Farmer Grain Trucking Options in a Deregulated Market

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ABSTRACT

Changes to the grain handling system in Australia are altering the trucking requirements of many farms. It is therefore important to assess the role and nature of farm truck operations.

This paper includes a discussion of the trucking decisions faced by farmers. A model of grain trucking costs is developed. The relationships between trucking costs and their determinants are tested and the costs of a number of trucking options, including contract services, are compared over a range of situations. A brief assessment of farm trucking is presented based on survey work in the wheat growing region of Grong Grong in southern NSW, undertaken in 1985/86 prior to deregulation.

Conclusions are drawn about which trucking options farmers should use and about possible effects on farm truck operations of changes in the grain handling industry.

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Farmer Grain Trucking Operations in a Deregulated Market

1. Introduction

Given last year's deregulation of the wheat market and continuing changes to grain handling systems in Australia during the 1980s, it is important to assess the role and nature of farmer utilised transport operations.

Farmer trucking decisions are likely to be affected by these changes for a number of reasons. Closure of silos located on rail branch lines and financial incentives for delivery of grain to silos located on rail main lines indicate a possibility of increased road delivery distances for farm trucks. Competition between silos for farmer patronage may lead to higher grain receival rates, shorter queuing and turnaround times and longer opening hours during harvest thus allowing more daily journeys for each farm truck. Deregulation of the wheat market and the grain handling system also offers potential for an increased role for on-farm storage of grains and the spreading of the demand for trucking capacity over a longer time span.

Whether such changes will lead to net benefits to farmers and to the system is not clear. Where the size and nature of individual farm grain handling tasks are likely to be altered by such changes, it is important that farmers review their existing storage and transport arrangements in order to optimise returns. In particular, they should decide how many and what kind of storages and trucks to operate and what use to make of alternatives to truck ownership such as hired or contractor trucking.

Current work on farm trucking by NSW Agriculture & Fisheries has two main has emphases: firstly, assessment of individual farm trucking operations prior to deregulation; and, secondly, estimation of the costs of various trucking options under a range of scenarios with a view to assisting farmer decisions following deregulation.

Two principal sources of data were used for this analysis. Firstly, costs for different trucking options were estimated at 1985/86 values on the basis of discussions with manufacturers and retailers, and through use of technical and commercial publications. Secondly, an assessment was made of farm trucking operations in Southern NSW during 1985/86 based on a survey of the Grong Grong GHA depot, records of other silos in the region and follow-up farm surveys.

This paper concentrates on some of the issues of farmer decision-making and on the methodology for estimating the costs of various trucking options. Data from the above sources is used to parametise a model of trucking costs. The relationships between trucking costs and their individual determinants are examined and implications are drawn about which trucking options farmers should use. Finally, a comparison is made between some of the findings of the cost model and the patterns of truck utilisation determined from farm survey data. A number of possible effects of changes to the grain transport industry are also suggested.

2. Relevant literature

Studies concerned particularly with the movement of grain from the farm include Kulshreshtha (1975), Tyrchniewicz et al (1971), Whan (1969), Kerin (1985), Read and Associates (1982), Meyer and Sparks (1987) and Meyer (1984). All use some form of cost budgeting to present and analyse cost functions for farm trucks in relation to grain transport. The studies of Tyrchniewicz et al, Whan and Kerin are of particular interest as they analyse the results of farm trucking surveys. Kulthreshtha provides a multivariate logit analysis of the reasons for farm ownership of particular types of trucks. Several studies adopt what Kerin describes as a "synthetic engineering" approach in order to examine farmer decisions; that is, the prediction of hypothetical cost functions for assumed models of farm transportion. The above papers were used extensively in the design of the farm survey and the trucking cost model and also to focus the current discussion. They are reviewed in detail in Rish et al (1990).

