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What Price for the Right to Go a-Droving? A Derived Demand Approach

by

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What Price for the Right to Go a-Droving?
A Derived Demand Approach*

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Abstract

Travelling stock reserves (TSRs) were established in Australia as a way of allowing the passage of livestock through settled lands to facilitate stocking of new lands. Subsequently, they remained important as a way of moving livestock from property to property or from property to market. Today, the area of land dedicated to TSRs in NSW is estimated at 2.3 million hectares, which are used more as a source of feed than as a livestock thoroughfare. The value of TSRs as a source of feed is particularly important during drought periods, and pricing of access for walking stock has become a subject of contention within the Rural Land Protection Boards (RLPB). The price of TSR permits for walking stock is considerably lower than for agistment, thereby compromising the capacity of the system to be self-funding. The objective of this study is to explore possible pricing arrangements using a derived demand approach. A representative linear programming model was developed for a farm in Nyngan, NSW. The model was used to obtain estimates of the demand elasticity for TSR services with respect to their own price, the price of supplementary feeds and the price of wool. The effect of drought on these elasticities was also explored.

Key Words: travelling stock reserves, derived demand, grazing, linear programming

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Introduction

In days gone by, overland droving was the only way of moving stock in Australia (McKnight 1977). Droving routes were established over a period of 100 years, originating as a way of allowing the passage of livestock through settled lands in order to allow stocking of new lands. They subsequently remained important for some time as a way of moving livestock from property to property or from property to market. Today, the routes used for droving are known as Travelling Stock Routes (TSRs). Stock routes were originally established as a massive web of unintegrated cross-country trails. With time, this web developed into an integrated pattern of well-defined routes. New South Wales, being the oldest Australian colony, pioneered the development of stock routes and of a formalised infrastructure for their management and maintenance (McKnight, 1977). TSRs occupy crown lands reserved by the NSW Government. Over time, watering points were established and various laws were enacted to protect both the stock routes and the adjoining landholders (Hall, 1987). Over the years, however, the droving use of TSRs has declined as alternative transportation technologies have arisen (Strong, 1993). Presently, TSRs are predominantly used for supplementary feed for stock.

Values of land allocated to TSRs other than for grazing have increasingly become recognised. The stands of native remnant vegetation within TSRs have become important for their own sake as well as for preserving natural wildlife corridors which link state forests and other reserves that are vital to native fauna and flora. Conservation of remnant vegetation within TSRs is not necessarily inconsistent with their use by livestock. Management plans are currently being formulated with the aim of reaching an acceptable compromise between the livestock and conservation demands on TSRs.

Overgrazing has occurred at times, especially during dry spells when there are shortages of feed and water. For instance, in the severe drought of 1964 to 1967, hundreds of thousands of sheep and cattle were put into “The Long Paddock”. Mobs became completely immobilised due to shortages of water and feed. Severe overgrazing occurred and several stock routes were ultimately closed (Hall, 1987).

A derived demand model for TSR services is developed in this paper. The model, a linear programming representation of a representative farm in the Nyngan District, is used to estimate demand elasticities for walking stock on TSR's with respect to permit, wool and oats prices.

Background

The Rural Lands Protection Act placed TSRs in NSW under the control of a network of Rural Lands Protection Boards (RLPBs) which report to the NSW Minister of Agriculture. There are 57 districts in NSW each administered by a local RLPB. Each Board is administered by eight directors elected by local landholders who pay rates to cover the running costs of its operation. Each Board is an autonomous entity (except for certain functions prescribed in the legislation) and is supposed to be run as a cost-efficient business for the benefit of rural landholders (Prell, 1994). The activities of each Board are funded from two sources (i) rates paid by local landholders which are based on the assessed carrying capacity of the land and (ii) revenue derived from fees charged to those running livestock on TSRs (Hall, 1987). Use of TSRs for livestock can be on an agistment basis or on a walking (or travelling) stock basis. For agistment, the permit allows the animals to graze on a particular reserve for a specified period ranging from one to four weeks. The permit can be renewed if necessary. A walking stock permit requires cattle and sheep to cover a distance of 16 km and 10 km per day, respectively.

