

Chapter 1

1.0 Introduction

Despite the perception that traditional agricultural production is becoming less significant to the wellbeing of the Australian economy, livestock industries continue to play an important role. For example, in 1994-95 livestock industries were directly responsible for almost \$8 billion of export income or 11.8% of total merchandise exports (Australian Bureau of Statistics [ABS] 1996, p. 24). Therefore the efficient operation of such industries is of both regional and national significance with changes in efficiency having significant effects on both national income and the regional distribution of that income. One aspect of this efficiency is the livestock selling process itself. Indeed Johnston (1994, p. 14) has observed that "...the efficiency and profitability of the meat industry is dependent on efficient and effective trading in livestock". Thus, an understanding of the economic efficiency of the livestock selling process has important implications for resource usage within the broader livestock industries.

For our present purposes it is useful to treat the livestock selling process as a separate sub-industry which directly affects the efficiency of the livestock industry as a whole. In order to analyse the efficiency of any industry it is necessary to establish a framework by which industry performance can be evaluated. It is the purpose of this chapter to provide such a framework for livestock saleyards. The chapter will also examine the present characteristics of the livestock selling industry to identify features likely to impact on the application of this

framework.

The chapter itself comprises five main parts. The first part of the chapter presents the background to this study and places this research in the context of previous investigations of saleyard selling. In order to analyse the role of livestock selling it is also necessary to appreciate both the national distribution of, and variations within, the broader livestock industries. For this reason, the second part of the chapter deals with features of the broader livestock industries and incorporates livestock selling within those industries. The third part of the chapter develops the construct of economic efficiency which provides the theoretical framework for this study. This section is extended in part four to discuss a number of broader conceptual issues and their relationship to market failure. The role of cost benefit analysis [CBA] is also discussed in this section. Part five briefly examines the concept of government failure and its relevance in the current context. The chapter ends with some brief concluding remarks.

1.1 Background and Rationale for the Study

Livestock selling in public saleyards is the single most popular method of sale despite relatively high selling costs and the variability of price at auction (Australian Bureau of Agricultural and Resource Economics [ABARE] 1992; Hall and Todd 1981, p. 17). Traditionally, municipal governments have provided livestock selling facilities in the belief that these facilities supported substantial regional economic activity and also provided the potential for revenue generation for local authorities. In 1994 one of the largest livestock selling centres in Australia was Wodonga with an annual throughput of over 227,000 cattle and more than 91,000 sheep. By way of contrast, other regional selling centres had much

lower levels of activity with fewer than 10,000 cattle and 20,000 sheep (Municipal Saleyards Association [MSA] 1995). The question arises as to whether all such facilities are capable of providing net benefits to the communities which fund their operation.

A number of studies have been conducted in the last decade which have examined, in part, the efficiency of saleyard selling. For instance, a report prepared for the Department of Agriculture and Rural Affairs and the Ministry for Planning and Environment into the distribution of saleyards in Victoria concluded that the excess capacity of Victorian saleyards provided "...ample scope for rationalisation to occur" (Saleyard Working Party 1986, p. 1). This report further recommended that the first stage of rationalisation required the concentration of saleyard selling into 33 saleyards instead of the current 45 municipal and 60 privately owned saleyards (Saleyard Working Party 1986, p. 2). An examination of data from the MSA indicates that, ten years later, most of the 45 municipal saleyards continue their operation despite the excess capacity identified in this report. Perhaps the ongoing operation of these facilities reflects the inability of the report to describe the broader benefits to be derived from saleyard selling. Alternatively, the continued operation of seemingly 'inefficient' saleyards may simply reflect the failure of some local governments to efficiently manage the resources under their control. It is the general lack of quantitative data relating to such facilities which inhibits an understanding of why these facilities continue to operate.

Little quantitative research exists on the minimum size of saleyard operation which would leave government expenditure neutral. At the same time the comprehensive restructuring of local government in Victoria, and movements towards privatisation, corporatisation, compulsory competitive tendering, and the like have prompted some councils to review the

ownership and operation of municipal saleyards. Accompanied by the increasing pressure on municipalities to provide a wider range of services, this has encouraged a view that saleyards should be treated “...more as an investment by the community [than a service], and ... produce a reasonable yield for the ratepayers’ investment” (Orton Agribusiness 1993, p. 27). Such views coincide with debate about the implementation of national competition policy at the local government level. It is these events which prompt the need for a thorough examination of municipal saleyard facilities. Moreover, this examination provides a vehicle for examining broader economic policy issues.

There were two major aims associated with the present research project. Firstly, it sought to examine the relationships between economic costs, revenue and volume in saleyards. More specifically, we attempted to define the minimum livestock throughput which leaves local government expenditure neutral. Identifying this threshold volume will assist local governments in understanding the operation of such amenities and enhance the capacity of decision makers to efficiently allocate resources between this and other public goods under their control. Secondly, we attempted a comprehensive cost benefit analysis [CBA] which incorporates the broader benefits and costs generated by municipal saleyards. The information obtained in establishing minimum efficient throughput is included in this analysis, though other factors, such as the additional regional expenditure induced by the saleyards, was quantified to provide a comprehensive assessment of the net effect of these facilities.

1.2 Livestock Industries and the Livestock Selling Industry

Since saleyard selling is to be treated as a sub-industry of the broader livestock industries,

an examination of the characteristics and distribution of livestock transacted in saleyards appears warranted. This section of the chapter provides a brief overview of the distribution of livestock throughout Australia and presents a mechanism for rationalising the focus of this study.

1.2.1 Defining Livestock Industries

Australia supports a host of livestock activities of varying economic significance. While traditional livestock industries continue to dominate there has, and continues to be, growing interest in a wide variety of non-traditional or exotic livestock enterprises. While not ignoring the potential of such activities, this study will focus only on traditional livestock industries since these industries remain closely tied to saleyard selling. Livestock in this group includes sheep, cattle and pigs, which accounted for an estimated \$10.8 billion dollars worth of production in 1995-96 (ABARE 1995, p. 544).

While one of the major aims of this study is to examine the efficiency of livestock selling, the varying infrastructure requirements for selling individual species of livestock means that only a single species is considered. Varying infrastructure imposes vastly different costs on the provider of the selling facilities making meaningful inter-species comparisons very difficult. Any study of livestock selling which seeks to produce meaningful data must therefore be restricted to those operations which have similar resource requirements. To this end it is essential to narrow the focus of the study to a particular species; namely cattle.

It is worth noting that within the cattle livestock industry there are a number of sub-industry groups identifiable by the outputs obtained from those livestock. The ABS, for example, distinguishes between meat cattle and milk cattle (ABS 1994, p. 4). However, it is not

feasible to produce a livestock industry classification which is completely without ambiguity. For example, dairy cattle are traditionally culled for age and sold for meat. Similarly, bull calves from dairy herds are often sold for slaughter and producers may switch between types of production in response to changing profitability. Wide variations also exist within these sub-industry groups. Meat cattle, for example, can be sold as either 'store' cattle, purchased by other cattle producers, or as 'fat' or 'prime' cattle sold for slaughter. A distinction may also be drawn between those cattle fed rations of grain and those raised on grass. The point is that there is no single cattle livestock industry. Rather the cattle livestock industry comprises many different enterprises producing outputs which may be similar in some respects and vastly different in others. While this may appear to be a matter of semantics, its relevance to this particular study should not be underestimated.

Since the focus of this study falls on the sale of livestock in saleyards, a method is required to quantify the livestock being sold. It is clear that aggregating units of output, where that output possesses very different characteristics, may pose serious difficulties. Grain fed prime cattle, for instance, are not sold in the same 'market' as aged dairy cows, yet much of the data available on livestock sales does not make this distinction. This issue will be discussed in greater detail in chapters two, but it is worth noting at this stage that just as there is probably no one livestock industry so also there is no one specific livestock selling industry. Rather, the livestock selling industry comprises a multitude of specialised markets with the activities of these markets partly dictated by the specific characteristics of the livestock transacted. Thus, as the characteristics of the livestock vary, so the livestock selling process changes. Any study which seeks to quantify the livestock selling process must therefore be mindful of these variations and conclusions from such research should be prefaced with appropriate caveats.

1.2.2 The Cattle Industry

Livestock selling is, in many ways, determined by the distribution and variation of the livestock being sold. It is therefore appropriate to briefly examine that distribution and variations within the cattle livestock industry. The national cattle herd comprises over 23 million cattle and calves predominantly distributed within the eastern states of Queensland, NSW and Victoria (ABS 1992, p. 5). This distribution is summarised in Table 1.1 below:

Table 1.1: Percentage Distribution of National Cattle Herd by State, 1992

NSW	VIC	QLD	SA	WA	TAS	NT	ACT
23	15	41	4.3	6.9	2.5	5.6	0.05

Source: Adapted from ABS 1992, p. 5

The majority of the cattle herd in Queensland (97%) are 'meat' cattle with increasing dairy activities in NSW and Victoria reducing this proportion to 94% and 60% respectively. These variations are largely attributable to environmental factors as are the variations in cattle breeds between the different states. Zebu breeds populate the more tropical areas of Queensland while British and European breeds dominate the herds of the southern states. There are also significant variations in herd size which can partly be traced to environmental conditions.

In the southern states cattle are commonly run in conjunction with other livestock enterprises, such as wool and lamb production (Saleyards Working Party 1986, p. 15). The tropical environment of northern Queensland tends to restrict livestock production to a single species. Average herd sizes are generally much smaller in the southern states; 127

head in Victoria, for example (ABS 1994, p. 1). This variation, in particular, imposes significant restrictions upon the method of livestock selling adopted by cattle producers in such states.

Meat processors may buy cattle directly from cattle growers thus bypassing the saleyard system to ensure reputable supply and to reduce transaction costs. Generally, processors are attracted to larger herds since this provides the greatest potential economies of scale for such transactions. Owners of small herds are therefore more reliant on the saleyard system since their capacity to attract buyers through direct selling is restricted. This, combined with the high transport costs of large, geographically remote herds, accounts for the dominance of saleyard selling in Victoria and the dominance of direct selling in northern Queensland (Saleyard Working Party 1986, p. 1; Hall 1978, p. 4). Since the focus of this study falls on the efficient use of saleyards, and saleyard selling predominates in Victoria, it is appropriate to restrict this study to the sale of cattle in Victoria.

1.2.3 Cattle in Victoria

The ABS (1994, pp. 1-2) has estimated the total value of the Victorian cattle industry at \$2,244 million in 1993-94. While 62% of the total cattle herd were described as 'meat' cattle, 'milk' cattle production was estimated at 63% of the total value of production. Meat herds and dairy herds had an average size of 127 head and 181 head respectively. The Victorian meat herd is concentrated in the Western Districts, Ovens-Murray, Gippsland and Goulburn areas. Higher rainfall areas of Gippsland and the Western District and the irrigated pastures of the Goulburn Valley accommodate the majority of the states dairy herd (Saleyard Working Party 1986, p. 19). The distribution of the Victorian meat and dairy herds is summarised in Table 1.2.

Table 1.2: Percentage Distribution of Victoria's Cattle Herd, 31 March 1994

Statistical Division	% of Meat Herd	% of Milk Herd
Melbourne	6.0	2.8
Barwon	4.5	6.9
Western Districts	20.7	21.7
Central Highlands	4.4	0.5
Wimmera	2.1	0.1
Mallee	2.8	2.8
Loddon-Campaspe	7.4	9.5
Goulburn	13.2	21.8
Ovens-Murray	12.9	3.7
East Gippsland	8.1	5.1
Gippsland	17.7	25

Source: Adapted from ABS 1994, p. 6

Table 1.2 highlights the problem of defining livestock throughput discussed earlier in section 1.2.1. Given the significant variations in cattle types between districts, data must be carefully selected to avoid problems inherent with inter-district comparisons. Throughput data collected from saleyards in the Goulburn Valley, for example, where dairy herds are more prevalent, cannot be meaningfully compared or aggregated with data from the Ovens-Murray district where meat cattle predominate. Notwithstanding that a significant proportion of bobby calves are sold outside the saleyard system (Saleyard Working Party 1986, p. 19), potential exists for attributing similar throughput quantities to those yards dealing with large numbers of dairy calves and those predominantly dealing with older cattle. It is therefore preferable that saleyard data be selected from areas exhibiting similar livestock populations. To this end, it is probably more appropriate to use disaggregated data at the

local area level to ensure that there is some degree of consistency within the saleyard data.