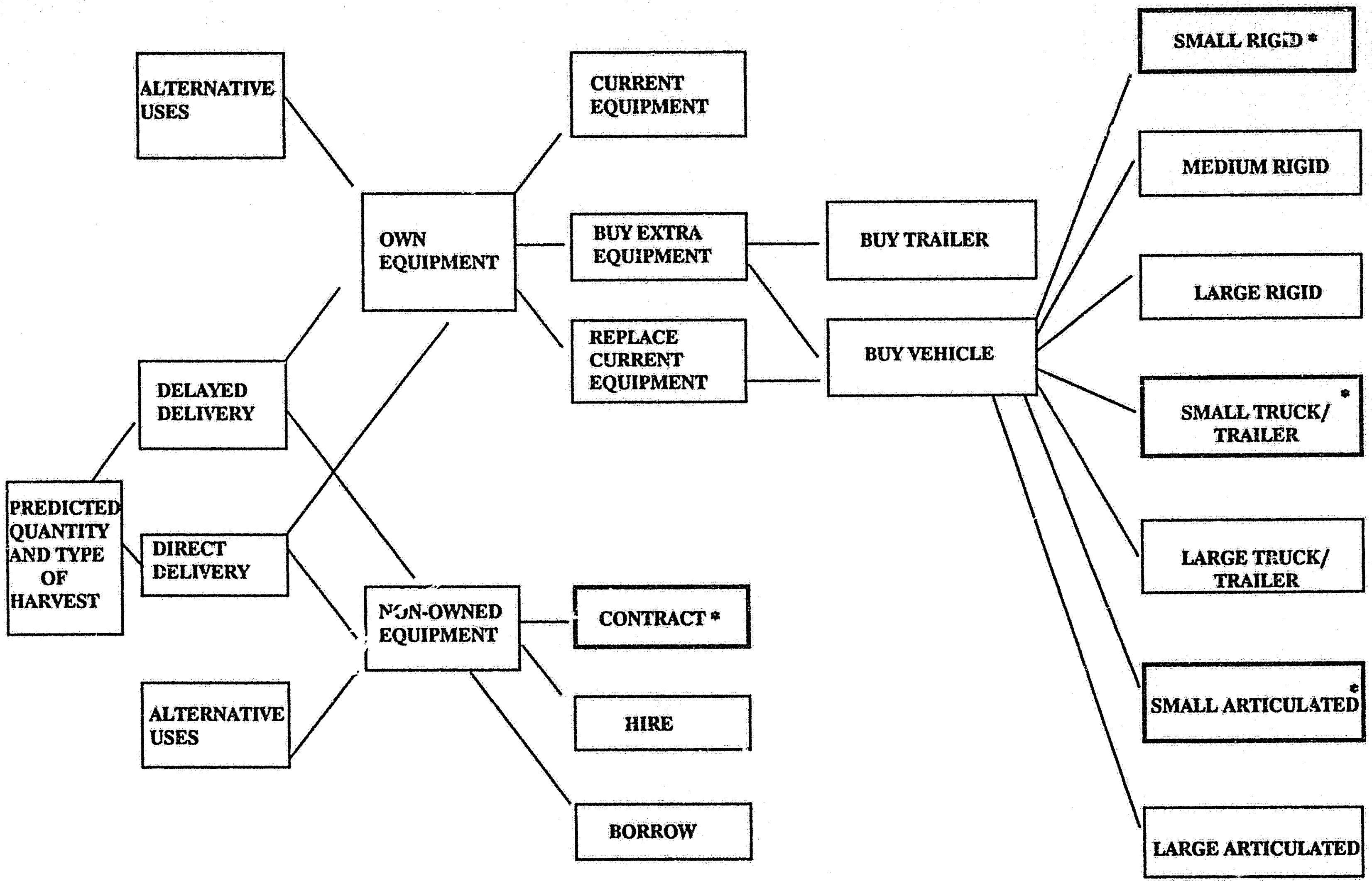
3. Farmer decisions

It is expected that farmers will maintain a trucking capacity that is likely to minimise the costs to the farm in the long run and at the same time provide an acceptable level of reliability to effect the farm trucking operations. Meyer and Sparks (1987) outline a decision tree for farmers considering grain trucking options for a given situation, as follows: the first main decision is whether to use owned equipment or contract or hire services; if farmers decide to use owned equipment, the second main decision is whether to use current equipment or other equipment; if purchasing another truck or trailer, should it be new or used and what size?