Each RLPB has autonomy in setting charges for agistment. Agistment charges are generally set with reference to private agistment rates charged in the district, with a discount normally applied in recognition of the additional cost of employing drovers to shepherd agisted livestock. In contrast, charges for walking stock are set uniformly across NSW by the Minister of Agriculture, based on a recommendation from the State Council of RLPBs. Daily charges for the TSR permit required to walk stock are considerably lower than those for stock on TSR on an agistment basis. The amount by which walking stock charges are set below agistment charges appears to be greater than can be explained by walking stock having a lower feed conversion efficiency than agisted stock (due to the additional energy expended by the former category).

Current Issues

In recent times TSRs have attracted some controversy. Transport technology has rendered the original purpose of TSRs obsolete and, as noted above, there is an increased demand for non-livestock uses of TSRs. Pricing and regulation of walking stock have become a subject of considerable contention within RLPBs and their constituencies. For instance, each year there is a motion put forward at the NSW Farmers Annual Conference requesting that the TSR system be dismantled.

There are two main reasons put forward by landholders for opposing continuation of the TSR system. Firstly, despite stated policy, revenues earned by most RLPBs from grazing permits do not cover the costs of operating the TSR system. Thus it has not been uncommon for revenue from rates levied on constituent landholders to be used to cross-subsidise TSR operating costs. Secondly, only a small minority of ratepayers use TSRs. Much of the use is by non-ratepayers, including dealers who buy mobs of sheep or cattle and travel and/or agist on TSRs. Hence, there is resentment that RLPB ratepayers are cross-subsidising other members of the community. Furthermore, TSRs are sometimes perceived as being poorly managed, resulting in land degradation and spread of animal diseases and pests.

It is hypothesised that an important cause of each of these sources of opposition to the continuation of the TSR system is the existing regulatory and pricing arrangements for walking stock. It is expected that if charges for walking stock were set competitively (as is the case with charges for agistment on TSRs), revenue from grazing on TSRs would increase considerably, thereby reducing or eliminating the need for revenue from rates to be used for cross-subsidising TSR operations. Also, higher prices for the use of TSRs by walking stock would be expected to result in a reduction in this category of use, with a significant share of this demand for grazing possibly shifting to the agistment category of use.

Study Area

The Nyngan RLPB district is about 59,000 km^2 in size and extends from the Queensland Border in the north to Bobadah and Nymagee in the south and also extends to the boundaries of Warren Shire

(Cunningham *et al*., 1982). The district forms part of the so-called North-South drift-way within which an interlinked network of TSRs extends from southern Queensland through western NSW (but east of the Western Lands Division boundary) to northern Victoria. Use of the drift-way was greatest during the latter half of the nineteenth century (McKnight, 1977). Traditionally, the drift-way was used by dealers or graziers to capitalise on seasonal variations of feed availability, and related variations of livestock prices, along its length. Stock acquired inexpensively in feed shortage areas by dealers or graziers would be walked considerable distances to areas with current greater feed availability where they would be fattened and eventually sold. Even though motorised transport has lessened the importance of the drift-way for this purpose, some dealers have continued this strategy. Out of a total Board area of 1.8 million ha, the rateable area is 1.6 million ha. TSRs account for about 35,000 ha, or 2.2 per cent of the rateable area. The whole area has an assessed carrying capacity of 1.6 million stock (Prell, 1994). Overgrazing during droughts is a major contributor to land degradation in the district (Cunninghan *et al*, 1982). The low quality of feed during the dry season, which lasts for about eight months, necessitates readily available supplements for stock to subsist on, and TSRs remain an important source of supplementary feed in Nyngan RLPB district.

Recent Trends in the Use of Nyngan RLPB Travelling Stock Routes

Trends in the total use of TSRs across the district for various purposes are shown in Figure 1 for the six-year period from 1990 to 1995. Use is measured in total head days. A head (sheep or cattle) day refers to one day spent on a TSR by one head of livestock. It is apparent that over this period, TSRs were used to a much greater extent for walking than for agisting sheep. Use of TSRs for walking sheep, however, was much higher at the beginning of the period, when drought conditions prevailed, than towards the end when feed on TSRs was scarce.

