REVIEW OF MARKETING AND AGRICULTURAL ECONOMICS
VOL. 48, No. 2 (*August*, 1980)

The Demand for Hired Labour on Australian Sheep Farms

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The motivation for this study was provided by the interest currently being expressed in the effects of rising wage rates and other factors on the employment levels in various industries in Australia. An attempt is made to examine a number of key factors affecting the demand for labour in a major subsector of Australian agriculture. Using the average farm-firm approach, a time-series econometric model of the demand for hired labour for Australian sheep farms is developed and estimated. Major findings on the determinants of labour demand are discussed, together with their policy implications.

1 Introduction

A number of aggregate level studies (*e.g.*, Ryan and Duncan, 1974; Joyce, 1975; Bhati, 1978; Crowley and Spasojevic, 1980) have been conducted to analyse the labour market for Australian agriculture as a whole. But there is a need for more research in this area. Powell and Condon (1980) recently suggested that a fruitful area for further research would be the analysis of the labour market at a lower level of aggregation. This could be in terms of regions, States or individual subsectors of the agricultural sector. Analyses at the subsector level are useful because they can show how the labour market in individual subsectors responds to economic changes. They also put the results of the aggregate level studies in perspective and, thus, they can significantly add to our understanding of the labour market as a whole. Based on this reasoning, a study of demand for hired labour on Australian sheep farms was considered worthwhile. There has been no previous study of the factors affecting the labour demand in this important Australian industry.

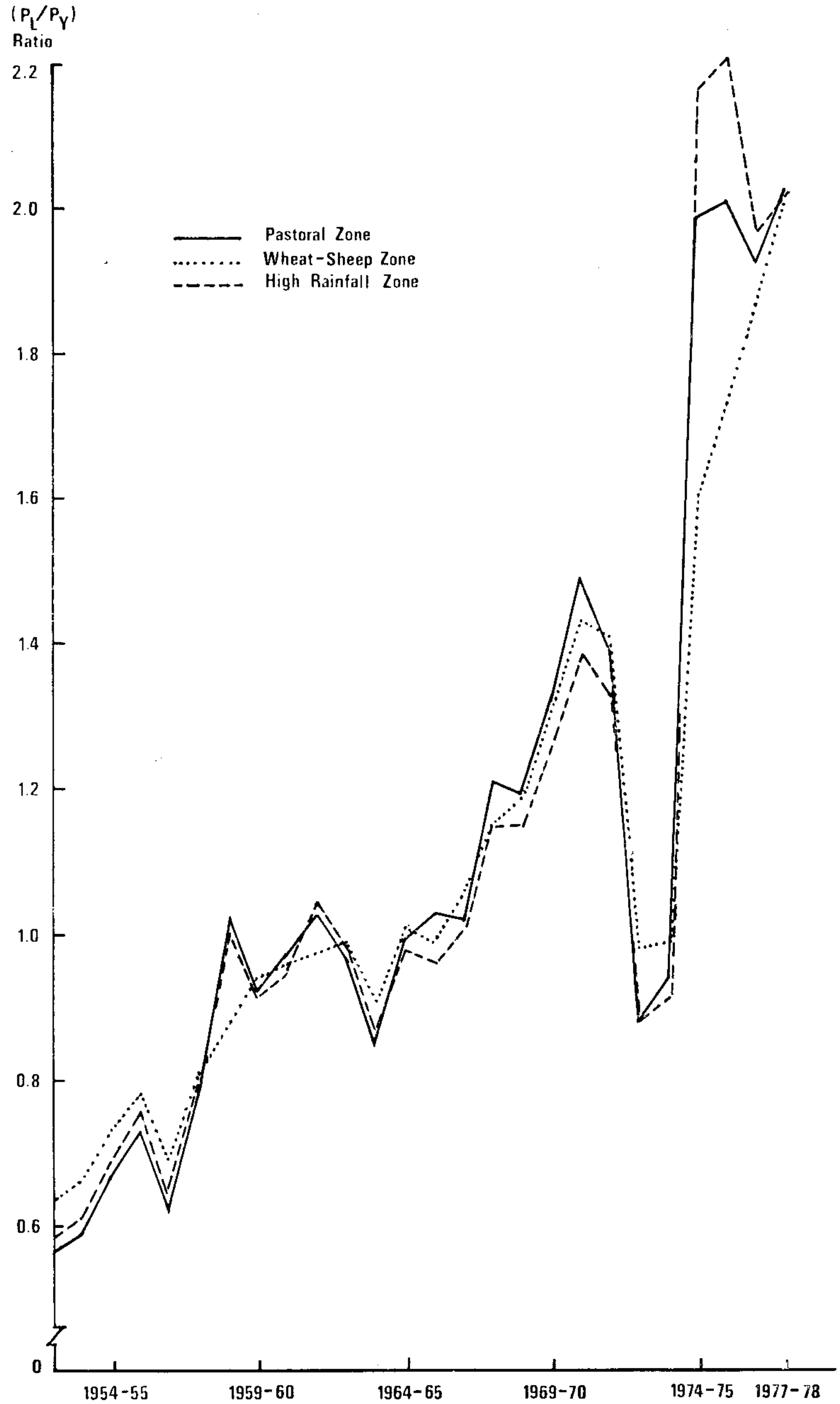
The specific aims in this study are—to identify the major determinants of demand for labour on sheep farms; to make an estimate of the nature and magnitude of the effect of each determinant of labour demand; and to describe policy implications of the findings.