It may be argued, however, that a main decision concerning the role of farm storage should be made earlier. The use of non-paddock farm storage is likely to be a major influence on trucking costs for several reasons. Firstly, off-farm destinations for grains stored on farm may well be different than for grain trucked directly from the paddock (Meyer, 1984). Secondly, on-farm storage involves double-handling of grain from paddock to storage and from storage to off-farm destination; and, thirdly, the need for transport capacity can be spread over a longer time span using on-farm storage. Ultimately all grain produced (except for the farm's own requirements for seed and feed grains) will be delivered off-farm. How far grain is carried, when it is delivered and at what rate, however, will effect trucking costs. It is therefore important for farmers to decide as the main decision how much of the expected harvest to deliver off-farm directly from the paddock and how much to deliver into farm storage. This choice will be based on their assessment of the costs and benefits of farm storage as opposed to direct delivery. Decisions will depend also upon the alternative uses envisaged for trucks and upon farmer perceptions about the risks involved in truck ownership and the costs and reliability of other options.

Figure 1 shows the decision tree. The options of borrowing and hiring trucks are included together with a number of trailer and truck choices for augmenting or replacing existing equipment. The following discussion is concerned mainly with assessing several of these options. Evaluation of the optimum balance of on-farm storage and direct delivery is a projected study and is not further considered here.

FIGURE 1: FARMER DECISION TREE FOR GRAIN TRANSPORT



* The costs of utilising these alternatives are considered in detail in this discussion.

4. Model

The costs of delivery of a quantity of grain by a particular truck may be categorised generally as a proportion of the annual fixed costs of ownership (depreciation on the truck, interest on the capital invested in it and registration and insurance) and the variable or operating costs.

The fixed costs are incurred independently of truck utilisation and therefore become less significant as utilisation is increased. The variable costs may be divided into the cost of operation while travelling (fuel, repairs and maintenance, tyres and driver's wages) which depend on both the volume of grain to be carried and the distance travelled; and transfer costs (loading, unloading and queuing) which depend upon the number of truck journeys involved (and consequently the volume of grain carried) but not upon the distance travelled.

The fixed costs are hypothesised to be a function of:

proportion of annual truck use accounted for by such delivery (P)
replacement value of the truck (R)
annual depreciation rate (e)
truck age (a)
interest rate (i_t)
registration and insurance (reg),

and the variable costs as a function of:

average one-way journey distance (AD)
volume of grain carried (V)
average load carried (L)
fuel consumption rate (FC)
fuel price (FP)
repairs and maintenance cost (RM)
tyre rate (TR)
driver's wage (W)
average speed of the truck (AS)
loading rate (LR)
queuing cost (Q).

To account for variation in the loading of grain trucks by farmers, a variable, degree of loading, is included where:

average load carried = degree of loading x maximum legal load capacity of the truck.

For the purposes of comparing costs of different truck options, depreciation and interest rates, wage rates and fuel price are considered uniform for all truck categories. Annual depreciation and interest costs are obtained by a diminishing balance method based on the age and the estimated market value of the truck.

Assuming the variables:

replacement cost
registration and insurance
fuel consumption
repairs and maintenance rate
tyre rate
average speed
loading rate
loading capacity

to be determined by the truck category (or type), total costs for delivery of a quantity of grain by a category i truck, TC_i, are hypothesised to be a function of:

volume of grain carried
average one-way journey distance
proportion of annual use accounted for
age of the truck
degree of loading

and are given by*:

$$TC_i = P \times [R.(1-e)^a.[e + i_t(1-e)/(1+i_t)] + reg]$$

$$+ 2 \times AD \times V/L \times (FC.FP + RM + TR + W/AS) + V \times LR \times W/60 + Q.$$

From this specification, the relationship of total costs to individual key variables (holding all but one variable constant) is: linear for each of volume carried, distance travelled, per cent use and replacement value; hyperbolic for degree of loading; and a declining power function for truck age. Average grain transport costs will decrease with increases in volume of grain carried, average one-way journey distance, age of the truck, alternative utilisation and degree of loading.