Conversely, TSRs were used more by cattle on an agistment basis than on a walking basis. Comparison of the degree of use of TSRs by sheep and cattle requires that numbers of respective head days be adjusted to account for the appreciably greater feed demands per head day in the case of cattle. Such a comparison would require head days for cattle to be multiplied by a factor of about ten. It is apparent that after accounting this factor, the greatest demand over the six-year period for grazing on TSRs comes from cattle agistment (Table 1), followed by walking cattle, walking sheep and, lastly, agistment of sheep. Overall, use of TSRs for agisting stock was greater than for walking stock. This was not expected, given that fees charged per head for walking stock are much lower than the fees charged for agistment.

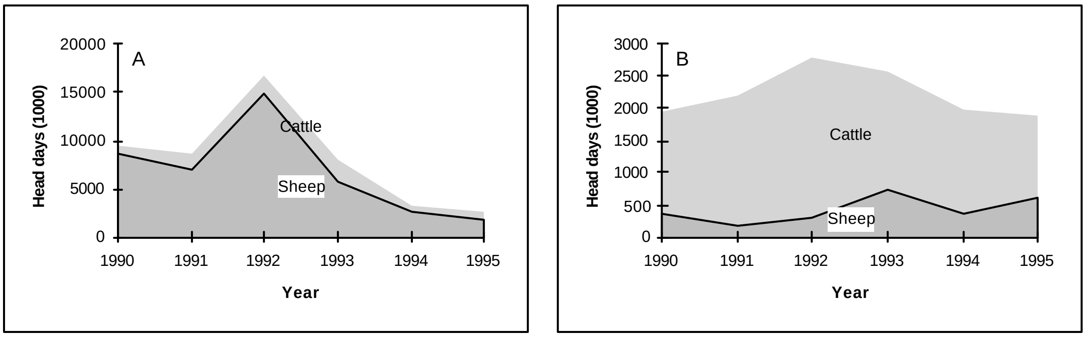

Figure 1. Trends in the use of TSR's in the Nyngan RLPB District for walking stock (A) and agistment (B)

Table 1.Average use of travelling stock routes from 1990 to 1995, Nyngan RLPB district.

Livestock Class	head days/year	Sheep days equivalent
Walking Cattle	13,171,580	79,029,480
Walking Sheep	6,788,777	40,732,663
Agistment Cattle	18,033,148	108,198,890
Agistment Sheep	419,056	2,514,334

Previous Studies

The majority of studies on TSRs have focused on environmental issues and biological classification of plant species. Williams and Metcalf (1991) studied the environmental values of TSRs in the Armidale district and concluded that these TSRs do have important environmental values which merit recognition and continuing positive management by the RLPB. Fletcher (1993) and Strong (1993) carried out vegetation surveys of TSRs, in the Glenn Innes RLPB district, to assess the conservation value of the remnant native vegetation and to define relevant management practices. Other studies by Hall (1987) and Hampton (1988) focused on the multiple purpose utilisation of TSRs. Hampton (1988) reviewed the multiple options for the management of TSRs in NSW while Hall (1987) conducted a survey of the Corowa district on the issue of multiple use planning for TSRs.

The mathematical programming approach has been popular in the estimation of derived demand for irrigation water. Flinn (1969) used this approach to derive regional demand schedules for water in the Yanco Irrigation Area. He estimated regional demand by aggregating over derived demand estimates. Gisser (1970) used parametric linear programming to construct demand schedules for importing water to a river basin in the U.S.A. Briggs Clark *et al.* (1986) modelled short-term demand for irrigation in the Murrumbidgee and Coleambally Irrigation Areas of southern NSW.

The only study on the economics of TSRs that appears to have been undertaken is that by Christiansen (1990), who used gross margin analysis to assess droving and leasing of land as alternatives to purchasing land in order to enter or expand beef industry production. The present study appears to be the first attempt to apply derived demand techniques to determine the value of TSRs.

Method

The Representative Farm

A case study farm from Nyngan RLPB district was used as a basis for developing a representative farm model. Given the time and resource constraints of the study, it was not feasible to estimate the demand for TSRs for each of the 378 farms in the RLPB district and thereby develop an aggregate demand schedule. The case study property was nominated by the RLPB Ranger as reasonably typical of the properties in the Nyngan RLPB district using local TSRs for grazing.