The focus on the demand for hired labour in this study is for two reasons. First, the wages paid to hired labour are a matter of concern to nearly every sheep farmer because of the increasing trend in wage rates relative to the prices received by farmers (Figure 1). Second, a proportion of the total under-employed and unemployed persons in rural areas presumably come from the hired labour category which is currently facing an unemployment problem.

* Bureau of Agricultural Economics (BAE), Canberra. This is a revised version of a paper presented at the Twenty-fourth Annual Conference of the Australian Agricultural Economics Society, Adelaide, 12–14 February, 1980. The author is grateful to several persons for their valuable comments and help on earlier drafts of this paper; in particular, he is grateful to Lloyd McKay, Geof Watts and an anonymous referee without implicating them for any remaining shortcomings.

Figure 1

Movements in Wage Rate (PL) Relative to Prices Received by Farmers (PY) in the Australian Sheep Industry



Thus, the concern in this study with hired labour reflects the concern of the farmers on one hand and the concern of the rural work-force on the other· The hired labour examined in this study is the on-farm hired labour, which excludes the labour component of contract services (because available data do not permit separation of the labour from the machinery component of contract services), and the shearing labour (because the demand for shearing labour is apparently almost completely inelastic).

The study is based on the BAE's annual Australian sheep industry survey data by its three zones, namely, the Pastoral, Wheat-Sheep and High Rainfall Zones (BAE 1976, 1979). It covers the period from 1954–5 to 1977–8. The demand function is estimated on the basis of the average quantity of hired labour used per farm.

The remainder of the paper is divided into three sections. Section 2 is devoted to developing the labour demand model and to describing the data and econometric procedures used. Results of the estimated model are interpreted and described in section 3. Finally, section 4 contains the main findings and their policy implications.

2 The Model

2.1 Model Specification

According to microeconomic theory, a firm's input demand function is homogeneous of degree zero in three prices: price of the input, price of other inputs and price of the product produced (Henderson and Quandt, 1971, p. 69). Based on this theory, the quantity of hired labour demanded by a sheep farm firm (*DHL*) at time (year) t can be stated to be a function of relative wages (P_L/P_Y), *i.e.*, money wage rate (P_L) relative to product price (P_Y), and relative prices of other inputs (P_I/P_Y), *i.e.* composite price of inputs other than labour (P_I) relative to (PY). Thus,

$$DHL_t = f[(P_L/P_Y)_t, (P_I/P_Y)_t] \tag{1}$$

DHL is measured in terms of the average number of man-weeks worked by casual and permanent hired on-farm labour per farm in the t-th year. Depending upon the nature of the work, according to BAE survey procedures, a week's work by a junior worker (under 21 years of age) and by a semi-retired person is equivalent to between 0.5 and 1 week's work by an adult male, and that of a female worker is between 0.75 and 1 week's work of the adult male work unit (BAE, 1976). P_L and P_I are measured by the BAE annual indexes of wages (wage rate) and of total prices paid for inputs (excluding wages) by farmers, respectively. P_Y is an index of prices received by sheep farmers.[1]