The risk of comparing livestock data based on significantly different definitions can be further reduced by narrowing this data to saleyards that possess similar cattle selling facilities. As previously noted, different species have differing saleyard infrastructure requirements making comparisons between yards dealing in different species difficult. Similarly, the sale of store cattle alone faces different infrastructure requirements than those facilities handling the sale of both store and prime cattle. Prime cattle are usually sold on a 'live weight' basis requiring scales with the capacity to accurately weigh cattle prior to sale. Store cattle, however, tend to be sold on the basis of open auction and thus have lower infrastructure requirements than those saleyards dealing in prime cattle. Since it is desirable to minimise the variation within the data attributable to such definitional differences, this study will focus primarily on those saleyards conducting both fat cattle and store cattle sales. This issue is addressed in greater detail in chapters two and four.

1.2.4 Livestock Selling in Victoria

Saleyards represent only one of a number of selling mechanisms available to the cattle producer. Other forms of sale include direct selling and computer aided marketing. Direct selling comprises both paddock sales and 'over-the-hook' sales. Paddock sales can occur for either store or prime cattle with prime cattle being purchased by processors on either a per head or per kilogram basis. Over-the-hook sales are generally conducted on a dressed weight per kilogram basis. Computer aided livestock marketing [CALM] is a relatively recent development, only established in 1987. CALM involves the sale of cattle by objective description with buyers lodging their bids with appropriate computer software.

Research by ABARE suggests that throughout Australia, between 1990-92, 58% of prime cattle were sold in saleyards, 38% of sales involved direct selling, and 4% were sold by CALM and other methods. Similarly, in 1992 an estimated 49% of both prime and store cattle were sold in saleyards, while 41% were sold by direct selling (Johnston 1994, pp.10-11).

It is worth emphasising that the selling process is far from static and the lack of current data precludes broad generalisations. However, there is clearly increased direct interaction between cattle producers and processors. In part, this reflects the general shortening of the supply chain and the desire to improve communication between producers and retail consumers. There is also a cost advantage to those producers capable of accessing direct selling where prices are comparable to saleyard prices. Nevertheless, particularly in Victoria where lot sizes are relatively small, saleyards are likely to remain the most dominant method of cattle livestock selling (Cruse, Toohey and Pooley 1996, p. 2).

1.3 Efficiency and Saleyard Selling

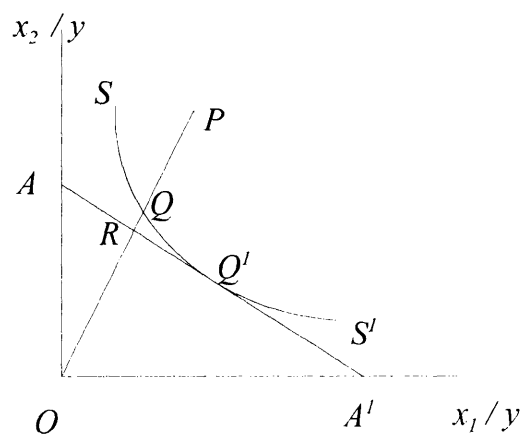
Section 1.2 presented the advantages of restricting a study of saleyard selling to Victorian saleyards. Moreover, there are also discernable research benefits in examining a single livestock species and using data from saleyards with similar infrastructure and livestock characteristics. We now turn to the framework by which industry efficiency can be evaluated. More specifically, we discuss the concept of economic efficiency.

1.3.1 Economic Efficiency

Following Farrell (1957), it is possible to identify two main forms of efficiency and

theoretically measure firm efficiency against these constructs. These constructs are demonstrated with the aid of Figure 1.1. The firm is assumed to produce a single output, $[y]$, from two inputs, $[x_1 \text{ and } x_2]$, under constant returns to scale.

Figure 1.1: Types of Efficiency



Source: Farrell (1957)

The term ‘technical efficiency’ refers to the firm’s ability to obtain maximum output from a given quantity of inputs. That is, technical efficiency is defined by production on the fully efficient firm’s isoquant, SS' . If a firm produces a given output defined by SS' but chooses an input combination P , the firm’s technical efficiency is measured by the proportional reduction in inputs that could be achieved without affecting output $[OQ / OP]$.

‘Allocative efficiency’ refers to the firm’s ability to use inputs in proportions which reflects their relative prices. In figure 1.1, allocative efficiency implies selection of an input

combination along the price ratio line AA' . If production again takes place at P , allocative efficiency is measured by the ratio OR / OQ , since RQ represents the reduction in costs which could be achieved if production took place at Q' instead of Q . Note that both Q' and Q are technically efficient yet only Q' is both allocatively and technically efficient. The overall or 'economic efficiency' of the firm is then defined by the product of both allocative and technical efficiencies, or the ratio OR / OP .

The analysis by Farrell (1957) is useful in highlighting the different aspects of economic efficiency. However, there are a number of practical limitations to the application of this framework in the context of the current study. Most significantly, this approach implies complete knowledge of the firm's underlying production function as embodied in the shape of the isoquant SS' . While a more complete discussion of the saleyard production function is reserved for chapter two, it can be noted here that the absence of comprehensive production data will impinge on the application of Farrell's (1957) work. It is therefore necessary to turn to the broader Pareto criterion which underpins the previous analysis of economic efficiency.

1.3.2 The Pareto Criterion

Since economics concerns itself with the allocation of society's scarce resources, some criterion needs to be developed to distinguish between superior and inferior allocations. The Italian economist Vilfredo Pareto developed what is arguably the most widely applied criterion for adjudging inferior and superior states. Under this criterion a policy change which leads to an increase in the welfare of all is regarded as desirable. Where the welfare of some is improved, while the welfare of others does not decline, a net welfare improvement results and policy change is recommended. This is the stronger of the Pareto

criterion and defines an optimal distribution as the complete exploitation of all potential Pareto improvements. Alternatively, a Pareto efficient allocation exists where no redistribution of resources is possible without making someone worse off (Johansson 1991, p. 10).

The ‘first theorem of welfare economics’ states that a competitive equilibrium simultaneously achieves a Pareto efficient allocation (Johansson 1991, p. 15). Moreover, such an equilibrium provides three necessary conditions for achieving economic efficiency and therefore the foundations of a framework capable of evaluating industry efficiency. Firstly, exchange efficiency exists where it is not possible to achieve a welfare improvement by altering the exchange of goods between consumers. This occurs where consumers relate their preferences directly to market prices to maximise satisfaction. This condition is summarised by equation (1.1) below:

$$MU_A/MU_B = P_A/P_B \quad (1.1)$$

where MU_A and MU_B represent the marginal utility derived from two different goods, A and B , while P_A and P_B refer to the prices of A and B respectively. In competitive markets all consumers face a single price for each good. It follows, under assumptions of competitive markets and utility maximisation, that all consumers reach an equilibrium where the marginal utility derived from each good is equal to the price of that good. Where consumers have differing marginal utilities for the same good adjustments to the relative prices of goods will arise until the equilibrium condition described by equation (1.1) is fulfilled.

A similar argument applies to the second condition for economic efficiency; efficiency in

production or technical efficiency. Technical efficiency occurs where no increase in output is possible from a rearrangement of the factors used in production. While this is defined by production on the efficient firms isoquant in Figure 1.1, it may also be represented more generally in equation (1.2) below:

$$MPP_L/MPP_K = P_L/P_K \quad (1.2)$$

MPP_L and MPP_K represent the marginal physical product of factors L and K , respectively. Similarly, P_L and P_K represent the prices of factors L and K . An assumption of competitive input markets again implies a single price for each input. Any disparity in the marginal physical product of inputs in the production of different goods will give rise to a change in relative factor prices stimulated by movements in the demand for inputs. Such adjustments will continue until the equilibrium condition described in equation (1.2) is fulfilled.

The previously described conditions are necessary but not sufficient to achieve economic efficiency. Economic efficiency is achieved when the assortment of goods produced within the economy is such that it maximises the satisfaction from society's limited resources. That is, "...the extent to which people prefer one good to another is equal to the relative cost of supplying those goods" (Harvey 1991, p. 175). This condition is summarised by equation (1.3) below:

$$MU_A/MU_B = P_A/P_B = MC_A/MC_B \quad (1.3)$$

where MC_A and MC_B are the marginal costs associated with the production of an additional unit of A and B , respectively.

Defining efficiency in these terms is not only completely consistent with the earlier framework employed by Farrell (1957) but also has the attraction of being practically applicable in the current context. Part of the intention of this research is to investigate the economic costs and revenues associated with municipal saleyards. While a comprehensive discussion of these issues is reserved for chapters two and four, at this point it can be noted that equation (1.3) has particular appeal as an instrument for evaluating the economic efficiency of saleyard enterprises. Since it is the intention of this dissertation to employ cost rather than production data, a comparison of the marginal cost of saleyard selling with prices provides the framework for examining economic efficiency in the saleyard sub-industry. Moreover, such a comparison implicitly suggests industry performance is being evaluated against the efficiency associated with the competitive market structure.

The Paretian framework described by equations (1.1), (1.2) and (1.3) is typical of that founded on Pigovian partial equilibrium analysis. An alternative, theoretically consistent framework is Walrasian general equilibrium analysis. However, given the current focus on a single sub-industry, partial equilibrium analysis is considered sufficient for assessing the efficiency of saleyard selling.

1.4 Broader Economic Constructs and CBA

The second phase of this study attempts to extend the breadth of analysis beyond the internal relationships between saleyard costs, revenues and livestock throughput. The framework used to measure internal efficiency is founded on Pareto principles. The inclusion of external issues implies a movement away from these principles towards the compensation principles accredited to Hicks (1939) and Kaldor (1939). At issue are a

number of broader economic constructs which warrant discussion. It is worth emphasising that discussion of these ‘external’ issues is not restricted solely to the more narrowly defined construct of an ‘externality’. An explanation of the nomenclature applied in this study and relevant external issues appears in the following section.

1.4.1 External Issues and Market Failure

Any comprehensive assessment of the efficiency of livestock selling must look beyond net internal costs alone. The saleyard selling system may generate incidental effects for others outside the municipal government. It is thus necessary to both measure and incorporate these events into a broader economic framework than that described in the previous section.

It can be argued that the term ‘externality’ has a relatively narrow definition and much effort could be devoted to definitional issues which arise from the use of this term. However, it may be more productive to simply classify all non-internal issues as external events and focus on their relevance to the current study.

There is no guarantee that the internal and external elements of saleyards result in welfare improvements for all parties. Moreover, a movement away from examining saleyards solely in the context of the competitive firm implies a change to the criterion used to evaluate economic efficiency. The Pareto criterion used to underpin the comparison of saleyards with the competitive firm is replaced by the compensation criterion which assumes hypothetical redistributions between ‘winners’ and ‘losers’. The Kaldor (1939) criterion defines desirable policy change in terms of a hypothetical redistribution from ‘winners’ to ‘losers’. That is, a policy change satisfies this criterion if the ‘winners’ could compensate ‘losers’ and still remain better off. Actual compensation is not required to fulfil this test. The Hicks (1939) criterion supports projects where a hypothetical redistribution from

'losers' to 'winners' cannot achieve the higher level of welfare possible through support for the project. That is, 'losers' cannot 'bribe' 'winners' into refraining from the project (Johansson 1991, p. 22). It is these criteria which provide the vehicle for exploring issues beyond the internal costs and revenues of saleyard facilities.

Broadening the current study to investigate 'external events' also implies an examination of market failure. More specifically, examining issues beyond the internal workings of 'the firm' implies that internal efficiency no longer coincides with social efficiency. Therefore, it may prove useful to briefly review the general sources of market failure and their relevance to the current research. Market failure arises where the unfettered market produces an outcome which is not economically efficient. Since efficiency implies that all mutually beneficial gains are fully exploited, an alternative description of market failure centres on the question of why some mutually beneficial trades remain unexploited by rational economic agents. Gravelle and Rees (1992, p. 513) suggest that there are three basic reasons why advantageous exchange may not occur. Firstly, individuals may not have sufficient control of a commodity or resource to undertake the necessary exchange. Secondly, high transaction and information costs can erode the advantages of trade. Finally, the individuals involved in trade may be unable to negotiate and agree upon the terms of mutually advantageous exchange. These causes of market failure manifest themselves in the six categories of market failure traditionally identified by welfare economics. Each of these categories is briefly discussed below:

Economies of Scale and Monopoly

The framework of the competitive firm which results in Paretian efficiency is largely founded on production functions which exhibit constant returns to scale. The resulting cost functions

force the competitive firm to constrain output such that the additional revenue derived from the last unit of output equates the additional cost. In a competitive market structure this behaviour automatically aligns price with marginal cost. However, if the firm is subject to technologies which result in continually falling average and marginal costs, the competitive output response which equates price and marginal cost becomes implausible. Moreover, employing such technologies has the potential to produce superior outcomes to those described by competitive equilibrium. In this respect the competitive equilibrium fails to correspond with economic efficiency. In addition, where technologies provide falling average cost, market concentration is likely to increase. Firms in these markets are able to enjoy greater market power than that available to the competitive firm. Again the unfettered market in these circumstances has no innate mechanism to deliver economic efficiency.

