be estimated at about 0.06 per cent of the total expenditure in grain handling, or 0.01 per cent of the total value of the wheat crop. At a farm gate price of say \$100 per tonne, this

is equivalent to a loss of 1 cent per tonne. As is usual in this form of analysis, the total welfare loss is proportional to the square of the size of the distortion, so that a 30 per cent distortion (implying that one facility was almost twice as expensive as the other) would imply a welfare loss of 9 cents per tonne.

It is reasonably straightforward, in principle, to relax the assumption that all wheat must pass through the grain handling system, thereby taking account of sales under the old permit system or direct grower-to-buyer sales in the new deregulated environment. In this case the term e_g must be re-interpreted as an elasticity of supply to the grain handling system. This will obviously be higher than the elasticity of total supply but, given the potential size of the direct grower-to buyer market, an upper bound of 2 seems reasonable. If sales that do not go through the grain handling system are not subject to charges, the distortion may be calculated using equation (8). This would yield a revised estimated efficiency cost of pooling of 2 cents per tonne.

It is also possible to drop the assumption that the cost function is linear and to admit the possibility of scale economies at individual sites, though some complex problems arise. The base for comparison now becomes the situation in which each site charges a price equal to average cost. This base situation involves a deadweight loss associated with the fact that average cost exceeds marginal cost⁶. The effect of pooling is to increase the distortion at the site with lower average costs and reduce it at the site with higher average costs. In general, given the non-linearity of welfare losses, the effect of pooling will be to increase the total deadweight loss. However, there are possible cases where the opposite will occur. If the sites have equal marginal costs and equal demand elasticities, pooling will be consistent with the Ramsey pricing rule and will lead to efficiency gains. These issues will not be examined in detail here. The order

⁶ If an unlimited source of lump-sum tax revenue were available, the socially optimal policy would be to charge marginal cost and pay the losses from general revenue. Unfortunately, no such revenue source has yet been discovered.

of magnitude of the estimates derived from the linear model is still applicable, and this indicates that the efficiency cost of pooling across widely separated sites is small.

The question arises as to why the first move away from cost pooling taken by the Australian wheat industry was to remove pooling between states. Although the above static analysis suggests that the efficiency consequences of this step were not large, the distributional effects were substantial. If the 10 per cent distortion referred to above applied to the average costs of two states, with an output of 5 million tonnes each, then the low-cost state would be losing \$1.50 per tonne, or \$7.5m per annum, as a result of pooling. It seems likely that an unwillingness to tolerate this transfer, rather than perceived efficiency gains, was the main cause of the abandonment of pooling between states.

From the static analysis, it seems likely that losses associated with pooling of costs among receival points will arise when deliveries are made to points with high marginal costs rather than to nearby sites with low marginal costs. If transport costs to the two sites are equal, the social loss is equal to the difference in marginal costs. If the high-cost site is closer, then the loss from pooling is equal to the difference in marginal costs less the saving in transport cost. Obviously, effects of this kind are only relevant within the region where differences in marginal costs are greater than the additional transport costs. Pairwise differences in average costs between sites in New South Wales may be as great as \$12 per tonne with more typical values being of the order of \$2 to \$5 per tonne (see Royal Commission into Grain Storage, Handling and Transport 1988b). Given a marginal resource cost of road transport from farm to receival point of \$0.20 per tonne kilometer, the largest distance between sites (or, more precisely, between the boundaries of the catchment areas of sites) for which losses of this kind would be relevant is 60 kilometers. Assuming that the radius of the catchment areas of the sites is of the order of 10 kilometers then the total distance between the sites is bounded above by 80 kilometers. More generally, the relevant upper bound is given by:

$$(9) \quad M = 2R + D/t$$

where: D = cost divergence; t = marginal cost of transport ; and R = radius. For the more typical range of cost divergences from \$2 to \$5, the corresponding range of distances is 30 to 45 kilometers.

An arithmetic illustration of the loss associated with pooling among nearby sites may be given as follows. Suppose two receival points are 20 kilometers apart and farms are uniformly distributed along the interval between them. Suppose further that each site is subject to constant marginal costs, that these marginal costs are \$2 higher at site A than at site B and that the marginal cost of transport is 20 cents per tonne kilometer. The most cost-effective solution for farmers less than 5 kilometers from site A is to deliver to that site and all others to deliver to site B. Under pooling, all those less than 10 kilometers from site A will deliver to that site. The average social loss associated with deliveries to the 'wrong' site is \$1.50 per tonne. Since these represent $5/20 = 25$ per cent of total deliveries, the average social loss across all deliveries is 38 cents per tonne. Broadly speaking, this loss will increase with the square of the divergence in costs. Once the cost divergence rises above \$4 per tonne, the optimal solution involves closure of site A. The social costs of pooling in this case is \$1.50 per tonne. Beyond this point, each additional increase of \$1 per tonne in the divergence yields an increase of 50 cents per tonne in social costs of pooling (since only the 50 per cent delivered to site A is affected.)