[1] PY is a weighted annual index of prices received on sheep farms. For year t, PY = (BAE prices received index for wool × ratio of average wool returns to average total returns per sheep farm) + (BAE prices received index for sheep × ratio of average sheep returns to average total returns per sheep farm) + (BAE prices received index for cattle × ratio of average cattle returns to average total returns per sheep farm) + (BAE prices received index for total grains × ratio of average crop returns to average total returns per sheep farm) + (BAE prices received index for total of all products × ratio of average other returns to average total returns per sheep farm). The base of all indexes is average 1960–1 to 1962–3 = 100 (BAE 1976, 1979).

However, *DHL* is likely to be a function of the "expected" relative factor prices, denoted below by *, rather than of the observed prices. The latter prices are not fully known in advance to a typical farmer and, therefore, he makes his farm decisions based on the expected prices which are a function of the past and the partially known present prices. Hence,

$$(2) \qquad DHL_t = g[(P_L/P_Y)_t^*, (P_I/P_Y)_t^*]$$

Owing to the input substitution effect, *DHL* will be a decreasing function of $(P_L/P_Y)^*$ and an increasing function of $(P_I/P_Y)^*$.[2]

The model of equation (2) needs to be expanded for empirical work based on characteristics typical of Australian sheep farms and other circumstances which affect *DHL*. An expanded model is,

$$(3) \qquad DHL_t = h[(P_L/P_Y)_t^*, (P_I/P_Y)_t^*, DIA_t, FL_t, S_t, t]$$

DIA in equation (3) refers to a binary or dummy variable representing the Investment Allowance Policy for primary producers. The policy was introduced by the Australian Government in August, 1963, with the main aim of encouraging investment in plant and machinery. Under the policy, 20 per cent of the cost of new plant and machinery was an allowable deduction from a farmer's taxable income. The policy was discontinued in August, 1973, but before its discontinuation could markedly impede investment, due to certain provisions granted for the transition period, the policy was restored in January, 1976, for continuation until June, 1985. During the first two and a half years of this period, the rate of investment allowance was up to 40 per cent and thereafter up to the previous level of 20 per cent. Further information on investment allowance can be found, for example, in *Income Tax for Primary Producers* (Department of Primary Industry, 1979). The introduction of such a policy will stimulate investment in new plant and machinery as has been argued by, among others, Glau (1971), Chisholm (1974) and Fisher (1974), because the policy reduces the effective price of the items. But, as P_I is based on market prices, the P_I/P_Y variable does not capture the price reduction effect of the policy. Unfortunately, unavailability of required data does not allow adjustment to P_I in consideration of the policy's price reduction effect. Hence, it is necessary to specify the policy as a separate determinant of *DHL* and its measurement by a binary variable approach.

In view of the recent findings on the input substitution in Australian sheep industry by McKay *et al.* (1980), the new plant and machinery acquired under the influence of the Investment Allowance Policy are expected to be substitutes for labour. Consequently, *DHL* will be a decreasing function of *DIA*.

FL in equation (3) is the average quantity of unpaid family labour, measured in man-weeks, employed per sheep farm. The definition of man-weeks and the source of data for *FL* are the same as given above for *DHL*. Incorporation of *FL* in the model is based on an observation made by Hoogvliet (1976, p. 54) that there has been a tendency on sheep farms to substitute family labour for hired labour. Thus, since family labour can be regarded as a substitute input for hired labour, it should be specified in the model in terms of its relative wage rate. But its relative wage rate will be different from that of hired labour (P_L/P_Y) because of the significance of non-pecuniary aspects of total net rewards received by family workers in return for

[2] Under certain conditions, as Nagatani (1978) shows, the demand for an input could be a decreasing function of the substitute input price.

working on their own farms. As these data are unavailable, it is not possible to specify a relative wage rate for family labour, which is, therefore, incorporated in the model as the quantity of family labour used per farm.[3] It is expected to be a negative determinant of *DHL*.