These issues are at the core of the first phase of this study. Identifying the relationship between costs and saleyard output will uncover the extent to which saleyards currently operate at minimum efficient scale [MES]. This analysis can be extended to also reveal economies available through any rationalisation of saleyard selling. Moreover, a comparison of costs and the price of saleyard selling may be used to examine potential misuse of market power and inefficiencies. A comprehensive discussion of the methodology employed to achieve this task is presented in chapter two while the results derived from this part of the analysis appear in chapter four.

Externalities in Production or Consumption

A second form of market failure arises where parties outside the competitive market are subject to spillover effects for which there is no reciprocal payment. Under these circumstances the market price paid for output will no longer reflect the full costs and

benefits associated with production and consumption. Pigovian analysis of externalities holds that the wedge driven between social and private costs can be addressed through government intervention. More specifically, taxing harmful externalities and subsidising beneficial externalities has the effect of realigning private and social costs such that economic efficiency is achieved. However, this view of production and consumption externalities is not universal. In his classic analysis of social costs, Coase (1960) argues that externalities arise from poorly defined property rights and redress via market mechanisms produces a narrow view of the problem. Where the recipient and the generator of an externality have clearly defined property rights and are able to negotiate with complete information and without cost, the resulting interaction of these private agents itself results in a Pareto efficient outcome. Thus, the Coasian view considers the problem of externalities in terms of adequately defining property rights and establishing a suitable 'market' for the trade of such rights (Cornes and Sandler 1986, p. 59).

In terms of the current study the reliance of Coasian analysis on a costless exchange of property rights under conditions of perfect knowledge is unduly restrictive. Rather it is more likely that a fruitful investigation of saleyard externalities can be achieved by accepting the Pigovian view. Focus is therefore directed to the extent to which externalities impose costs or consign benefits to other parties.

Perhaps the most visible externality associated with saleyard selling is the environmental pollution created by such amenities. Both the odour and the disposal of nutrient-rich effluent from saleyard facilities pose considerable technical difficulties. This is particularly apparent where changing land use patterns have altered the surrounding environment by residential development encroaching on previously rural or industrial land. Clearly, the

impact of saleyards in this context is to impose costs on adjoining landholders. Economic analysis has assisted in the development of a variety of techniques to quantify these costs. A comprehensive discussion of these methodologies is presented in chapter three.

In a broader context, saleyards also represent a major source of pollution for streams and rivers. The eutrophication of Australian waterways has become an important environmental and political issue, and policy makers have responded largely by focussing on point sources of pollution (Hill 1994). A variety of studies have shown that individuals place considerable value on water quality [see, for example, Crase 1996, Crase 1997, Hill 1994] and yet the discharge of waste to downstream users by saleyards can, in many cases, occur with minimum or no payment.

Again there are a variety of techniques in the economic literature which are capable of assessing the value of these harmful externalities. Unfortunately, the possibility of employing these techniques in this study are limited. While the externalities generated by any one saleyard facility can be examined with some accuracy by utilising these techniques, the focus of this study is to address the efficiency of cattle livestock selling throughout Victoria. Thus, the inclusion of these externalities into this analysis would require an assessment of the environmental externalities of every saleyard in Victoria, and a summation of those externalities. Moreover, given the dynamic nature of environmental policy, the relocation of many saleyard facilities, and the imposition of control measures to restrict environmental degradation, such a summation would be subject to many onerous qualifications. It may thus be more appropriate to note such externalities as qualifying potential policy recommendations.

The stress imposed upon livestock via saleyard selling may also be regarded by some as a detrimental side effect of the saleyard industry. However, the question arises as to whether this stress is an externality of the saleyard selling process. The transportation and handling of stock in the confines of saleyards undoubtedly imposes stress on livestock and yet the consequences of this stress are internalised by the participants in the selling process. Purchasers, particularly of prime cattle, are well aware of the effect of livestock stress on the value of livestock, and are likely to adjust their bids accordingly (Bureau of Agricultural Economics 1980, p. 99). Thus, the sellers of livestock are forced to internalise these effects in the form of reduced revenues.

Incomplete Markets

A third source of market failure arise where markets simply do not develop despite demand being sufficient to pay the costs of production and distribution. This form of market failure is often discussed in terms of capital and insurance markets and often relates to the absence of complementary markets. For example, large scale infrastructure investment may not occur because of the absence of a coordinating facility between the different levels of government and numerous private firms. In turn, the absence of this coordinating facility may stifle activity in downstream markets. Public provision of the coordinating facility is then required to promote the operation of other private markets.

This source of market failure does not appear to be significant in the current study. Saleyard selling is only one of a number of selling mechanisms to have evolved for livestock producers. This implies the presence of an active private market for selling services. Similarly, the multiplicity of saleyard venues and developments in livestock transport which have resulted in producers accessing a wider range of saleyard is not consistent with

incomplete markets.

Incomplete Information and Information Failure

The efficiencies implied by the competitive market are contingent upon accurate market information being available to both buyers and sellers. Market information is required to ensure that an efficient price provides adequate signals to which buyers and sellers can respond. An efficient price may be regarded as one which "... communicates supply and demand and the quality preferences of the buyer" (Hall 1978, p. 29). Pricing efficiency in the competitive model is achieved via the assumptions surrounding the structure of the market place. Specifically, the presence of numerous buyers and sellers and the symmetry of information between these groups leaves neither party with the potential to generate or exploit an advantage. Buyers cannot gain access to the product without paying a price sufficient to cover the marginal cost of resources used in production. Similarly, sellers cannot sell for a price greater than marginal cost in the long run due to the ability of other suppliers to adjust to perceived above normal profits.

Information failure and the resulting divergence from a Pareto efficient output was highlighted in Akerloff's (1970) classic study of the market for second-hand motor vehicles. While a complete discussion of Akerloff (1970) and others is reserved for chapter three, it is worth noting that pricing efficiency cannot be guaranteed where the information base of market participants is flawed or inadequate. Where buyers or sellers withhold, or fail to seek information, the resulting price is more likely to reflect the characteristics of the information gathering process than the worth of the good or service.

By selling cattle through a saleyard, producers are able to visually compare the attributes

of their own livestock with others in the market. Since such sales are conducted publicly, producers need not actually sell cattle to acquire such information. This substantially reduces the search costs for producers seeking to establish market values for their output with information gleaned from such sales adding to the bank of market intelligence available to the cattle producer (Hall and Todd 1981). Producers may, for example, use such information to adjust output if premiums are paid to livestock which exhibit particular characteristics.

Studies have also shown that less volatile saleyard prices are attained where the volume of livestock is sufficient to generate considerable buyer interest (Hall and Todd 1981; Saleyard Working Party 1986). Of special importance here is the capacity of well attended saleyards to generate market information benefiting others in the livestock industry who may choose not to use the saleyard system to transact in livestock. However, it should be noted that such information may not be evenly distributed, particularly where the number of buyers and sellers is reduced. Indeed, where the sale is restricted to only one buyer and one seller a bilateral monopoly could develop where price, rather than reflecting the opportunity costs of production or the preferences of buyers, may simply reflect the relative strengths of the two parties. Particularly where cattle are sold directly to processors, information may be distributed asymmetrically between the two parties. Processors generally employ agents who act on their behalf, securing livestock that possess predetermined characteristics. These agents interact frequently in both the direct selling and saleyard markets and are generally armed with current market intelligence. Producers, on the other hand, may sell cattle only once or twice per year. The information base available to such producers may be significantly less than that available to buyers. The findings of recent research funded by the MRC supports this view observing that "...the selling decision is particularly difficult for

direct sellers who must confront unknowns about the competitiveness of price and grading in relation to the consignee's particular livestock" (AACM International 1995, p. vi). Moreover, the same research indicates that competitive quotes gained from saleyards are the penultimate source of information for producers involved in direct selling prior to sale (AACM International 1995, p. 10). The essential point is that market information gained from saleyards has value and this value needs to be included in a comprehensive analysis of the benefits and costs of saleyards.

An additional dimension to the heavy reliance of producers on price indicators from saleyards is also worth noting. Price information is collected from saleyards and distributed by a range of government agencies. Given the growth in direct selling and other methods of marketing, it could be argued that the volume of cattle passing through saleyards has been restricted. Further, since livestock volumes are an important component in achieving competitive quotes in saleyards (Saleyard Working Party 1986, p. 11), it may be possible for processors engaged in direct purchases to offer livestock sellers lower prices on the basis of falling prices in saleyards. In effect, the increased use of direct selling by cattle producers may ultimately limit the ability of those producers to acquire higher and more efficient prices. This may be directly attributed to the relationship between livestock volumes in saleyards and market information.

While these complications of the livestock selling process are significant, it is clear that saleyards have the potential to generate benefits for producers in their search for market information. This is further evidenced by the propensity of even large cattle producers to continue to use the saleyard system despite its relatively high selling costs when compared with direct selling. Some may interpret this cost differential as a penalty imposed upon small

producers unable to access buyers offering direct selling contracts, or the exploitation of imperfect information on the part of those providing the selling service. Given the continued use of the saleyard system by some larger producers, however, it may be feasible to more closely examine these costs and interpret the cost differential as the perceived value of that market information. Alternatively, such cost differentials may be interpreted as a premium that larger cattle producers are willing to pay to reduce the risk of dealing exclusively and directly with a single processor. Regardless of the interpretation placed on such pricing differentials, any study of the saleyard selling system which ignores the benefits of market information generated by that system would be incomplete. A more detailed discussion of these concepts, and attempts to quantify the value of this information are dealt with in chapters three and five.

Public Goods

Public goods are those goods and services which are non-rivalrous and non-excludable and represent another source of market failure. By definition it is not possible to charge a price for such goods because of the capacity of free-riders to consume them without payment. Moreover, given that the opportunity cost of providing public goods to additional customers is zero, efficiency would dictate that the price of these goods should also be zero. Since the competitive market is driven by self-interest, the provision of public goods will not normally occur under competitive market conditions. Put simply, a zero price fails to generate benefits to private individuals and thus fails to stimulate supply. It is this market failure which has prompted governments at all levels to supply such goods.

Since municipal saleyards are provided by local government, it is necessary to investigate whether such a provision occurs because of the public good nature of the saleyard service.

If this is the case, it would be necessary to measure the efficiency of the saleyards selling system using a different framework to that described in section 1.2 [see, for example, Samuelson 1954; 1955]. The use of saleyards can be restricted to only those economic agents who are capable of paying the required fees and charges. In this respect it is difficult to regard saleyards as non-excludable. Moreover, the existence of saleyards operated by private pastoral companies would also reflect the private rather than public good nature of this service.

While it would appear that saleyards have few underlying public good characteristics, the information provided by such facilities does exhibit public good characteristics. In the previous discussion the role of saleyards in providing market information to improve pricing efficiency within the livestock industry as a whole was outlined. It should also be noted that producers of cattle do not have to actively sell cattle in a saleyard to gather information from saleyards. In this respect it may be possible to regard this information as a public good for which it is not feasible to charge a price. It is also not possible to prevent producers from becoming recipients of saleyard information.

In this case, the nomenclature applied to such information is simply a matter of semantics. Whether this information is treated as a public good, or whether it is treated as a beneficial externality, will have little bearing on the outcome of this research. Rather it is important to recognise that the information provided by saleyard selling to the livestock industry must be incorporated into the analytical framework used to adjudge the efficiency of the saleyard selling industry. In this respect it is also worth noting that governments generally have a role in “...providing [an] environment where transaction costs are minimised” (Johnson 1994, p. 14) and to ignore this role would deliberately understate the benefits generated by

municipal saleyards.

Macroeconomic Business Cycles

A final oft-quoted source of market failure relates to fluctuations in the business cycle. These periodic fluctuations are characterised by high inflation during the upswing and high unemployment and falling incomes during the downswing. Macroeconomic intervention is generally aimed at reducing the severity of these fluctuations. There is no general consensus on appropriate policy measures to achieve this goal. At one extreme some market economists argue that markets themselves correct more rapidly without intervention and appropriate policy action should centre on removing constraints which inhibit the performance of markets. In short, exponents of this view are more inclined to regard fluctuations in the business cycle as the manifestation of other imperfections in the economy, including government regulation itself. At the other extreme, adherents to the interventionist school view fluctuations in the business cycle as evidence of the inability of markets to produce socially and economically optimal outcomes. In particular, interventionists cite the slow pace of market adjustment and the inability of markets to clear as grounds for increased government intervention in the economy. Analysis of macroeconomic business cycles as a source of market failure is beyond the scope of the current research.