Pooling Among Users of a Given Site

The problems associated with pooling costs among receival points have been given considerable attention (Spriggs, Geldard, Gerardi and Treadwell; ACIL). Pooling across the users of a particular receival point may also give rise to efficiency losses.

There are a number of reasons to suspect that some deliveries will be more costly to process than others. The important factors to consider include delivery time, amount delivered (both in total and per truck), moisture content and qualitative factors such as the number of segregations required. The question of queuing costs associated with peak delivery times is also an issue. In addition it is important to consider the effect on total operating costs of variations in the pattern of delivery. The level of operating costs will depend on: (a) the number of weeks for which the facility is open for deliveries; and (b) the pattern of deliveries during that period.

If the short-run average operating cost curve is U-shaped, operating costs will be minimized by a uniform pattern of deliveries, such that the facility operates continuously at the cost minimizing level of throughput.

Given a known level of total deliveries, the determination of the optimal number of weeks for which the facility should open would initially appear fairly simple. In fact however, not only is the total volume of deliveries stochastic, but it is necessary to take account of costs to farmers as well as the operating costs of the facilities. This would probably require a longer opening period than that which would minimize average operating costs.

For any given period of opening, however, a U-shaped (or more generally convex) short-run cost curve implies that a uniform pattern of delivery is preferable to an uneven one and hence that some degree of peak-load pricing would improve efficiency. In some cases, this may imply the paradoxical policy of levying peak-load charges in periods of relatively high deliveries even though deliveries are at all times below the cost-minimizing level. In such cases, however, the gains from peak-load pricing are likely to be small and probably not worth the transactions costs associated with its introduction.

It is of interest to consider some further implications of peak-load pricing. In

particular, it is useful to observe that the present pricing structure gives farmers little incentive to organize deliveries so as to minimize operating costs of receival points. In particular, there is a strong incentive to deliver immediately after harvest. Grain handling authority receival points may incur considerable additional costs because of bunching of deliveries. However, except for queuing time, most of these costs are not borne by the farmers delivering at a particular time. Under pooling, in fact, costs are spread across all farmers in a State. But even in the absence of pooling among sites, individual farmers would not necessarily bear the costs associated with their choice of delivery time. Thus, delivery charges do not encourage farmers to use the receival points optimally. Quiggin (1990) examines the costs and benefits of peak-load pricing and concludes that a system of peak-load pricing could yield efficiency benefits of the order of \$1/ton.

The absence of peak-load pricing probably tends to reduce costs of self-delivery relative to use of contractors. Farmers will have a comparative advantage in integrating delivery decisions with on-farm activities. By contrast, it seems likely that independent contractors would have an advantage in minimizing delivery costs in the face of variable prices. In addition, it seems likely that the opportunity cost of waiting time is greater for farm trucks and post-harvest farm labor than for contractors' vehicles and labor. By employing waiting time as a rationing device, the present system tips the balance against contract delivery.

Economies of scope may also be lost. It is possible that a system with variable delivery charges would increase economies of scope associated with the use of a flexible fleet of trucks. Hence, it is possible that the current market structure could be replaced by one displaying both lower levels of self-delivery and somewhat higher market concentration.

It is worth discussing briefly some differences among users other than time of delivery which may have an impact on system costs. In most activities, there are some

benefits, such as reduced record-keeping costs, associated with large deliveries and these are frequently reflected in bulk discounts. In the case of grain handling, it is also likely that variations in the size of trucks used for deliveries will have cost implications at the receival point. Since there are fixed 'overheads' associated with unloading trucks, it is to be expected that costs per tonne will decline as truck size increases up to some limit set by the design of the receival facilities. The absence of bulk discounts together with cost pooling among users at a particular site has the effect of discouraging the use of trucks larger than average, *ceteris paribus* . It is also worth noting that the resource costs per tonne kilometer associated with a typical double axle farm truck used for delivery from farm to receival point is some three times greater than that of six axle articulated units (Bureau of Transport Economics). If full resource costs are not recovered from truck operators it follows that pooling across users at a particular receival point causes losses to society in addition to those experienced in the handling system.

In the case of pooling across users at a particular site there are likely to be significant gains in efficiency resulting from changes in current pricing arrangements. However, policies based on the efficiency criterion are unlikely to receive general support if their distributional consequences are perceived as being adverse. In the unlikely case that lump-sum redistribution were feasible, there would be a potential Pareto improvement. An alternative defence of the efficiency criterion in this case is based on the fact that there are unlikely to be systematic differences in deservingness between gainers and losers and, hence, it is reasonable to aggregate gains and losses without any form of weighting. A third possibility which is particularly relevant in the case of differential pricing at a particular site is that the distributions of costs and benefits for particular changes will not be highly correlated with each other and may vary over time. In this case, averaging over several changes, and perhaps over several years, should mean that policies which reduce average costs lead to something approaching

a Pareto improvement.