S represents seasonal conditions consisting of factors such as drought, flood and infestations by pests and diseases, which are known to cause wide annual fluctuations in farm output and thereby in *DHL*. In the absence of data measuring each of these factors, the lambing percentage is specified, following Malecky's (1975) approach, as a representative variable for *S*. It is expected to be a positive determinant of *DHL*.

Finally, the t in equation (3) is a time trend. The time trend accounts for changes in *DHL* due to changes in farm size, technology, trends towards the use of contractors for farm work, syndication of farms, and other changes occurring over the period 1954–5 to 1977–8. Many of these changes are interrelated and are difficult to measure separately, partly because of lack of time series data on each one of them. The time trend is therefore a proxy variable representing these several changes. It may be mentioned that a time trend variable has been used for similar reasons in several studies on demand for inputs. It is specified in the model as 1954–5 = 1955, 1955–6 = 1956, and so on.

2.2 Estimation Model and Procedures

A number of specific models capable of estimation were considered. But, based on a chi-square test (Rao and Miller, 1971, pp. 107–11), the model preferred was—

$$\text{(4)}\quad \log DHL_t = b_0 + b_1 \log (P_L/P_Y)_t^* + b_2 \log (P_I/P_Y)_t^* + b_3\, DIA_t + b_4 \log FL_t + b_5 \log S_t + b_6\, t + u_t$$

where log is a natural logarithm, b_0 is the intercept, b_i, $i = 1, \ldots, 6$, are regression coefficients, and u is a random disturbance term. Comments on major features of this model are given below.

A sheep farmer's current expectations of the unobservable relative wage rate and the price of other inputs, *viz.*, $(P_L/P_Y)_t^*$ and $(P_I/P_Y)_t^*$ respectively, were assumed to be functions of the partially known present and the past values of observable (P_L/P_Y) and (P_I/P_Y), respectively. The lengths of the lags and the weights of each of the past values of the individual price variables were determined by an iterative search procedure based on the criterion of maximization of $\bar{R}^2$ of the *DHL* regression model. The procedure is given by Rao and Miller (1971, pp. 163–5). Accordingly, the most appropriate weights and lag lengths underlying $(P_L/P_Y)_t^*$ and $(P_I/P_Y)_t^*$ were—

$$\text{(5)}\quad (P_L/P_Y)_t^* = 0.719\,(P_L/P_Y)_t + 0.216\,(P_L/P_Y)_{t-1} + 0.065\,(P_L/P_Y)_{t-2},$$

$$\text{(6)}\quad (P_I/P_Y)_t^* = 0.807\,(P_I/P_Y)_t + 0.161\,(P_I/P_Y)_{t-1} + 0.032\,(P_I/P_Y)_{t-2}.$$

[3] Tyrchniewicz and Schuh (1969, p. 771, Footnote 3) faced a similar data problem and used a similar method when estimating a hired labour demand function for U.S. agriculture. Also, in the light of recent theoretical developments in the fields of allocation of time and of household production functions, as outlined by Gronau (1977) and others, the relative wage rate for farm family labour is determined endogenously by a set of at least three interacting forces—family's demand for leisure and on-farm and off-farm employment functions. Accordingly, the family wage rate relevant for on-farm employment is more difficult to determine than the conventional microeconomic theory would suggest.

It will be seen that, in each of the two price expectation functions (equations (5) and (6)), the weights decline geometrically and add to unity. These lag lengths and weights were found to be appropriate individually in all three zones. Fixed-weight Fisher lags, as used by Ryan and Duncan (1974), were also tried but these yielded larger standard errors for regression coefficients and smaller $\bar{R}^2$ than was the case with the geometrically declining lag forms eventually used in this study. The Nerlovian partial adjustment distributed lag model was also found to be inappropriate because the lagged dependent variable emerged as a dominant variable, rendering the price and other independent variables statistically nonsignificant.[4]