The area of the representative farm is 2,600 ha, with 1,700 ha allocated to natural and improved pasture and 900 ha to crops. The farm family is the major source of labour, providing about 2,600 hours of labour annually, while hired labour employed on a casual basis usually contributes another 200 hours annually. Apart from hired labour for on-farm activities, drovers are hired when needed to manage livestock on a TSR. In general, one drover can manage up to 3,000 sheep at a time. Cropping is limited to cereal grain production (wheat, barley and oats). As all cropping is on a dryland basis, yields are highly sensitive to seasonal conditions. For instance, the yields can be as high as two tonnes per hectare in a good season and as low as 0.8 tonnes per hectare in a poor season. These crops are produced mainly for the market except for oats which can also be grazed during drought conditions.

Merino ewes are the major livestock activity, followed by cattle for fattening. Around 2,000 merino ewes are typically run for lambs and wool and about ten calves are usually purchased each year for fattening and/or turning off vealers. Merino ewes are replaced after every six years. A large proportion of the area of the representative farm is allocated to native and improved pasture. There are about 1,450 ha of native pasture and 250 ha of improved pasture. Improved pasture varieties are re-established every five years.

Due to variable climatic conditions, seasonal feed shortages can arise. Under such circumstances, the case study farmer supplements feed availability by purchasing oats and sometimes by purchasing hay. The representative farmer also supplements pasture feed by grazing sheep on TSRs on an agistment or walking stock basis. TSRs are considered by the farmer as an important source of feed for livestock.

Relevant information regarding farm resources, constraints, production organisation, operation and production activities were provided by the case study farmer. Information required to develop gross margin budgets, and estimate livestock feed requirements and LP coefficients was obtained from Patrick (1996), Davies and Llewellyn (1994) and Turvey (1988).

Model Description

The representative farm model was developed within a linear programming (LP) framework. The objective of the representative farmer is assumed to be maximisation of annual gross margin. The objective function incorporates gross margins for crops and livestock activities and variable costs associated with other activities of the representative farm. Variable costs relating to pasture enterprises, hired labour, TSR permit fees, costs of hiring a drover and supplementary feed purchase on a seasonal basis are included in the model as negative objective function coefficients.

Cropping Activities

The cropping activities included in the model were wheat, barley and oats. The yields of each of these crops was assumed to be 1.5 tonnes per hectare. These crops are grown specifically for market. The farm-gate prices of wheat, barley and oats were assumed to be $185, $170 and $130 per tonne, respectively. The resulting gross margins were $166, $151 and $146 per ha for wheat, barley and oats, respectively.

Livestock Activities

Both sheep and cattle activities were incorporated in the model. The sheep activity involves merino ewe production for wool and lamb meat, while the cattle activity involves purchase of young calves for fattening to vealers. The gross margins for the sheep and cattle activities were estimated to be $53 and $331 per head, respectively.

Pasture Activities

Pasture activities include native and improved pasture production. In the model, no cost is incurred in the native pasture activity. The cost of improved pasture production in a year was estimated to be $19.55 per ha. Both native and improved pastures are grown mainly to provide feed for the livestock enterprises. The opportunity to transfer pasture feed produced in one season to the following season was included as an activity in the model. Three such activities were included for each of native and improved pasture (thus six in all), for transfers from (a) spring to summer; (b) summer to autumn; and (c) autumn to winter. An activity for feed transfer from winter to spring was not included since winter is the most limiting season in terms of feed supply.

TSR activities

Use of TSRs can be on an agistment or walking stock basis. TSR use can be expressed in head days for both agistment and walking uses. The number of head days is given by multiplying the number of stock using TSR by the number of days for which the use takes place. To qualify for the use of TSRs, permits are purchased from the RLPB at $0.20 per sheep day for agistment, and $0.02 per sheep day for walking.

Since the representative farmer has very few cattle, it was assumed that only sheep could be grazed on TSRs. TSR walking and TSR agistment activities were included for each of the four seasons (thus there were eight TSR activities in total). Hiring a drover is necessary when agisting or walking stock. A hired drover activity for TSR agistment was included for each of the four seasons. Likewise, a hired drover activity for TSR walking stock was included for each of the four seasons. The cost of hiring a drover for TSR agistment was assumed to be $170 per day while the cost of hiring a drover to walk stock was assumed to be $200 per day.