Concluding Remarks

The Royal Commission into Grain, Storage and Transport has provided a detailed outline of the distributional consequences of pooling in the Australian grain handling industry. In many cases the estimates of the distributional effects are large. Although there has been mention of the efficiency costs of pooling (see for example Spriggs, Geldard, Gerardi and Treadwell), there are few estimates of the extent of these costs. In the case of the grain handling industry, losses due to pooling arise as a result of pooling among sites and pooling among individuals at particular sites. It has been demonstrated above that the efficiency losses associated with pooling among sites decline as the distance between the sites under consideration increases. Indeed, efficiency costs are likely to be lowest where the distributional effects are largest. The costs of pooling among individuals at a particular site arise, among other things, as a result of differences in delivery times and the size of truck used for delivery.

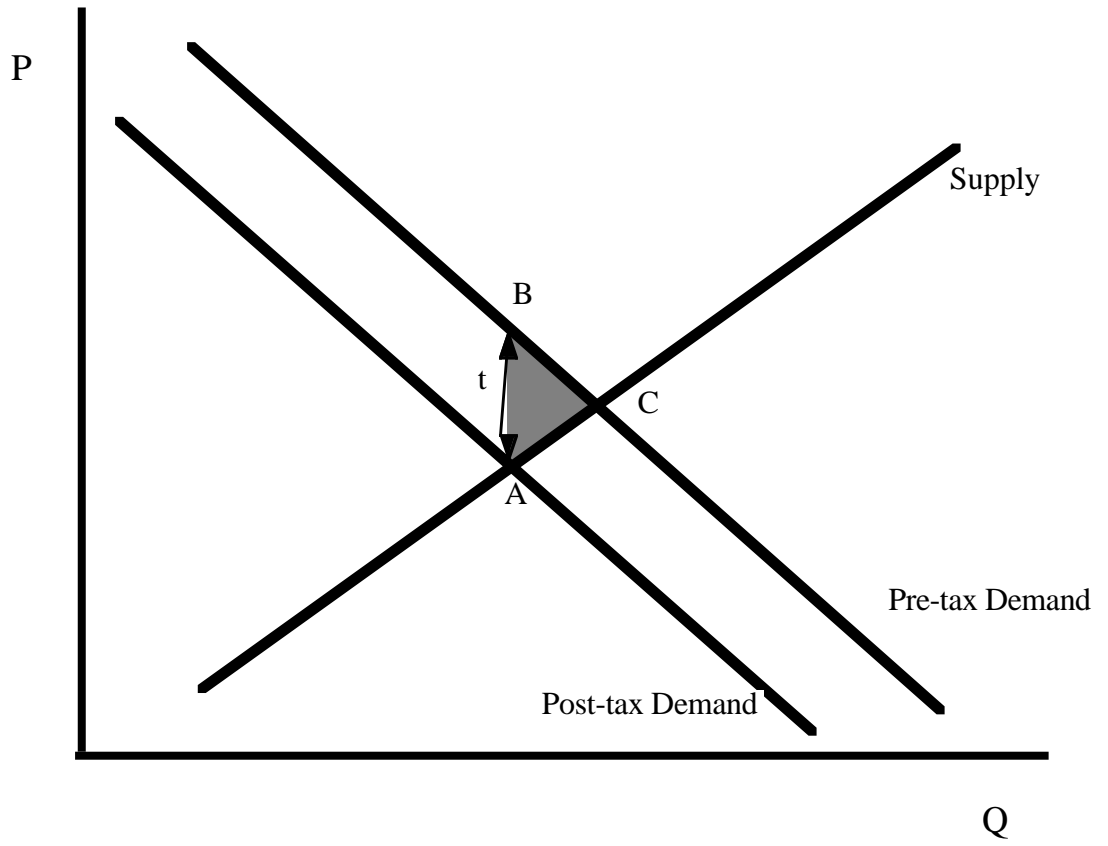
The discussion has centred around the direct effects of pooling in the grain handling industry. At least in theory, the efficiency costs of pooling at this level can be assessed. What is not known, however, is the extent of some of the indirect costs of pooling that arise, for example, as a result of the reduction in scrutiny of the performance at given sites as a result of a lack of publicly available information.

Cost pooling exists in both grain transport and marketing as well as in the handling industry. The efficiency effects of pooling across the entire grain transport, handling and marketing sector have not been considered here. It is likely that the total costs of pooling to the Australian grains industry have been considerable. For example, the fact that the marketing authority pools across wheat types classified in broad grades, such as Australian Standard White, has masked price signals to growers with respect to grain

quality. This has an effect on investment decisions at the farm level, and also masks the signals to the plant breeding industry and hence distorts investment in plant breeding research. Given such effects it follows that the grain industry may be on a lower long-run growth path as a result of pooling than would otherwise be the case.

However, it is not true that any shift towards charging higher prices to higher cost users will necessarily lead to an improvement in long-run resource allocation. As long as growers have an influence on investment and management systems, it is important to organise pricing policy in such a way as to emphasise their joint interest in minimizing system costs rather than their competing local interests. Otherwise short-run efficiency gains may be offset by long-run distortions in investment decisions.

Figure 1
Triangle Method for Assessing Welfare Loss



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