Spatial Income Redistribution

Additional regional expenditure and the multiplier implications of an activity are constructs which cannot be easily considered under the heading of market failure. Nevertheless, some discussion of these constructs is warranted since it is this additional expenditure which has traditionally been used by some local authorities to justify the continued operation of

particular saleyard facilities (White, F. 1995, pers. comm., 12 Sept). More specifically, it has been the historical view of many local governments that the presence of a saleyard facility generated considerable domestic economic activity beyond the boundaries of the saleyard. It was believed that the presence of the saleyard facility attracted additional expenditure in local businesses. It was further argued that this expenditure indirectly generated local employment and income. This income was assumed to be additional to any income directly derived from the selling facility. While we will investigate this claim more thoroughly, it is worth noting that this historical view has been challenged. A study on behalf of the Meat Industry Committee suggested that only the economies of smaller towns rather than larger towns were more likely to benefit from any increased saleyard activities (Saleyard Working Party 1986, p. 13). Similarly, Hall (1978) makes note of the role of credit facilities from pastoral houses associated with livestock selling, but suggests that the impact of these facilities is likely to be of little economic significance. The relocation of a number of saleyards in Victoria and the consequent negligible effect on local business activity would also suggest that the historical view of saleyards as generators of additional local economic activity requires further analysis (Saleyard Working Party 1986, pp. 13-14). However, ignoring the role of saleyards as a catalyst for additional regional expenditure would severely impinge on policy recommendations derived from this research. An analysis of the methodology for further testing this view is provided in chapter three.

1.4.2 Cost Benefit Analysis [CBA]

Clearly the framework of the competitive firm alone is inadequate to provide a comprehensive assessment of government owned saleyards. More specifically, such a framework does not readily permit the inclusion of broader community costs and benefits. On the other hand, an understanding of direct costs and revenues of the saleyard operation

is necessary to comprehend the extent to which these facilities impose financial costs or benefits on the community. Accordingly, this study must combine an analysis of saleyard selling from the perspective presented by neo-classical economic theory with the wider costs and benefits generated by such amenities. The technique most appropriate for marrying these two perspectives is cost benefit analysis [CBA].

CBA is a relatively recent development in economics, with early work by the US Marine Corp in the 1940's forming the foundation of the formal literature on CBA dating from the early 1960's. The primary function of CBA is to enhance the capacity of decision makers to make informed decisions about the anticipated net welfare consequences of proposed projects. In the current context, CBA will be used to examine the operation of municipal saleyards to assess whether continued public funding is justified on economic grounds alone. It is possible to identify four basic steps in the application of CBA.

Firstly, all costs and benefits attributed to a project need to be identified. Secondly, each cost and benefit must be assigned a price. Where market prices are available it may be appropriate to use market prices as proxies of societies valuation of cost or benefit. While some techniques for assigning values to non-market items have been briefly discussed in section 1.3.1, it should not be assumed that these techniques enjoy universal support. It should also be noted that an array of difficulties arise when market prices are not available. These difficulties will form the basis of detailed discussion in future chapters. The third basic step in CBA involves discounting any values assigned to future benefits and costs to produce a comparison in present value terms. Applying a specific decision rule to the assembled data is the final step in CBA (Harris 1991, p. 527).

One final point should be addressed on the application of a CBA decision rule. Since 1995 Victorian saleyards have been the subject of a voluntary code of practice. This code relates to matters of animal welfare as well as the occupational health and safety of those employed in saleyard facilities. The implementation of this code is likely to significantly increase the infrastructure requirements of some saleyards, particularly older saleyards. When examining the current net benefits and costs of saleyards, it is important to be mindful of any additional costs associated with upgrading saleyard facilities so that they comply with this code. That is, the maintenance of the *status quo* may be justified under a positive net present value criterion, yet the incorporation of infrastructure changes to meet statutory requirements at a later date may lead to different conclusions.

1.5 Government Failure

Section 1.4 was largely devoted to an analysis of the sources of market failure and their relevance to the current study. Market failure provides the conceptual justification for examining broader issues than simply the internal attributes of municipal saleyards. More specifically, we argue that a comprehensive understanding of the operation of municipal saleyards is only possible if all relevant ‘external issues’ are assimilated into an investigation of the internal features of these facilities. Given the focus of section 1.4 on market failure, a complete treatment also requires discussion of ‘government failure’. Examination of this construct is also warranted since the results of this research could be used to point to the presence of ‘government failure’, and accordingly argue for reduced government intervention in this area.

1.5.1 Government Intervention and Government Failure

Government intervention has traditionally been justified on the basis of four main arguments. Firstly, the various forms of market failure which result in economically inefficient outcomes have been used to support the intervention of governments in market economies. Secondly, the distributional characteristics of markets have not always accorded with 'socially accepted' standards of equity. Moreover, some have argued that aspects of distributional equity are akin to public goods. Consequently, the private market has the propensity to under-produce relative to the optimal level of distributional equity (Wolf 1988, p. 29). Thirdly, government intervention has been supported on the merit and demerit good grounds that not all individuals behave in their own best interests. Finally, equality of economic opportunity has been used to support government intervention, particularly in labour markets.

Since the 1920's economists have traditionally argued that governments have both the motivation and ability to improve on market outcomes and maximise the welfare of society. Governments can, for example, "...produce goods, internalise social costs and benefits, regulate decreasing cost industries, and redistribute income [such that] ...these actions redistribute resources to maximise welfare" (Johnson 1994, p. 5). However, by the 1960's economists had begun to question this 'public interest' approach to government. The 'public interest' view attracted criticism on three main grounds. Namely, governments lacked the knowledge to adequately assess welfare losses, governments lacked the ability to appropriately intervene, and governments were not motivated by altruism. In sum, governments are "...constrained by information and incentive problems" (Heyne 1991, p. 561) and are "...no more infallible than private markets" (Stiglitz 1993, p. 599). These views led to a voluminous literature on government failure which generally seeks to explain

the inability of government policy to achieve economically and socially efficient outcomes.

1.5.2 Conceptual Paradigms within Government Failure

A number of conceptual paradigms have evolved under the heading of government failure. While a thorough exposition of all paradigms is beyond the scope of this research, it may be useful to highlight some of the major contributions in this area and note the relevance of specific concepts in the current context. Firstly, an approach accredited to Stigler (1971) addressed government failure in terms of the supply of market intervention in response to the demands of electoral constituents. A second approach focuses on the development of normative frameworks for the evaluation of government policy. Notable contributions in this area include work by Wolf (1989), Le Grande (1991) and Vining and Weimer (1991). A third approach, which has the potential to offer considerable insight in the current context, is public choice theory.

Public choice theory involves the study of non-market decision making by extending the *homo economicus* postulate to the political process (Mueller 1989; Scrimgeour and Pasour 1994). It centres on the notion that governments and their agencies comprise rational individuals who seek to maximise their individual welfare rather than act as servants of the broader public interest. Generally, public choice theory identifies a threefold typology of government failure; 'legislative failure', 'bureaucratic failure' and 'rent seeking'. Legislative failure arises where public goods are provided in an allocatively inefficient manner as a result of the pressures of constitutional democracies. Bureaucratic failure describes the inefficient application of policy by public bureaucracies while rent seeking involves costly lobbying by individuals and group to secure a redistribution of income in their favour. Both bureaucratic failure and rent seeking may have relevance to the current study.

It is argued by proponents of public choice theory that the bureaucratic control of governments leave them less accountable than private firms. For example, Scrimgeour and Pasour (1994, p. 275) note that

"...[I]n the private arena where one's own funds are at risk, ... the decision maker has a strong incentive to shut down a failing enterprise. In the government sector, in contrast, there is an incentive to increase the scope of the activity, regardless of its effectiveness."

This may be of particular significance when analysing the response of municipalities to the inefficiencies identified by the Saleyard Working Party (1986). As already noted, while this report recommended the rationalisation of saleyards in Victoria, many municipalities have responded to these perceived inefficiencies by investing additional public funds in new and improved saleyard facilities. Clearly, quantification of any other benefits generated by saleyards is critical in determining whether such actions are consistent with the predictions of public choice theory generally, and bureaucratic failure in particular. Alternatively, this may reflect the capacity of decision makers to respond to the broader benefits derived from such amenities.

Rent seeking involves behaviour by interest groups to attract economic rents from government. Relatively small interest groups lobby government to achieve preferential policy treatment which cannot be eroded by the competitive market. Such behaviour generates social waste rather than social surplus. In the context of this study, rent seeking may be evidenced by the continued support of unprofitable saleyard venues to enable beneficiaries of the saleyard's operations to enjoy a higher level of income. In effect, public

support for such saleyards may represent a redistribution of income from the broader municipal community to those who directly or indirectly profit from the saleyard. It is also worth noting that beneficiaries have intense preferences for saleyards and are generally able to expend considerable energies on gaining rents, while those who suffer have weak preferences against saleyards and are less inclined to resist rent generating programs (Scrimgeour and Pasour 1994, p. 277). Where saleyard operations require continued financial support from municipal government, it is preferable that this support is provided to serve the 'public interest' rather than the rent seeking interests of those who benefit from its operation. An assessment of the extent of rent seeking behaviour is only possible if a thorough analysis of all costs and benefits of saleyards is conducted.

1.6 Summary

The discussion throughout this chapter has focussed on developing the methodological framework for assessing the internal and external attributes of municipal saleyards in Victoria. In summary, the internal characteristics are to be evaluated against the framework of the competitive firm. To this end data on saleyard costs and revenues will provide the basis for analysing economic efficiency. The analysis is then to be extended to include broader issues such as the additional regional expenditure induced by saleyard facilities and the value of market information gleaned from livestock saleyards. These broader issues are considered along with the internal characteristics of saleyards in a cost benefits framework. It is this framework that provides the foundation for policy recommendations about the future use of these facilities.

It is also possible that the results of this research can be used to uncover potential areas of

government failure within local government in Victoria. This is of particular significance as local governments now also confront issues arising from amalgamation, the implementation of national competition policy and the broader microeconomic reform agenda in Australia.

Chapter 2

2.0 Introduction

A broader understanding of the economic role of saleyard selling can be developed through the application of CBA. This analysis provides for the aggregation of both direct and indirect benefits and costs into a single framework which provides useful input into the decision making process. However, the successful application of this framework rests on the capacity to quantify costs and benefits which relate to saleyard selling. This chapter reviews the techniques which can be used to estimate the direct costs and benefits of saleyard selling and discusses their application to this study.

The chapter itself is divided into four main parts. Part one discusses the nature of production since there is a theoretically plausible direct relationship between the production process and production costs. This theoretical relationship is developed in part two where we derive generalised cost functions. Of particular significance here is the appropriate functional form used to describe the relationship between output and cost. The third part of the chapter discusses techniques for estimating cost functions with particular emphasis upon empirical estimation. The final part of the chapter addresses the estimation of demand and revenue functions.

2.1 Production Functions

In section 1.3 a theoretical framework was presented upon which industry performance could be adjudged; namely, the neoclassical theory of the competitive firm. This framework

postulated that costs and revenues are both functions of the firm's output and that the firm responds to profit maximising incentives to produce at a level which generates both allocative and productive efficiency. Moreover, the behaviour of cost as output increases forms one of the cornerstones on which this theory is built. Since economic efficiency is partially contingent on the relationships established between output and cost, it is necessary to closely examine this relationship to identify any constraints which may be important in the broader analysis of saleyard selling.

2.1.1 Production in the Short-Run

Production itself relies on the combination of inputs. Production is traditionally divided into two distinct theoretical time periods. The short-run is that time period within which at least one of the inputs to the production process is fixed, while the long-run allows for complete flexibility of all inputs. A generalised production function can therefore be specified as:

$$Q = f(X_1, X_2, \dots, X_n), \quad (2.1)$$

where Q represents the level of output and X_i is a specific input to production. In the short-run at least one of these inputs is held constant, leaving increments in Q solely dependent upon the productivity of successive increments in variable inputs. For simplicity, the analysis usually focuses on only two inputs, one variable and the other fixed. This can be expressed as follows:

$$Q = f(X_1/X_2) \quad (2.2)$$

where either X_1 or X_2 is held constant in the short run. Expressing the production function

in this manner simply implies that the level of output is in some way dependent upon the rate of usage of the variable input. Of greater significance and controversy is the nature of this relationship. The traditional hypothesis holds that successive increments in the variable factor lead to positive changes to output. These changes initially occur at an increasing rate, reflecting the relative scarcity of the variable input. However, at some stage the fixed input becomes relatively scarce causing the productivity of the variable factor to decline; that is, the law of diminishing marginal returns becomes operative.