Other Activities

Allowance is made in the model for the purchase of supplementary feed (oats) in each of the four seasons. The cost of oats was assumed to be $125 per tonne in each of the four seasons. An option for hiring labour for on-farm production activities when family labour is in short supply was included as an activity for each of the four seasons. The cost of hiring labour in each season was assumed to be $100 for a working day of eight hours.

Constraints

Constraints included in the model relate to availability of land, seasonal feed ties, labour available for droving, labour available for on-farm activities, maximum cattle and maximum purchase of oats as a supplementary feed. The total land available is 2,600 ha, and a maximum of 900 ha is allowed for the production of crops. This constraint is imposed due to limits in the availability of suitable land and cropping machinery. A minimum of 250 ha of improved pasture was also imposed on the model, in recognition of the current area allocated to this activity.

Feed supply per hectare of pasture varied according to season. Feed tie constraints for each of the four seasons require that demand for feed in any season be less than or equal to the supply of feed in that season. Demand for feed in a particular season comes from the livestock activities as well as the seasonal feed transfer activities (feed transferred from a season represents a demand). Supply of feed in a particular season comes from pasture activities, from purchase of oats, from TSR agistment and walking activities, and from the seasonal feed transfer activities (feed transferred into a season represents a source of supply). It was assumed that transfer from one season to the next results in a loss of 40 per cent in feed value due to senescence and rotting of plant material (Rickards and Passmore, 1977).

The feed requirement per ewe was assumed to be 5.94 LSM[1] , 3.96 LSM, 3.76 and 4.71 LSM in spring, summer, autumn and winter, respectively. The corresponding figures for cattle were assumed to be 19.62, 21.55, 22.24 and 26.21 LSM per head (Turvey, 1988). It was assumed that feed availability on TSRs is non-limiting. That is, there would be more than enough feed for any number of sheep put on TSRs by the representative farmer. However, it was assumed that walking stock need ten per cent more feed to attain the production levels assumed in the gross margin budgets than do stock grazed on-farm or agisted on TSRs. Thus, feed supply per sheep day of TSR walking stock was set at 90 per cent of the "standard" seasonal feed requirements assumed in calculation of the gross margin.

The maximum number of sheep a drover can manage was assumed to be is 3,000. Labour was modelled as being available from the farm family and from casual hiring of labour. Maximum labour provided by the farm family was set at 2,600 hours annually. A maximum of 200 hours per year of hired labour was also set in recognition of the farmer's reluctance to take on too much of a supervision load.

The cattle activity on the representative farm is a sideline to the sheep activity and was limited to twenty head. The maximum amount of oats that can be purchased annually was assumed to be 200 tonnes. This limit is in recognition of the farmer's limited capacity to store and handle grain. A tonne of oats was assumed to be equivalent to 41.8 LSM (Rickards and Passmore, 1977).

Derived Demand Estimation

As in previous applications of LP models for deriving an input demand schedule, the analysis in this study involved investigation of the own-price and cross-price effects on demand for the input of interest. Parameterisation of the TSR walking permit fee was undertaken systematically (holding all other prices constant) to obtain a demand schedule for TSR walking permits in average, poor and good seasons. The price/quantity data obtained could thereby be plotted to derive a stepped demand function for TSR walking permits.

The crop yields and pasture feed supplies specified earlier in this chapter assume an average season. In the case of a poor season, crop yields and pasture feed supplies were assumed to be 50 per cent of what was assumed in an average season. In the case of a good season, pasture production and crop yields were assumed to be 150 per cent of those assumed in an average year.

Since wool is the most relevant output from TSR use in the representative farm and oats the most relevant substitute to feed from TSRs, the effects of variation in the prices of these items on the demand for TSR walking permits were of considerable interest. The prices of these items were, in

[1] LSM: The amount of feed required to maintain a 50 kg dry sheep for one month

turn, increased and decreased by 10% and 25%, for a total of five price levels for wool and five for oats.