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* Full details concerning the estimation of individual components of costs and the definition and parametisation of truck categories are given in Rish et al (1990).

5. Results

5.1 Farm grain trucking in Southern NSW

Some findings derived from analysis of the Grong Grong survey data in relation to the patterns of farm truck utilisation are summarised here. Costs were estimated using the above cost equation and not by auditing actual farm expenditure. Detailed methodology and results are reported in Rish et al (1990).

Significant quantities of four grain types were trucked by sample farms during 1985/85. These were, in order of importance, wheat, oats, barley and lupins. The average volume of grain trucked per sample farm, double-counting grain handled twice, was 1424 wheat tonnes equivalent (wte). It was estimated that 74 per cent of this quantity was delivered to off-farm destinations while the remainder was distributed on-farm. In relation to off-farm deliveries, approximately 76 per cent of grain was delivered to GHA depots while the remainder was delivered to private destinations. Fifty per cent of farms delivered grain to more than one GHA depot although no farms delivered to more than three. As would be expected, farmers used closer depots more extensively than those farther away. The unweighted mean one-way distance travelled by trucks from farm to GHA depot was 19.7 kilometres. Approximately 76 per cent of all grain harvested was trucked directly off-farm from point of harvest (either with or without paddock storage on-farm of less than one week), while the remainder was delivered into farm storage.

The number, type and ownership of vehicles used to carry grain for individual sample farms were diverse. An average of 3.41 trucks were used per farm. However, 62 per cent of farms used three trucks or less. Twenty nine per cent of all trucks utilised by individual sample farms were solely owned by that farm, a similar number were part-owned while approximately 39 per cent were contractors' vehicles and 5 per cent were hired or borrowed. Fifty nine per cent of sample farms used a combination of owned or part-owned trucks and contract or hired trucks, 39 per cent of farms used only owned or part-owned trucks while only one farm relied exclusively on non-owned trucking. An average of 1.92 trucks were owned or part-owned per sample farm. Thirty per cent of trucks identified carried grain for more than one sample farm. Smaller trucks tended to be owned or part-owned by sample farms while larger trucks tended to be contract vehicles. Non-contract trucks were used for approximately 80 per cent of off-farm deliveries with contract trucking accounting for the remaining 20 per cent.

The total cost per sample farm in relation to own grain delivery during 1985/86 was $6019, consisting of 11 per cent on-farm delivery costs and 89 per cent off-farm delivery costs. Seventy three per cent of expenditure was for owned, part-owned and hired or borrowed trucks while the remainder was for contract trucking. Non-contract grain transport expenditure comprised 57 per cent fixed costs and 43 per cent variable costs, the major components being depreciation and interest (40 per cent) followed by fuel (16 per cent) and registration (14 per cent).

Some categories of trucks tended to have higher levels of utilisation by individual farms than others. The highest category (largest) truck/trailers, rigid-bodied and articulated non-contract trucks had the highest off-farm and overall utilisation per truck per farm where used.

Grain use (including grain transported on behalf of other farmers) accounted on average for 71 per cent of annual truck utilisation per truck, although such utilisation ranged from an average 52 per cent in the case of large rigid-bodied trucks to 97 per cent for large articulated trucks.

5.2 Sensitivity:

Following the method of Meyer and Sparks (1987), the sensitivity of total grain delivery costs to changes in each particular variable was tested. The change in total cost, c is given by:

$$c = [TC_1 - TC_2] / TC_0$$

where,

TC_0 = the total cost using the base model values;
TC_1 = the total cost using base model values except for the nominated variable which is increased by 20 percent; and
TC_2 = the total cost using base model values except for the nominated variable which is decreased by 20 percent.

For a basic model, the following assumptions were made:

- one-way distance per grain delivery is 20 kilometres;
- volume of grain to be delivered per truck per year is 700 wte;
- this represents 75 per cent of the annual use of the truck;
- the truck is 15 years old, petrol driven, annually registered and insured against third party property damage;
- it is loaded to its maximum legal limit;
- the driver received a wage at the farmhand rate.