There are a number of important assumptions which underpin the acceptance of the diminishing returns hypothesis. Firstly, it must be assumed that management practices are perfect. Thus, the firm will always choose the input combination which is capable of maximising output given the technological constraints confronting the firm. Perfect management is also taken to imply that the firm will seek the minimum combination of inputs necessary to produce a given output since this minimises cost. Secondly, it must be possible for the firm to be able to obtain variable factors and apply them in continuous increments so as to produce continuous smooth increments in production. This implies that production can be controlled by tiny and progressive changes to variable inputs without the necessity to purchase these inputs in discrete and separate amounts. Thirdly, it is necessary to assume that variable inputs may be continuously substituted for fixed input without discontinuous changes in production. Finally, it must be assumed that the quality of inputs and outputs does not vary and that both inputs and outputs remain homogenous.

There is some doubt as to whether these characteristics are reflective of modern production techniques. The law of diminishing returns is an observed generalisation. Dean (1976, p. 5) notes, for example, that "...the law of diminishing product increments is not based upon

an extensive body of validated technological data ... [and] the appropriateness today of the assumptions that underlie this model is highly refutable". However, this scepticism is not universal. Notwithstanding the assumption of fixed technology, Mansfield (1994, p. 200) suggests that the law of diminishing returns "...seems to hold for most production functions in the real world".

It is worth noting that the restrictions imposed on cost estimation as a result of assuming the law of diminishing returns may be less severe in the present context. It is likely that saleyard selling more closely corresponds with these assumptions than modern manufacturing production. The fixed inputs in the production process in saleyards may be reasonably equated to the physical capacity of the saleyard facility with increments in output requiring increased amounts of labour and other variable inputs. Generally, these variable inputs can be purchased in relatively small increments without the necessity for discrete 'jumps' in input usage and consequent discontinuous changes to output. Thus, provided we are prepared to accept that saleyard management will seek to minimise cost and that there are no significant variations in inputs, the only restriction imposed by assuming diminishing returns relates to the homogeneity of output.

The traditional treatment of production and cost is that output is regarded as homogeneous units of a single product. As indicated in chapter one, saleyards seldom deal in a single species of livestock. Moreover, within a particular species there are significant variations of output which would constrain the reliability of any estimation process. There are essentially four approaches to heterogeneous outputs. Firstly, production and cost functions can be developed for each type of output. However, this requires access to data which records only those inputs [and costs] attributable to a specific output. Where inputs are

shared between different outputs, and records fail to record the usage of these inputs separately, such an approach would not be possible.

The second approach to treating multi-product output is to develop an index which provides a weighting of the various outputs. This index can then be used to convert heterogeneous outputs into a homogeneous measure. Orton Agribusiness (1993, p. 32), for example, employed this approach when commissioned by the MRC to investigate the costs and benefits of livestock selling. They assumed a weighting ratio of seven to one when adjusting saleyard throughput of both sheep and cattle to undertake an analysis of direct and indirect saleyard employment. However, since “...no scheme of product weighting is fully satisfactory” (Dean 1976, p. 12) estimation of production and cost functions by this method should perhaps be employed only as a last resort.

A third approach, where output is not strictly homogeneous, employs multi-output models as a method of estimating production and cost. The application of these models is clearly more complex than that of the single output model. Moreover, representing output as a vector derived from the employment of various inputs still generally requires the aggregation of dissimilar outputs to prevent the analysis from becoming unwieldy. Others have also noted that the results from such models are not always easily transformed into policy recommendations. Vitaliano (1987, p. 306), for instance, observes that “...multiple output models typically suffer from difficulty in interpreting results and from multicollinearity among the output measures which causes unreliable parameter estimates, thus weakening much of their policy usefulness”.

The final method of treating multi-product output is to include any significant variations in

the characteristics of output as an explanatory variable in a statistical estimation process. This method is particularly appealing in the present context. As noted in chapter one, the focus of this study has been narrowed to a single species, namely cattle. Moreover, variations within these species are to be minimised by selecting data from regions where cattle populations exhibit similar characteristics. By including saleyard throughput of sheep as an independent variable in the analysis, and testing for the significance of this variable, it may be possible to explore the livestock selling process as a homogeneous production function without unduly restricting its usefulness in deriving generalised policy recommendations.

While the focus of this study falls on the estimation of cost functions rather than production functions, it is worth noting that considerable effort has been devoted to the measurement of production functions over the past forty years (Mansfield 1994, p. 214). Moreover, the estimation of production functions using either time-series, cross-sectional, or engineering data still hinges upon the application of an appropriate functional form in this estimation process. Acceptance of the diminishing returns hypothesis has generally implied that the production function takes either a cubic form or may be represented by a Cobb-Douglas specification. The cubic production function takes a form similar to that expressed below:

$$Q = aX_1^3X_2^3 + bX_1^2X_2^2 \quad (2.3)$$

Here X_1 is a fixed input while a and b are constants. Moreover, to produce the traditional $\cap$ -shaped marginal product and average product curves it can be shown that a must be negative and b must be positive. Such a function is the most general case allowing for initial increasing returns to the factor, momentary constant returns to the factor, and finally

diminishing returns (Douglas 1987, p. 223). Since X_1 is fixed, equation (2.3) may be rewritten as:

$$Q = A X_2^3 + B X_2^2 \quad (2.4)$$

where $A = aX_1^3$ and $B = bX_1^2$.

The Cobb-Douglas specification is described as follows:

$$Q = \gamma X_1^\alpha X_2^\beta \quad (2.5)$$

The fixed factor in this case is assumed to be X_1 with γ being a constant and α and β representing the elasticity of output with respect to variations in X_1 and X_2 respectively. It can also be shown that in order for the marginal product of the variable factor, X_2 , to be positive and diminishing, β must be constrained such that $0 < \beta < 1$. While the Cobb-Douglas specification of production has some useful algebraic properties, its application in any short-run analysis implies continually declining average and marginal products of the variable factor. To this extent the Cobb-Douglas specification does not exhibit all of the qualities of the theoretical production functions traditionally presented as the basis for analysing the firm's short-run production function (Maurice, Thomas and Smithson 1992, p. 378). The appropriate functional form for describing production will vary from industry to industry and is largely an empirical issue. However, it is important to note that the choice of functional form also reflects the underlying assumptions that are imposed upon the production process. More specifically, use of a short-run cubic production function implies an acceptance of increasing returns to the factor, followed by constant returns and then diminishing returns.

Use of a Cobb-Douglas production function implies an acceptance of the immediate onset of diminishing returns in the production process.

2.1.2 Production in the Long-Run

Production in the long-run permits all inputs to be varied. In common with short-run production it is again necessary to assume that management is perfect. Various other assumption imposed on short-run production, namely divisibility and homogeneity of inputs and outputs, are also imported to long-run production. While it would appear that we can now abandon the diminishing returns hypothesis, since this is based on the premise of at least one fixed input, its relevance in the long-run should not be understated. The relative abundance of a specific input in the long-run is still assumed to comply with the diminishing returns hypothesis. The consequent impact on the marginal product of inputs and the relevance of marginal products in determining marginal cost and efficiency will be addressed later in this chapter.

It was noted in section 2.1.1 that the Cobb-Douglas specification has some limiting properties which may restrict its usefulness in describing short-run production. However, this production function does possess characteristics which make it particularly appealing as a functional form for describing long-run production. Since the long-run is the period of time which allows for complete adaptability of inputs, both X_1 and X_2 are now variable. Again γ must be positive, while $0 < \alpha < 1$ and $0 < \beta < 1$ if this function is to exhibit the necessary qualities of a theoretical production function (Maurice, Thomas and Smithson 1992, p. 374). Represented in this form, the sum of the output elasticities with respect to X_1 and X_2 indicate the appropriate returns to scale. Namely, where $\alpha + \beta > 1$, the firm experiences increasing returns to scale, while $\alpha + \beta < 1$ indicates decreasing returns to scale, and $\alpha + \beta = 1$

represents constant returns to scale.

Increasing returns to scale exists where a proportionate change in the usage of all inputs gives rise to a greater than proportionate change in output. Alternatively, decreasing returns to scale occurs where the change in output is less than the proportionate to the change in inputs. Constant returns to scale implies that the change in output is exactly equal to the proportionate change in all inputs. It is important to note that returns to scale requires that the ratio of input usage remains unchanged; that is, all inputs are increased or decreased by the same proportion. The homogeneous nature of the Cobb-Douglas production function complies with this constraint. The production expansion path derived from the Cobb-Douglas representation implies that the relative usage of inputs is unaffected by the level of output.

In common with the analysis of short-run production and the assumption of diminishing returns, the application of the theoretical concept of returns to scale does not always adequately represent modern production techniques. In reality, modern production seldom conforms to the rigorous constraint imposed by scale economies. More specifically, output in the long-run is often modified by varying both the quantity of input usage and the proportions in which those inputs are used. Scale economies are a “...special case of economies of size” (Dawson and Hubbard 1987, p. 28) seldom duplicated in practice. Thus, while observable changes in costs attributable to the size of saleyards may theoretically suggest economies or diseconomies of scale, they should perhaps be more appropriately addressed as economies or diseconomies of size.

2.2 From Production Functions to Cost

The discussion has focused on the theoretical nature of production and the appropriate functional forms for the representation of that production. While identifying some of the limitations of applying a theoretical framework to empirical production data, a full exploration of these issues is beyond the scope of this study. Rather it may be more appropriate to retain these limitations as constraints upon any policy recommendations and instead focus on the estimation of cost functions. In particular, we should note the relationship between cost and production and the implications of adopting specific functional forms for their representation.

2.2.1 Short-Run Costs

Recall that the short-run is defined as the period of time which restricts at least one input to being fixed. Short-run costs therefore include both fixed costs, relating to the use of the fixed input, and variable costs, associated with the use of the variable input. Input markets are assumed to operate competitively. Thus, the price of variable and fixed inputs does not vary with their usage by the firm. Moreover, it is assumed that indirect variation in the price of inputs, through changes in quality and availability, do not occur.

It was also noted in section 2.1.1 that management is assumed to be perfect. This implies that management will employ only the minimum inputs necessary to produce a given output and will seek to maximise the production of outputs from a given number of inputs. This assumption is consistent with the profit maximising goals of the firm and combined with the assumption of constant input prices reduces the complexity of deriving the firms cost functions. Since production in the short-run is achieved by employing both fixed and

variable inputs, the short-run production function simply maps the behaviour of output against variations in the usage of the variable input. Recall that equation (2.2) summarises a generalised short run production function where either input is held constant.

$$Q = f(X_1/X_2) \quad (2.2)$$

Assuming that p_1 is the price of input X_1 and p_2 is the price of X_2 , total cost may be expressed explicitly as:

$$C = f(Q, p_1, p_2) \quad (2.6)$$

or:

$$C = X_1 p_1 + X_2 p_2 \quad (2.7)$$

Given that one of these inputs is held constant in the short run, say X_1 , equation (6) may be rewritten as:

$$C = F + X_2 p_2 \quad (2.8)$$

where F represents the fixed cost of production and $X_2 p_2$ is the variable cost of production. The object, however, is to derive a function which maps the behaviour of cost against variations in output. To achieve this the production function (2.2) must be inverted such that X_2 is expressed in terms of Q . That is:

$$X_2 = \phi(Q) \quad (2.9)$$

Thus, the short-run cost function can be expressed as:

$$C = F + p_2(Q) \quad (2.10)$$

What is immediately evident from equation (2.10) is that the functional form chosen to represent the firm's production will impact directly on the functional form appropriate to represent the firm's costs.

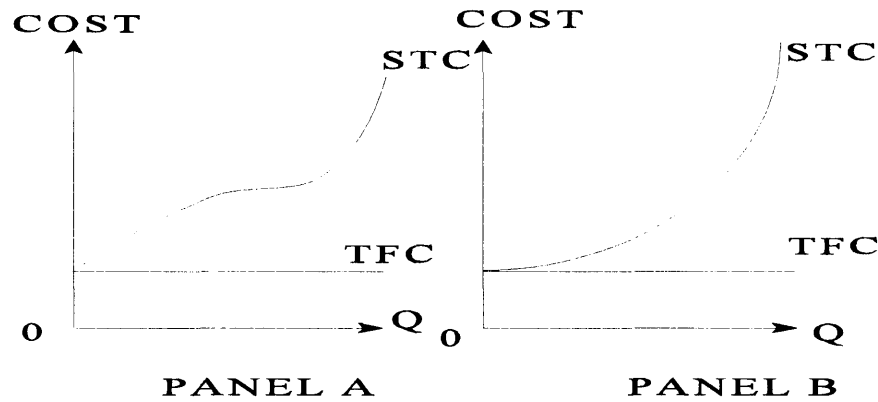
2.2.2 The Functional Form of Short-Run Costs

It may be useful to distinguish three different short-run cost functions to highlight the significance of the relationship between costs and production. Firstly, total fixed costs [TFC] refers to those costs which are associated with the use of the fixed input. Consequently, these costs remain constant throughout the short-run. Total variable costs [TVC] refers to those costs derived from the employment of the variable input. Since the employment of the variable factor is determined by the nature of the production function, the underlying assumptions imposed on the production function will ultimately influence the functional form of the short-run TVC function. Moreover, since total short-run costs [STC] are the summations of TFC and TVC, the functional form assumed for the short-run production function will also dictate the behaviour of the STC function.

