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Project 14349 CP87825

32nd Annual Conference of the
Australian Agricultural Economics
La Trobe University, Melbourne, 8-12 February 1988

PRICES AND EMPLOYMENT IN THE US FARM SECTOR

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In this paper a model of the US farm labour market is used to examine the likely effects of increases in agricultural support prices on farm employment in the United States. The results indicate that the demand for farm labour falls as output prices rise. This finding raises doubts as to the ability of US price support schemes to maintain employment levels in rural communities.

It is widely accepted (see, for example, Curran, Minnis and Bakalor 1987) that domestic price support schemes for agricultural output in many Western countries have had a massive distortionary effect on world trade. Although the main effects of such policies have been on international markets, the reasons for their adoption lie in attempts to alleviate domestic problems. Among the stated aims of support for agricultural prices is the maintenance of farm employment.

In most Western economies, large increases in the output of agricultural produce have been accompanied by large and sustained declines in farm employment. The main suggested reasons for such declines have been increases in productivity and in the price of labour relative to other inputs. On the implicit assumption that the elasticity of demand for farm labour with respect to farm output prices is significant and positive, output prices have been supported. It is intended in this paper to test whether this assumption is valid for the United States.

To discover the role (if any) of price support in maintaining rural employment, it is necessary to determine the demand function of farm labour. Although there was a good deal of work in this area in the United States in the 1960s and the 1970s (see particularly Tyrchniewicz and Schuh 1969; Tweeten and Quance 1971; and Gardner 1972, 1981) there has been little recently. Interestingly, in one of these studies (Gardner 1981) the regression results indicate that price of output has a negative effect on farm employment, though this aspect of the analysis was not mentioned in the paper.

Evans and Lewis (1986) recently examined the market for farm labour in Australia. Estimating a model which included a labour demand function, they concluded that, when technical progress and the substitution of other inputs were allowed for, the effect of a change in output prices was small but negative. That is, farm labour was an 'inferior input', in the sense that - given an output price rise - the labour saving effects of increased capital formation more than offset any increase in demand for labour that would be implied by increased output if capital were held constant. The implication, if such a result holds for other Western countries such as the United States, is that farm price support cannot be justified as a means of maintaining farm employment.

In this paper a model similar to that of Evans and Lewis is applied to the US farm labour market to identify the separate effects of productivity, relative input prices and output on farm employment.

Method

The model has its origins in traditional neoclassical demand and supply analysis. It employs a disequilibrium specification to allow for labour market adjustment. (A market is defined to be in disequilibrium when it does not clear instantaneously.) The model relies heavily on specifications successfully applied both to non-rural labour markets (see, for example, Rosen and Quandt 1978; Lewis and Makepeace 1984; Sarantis 1981; and Lewis and Kirby 1987), and to the rural labour market in Australia (Evans and Lewis 1986).

Demand for labour

The demand for labour in the farm sector is assumed, in aggregate, to be a derived demand arising from the maximising of profit by farm firms subject

to prices received, prices paid and a production function relating total farm output to labour, non-labour inputs and technological progress (proxied by time). Imposing the usual homogeneity restriction and making prices received the numeraire, aggregate demand for labour can be expressed in the form:

$$(1) \qquad \log(N^d)_t = \alpha_0 + \alpha_1 \log(W/PR)_t + \alpha_2 \log(PNLI/PR)_t + \alpha_3 t + V_{1t}$$

where

- N^d = demand for labour;
- W = rural wage rate;
- PR = prices received;
- $PNLI$ = prices paid for non-labour inputs;
- t = time;
- V_1 = error term, assumed to be normally distributed with mean zero, constant variance and zero covariance.

The double log specification is chosen as an approximation to a general, unknown input demand function. Neoclassical theory predicts that the coefficient of wages will be negative and that of the other inputs positive, labour and other inputs being substitutes. The coefficient of time captures exogenous shifts in the production function over time, such as technological progress. If these effects are labour saving, this coefficient will be negative.

Supply of labour

The supply of labour to the farm sector - as to other sectors of the economy - is assumed to be determined by utility maximisation subject to a budget constraint. This yields a function which includes real farm wages and real non-farm wages, the latter approximating the opportunity cost of working in the rural sector. Time is included to incorporate exogenous changes in supply over time. Therefore, the equation for supply of labour is:

$$(2) \qquad \log(N^s)_t = \beta_0 + \beta_1 \log(W/CPI)_t + \beta_2 \log(AWE/CPI)_t + \beta_3 t + V_{2t}$$

where

- N^s = supply of labour;
- W = rural wage rate;
- AWE = non-farm wage rate;
- CPI = consumer price index;
- t = time;
- V_2 = error term, assumed to be normally distributed with mean zero, constraint variance and zero covariance.

Again the double log specification is chosen as an approximation to a general, unknown supply function. The own-wage coefficient is expected to be positive and that of alternative wages negative. The coefficient of time may be positive or negative depending on whether exogenous changes in labour supply have been toward or away from farm work.