DIA was originally set equal to zero for years 1954–5 to 1962–3 and to unity for years 1963–4 to 1977–8. However, preliminary results with this specification were statistically nonsignificant, suggesting that the effect of the policy on *DHL* was not immediate for an average sheep farm. This may be due to several factors, *e.g.*, the lagged response of lumpy investment in new plant and machinery to changes in their effective prices and the lapse of time involved in adjusting demand for labour and other inputs to the flow of services of newly acquired plant and machinery. To explore the *DHL* response lags, the zero values were therefore shifted further in steps of one year at a time and the results compared. Results consistent with the *a priori* belief, together with statistical significance at conventional levels of probability, were obtained when $DIA = 0$ for years 1954–5 to 1965–6 and $DIA = 1$ for the remaining years of the period for the Pastoral and Wheat-Sheep Zones; $DIA = 0$ for 1954–5 to 1964–5 and $DIA = 1$ for the remaining years for the High Rainfall Zone. These outcomes suggest that, for an average sheep farm, there was a lag of 2–3 years for the Investment Allowance Policy to have a measurable effect on *DHL* through investment in plant and machinery.

Defining the long run as the period during which a firm achieves equilibrium, the regression coefficients b_1 and b_2 in equation (4) can be interpreted as the long-run price elasticities. A feature of the model is that, while the long-run demand elasticities remain constant, the short-run elasticities are variable arising from the log specification of $(P_L/P_Y)_t^*$ and $(P_I/P_Y)_t^*$. Other b_i regression coefficients may be interpreted as "shifters" of the demand curve. The value of any of these coefficients is interpreted as a constant long-run demand elasticity from such a shift.

The estimation model in equation (4) is a single equation model. It assumes all explanatory variables to be exogenous and implies that employment is demand-determined. Data limitations were mainly responsible for the adoption of these assumptions.[5]

[4] The following example of the estimated partial adjustment labour demand function for the Pastoral Zone illustrates this comment (t ratios are in parenthesis):

$$\log DHL_t = \underset{(0.76)}{22.203} - \underset{(-0.20)}{0.242} \log (P_L/P_Y)_t + \underset{(0.28)}{0.357} \log (P_I/P_Y)_t - \underset{(-0.34)}{0.033}\, DIA_t$$
$$+ \underset{(0.38)}{0.167} \log FL_t - \underset{(0.01)}{0.001} \log S_t - \underset{(-0.76)}{0.011}\, t + \underset{(3.29)}{0.707} \log DHL_{t-1}$$
$$\bar{R}^2 = 0.89 \qquad DW = 1.55$$

[5] For example, the simultaneous estimation of *DHL* with demand for family labour was not possible due to lack of data on wage rates for family labour, as explained earlier. The simultaneous estimation of *DHL* and the demand for capital was assessed as infeasible in view of the survey data limitations on capital, which have been fully described by Waugh (1977). It is therefore possible that the estimates may be biased. However, the Ryan-Duncan study revealed little difference between the estimates derived from single-equation and multiple-equation approaches. Hence, there may be only little bias in the single-equation estimates of this *DHL* model.

Using ordinary least squares (OLS), the model given as equation (4) was estimated separately for the Pastoral, Wheat-Sheep and High Rainfall Zones. However, some of the independent variables were not significantly different from zero at the 5 per cent level. The equations were therefore re-estimated after excluding the non-significant variables, and these are presented in Table 1.

3 Interpretation and Discussion of Results

Most of the regression coefficients in Table 1 have signs consistent with *a priori* expectations. Also, as the $\bar{R}^2$ values show, a majority of the total variation in *DHL* has been explained by the independent variables in each equation. The two-tailed test on the estimated Durbin-Watson statistic (DW) for first-order autocorrelation at the 1 per cent level did not reveal any autocorrelation for the Pastoral and High Rainfall Zones. The test was inconclusive for the Wheat-Sheep Zone; the estimated DW (1.55) was, however, much closer to the tabulated upper limit (1.66) than to the lower limit (0.66), implying an absence of first-order autocorrelation. An examination of correlograms of residuals and the chi-square test for the three zones did not suggest the presence of higher-order autocorrelation either. The estimated *DHL* functions given in Table 1 are interpreted and discussed below under the *ceteris paribus* condition.