Recall that a cubic production function such as equation (2.4), brings increasing returns to the factor initially, constant returns and then eventually diminishing returns, while the Cobb-Douglas function [equation (2.5)] implies the immediate onset of diminishing returns. The contrasting effect of these different production functions on the shape of the STC function is depicted geometrically in Figure 2.1. Panel A shows the resulting STC function when

production is represented by the cubic equation, while panel B depicts STC when the Cobb-Douglas specification is adopted to represent short-run production.

Figure 2.1: Cubic and Cobb-Douglas Specifications



While the shape of the STC function and the underlying production function are significant, two other cost functions are also important for managerial decision making. Short-run marginal cost [SMC] is the additional cost associated with a single unit change in output. Given the continuous nature of the STC function, SMC may be viewed as the gradient of the STC function. Clearly, the shape of the SMC function will differ with the functional form chosen to represent STC, and by implication the functional form of the production function. The SMC function associated with panel A in Figure 2.1, for example will decline at first, reach a minimum and then increase. Alternatively, the SMC function derived from STC in panel B will rise for all units of output. SMC is particularly useful in determining the firm's profit maximising level of output since this is identified by equating SMC and marginal revenue [MR].

Average total cost [SATC] is STC per unit of output. As STC comprises both fixed and

variable costs, it is possible to divide SATC into average variable costs [SAVC] and average fixed costs [SAFC]. SAFC decline for all units of output at a decreasing rate while SAVC can be either increasing or decreasing. Where a cubic production function is assumed, as in panel A of Figure 2.1, SAVC will be U-shaped. Alternatively, the assumption of a short-run Cobb-Douglas production function, panel B, produces rising SAVC at an increasing rate. It is worth noting that both the cubic and the Cobb-Douglas specifications produce U-shaped SATC curves given the influence of falling SAFC at low levels of output. Moreover, this implies that SMC must lie below SATC while it is decreasing, intercept SATC at its minimum, and lie above SATC while it is rising. Locating the minimum point on the SATC functions identifies the level of output which minimises the unit cost of production, given the constraint of having at least one fixed input.

It has already been noted that the cubic production function more closely conforms to the traditional economic analysis of production; that is, it exhibits increasing returns to the factor initially, followed by momentary constant returns and the onset of diminishing returns at some higher level of output. With this in mind it is worth pursuing the mathematical form of the cost functions associated with panel A, Figure 2.1. Moreover, mathematical form will significantly influence the results of any short-run cost estimation. In order for SAVC to take a U-shape, an appropriate specification would be similar to that described by equation (2.11):

$$AVC = g + hQ + iQ^2 \quad (2.11)$$

with the restrictions that $g > 0$, $h < 0$, and $i > 0$. These restrictions are also carried to the TVC, STC and SMC derived from equation (2.11):

$$TVC = gQ + hQ^2 + iQ^3 \quad (2.12)$$

$$STC = F + gQ + hQ^2 + iQ^3 \quad (2.13)$$

$$SMC = g + 2hQ + 3iQ^2 \quad (2.14)$$

Using these specifications, the output level which minimises SMC can be identified as:

$$Q_m = -h/2i \quad (2.15)$$

[For a detailed proof of these parameters and other functional forms see, for example, Maurice, Thomas and Smithson 1992, pp.418-419].

Equations (2.13) and (2.15), in particular, can then be employed in short-run cost estimations to identify the level of livestock throughput for a single municipal saleyard faced with a short-run production scenario. Moreover, these equations form the foundation of the statistical estimation of short-run cost since a functional form must first be specified to regress cost and output data. A more detailed discussion of statistical cost estimation is presented in section 2.3.4.

2.2.3 Long-Run Costs

In the analysis of short-run costs in section 2.2.1 the assumption of perfect management was noted. This has been used to date to ensure that the output achieved by the firm is the maximum feasible output given its known production function. The perfect management assumption defined in this way implies “output efficiency” and allows for the derivation of

short-run cost by simply inverting the production function (Gravelle and Rees 1992, p. 181). Since in the long-run all inputs are variable, the perfect management assumption is extended to also imply “technical efficiency”. That is, the firm cannot reduce the usage of any of its inputs without reducing the level of output (Gravelle and Rees 1992, p. 183).

Again assuming fixed input prices, the long-run cost function implies that equation (2.7) must be minimised subject to some production constraint:

$$\text{minimise: } C = X_1 p_1 + X_2 p_2 \quad (2.16)$$

$$\text{subject to: } Q = f(X_1, X_2)$$

Clearly, the functional form of the production constraint will again impact on the related cost function. It may therefore prove useful to review the properties of the Cobb-Douglas production function commonly used in long run-analysis. This production function takes the form:

$$Q = \gamma X_1^\alpha X_2^\beta \quad (2.5)$$

where Q is output, γ a constant, X_1 and X_2 are inputs, and α and β the output elasticities of X_1 and X_2 respectively. Firstly, it is worth noting that this specification is homogenous. A homogenous function is identified by the quantum of the change in the dependent variable, given some change in the value of all independent variables. More specifically, if both X_1 and X_2 in equation (2.5) are multiplied by some amount, z , then Q will change by z^n . Moreover, if $n = 1$, the function is linearly homogenous and Q changes by the same

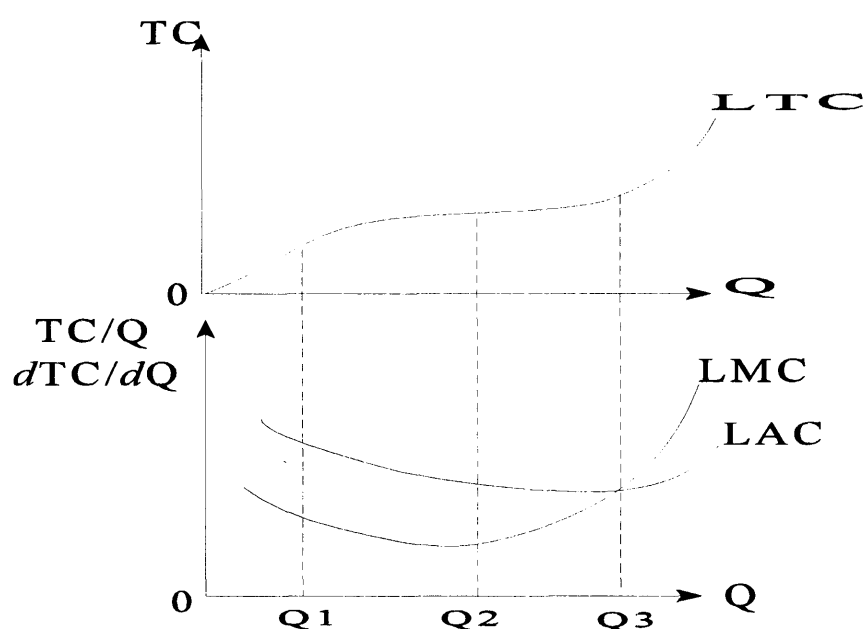
proportion as the change in X_1 and X_2 . Where $n > 1$ and $n < 1$, the change in Q will be proportionally greater than and smaller than the original change in X_1 and X_2 respectively. It is this feature which allows for the immediate identification of scale economies, since for the Cobb-Douglas specifications $\alpha + \beta = n$. The assumption of linearly homogenous production has been used extensively in economic theory despite the fact that it may not always hold true in empirical analysis (Doll and Orazem 1984, p. 208). Under the assumption of linear homogenous production, for example, it can be shown that the marginal product of an input is independent of the scale of production. Similarly, the assumption of linear homogeneity allows the application of Euler's theorem so that output becomes the sum of marginal products multiplied by the level of input usage.

A second useful feature of the Cobb-Douglas specification is that it can be written as an increasing transformation of a linearly homogenous function; that is, it has homothetic properties. It can allow for increasing, decreasing and constant returns to scale and yet retain many of the useful features of a homogenous function. Moreover, a homothetic function of this form can be used to derive convex isoquants and straight-line expansion paths. These features suggest that the marginal rate of technical substitution declines as the input becomes relatively more abundant and that input proportions will not be affected by output levels.

The application of the Cobb-Douglas specification to long-run production typically leads to a LTC function similar to that depicted in Figure 2.2. This can be derived by varying the scale of output and mapping the change in total cost [indicated by shifts in isocost functions] against changes in output [indicated by the position of the isoquant function]. What should be immediately evident from Figure 2.2, is the similarity between the shape of LTC and the

cubic representation of STC in panel A of Figure 2.1. Moreover, since SMC and SATC are derived directly from the STC function, the LMC and LAC functions will exhibit similar features to those of the SMC and SATC associated with panel A of Figure 2.1. Thus, given these specifications, LAC and LMC will appear U-shaped with LMC intersecting LAC at its minimum. Economies of scale and diseconomies of scale will be revealed by falling LAC [where $LMC < LAC$] and rising LAC [where $LMC > LAC$] respectively. Constant returns to scale are indicated by constant LAC or the equating of LMC and LAC over a range of output.

Figure 2.2: Long-Run Cost Curves



The textbook treatment of LAC involves applying the envelope theorem to a variety of SAC functions under an assumption of perfect management. Since firms will always choose to produce at lowest unit cost, and in the long-run management can vary the scale of production, it can be shown that the LAC function is simply the envelope curve which includes all lower segments of SAC at different levels of output. The geometric result is U-

shaped LAC, with initial falling LAC reaching some minimum and then rising. This does not imply that LAC is symmetrical with equal magnitude of economies and diseconomies of scale. It simply suggests that the theoretical LAC must have a negative slope initially and conclude with a positive slope. Investigations of the shape of the LAC curve have been the subject of many empirical studies of different industries. The results of these studies have not always complied with the theoretical U-shaped LAC function and accordingly have served to fuel debate about the suitability of the theoretical foundations upon which cost curves are built.

Mansfield (1994, pp. 264-265), for example, lists 32 different US studies of both private and public sector costs. These studies occurred between 1963 and 1989 and many generated results which contradict the theoretical U-shaped LAC function. The most common contradictions are the frequent reports of L-shaped LAC and constant marginal cost. Such results may again be used to question the validity of the short-run cost functions which underpin the long-run cost constructs. Moreover, the absence of diminishing returns in short-run production will ultimately produce LAC functions which contradict the traditional long-run cost constructs. These results may also be used to question the validity of assuming a fixed input at any stage of the production process. In addressing the latter of these issues it is worth considering the contribution of Kaldor (1934) and his theoretical treatment of U-shaped LAC.

Kaldor (1934) developed a rationale for U-shaped LAC based on the premise of fixed managerial skill within the firm. This approach posits that the supply of 'coordinating ability' or management is fixed even in the long-run, since coordination implies a comparison of all decisions. Moreover, because such comparisons cannot be adequately

performed by simply increasing the number of managers, this factor can be reasonably assumed to be fixed, even in the long-run. The assumption of at least one fixed factor in the long-run implies rising LAC at some level of output and is contrary to the findings of L-shaped LAC. Following Kaldor's (1934) argument, cost estimation techniques have been employed which are frequently underpinned by a U-shaped LAC functional form.

While such issues may appear far removed from the estimation of costs in municipal saleyards, it is worth dwelling upon the importance of the relationship between theoretical constructs and estimation techniques. Statistical estimation, for example, requires the collection of data and the 'unbundling' of significant variables from random errors. This is generally conducted by regressing dependent variables against independent variables. The functional form chosen for this regression analysis is crucial in the determination of results. A useful illustration of the importance of functional form in determining the results of cost estimation is the recent debate surrounding LAC in the dairy sector in England and Wales [see, for example, Mukhtar and Dawson 1990; Hubbard 1993; Burton, Ozanne and Collison 1993].

Using similar data Mukhtar and Dawson (1990) and later Hubbard (1993) investigated scale economies using a translog functional form. In both cases the result was a U-shaped LAC curve suggesting economies of scale, before some minimum unit cost was reached, followed by diseconomies of scale. Burton, Ozanne and Collison (1993, p. 502) note that such results do not prove the existence of the traditional U-shaped LAC function in this industry since "...with the chosen specification it is not possible to obtain anything else". Similarly, in a later study by Hubbard (1993a) an alternative 'reciprocal' specification was employed to estimate costs in the same industry. The resulting L-shaped LAC suggested that economies

of scale were enjoyed at all levels of output despite becoming progressively smaller as output increases.