With regard to sensitivity testing for different types of seasons, limits on the divergence of livestock numbers from those in an average season were imposed in the LP model. This was to reflect the farmer's less-than-total flexibility in changing livestock numbers from year to year in response to seasonal or market conditions. Limits on flexibility are due to such factors as problems of purchasing/selling livestock when other farmers are seeking to do the same and constraints placed on the farmer's livestock breeding program. In a poor season, therefore, the number of ewes was, for any given set of prices, constrained so as to be no lower than 80 per cent of the number that would be carried in an average season. Similarly, in a good season, the number of ewes carried was constrained to be no higher than 120 per cent of the number that would be carried in an average season (given the same set of prices).

Calculation of elasticities

As noted by Flinn (1976), the stepped demand functions generated by the linear programming procedures are not convenient for calculation of demand elasticities. A solution to this problem used by Flinn (1976), Briggs Clark *et al.* (1986) and Fahmi (1991) is to estimate continuous demand functions by means of multiple regression. Flinn used the mid-points of each step as discrete observations for such a regression. Briggs Clark *et al.* used discrete price/quantity combinations associated with pre-chosen combinations of own-price and cross-prices. In this study, an approach similar to that of Flinn was implemented.

A derived demand function for TSR walking permits was estimated by multiple regression for each of the three season types. It turned out that there was no need to do so for the good season scenario as the demand for TSR walking permits remained at zero under all cross-price combinations, even with a zero permit price. The demand function estimated by multiple regression in each case was:

$$Q = f\,(P_p, P_w, P_o)$$

where Q is demand for TSR walking permits (in sheep days); $P_p$walking permit price ($ per sheep day), P is price of wool ($/kg) and P_o is price of oats ($/t). From the estimated demand function, it was then possible to calculate the own-price and cross-price elasticities. The own-price elasticity of demand is given by:

$$\in_d = \frac{\partial Q}{\partial P_p} * \frac{P_p}{Q}$$

The elasticity of demand with respect to the price of wool is given by:

$$\in_{d,\ pw} = \frac{\partial Q}{\partial P_w} * \frac{P_w}{Q}$$

Elasticity of demand with respect to the price of oats is given by:

$$\in_{d,\ po} = \frac{\partial Q}{\partial P_o} * \frac{P_o}{Q}$$

The values of the various partial derivatives were obtained from the coefficients of the estimated demand functions.

Results and Discussion

Demand schedules for TSR Walking Permits, Base Case

The stepped demand function for average and poor seasons, estimated by the method detailed in the previous section, are presented in figure 2 and table 2. These functions were estimated using base case values for oats and wool prices.

Table 2. Demand for TSR walking permits (sheep days per year) in poor, and average years under base price levels

Permit price ($/sheep day)	**Poor year**	**Average year**
0.0000	554,095	28,602
0.0475	"	22,228
0.0500	436,627	"
0.0700	372,627	"
0.0750	247,219	0
0.0950	115,168	
0.1250	107,206	
0.1500	60,361	
0.1550	0	

As would be expected, the demand for TSR walking permits at any given permit price is greater in a poor season than in an average season. In a good season, however, the upper limit on labor availability, rather than feed availability, becomes binding on ewe numbers. Thus, additional feed made available by purchasing walking permits has a zero marginal value product (and thus there is zero demand for them even at a zero price).