Table 1: *OLS Estimates of Hired Labour Demand Functions: by Zone, Australia:* 1954–5 to 1977–8

Independent variable	Expected sign of coefficient	Zone		
		Pastoral	Wheat-Sheep	High Rainfall
$(P_L/P_Y)_t$*	−	−4.014 (−4.44)	−0.954 (−3.95)	−5.208 (−5.11)
$(P_I/P_Y)_t$*	+	4.125 (4.81)	0.886 (3.24)	4.924 (4.97)
DIA_t	−	−0.264 (−2.91)	−0.142 (−3.58)	−0.204 (−1.92)
FL_t	−		1.175 (3.07)	
S_t	+	0.305 (1.86)	0.633 (2.13)	
t	+, −	0.031 (1.80)		0.097 (4.92)
Intercept		−58.163 (−1.69)	−5.004 (−1.94)	−187.350 (−4.85)
$\bar{R}^2$		0.89	0.81	0.55
DW		1.79	1.55	1.88
S.E.		0.098	0.054	0.111

Note: t ratios are within parentheses.

3.1 Relative Wage Rate $(P_L/P_Y)^*$

The estimated values of b_1, the long-run elasticities with respect to $(P_L/P_Y)^*$, in the three zones range from -0.95 for Wheat-Sheep Zone to -4.0 for Pastoral and -5.2 for High Rainfall Zones. The short-run elasticities at mean level are -0.78, -3.3 and -4.3 for Wheat-Sheep, Pastoral and High Rainfall Zones, respectively. Thus, even with a 1 per cent increase in $(P_L/P_Y)^*$ in a year, *DHL* can be anticipated to fall, on average, by between 0.8 per cent and 4 per cent within a year and by a total of between 1 per cent and 5 per cent within a 3-year period, depending upon the zone concerned. These results lead to the conclusion that, if the increasing trend in the relative wage rate continues in the future as in the past, it is highly probable that, from the employment viewpoint, the demand for on-farm hired labour may decrease much more than the increase in the wage rate and that, from the viewpoint of farm costs, the expenditure on this labour may actually fall as the wage rates increase.

It will be noticed that the elasticities for the Wheat-Sheep Zone are much smaller than those for the Pastoral and High Rainfall Zones. This is due to the differences in the characteristics of farm production among these zones. Taking an important characteristic to illustrate this, the Pastoral and High Rainfall Zone farms are oriented more towards sheep and cattle production and have only a narrow choice of feasible farm enterprises available to them. But the Wheat-Sheep Zone farms can easily choose a number of crop enterprises, in addition to the sheep and cattle production. Consequently, in response to an increase in the relative wage rate, it is comparatively easy for the farmers in the Wheat-Sheep Zone to alter their optimizing output mix which causes a relatively smaller rate of decrease in the demand for hired labour. Further, the Wheat-Sheep Zone farmers are unable to postpone certain farm operations especially in crop production which require hired labour. In contrast, the farms in the other two zones, because of the limited opportunity to alter their output mixes, respond among other ways, by postponing certain farm tasks requiring the use of hired labour; later, when the wage rate falls, they react by hiring labour not only for the current activities but also for the previously postponed farm tasks. Hence, an identical percentage change in the wage rate produces a much greater percentage change in the *DHL* in the Pastoral and High Rainfall Zones than in the Wheat-Sheep Zone.

3.2 Relative Price of Other Inputs $(P_I/P_Y)^*$

Estimates of b_2 coefficients pertaining to $(P_I/P_Y)^*$ are positive in all zones. However, they are significantly different from unity in only the Pastoral and High Rainfall Zones. These estimates imply that, if $(P_I/P_Y)^*$ increases by 1 per cent in a year, *DHL* can be expected to rise on average by between 0.9 per cent and 5 per cent within a 3-year period and by about 0.8 per cent to 4.5 per cent within the year. Clearly, an increase in $(P_I/P_Y)^*$ induces a strong substitution effect. Again, the short-run and long-run elasticities are much smaller in the Wheat-Sheep Zone than in the livestock-oriented Pastoral and High Rainfall Zones. The reasons for this are in principle akin to those given above.