To illustrate the results, Table 1 shows the change in total costs for several truck types caused by changes in the fuel price, truck age and average one-way journey distance.

Table 1. Per cent changes in total costs caused by plus and minus 20 per cent changes in nominated variable

	Fuel price %	Truck age %	Distance %
Basic rigid truck	12	-14	27
Small truck/trailer	10	-21	17
Small articulated truck	6	-38	10

The most influential variables were found to be the volume of grain carried, the average one-way journey distance and the degree of loading (where fixed costs were less than variable costs as a proportion of total costs); and the age of the truck, its replacement value and the percentage of annual use represented (where fixed costs were greater than variable costs). No clear relationship was found between average costs and truck size (category) and it is expected that larger trucks would be under-utilised at the levels of use hypothesised.

5.3 Comparison of costs of four grain trucking options.

The sensitivity of total cost as estimated by the above equation to each of the key variables (the volume of grain carried, the average one-way journey distance, the degree of loading, the age of the truck, its replacement value and the percentage of annual use represented) was further tested for four commonly used trucking options, again varying only one variable at a time from the base model. The options considered were:

1: a basic rigid 2-axle truck with a maximum load capacity of 9 wtes,
2: the same truck with a 6-wte capacity "pup" single axle trailer,
3: a 3- or 4-axle articulated vehicle with a capacity of 18 wtes, and
4: a contract trucker, with costs calculated according to a generally obtainable contract rate.

To illustrate, in relation to average distance travelled per truck journey, AD, the total cost, $TC, is given by

Option 1: $\$TC = 130.9AD + 1298$
Option 2: $\$TC = 64.2AD + 1728$
Option 3: $\$TC = 49.6AD + 2852$
Option 4: $\$TC = 5250$ if $AD \leq 17$ or,
$\$TC = 77(AD - 17) + 5250$ if $AD > 17$.

The graph of these functions (Figure 2a) shows that total cost is least for the basic rigid truck for distances less than about 8 kilometres, for the truck/trailer for distances from about 10 to 80 kilometres and for the articulated truck for longer distances. However costs for these three options do not appear to vary greatly for distances less than about 25 kilometres. The contract option is generally expensive.

Of particular interest is the relation between total costs and the degree of loading. Figure 2b shows that the degree of loading influences costs for the rigid truck more than for the other truck options. Where trucks are loaded at or below the maximum legal limit, the truck/trailer has the lowest total costs followed in order by the articulated and rigid trucks and the contract option, although contract trucking is likely to be cheaper than use of the rigid truck loaded to less than about 65 per cent of its legal capacity. Where trucks are loaded above legal capacity, total costs remain lowest for the truck/trailer but are less for the rigid than for the articulated truck. At a load level of over 200 per cent of legal capacity costs for the rigid