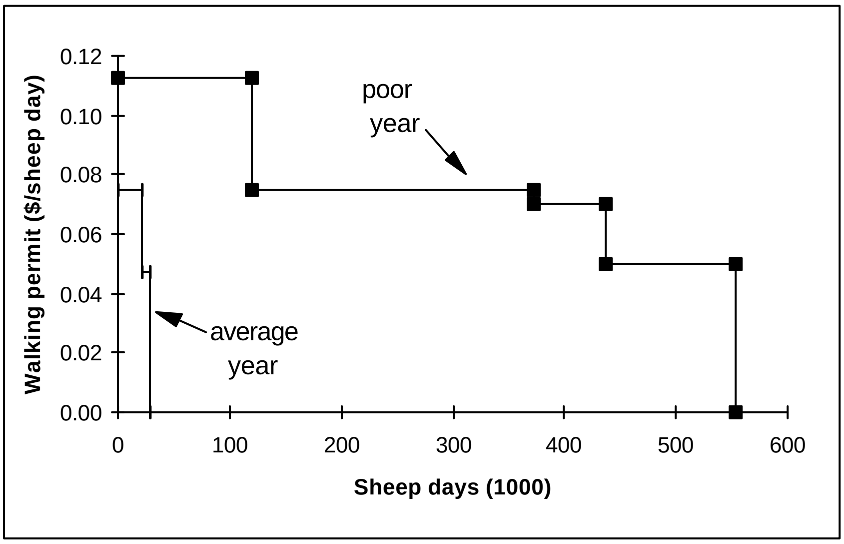

Figure 2. Demand schedule for walking permits in an average year and a poor year

At the existing TSR permit price of ($0.02 per sheep day), the demand for TSR walking permits was estimated to be over 22 times greater in a poor season than in an average season. In a poor season demand for walking permits was greatest in spring and winter, whereas demand for permits occurred only in winter in an average season. There was no demand for TSR agistment permits in either of these seasons.

In an average season the farmer would substitute oats for TSR walking permits once the price exceeds $0.0750 per sheep day. In a poor season, oats are substituted in autumn for walking permits once the permit price exceeds $0.05 per sheep day and the same occurs in winter when the permit price exceeds $0.08 per sheep day.

Effects of Wool and Oats Prices

The estimated stepped demand schedules for some of the alternative cross-price combinations are shown in Tables 3 and 4. As expected based on economic theory, in general it is seen from these tables that:

a) The demand for an input (walking permits) increases as the price of the output (wool) increases (and the reverse is true as the price of wool decreases); and
b) The demand for an input (walking permits) increases as the price of the substitute input (oats) increases (and the reverse is true as the price of oats decreases).

Table 3. Demand for TSR walking permits (sheep days per year) in poor, and average years for variations in wool price (+25% and -25% refer to increases and decreases in the base wool price).

Permit price	Poor year		Average year	
($/sheep day)	+25%	-25%	+25%	-25%
0.0000	994.732	554.095	28.602	22.228
0.0200	862.213	"	"	"
0.0250	567.627	"	"	"
0.0425	"	437.874	"	"
0.0475	446.411	372.627	"	"
0.0600	"	365.281	"	"
0.0725	"	"	"	0
0.0750	"	"	0	
0.0775	"	284.701		
0.1000	159.262	77.202		
0.1125	0	0		

Table 4. Demand for TSR walking permits (sheep days per year) in poor and average years for variations in oat price (+25% and -25% refer to increases and decreases in the base oats price).

Permit price	Poor year		Average year	
($/sheep day)	+25%	-25%	+25%	-25%
0.0000	554.095	554.096	28.602	28.602
0.0200	"	436.627	"	"
0.0400	"	152.108	"	0
0.0475	"	"	22.228	
0.0600	427.874	"	"	
0.0675	"	0	"	
0.0750	372.627		"	
0.0850	"		0	
0.0875	292.663			
0.1100	80.126			
0.1525	77.202			
0.1550	0			

Elasticities of Demand for Walking Permits

Due to the linear form of the continuous demand functions, the various elasticities of demand vary as own-price and cross-prices change. Own-price and cross-price elasticities of demand for various combinations of prices under average and poor seasons are presented in Table 5.

Estimated own-price elasticities for average and poor seasons remain in the inelastic range as walking permit price increases from $0.00 to $0.06. This implies that walking permit price increases within this range will increase the total revenue to the RLPB from the representative farmer. Price increases in excess of that range will reduce the total revenue earned from the representative farmer.

Table 5. Price elasticities of demand for TSR walking permits during average and poor years

	Elasticity of demand with respect to					
Permit price	Own-Price		Wool Price		Oats Price	
($/sheepday)	Average	Poor	Average	Poor	Average	Poor
0.00	0.00	0.00	0.39	0.48	0.42	0.70
0.02	–0.17	–0.18	0.45	0.57	0.49	0.82
0.04	–0.40	–0.43	0.55	0.69	0.59	0.99
0.06	–0.76	–0.81	0.68	0.88	0.74	1.26
0.08	–1.35	–1.49	0.91	1.20	0.99	1.73
0.10	–2.55	–2.97	1.38	1.92	1.49	2.76
0.12	–6.24	–8.75	2.81	4.71	3.04	6.79

In general, the demand for walking permits in a poor season is slightly more sensitive to changes in permit price than is the case in an average season. For instance, at the current permit price level of $0.02 per sheep day, the own-price elasticity is –0.17 in an average season and –0.18 in a poor season.