Having noted, above, the relative wage and the cross price elasticities of *DHL*, it is now proposed to compare them with the elasticity estimates of aggregate demand for hired labour in Australian agriculture as a whole. Aggregate level elasticities for hired labour have been estimated by Ryan and Duncan (1974), Joyce (1975) and Crowley and Spasojevic (1980). These are presented in Table 2, together with the elasticity estimates, by zone, from the present study. It is observed from the table that, compared to the Ryan-Duncan study, the Joyce and Crowley-Spasojevic studies are closer to this study in terms of the periods covered by them. Hence, although the elasticity estimates from the Ryan-Duncan study provide an interesting contrast, it is preferable to compare the elasticity estimates of this study with those from the Joyce and Crowley-Spasojevic studies only. Accordingly, it is noticed from the table that the aggregate elasticities for the agricultural sector fall generally within the range of the elasticity estimates for the sheep farms in the three zones. The elasticities for the Pastoral and High Rainfall Zones are obviously much larger than those for the agricultural sector as a whole.

Table 2: Price Elasticities of Demand for Hired Labour for Australian Agriculture as a Whole and the Sheep Farms: by Zone

Study	Data period	Elasticity			
		Own-price		Cross-price	
		LR	SR	LR	SR
	Agriculture as a whole				
Ryan and Duncan (1974) ..	1948–9 to 1967–8..	−0.58	−0.29	0.75	0.38
Joyce (1975)	1949–50 to 1970–1	−1.31	−0.54	0.89	0.56
Crowley and Spasojevic (1980)	1964 to 1978 ..	−1.50	−1.28	1.30	1.10
	Sheep farms				
This study—					
Pastoral Zone	1954–5 to 1977–8..	−4.01	−3.31	4.12	3.76
Wheat-Sheep Zone.. ..	1954–5 to 1977–8..	−0.95	−0.78	0.89	0.77
High Rainfall Zone ..	1954–5 to 1977–8..	−5.21	−4.32	4.92	4.54

Note: The own-price and cross-prices for labour substitute inputs were relative to prices received by farmers. LR = long-run. SR = short-run.

Such wide differences in elasticity estimates between the agriculture sector and its sheep industry subsector could be due to several reasons. Two major reasons appear to be, first, this study is concerned with on-farm hired labour and, since the on-farm labour excludes, for instance, shearing labour (which has a highly inelastic demand), the elasticity estimates for on-farm labour obtained in this study are likely to be larger than those of the demand for all types of hired labour taken together as in the aggregate studies. Second, certain subsectors of agriculture, *e.g.*, the Wheat-Sheep Zone, possibly have small elasticities and others much larger; as a result, the elasticity estimates for the agricultural sector as a whole could turn out to be relatively small.

3.3 Investment Allowance Policy (DIA)

The negative and significant b_3 coefficients for *DIA* in Table 1 imply that the policy's effect was to cause a substitution of capital for labour and thus a reduction in the demand for and employment of labour. Of course, the possible effects of the Investment Allowance Policy on investment in plant and machinery on farms had been generally assessed and forecast in a number of studies referred to earlier. But this, as far as is known, is the first time that the policy has been explicitly incorporated into a farm labour demand model. Hence, it may be desirable to presently regard this finding as suggestive rather than conclusive. Also, it would not be prudent to view the employment-reducing effect of the investment allowance on *DHL* in isolation of its other possible effects because the Investment Allowance Policy would have certain positive effects too (*e.g.*, on-farm productivity and income) which cannot be ignored if a balanced view of the policy is to be obtained.

3.4 Family Labour (FL)

The estimates of b_4 in Table 1 imply that the null hypothesis of no relationship between *DHL* and *FL* could not be rejected for the Pastoral and High Rainfall Zones. However, in the case of the Wheat-Sheep Zone, *FL* variable was not only significant but, contrary to *a priori* expectations, it had a positive sign also. This implies a complementary relationship between hired and family labour use in this particular zone.