FIGURE 2a: TOTAL COSTS vs AVERAGE ONE–WAY DISTANCE

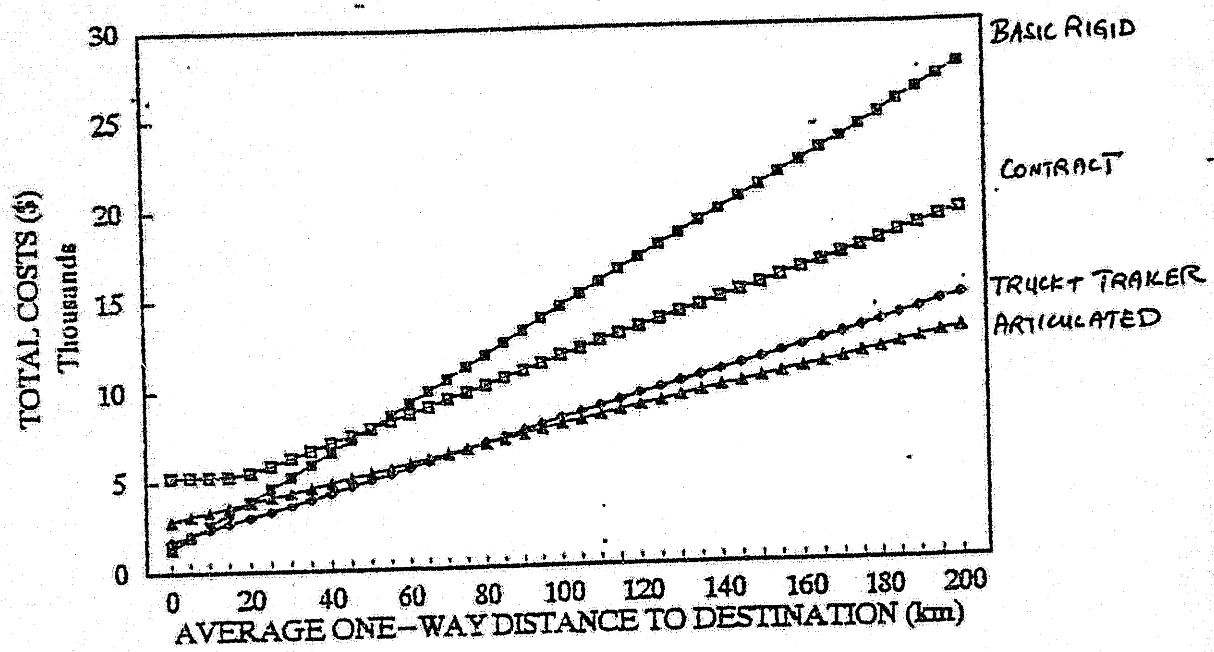
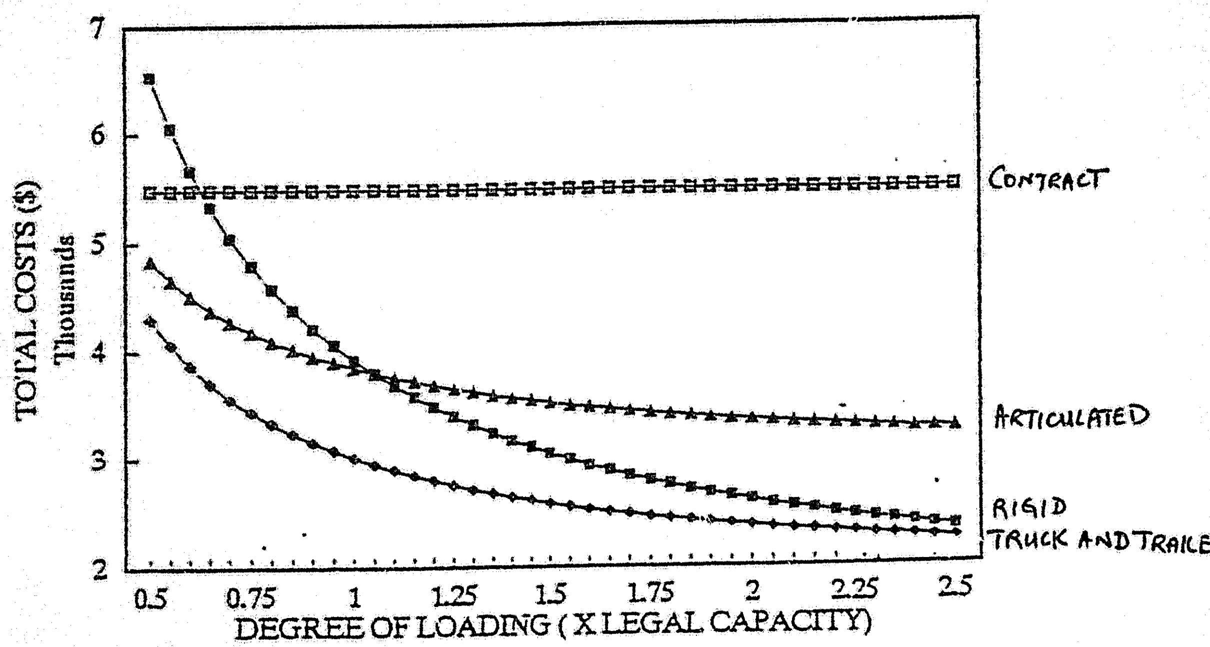


FIGURE 2b: TOTAL COSTS vs DEGREE OF LOADING



truck approach those for the truck/trailer. It can also be seen the basic rigid truck loaded to about fifty per cent over its legal capacity has similar costs to the legally loaded truck/trailer.