Similar contradictions are apparent in Vitaliano's (1987) investigation of hospital costs in the US. Testing different functional forms, he shows that seemingly satisfactory estimations of U-shaped LAC can be improved by choosing a different functional form which allows for L-shaped LAC. The point is that the functional form chosen to represent cost data significantly affects the results derived from analysis of that data. Moreover, the chosen functional form is determined by the theoretical constructs researchers bring to the analysis and therefore, by implication, the assumptions that researchers are prepared to make about such constructs. In the case of estimating the direct costs associated with municipal saleyards it may be prudent to test different functional forms rather than impose any further constraints on the usefulness of policy recommendations.

A final point worth noting in this regard is the possible coexistence of both L-shaped and U-shaped LAC within the same industry. Competitive firms may risk significant losses and possible closure if output is expanded to the point where economies of scale or constant returns to scale are exhausted. Therefore statistical observations may not be available to demonstrate the level of output at which LAC turns upwards. Thus, while U-shaped LAC is theoretically plausible, statistical 'proof' of this hypothesis may not be possible given the limited output observations available.

The estimation of direct saleyard costs will focus on LTC rather than LAC. This follows Dean (1976, p. 14) who contends that estimation of total rather than average cost tends to "...yield more reliable findings". This view is also supported by empirical studies like that

conducted by Vitaliano (1987). He observes that "...estimation of a total rather than an average cost function is preferred on econometric grounds because the later introduces the size or output variable on both sides of the equation" (Vitaliano 1987, p. 306). While this is likely to improve the estimation process, it should be noted that one of the aims of the present study is to identify the range of output which generates minimum unit cost. This is not too onerous a task since the transformation of LTC into LAC and LMC is relatively straightforward.

2.2.4 The Functional Form of Long-Run Costs

A comparison of the LTC function depicted in Figure 2.2 and the STC in panel A of Figure 2.1 intuitively suggests that equations (2.11), (2.12), (2.13), (2.14) and (2.15) may be equally appropriate for representing long-run costs. However, it can be shown that where a cubic specification is used to represent LTC a doubling of all input prices fails to double LTC (Maurice, Thomas and Smithson 1992, p.401). Alternative functional forms are therefore required to adequately represent LTC. The commonly used log-linear specification for total cost derived from the Cobb-Douglas function (2.5) is illustrated in equation (2.16):

$$TC = \alpha Q^\beta p_1^\gamma p_2^\delta \quad (2.16)$$

If the parameters γ and δ are restricted such that $\gamma + \delta = 1$, a doubling of input prices, p_1 and p_2 , will lead to a doubling of the total cost of production. As noted earlier this is not a feature of other cubic specifications and therefore limits their use in long-run analysis.

An alternative transformation of the Cobb-Douglas production function was developed by

Nerlove (1963) in his classic study of the US power industry. Using this transformation, the least cost function derived from the Cobb-Douglas specification in equation (2.5) is represented by:

$$\ln C = \ln A + 1/v \ln Q + \alpha/v \ln p_1 + \beta/v \ln p_2 \quad (2.17)$$

where C is total cost, p_1 and p_2 the prices of inputs X_1 and X_2 respectively, $v = \alpha + \beta$, and $A = v(\gamma\alpha^\alpha\beta^\beta)^{-1/v}$. Here the elasticity of total cost with respect to output is given by $1/v$. Employing equation (2.17) results in a total cost function with a positive and significant intercept. This implies that the firm is faced with some non-variable costs even in the long-run (Vitaliano 1987, p. 308). It can be argued that in the long-run it might be expected that zero output would be associated with zero cost. However, given the public ownership of municipal saleyards and the possibility of treating saleyard infrastructure as a sunk cost, a positive intercept term for LTC may be plausible.

One of the difficulties involved in employing equation (2.17) is the inclusion of non-size independent variables other than input costs. The incorporation of the effect of other animal species in the analysis of saleyard costs, for instance, is not easily accommodated by these functional forms. It may thus prove useful to test the quadratic form presented in equation (2.18) below:

$$C = a + bQ + cQ^2 + d_i X_i \quad (2.18)$$

In this case, X_i represents a vector of non-size explanatory variables including input costs and other species throughput. Since equations (2.17) and (2.18) generate U-shaped LAC,

an alternative functional form that allows for L-shaped LAC should also be tested. A useful specification for this purpose may be the logarithmic form presented by Vitaliano (1987):

$$\ln C = \ln A + 1/v \ln Q + d_i X_i \quad (2.19)$$

Here the elasticity of cost with respect to output is derived from the value of $1/v$.

Thus, by employing equations (2.17), (2.18) and (2.19), it is possible to test a variety of functional forms in the representation of long-run saleyard costs. Clearly, each of these forms has both strengths and weaknesses in its capacity to adequately combine the theoretical constraints of economic constructs with the robust estimation required of valid data analysis. These issues will form the basis of part of the discussion in chapter four.

2.3 Estimation of Cost Functions

In section 2.2 the relationship between theoretical constructs and appropriate functional forms was stressed. Moreover, it was stressed that the functional form chosen to represent production and cost would substantially influence the results derived from the analysis of cost data. We now turn to the sources of cost data and the various methodologies available to derive generalised cost functions. Cost estimation techniques can be broadly grouped into four main categories according to the data upon which the estimation is founded. These are analysis of accounting data, engineering data, survivorship data and statistical cost estimation.

2.3.1 The Accounting Approach

Accounting data are observed to identify those costs which are fixed, variable and semi-variable. These data are then used, along with the judgement of experienced managers, to make decisions usually relating to short-run costs. While this approach is relatively simple and inexpensive, its usefulness for research into public amenities and associated policy recommendations is limited. Instead, this approach should be used as an adjunct to more sophisticated methods of cost estimation (Dean 1976, p. 8).

The attempt by Orton Agribusiness (1993) to comment on the possibility of scale economies and the relative profitability of saleyards is illustrative of the accounting approach. Income and expenditure data were collected on eight Victorian saleyards for six years. The average surpluses or deficits of the last two years were then compared against saleyard throughput, although depreciation expenses were omitted since this had not been included by all municipalities. No other attempts were made to adjust accounting data to reflect the opportunity cost of resources. The conclusion that “...there is some evidence that the profitability of the saleyard complex is related to throughput and that larger saleyards are more profitable than smaller saleyards” (Orton Agribusiness 1993, p. 14) must therefore be treated with caution. This perhaps explains why the conclusion is contradicted, in part, by the same authors in their claim that “...there is some evidence in the [same] financial results that regionalised, medium sized saleyards may be the most economical and profitable” (Orton Agribusiness 1993, p. 15).

The accounting approach is generally adopted by private firms even though it lacks the flexibility to adequately cope with variations in input prices and relies heavily on management expertise over a wide range of output. Moreover, the accounting approach is

seldom more than qualified random observations frequently biased by the recording system adopted to monitor the firm's transactions and costs. While the accounting approach appears unsuitable for a detailed study of saleyard selling, it is worth noting that accounting data may well be employed in the more sophisticated engineering and statistical approaches. However, the distinguishing feature of these approaches is the attempt to accommodate theoretical constructs by appropriate adjustments to those data.

2.3.2 The Engineering Approach

The engineering approach derives from the direct relationship between production and cost. Describing the production process as an engineering function then permits the mapping of cost against output. It therefore relies on an accurate and complete understanding of the relationship between physical inputs and outputs. Some commentators have questioned the depth of engineering knowledge about industrial production, in particular, and therefore cast doubt over the accuracy of this approach. Dean (1976, p. 9), for example, describes this approach as "...systematic conjecture about what cost behaviour ought to be in the future upon the basis of what is known about the rated capacity of equipment, modified by experience with manpower requirements and efficiency factors, and with past cost behaviour". Nevertheless, the approach has been used with qualified success in describing some industrial production processes and costs [See, for example, Chenery 1949; Zagouras, Caouris and Kantos 1989] .

A noted example is Chenery's (1949) classic study of pipeline transportation. Drawing on the engineering relationships described as Weymouth's formulae and knowledge of relevant input costs from earlier statistical and engineering analysis, Chenery (1949) derived short-run, intermediate and long-run average cost functions for the pipeline transportation of

natural gas. It is worth noting that Chenery (1949, p. 514) admits that his study involves “...one of the simplest processes known” and therefore lends itself to the engineering approach of cost analysis. Moreover, it is acknowledged that “...in only a relatively small proportion of cases do engineers understand well enough what goes on in the transformation of materials into products to reduce the transformation to an analytical model” (Chenery 1949, p. 530). This reliance on a ‘complete’ engineering model was tested by Zagouras, Caouris and Kantsos (1989) to show that even general engineering information and computational engineering models can be used to successfully derive economic functions. Notwithstanding this success, researchers employing the engineering approach frequently note that it is not always feasible to use the engineering approach to analyse economic constructs. To this end it should be recognised that the engineering approach, like the accounting approach, is a useful complement to other methods of cost estimation.

2.3.3 The Survivorship Approach

The survivorship technique was pioneered by Stigler (1958) and focuses on the changing market shares of firms of different size. If market share diminishes over time for firms of a particular size, it is assumed that these firms fail to operate at minimum efficient scale [MES]. Alternatively, an increase in market share over time is taken to imply operation at MES. Thus, by plotting these relationships it is possible to establish a scale curve or LAC function for a particular industry. Clearly, this technique is inappropriate for short-run cost estimation.

Another of the limitations of this approach is the strength of the relationship between survivorship, market share and cost. Regulation, entry barriers and the like may distort this relationship so that increasing [or decreasing] market share bears little relationship to MES.

This is of special significance in the present context. As noted in chapter one, municipal saleyards may be subject to the vagaries of political choice. For example, municipal governments may choose to support the continued operation of saleyard facilities for a variety of political and strategic motives despite the saleyard's economic and financial performance. Under these circumstances information on a saleyards share of total livestock throughput would provide little useful evidence for the purpose of cost estimation.

2.3.4 The Statistical Approach

The statistical approach relies on the use of observable variations in costs to empirically identify cost / output relationships. Generally, observations of a firm's or an industry's costs are gathered and mapped against variations in output using multiple regression analysis. Consideration is given to potential variations in the cost data which arise from sources outside those allowed for by economic constructs. In effect, attempts are made to deliberately purify these data so that the cost observations closely conform to the rigorous definitions imposed by economic theory.

Studies of costs using a statistical approach can be broadly divided into two groups. Firstly, there are studies of data relating to a single firm over a range of output levels. These studies require the use of time series data. Secondly, there are studies which use cross-sectional data from a variety of firms within a given industry. The first of these categories is particularly appealing in analysing short-run cost functions while the latter have been largely employed to comment upon long-run costs and associated economies of scale and size. Since this study seeks to provide policy recommendations relating to both the short-run and long-run use of saleyards, it is necessary to discuss the application of both techniques.

Statistical Estimation of Short-Run Cost

Studies using data from a single firm are commonly used in short-run cost analysis since this more closely conforms with the theoretical short-run construct. Recall that the short-run is defined as a period of time too brief to allow for the complete adaptability of all inputs. Moreover, at the heart of statistical cost analysis is the notion that variations in cost are attributed only to variations in output and thus relate to underlying variations in the productivity of variable inputs as embodied in production functions. Thus, short-run cost analysis must seek to minimise variations in cost which occur as a result of such factors as management practices, changes in the relative price of inputs and altered technology. To achieve this with the data of one firm is difficult enough. However, to achieve this with data from a number of firms [or worse still to simply assume it of a number of firms] is likely to seriously undermine the possibility of robust estimation.

Dean (1976), in reviewing his own classic studies of a hosiery mill, a belt shop and a furniture factory, notes that three basic steps are required to cleanse cost data so that they are suitable for statistical short-run cost estimation. Firstly, data should be selected for a specific plant and time period when the influence of the aforementioned dynamic elements is minimised. Secondly, records must be amended so that data reflect economic usage rather than accounting convention. Finally, non-output cost influences are nullified through multiple regression analysis. A thorough exposition of these processes as they relate to sawyard selling is dealt with in chapter four. However, some of the more important considerations and limitations require immediate clarification.

Economic theory relates cost to variations in output. Accounting techniques for recording costs do not always reflect this relationship. Some costs may be arbitrarily distributed

making it difficult to trace the component of any cost variation to changes in output. Overhead costs, for example, may be arbitrarily assigned to a particular activity or time period even though those overheads relate to all of the firm's operations. Moreover, of added concern is the time lag between production and the recording of costs. Accounting costs may be recorded on a quarterly or annual basis and yet the recorded costs may bear little relationship to the production of that time period. Some inputs are paid for in advance. Others are accounted for long after their use in the productive process. Still others are distributed randomly by accounting convention, averaged, carried forward or transferred from time periods remote to the actual production of the firm.