In an earlier version of this study, which covered the years 1954–5 to 1975–6 only, the *FL* variable was found to be non-significant in the Wheat-Sheep and High Rainfall Zones. But it was significant and had a negative sign in the Pastoral Zone, thus indicating a substitution relationship, as was expected. From those and the present results, it seems that the relationship between the hired and family labour is rather unstable; this is probably the case with the agricultural labour market as a whole as Crowley and Spasojevic (1980, pp. 14–15) have shown.

3.5 Seasonal Conditions (S)

As explained in section 2, the seasonal conditions were specified by the lambing percentage proxy. Positive values of b_5 in Table 1 suggest that favourable seasonal conditions do increase *DHL*. However, b_5 is statistically significant in only the Pastoral and Wheat-Sheep Zones, implying that relatively favourable *S* in terms of a one per cent increase in the lambing percentage on average caused an increase in *DHL* of about 0.3 per cent in the Pastoral Zone and 0.6 per cent in the Wheat-Sheep Zone.

Non-significance of the *S* variable in the High Rainfall Zone is understandable in the light of a finding of a recent time-series study of the Australian sheep industry by Lawrence (1980, p. 202). He showed that farm output in this zone has varied very little around the trend. The output has remained stable and the effect of drought and seasonal conditions as a whole was relatively only minor. It is, therefore, not surprising to find that seasonal conditions have no significant effect on *DHL* in this zone.

3.6 Time Trend (t)

It will be recalled that the time trend proxy had to be used as a catch-all variable to represent several changes affecting *DHL*. Although a time trend is a convenient and therefore a common proxy, and is used in numerous studies, its interpretation is problematic because, in a time series analysis such as in this study, the time trend represents all major time-associated changes not included explicitly in the model. Hence, it is not possible to interpret the b_6

coefficients explicitly in terms of any one single change. However, it is worth noting in Table 1 that the coefficient is positive and significant only in the Pastoral and High Rainfall Zones. Nonsignificance of this variable in the Wheat-Sheep Zone is difficult to explain. It is, however, suspected that a part of the effect of the time trend variable has been captured by the previously discussed *FL* variable, because these two explanatory variables in this zone were closely associated, the coefficient of correlation between them being 0.8.

4 Main Conclusions and Implications

The demand for on-farm hired labour was found, on average, to be highly sensitive to increases in wage rates relative to the prices received by farmers. The findings on the distributed lag effect of the wage rate on labour demand suggest that, from the date on which an increase in the wage rate occurred, the resultant fall in labour demand continued to take place for up to three years. It, therefore, can be concluded that, if the trend of increasing relative wage rates continues, it is highly likely that the future demand for and employment of hired labour on sheep farms will fall.

The labour demand with respect to an increase in the prices of labour substitute inputs relative to prices received by farmers was found to be positively responsive in the short run as well as the long run. There was also a distributed lag effect on labour demand of approximately the same nature and magnitude as in the case of wage rate increases. It is, therefore, concluded that, when any circumstance or new policy measure directly reduces (increases) the relative price of these inputs, it can be expected to lead to a fall (rise) in the demand for and employment of hired labour.

The preceding conclusion is linked with the findings on the Investment Allowance Policy. This policy is macroeconomic in nature and its principal effects would, therefore, be expected to be on *aggregate* income and employment. Nevertheless, the introduction of the policy has the microeconomic effect of "reducing" the prices of allowable new plant and machinery in all enterprises, including sheep farms. Thus, the policy provides an incentive for farmers to invest in those items and substitute them for hired labour, which reduces the demand for and employment of labour on the sheep farms. However, the investment allowance may have increased employment in other sectors of the economy and it may also have helped to increase the income and productivity in the sheep industry.

The analysis also showed that (a) the demand for labour is likely to change at different rates in the sheep industry's Pastoral, Wheat-Sheep and High Rainfall Zones from an identical percentage change in the wage rate or prices of labour substitute inputs, and (b) these rates of change in the labour demand for the sheep industry could be markedly different from those for the Australian agriculture sector as a whole.

To conclude, this study has shed some new light on the factors affecting the demand for hired farm labour. It has shown the effects of rising wage rates and other factors on the demand for and employment of labour in the Australian sheep industry.

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