In general, total grain transport costs were found to be least over the widest range of all variables considered for the truck/trailer, followed respectively by the articulated truck and the basic rigid truck with the contract option most expensive. While this indicates preferred trucking choices for the situation examined, the above findings will not necessarily hold for situations that differ markedly from the base model. Ultimately, therefore, the appropriate choice of truck should be based on evaluation of the particular farm situation. Note particularly that queuing costs were not parametised in the current model due to lack of adequate data, even though they were considered to be significant determinants of trucking costs. This biases the model against use of the contract option, as the contract rate reflects a built-in queuing cost. It probably also biases results against the use of larger trucks*. Where extensive queuing is expected, these options are therefore likely to be more attractive.

5.5 Comparison of some findings from the cost model and farm survey data:

From the cost model, assuming a farmer owns a basic rigid-bodied truck, the addition of a trailer is likely to be a viable means of reducing average costs. However, there were few truck/ trailers identified within the Grong Grong survey population. The reason for this may be that farmers choose to overload trucks rather than incur the capital costs of a trailer which may have little use other than for the carriage of grain.

Rigid trucks with a maximum load capacity of about 12 wte were the most commonly identified truck type. This is consistent with the findings from the cost model that they are likely to be a good economic option. It is possible that they were more popular than truck/ trailers due to their greater general usefulness for non-grain tasks.

From the cost model it was found that ownership of larger truck types was unlikely to be economic unless costs could be spread over higher levels of utilisation than the average levels determined for sample farms. This could be achieved, for example, by shared ownership or by contracting on behalf of other businesses. As expected, farm survey data showed that smaller trucks tended to be owned or part-owned by sample farms while larger trucks tended to be contract vehicles.

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* Queuing costs may be viewed as an opportunity cost of idle labour and machinery associated with the truck and a potential opportunity cost incurred if harvesting operations are stalled (Kerin, 1985). Larger trucks require fewer journeys to execute a given task than smaller trucks and hence are subject to lower overall queuing times. The rate of queuing costs however is likely to be higher for larger vehicles. From data presented by Kerin, it is probable although not certain that queuing costs will be higher overall for smaller trucks than for larger trucks.

From the cost model also, contract trucking was found likely to be relatively expensive except where volumes to be carried were low or when comparisons were based on costs for farm-owned trucks newer than, say, five years old. It was found nonetheless, that use of contract trucking by sample farms was quite extensive: contract trucks carried twenty per cent of grain delivered to off-farm destinations by sample farms during 1985/86.

Possible reasons for using contract trucking include, firstly, the need to meet shortfalls in farm-owned trucking resources due to either the peaking of demand for trucking capacity at harvest time or in the event of truck breakdowns; secondly, the perceived unreliability of farm-owned trucks where delivery distances are high; and, thirdly, truck ownership being considered unjustified by the small scale of farming operations.

6. Conclusion: Possible effects of changes to the grain transport industry

The use of smaller farm-owned trucks is likely to be more economic if peak handling bottlenecks are reduced under a competitive grain handling system but less economic if longer average farm-to-destination distances result. It is possible that, due to their high age, many farm trucks will be unsuitable for greatly increased hauling distances. If the right farmer decisions are made average and even total trucking costs may be reduced by such changes. Further work is required, particularly in regard to the costs and benefits of on-farm storage of grains before the effects can be predicted and farmer responses optimised. This paper presents a method for estimating and comparing the costs of different trucking options under varying situations and also predicts a number of likely outcomes under an average grain delivery scenario for individual farms in Southern NSW prior to deregulation of the wheat market.

7. References

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