Analysis of elasticities under alternative price combinations revealed that the range of walking permit prices over which demand for permits remains own-price inelastic remains quite stable despite upward and downward variation in cross-prices of up to 25 per cent. The only cases where demand becomes own-price elastic at a walking permit price of less than $0.06 per sheep day occur in a poor season when either the wool or oats price is 25 per cent lower than the base level. There was no case where demand remained own-price inelastic at a walking permit price higher than $0.08 per sheep day.

Demand for walking permits becomes increasingly cross-price elastic with respect to wool and oats prices as the level of permit price is increased. That is, a given percentage change in the oats or wool price will have a greater proportionate effect on demand for walking permits if the permit price is higher rather than lower. At the current permit price level of $0.02 per sheep day, these cross-price elasticities lie within the range of 0.4 to 0.95 depending on the levels of the cross-prices. The high end of this range corresponds to the elasticity of demand with respect to oats price when wool price

is 25 per cent lower than its base. That is, demand for walking permits will be most sensitive to changes in the oats base level price when grazing is least profitable.
It is also evident that demand for walking permits in a poor season is more cross-price elastic than is the case in an average season.

Summary and Conclusions

The research problem addressed in this study concerned the pricing of permits allowing livestock to be walked on Travelling Stock Routes. The pricing policy appears to be based on the assumption that the main reason of walking stock on TSRs is to move them from one place to another. With motorised transport, however, this need has all but disappeared. The use of TSRs for walking stock is nowadays mainly for feeding stock. The low prices set for the right to walk stock on TSRs distorts grazier choices between walking permits and other options for feeding livestock (eg., on-farm pastures, purchased feed, TSR agistment permits) and thus can be expected to lead to losses of economic efficiency. The low price may also be responsible for many RLPBs being unable to cover the costs of managing and maintaining TSRs from the fees set for their use.

Information regarding the own-price elasticity of demand at the current price level would assist RLPBs to gauge whether a higher degree of costs recovery could be expected if walking permit fees were to be increased. Hence, the primary aim of this study was to estimate the own-price and cross-price elasticities of demand for walking stock access to TSRs in the Nyngan RLPB district.

As was expected, demand for walking permits was found to be considerably higher in a poor season than that in an average or good season. In fact the representative farmer's demand for walking permits in a good season was estimated to be zero, even at a zero permit fee.

The permit price above which own price elasticity of demand changed from inelastic to elastic (the threshold price) in an average season fell somewhere in the range of $0.06 to $0.08 per sheep day, with the actual level depending on prices assumed for wool and oats. The threshold permit price in a poor season fell somewhere in the range of $0.04 to $0.06. It is thus apparent that demand for walking permits by the case study farmer is own-price inelastic at the existing price of $0.02 per sheep day and that this price can be increased significantly before demand becomes elastic. That is, there is considerable potential to increase revenue earned from the representative farmer by increasing the walking permit fee toward the threshold level applicable to poor and average seasons.

Use of the representative farm approach means that caution is required in drawing general district-wide inferences from the findings of this study. Nevertheless, the findings from analysing a single representative farm provide useful insights for framing the pricing of TSR walking permits.

Furthermore, there are users of Nyngan RLPB TSRs other than Nyngan graziers. For example, there are dealers and others who drove stock through the district along the north-south driftway. This study has shed no light on the characteristics of the demand by these users for permits to walk stock on Nyngan RLPB TSRs. This is obviously an area where further research is warranted. Finally, there are also non-grazing demands on TSRs. A case in point is the demand to preserve remnant native vegetation on TSRs. Analysing these demands is also important if information is to be available to manage TSRs so that the various demands for the services provided by TSRs are to be most efficiently provided.

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