One of the most troublesome costs is depreciation. Depreciation refers to the deterioration of factors through use and the passage of time. The estimation of economic costs requires inclusion of that component of depreciation which is attributed to the usage of the input. The loss of value over time as a result of technological progress and the like should be strictly isolated from cost data if an accurate relationship between cost and output is to be derived. Moreover, the alternative treatments of depreciation by accountants can significantly impact on the resulting cost functions. Of special significance is the affect of depreciation methodology on the intercept term for the total cost function. An acceptance of linear depreciation, for instance, implies that "...the bookkept cost is the same in monthly total regardless of the output" (Dean 1976, p. 22) and therefore raises the intercept of the total cost function.

The necessary adjustments to hold input prices constant over time may also promote linearity within the short-run total cost function. It has already been observed that the theoretical short-run cost function is derived on the assumption of fixed input prices. Thus,

variations in the cost of producing output are created by changes in the relative productivity of variable factors as they are substituted in ever-increasing amounts for the fixed factor. The result is rising short-run marginal cost as the quantity of variable factors increases disproportionately to the increase in output. The data available for firms generally includes variations in the price of inputs. A factor price index can be used to account for these variations although this is likely to disguise any declining productivity associated with increased usage of variable inputs. The payment of overtime rates to labour, for example, is easily adjusted, but that adjustment process itself may help conceal the declining productivity of these extra labour hours. Moreover, the reality of declining productivity may be catered for by management decisions to alter input proportions. Once again, it is necessary to be mindful of these possible sources of contamination to the cost-output data.

Finally, it is worth noting the impact of management in general and learning curves in particular on costs-output data. Since the aim of statistical analysis is to expose only the relationship between output and cost, it is also necessary to consider variations in management practices and the state of learning within the productive process. Management may not be constant within the firm over the period of analysis. Superior management will generally permit production at lower cost since any X-inefficiency will be reduced or even eliminated. The passage of time may also provide greater familiarity with the production process. This learning may impact on the productivity of inputs and therefore reduce costs. Variations in cost from these sources will clearly contaminate any attempt to quantify the cost-output relationship along the lines suggested by economic theory. What is apparent from these contaminates is the need for close inspection of data with the assistance of those who are familiar with the production process. Indeed, it becomes necessary to embrace features of the engineering approach within statistical cost estimation if this procedure is to

prove fruitful as a source of policy recommendations.

Statistical Estimation of Long-Run Costs

Long-run statistical cost estimation can be undertaken by using cross-sectional data from different firms with varying productive capacities. The resulting estimates may provide evidence of scale or size economies and an estimate of MES. As with short-run statistical estimation, the data upon which estimates are based must be examined closely for variations beyond the scope of the theoretical constructs. All of the contamination in short-run data can also be present in data used to estimate long-run costs. Indeed, this contamination is likely to be of greater significance since variations may now appear both within and across firms. It is this variation and the lack of appropriate data which has restricted the use of long-run statistical cost estimation in many industries (Fuss and Gupta 1981, p. 124). In sum the statistical approach is more likely to produce robust estimates of cost only where the data is closely examined with the assistance of those who are familiar with the production process.

Most of the previously described caveats and adjustments to short-run data must also be applied to long-run estimation. However, there are three additional issues which require attention. Firstly, attention must be given to highlight the changed role of input prices in long-run analysis. Short-run analysis prescribes that variations in input prices must be cleansed from the data to ensure that costs respond only to those stimuli implied in the short-run production function. Long-run cost estimation generally includes input prices as explanatory variables. This need not imply that long-run estimation requires no adjustment to input prices from cyclical conditions and the like. Rather the inclusion of input prices as independent variables minimises the distortions created by geographically separate

operations and resultant differences in input prices (Mansfield 1990, p. 285).

Secondly, it is worth returning to the role of management in the long-run. In section 2.2.3 it was noted that treating management as a fixed input in the long-run can be used to support the theoretical U-shaped LAC function. Statistical long-run cost estimation permits the testing of this hypothesis provided that an appropriate proxy for management can be identified. Studies by Dawson and Hubbard (1987) and Mukhtar and Dawson (1990), for example, have shown that variations in management practices in the dairy industry displace the firm's cost curves downwards as management improves. These results are achieved by the inclusion of management as an explanatory variable in the estimation process. Whilst identifying the variation in saleyard management is beyond the scope of this study, nevertheless it is worth noting that such variations could significantly impact on estimates of MES.

Thirdly, it is worth drawing the distinction between pecuniary economies of scale and technical economies of scale (Shepherd 1990, p. 214). Pecuniary economies describe the financial benefits derived from increased size which do not directly relate to technical betterments. Examples include, for instance, the discounting of input costs for larger users of inputs. Such economies are distinct from the technical gains where the ratio of inputs to outputs declines as a result of specialisation and the like. Technical economies should strictly be the focus of any policy recommendations since it is these economies which are paramount in determining efficient resource allocation. Data used for statistical cost estimation is unlikely to draw this distinction. Thus, if pecuniary economies are significant, estimation of MES by the statistical approach is likely to be flawed.

A final point worth emphasising is the wealth of literature on statistical estimation and its application to the analysis of long-run cost. To date the only issue addressed in this respect has been the appropriate functional form to be adopted in the estimation process, since this relates closely to the theoretical constructs under examination. However, the debate on statistical estimation does not end here. Statistical issues such as the use of non-parametric rather than parametric estimation are also important in this area. Non-parametric estimation, for instance, avoids problem created by assuming a normally distributed residual error (Sengupta and Okamura 1993, p. 470).

2.4 The Estimation of Demand

The focus of the discussion until now has been restricted to the direct costs associated with saleyard selling. Reference to the competitive model depicted in chapter one would reveal that revenue also forms an important part of any analysis of the firm's activities. Moreover, since revenue is directly related to the behaviour of the firm's demand function it is appropriate to address the estimation of demand for saleyard selling.

2.4.1 Methods of Demand Estimation

The purpose of demand estimation is to map changes in the firm's output against variations in price. The resulting estimate automatically provides details of the firm's average revenue from which marginal revenue can be derived. Of special importance is the exposure of consumers price elasticity of demand as well as other factors such as the effect of variations in income. Demand estimation can be divided into three main categories.

Firstly, demand may be estimated by a series of market experiments. In essence, real market

prices are varied while attempts are made to hold all other relevant factors constant. The resulting variations in sales are then mapped to produce information on demand and elasticities. While producing evidence of consumer preferences from direct observations, this technique has a number of limitations. Since accurate estimation requires exposure of a large number of consumers to price variations, experiments of this nature may only be available to larger firms. Attempts by smaller firms to gain this information are likely to be compromised by the necessary adjustment to the time frame required for the collection of numerous observations. Moreover, this adjustment is likely to increase the influence of variables other than price. Market experiments are also likely to involve greater risk since genuine customers may be disaffected by experimental price changes.

Demand may also be estimated using statistical techniques. Time series data are usually used to provide information about product sales, prices, incomes and the prices of related goods. Multiple regression techniques are then used to ascertain the significance of the relationship between these variables. Since time series data are used, this technique has similar limitations to the market experiments conducted by the smaller firm. More specifically, time series data are more likely to contain variations from sources normally assumed constant in traditional demand analysis. A related restriction of this technique is the nature of the price and output observations themselves. Since these observations are derived from an active and dynamic market, they are likely to represent equilibrium output/price combinations. However, these combinations may prove to be of little value in estimating the total demand function. For example, if demand fluctuates widely while supply remains relatively stable the resulting regression analysis is likely to produce an estimate of the supply function rather than the demand function. Thus, only when demand is relatively stable over time and the supply function is displaced over a wide range of

outputs and prices, will the true demand function be revealed by conventional statistical techniques (Maurice, Thomas and Smithson 1992, p. 234). To some extent this 'identification problem' can be overcome by statistical techniques such as two stage least square regressions. Nevertheless, other problems frequently encountered when estimating demand statistically include multicollinearity, heteroscedasticity and autocorrelation (Douglas 1987, pp. 182-183).

The third method used to estimate demand involves the use of consumer surveys or questionnaires. In its simplest form the survey would ask respondents to reveal their willingness to purchase the good at different prices. However, since the responses are hypothetical, care needs to be taken in survey design to ensure that response bias is avoided. Response bias occurs where the data collected from the survey are sullied by the hypothetical nature of the scenario presented to respondents. A claimed willingness to pay a particular price does not guarantee payment in a genuine market situation. Put differently, there is no guarantee that promises to buy will translate into overt consumer actions and will therefore be representative of true consumer preferences. Moreover, since demand is both the willingness and ability to purchase, this technique is in danger of overstating the desires of consumers and ignoring the practicalities of payment. Despite these caveats, surveys can provide useful information about the preferences of consumers without the cost of market experimentation and without the technical complexity of statistical estimation.

2.4.2 Demand Estimation for Saleyard Selling

Demand estimation provides helpful insights into the revenue of the firm. While the framework of the neoclassical firm has been useful in a number of respects to date, the revenue raising activities in municipal saleyards generally fail to conform to the traditional

revenue constructs. This occurs for three main reasons. Firstly, revenues collected by municipalities from saleyards are of two main types. Selling agents make payments for the use of saleyard facilities while yard and weighing dues are imposed on the owners of the livestock. The payment by agents is generally not related to the volume of saleyard throughput, while yard and weighing dues are fixed on a per head basis. The result will produce a distinct L-shaped average revenue function with the first unit of livestock sold in the saleyard generating substantial revenue due to the agents' payments to the municipality. Further units attract constant marginal revenue equal to the established yard and weighing dues. Mapping the related revenue functions in price output space may lead to a misinterpretation of the sources of saleyard revenue. Moreover, the downwards sloping average revenue function which results cannot be interpreted as a demand function where the saleyard seeks to lower price to induce throughput.

A second restriction arises from the process of setting yard dues and fees by the municipal government. Despite the considerable market power enjoyed by some regional saleyards, fees and charges are unlikely to be raised to test the extent of user reactions. Revenues drawn from saleyard facilities are as much determined by the political processes within local governments as they are from the responses of consumers of saleyard facilities. Interests of livestock sellers may well be preserved by government decisions to limit increases to yard dues and the like for political motives rather than market motives. The resulting revenues are therefore likely to fail to reflect the tolerance of saleyard users to price increases and thus limit the interpretation of these revenues as demand functions.

Thirdly, yard and weighing dues are generally paid by the owners of livestock as an aggregate payment including transport, agency commissions and insurance. The size and

variation of yard and weighing dues may not be distinguished by the users of the saleyard. While this may suggest a modest degree of price elasticity, this may be untestable due to the political processes involved in the setting of such fees. The result is that revenues cannot be strictly regarded as reflective of demand in this case, since, to some extent they must be regarded as exogenously determined.

Despite these limitations, a thorough analysis of saleyard facilities cannot afford to ignore revenues generated by such facilities. Moreover, inclusion of these revenues is essential to establish the direct net benefits derived by the municipality from the existence of the saleyard facility. However, in addressing issues of efficiency, it may be more useful to rely on the estimation of cost functions related to saleyard facilities than any estimated revenue functions. The focus on cost rather than revenue estimation is common in the analysis of many publicly owned amenities since “...cost minimisation is much more general than profit maximisation and consistent with a variety of non-profit maximising models” (Cowing, Holtmann and Powers 1983, p. 263).

2.5 Summary

Estimation of the cost and revenue functions of municipal saleyards provides the opportunity to include direct benefits and costs within a general CBA framework. Statistical estimation can be employed but the estimation process itself highlights a number of theoretical issues which affect any subsequent policy recommendations. Firstly, the estimated short-run cost function, while providing useful information about the operation of a single saleyard, embraces a number of theoretical production constructs. Any use of estimated minimum average cost and marginal cost by saleyard management must therefore consider the

theoretical constructs which underpin the estimated functions.

Similarly, long-run cost estimates embrace a number of theoretical concepts through the functional form adopted for the statistical estimation. However, estimates of MES have the potential to provide valuable input to the efficient use and distribution of municipal saleyards throughout Victoria. Given the significance of these estimates, different functional forms are to be tested to allow for some degree of variation within the theoretical long-run cost constructs.

Finally, estimated revenue functions for saleyards will be estimated despite the fact that these functions bear little resemblance to the theoretical revenue functions of the firm. However, inclusion of these estimates is necessary to allow for a complete assessment of the direct costs and benefits to be derived from municipal saleyards.