Market adjustment

The equilibrium values of the endogenous variables, employment and wages, are determined by the above demand and supply equations. The observed

levels of employment and wages may differ from their market clearing values because of the high costs of adjusting labour and capital rapidly or because of institutional arrangements. On the supply side, labour movement can be inhibited by the search costs associated with changing jobs. In addition, the time and cost involved in acquiring new skills, and uncertainty as to the availability of alternative employment, present barriers to an immediate response to changes in prices. To determine the speeds of adjustment it is necessary to specify the process by which actual employment and wages adjust to changes in their equilibrium values.

The equilibrium values of employment and wages, W_t^* and N_t^*, are found by equating equations (1) and (2) and solving for those variables:

$$(3) \qquad \log(N^*)_t = \pi_0 + \pi_1 \log(PR)_t + \pi_2 \log(CPI)_t + \pi_3 \log(PNLI)_t + \pi_4 \log(AWE)_t + \pi_5 t + U_{1t}$$

$$(4) \qquad \log(W^*)_t = \pi_0^1 + \pi_1^1 \log(PR)_t + \pi_2^1 \log(CPI) + \pi_3^1 \log(PNLI)_t + \pi_4^1 (AWE)_t + \pi_5^1 t + U_{2t}$$

where U_{1t} and U_{2t} are error terms.

The observed values of N_t and W_t are assumed to be related to N_t^* and W_t^* by a partial adjustment mechanism (Chow 1977). In contrast to the practice of simply considering actual demand as adjusting to 'optimal' demand, this specification also models the adjustment of market values toward equilibrium. Also, wages and employment are treated symmetrically rather than specifying, a priori, which of them bears the burden of adjustment.

Thus,

$$(5) \qquad \log(N)_t - \log(N)_{t-1} = (1-\mu_1) [\log(N^*)_t - \log(N)_{t-1}]$$

$$(6) \qquad \log(W)_t - \log(W)_{t-1} = (1-\mu_2) [\log(W^*)_t - \log(W)_{t-1}]$$

It is expected that, in any period, employment and wages will move only partially to their current equilibrium values. If μ_1 or μ_2 is zero, the variable concerned adjusts to its equilibrium value instantaneously; if μ_1 or μ_2 is unity, the variable remains completely independent of the underlying equilibrium. In this sense equilibrium is simply a special case of disequilibrium. To estimate the parameters, a simple two stage procedure was adopted. First, equations (3) and (4) are substituted into (5) and (6), respectively; rearrangement gives:

$$(7) \quad \log(N)_t = \mu_1 \log(N)_{t-1} + (1-\mu_1)\,[\pi_0 + \pi_1 \log(PR)_t + \pi_2 \log(CPI)_t + \pi_3 \log(PNLI)_t + \pi_4 \log(AWE)_t + \pi_5 t + V_{1t}]$$

$$(8) \quad \log(W)_t = \mu_2 \log(W)_{t-1} + (1-\mu_2)\,[\pi_0^1 + \pi_1^1 \log(PR)_t + \pi_2^1 \log(CPI)_t + \pi_3^1 \log(PNLI)_t + \pi_4^1 \log(AWE)_t + \pi_5^1 t + V_{2t}]$$

Consistent estimates of the μ's and π's can be obtained by applying ordinary least squares to equations (7) and (8). Thence, consistent series for $\hat{N}_t^*$ and $\hat{W}_t^*$ can be calculated using equations (3) and (4) with actual parameters π replaced by estimates $\hat{\pi}$. The series generated for equilibrium employment, $\hat{N}_t^*$, and wages, $\hat{W}_t^*$, are then substituted for N_t^d, N_t^s and W_t in in equations (1) and (2). Application of ordinary least squares to equations (1) and (2) using the generated variables $\hat{N}_t^*$ and $\hat{W}_t^*$ yields consistent estimates of the structural parameters.[1]

Data

All data are annual, covering the period 1951 to 1984. The rural wage rate variable used is the United States Department of Agriculture (1985) index of wage rates paid to hired farm workers. Off-farm wage rates were measured by the average gross weekly earnings paid to workers in manufacturing industries (Council of Economic Advisers 1986).

The relevant price deflator in determining the supply behaviour of rural labour is the consumer price index (OECD 1987). This is in contrast to the demand equation, where the relevant deflator is the index of prices received for all output. The prices received index was derived from the gross farm income series and the index of farm output as published by the United States Department of Agriculture (1985). By using gross income in the calculation of average prices received, a measure is obtained which includes not only changes in market prices but also government support. The index of prices paid for non-labour inputs is taken from the US Department of Agriculture (1985).

In analyses of demand and supply in the labour market, the total amount of labour services is usually treated as a single variable. In the farm sector, however, due to the dichotomy between family and hired labour, it is appropriate to estimate separate schedules for these two labour categories. The employment figures were taken from US Department of Agriculture (1985). Family workers are there defined as 'farm operators doing one or more hours of farm work and members of their families working 15 hours or more during the survey week without cash wages'. The hired workers series includes 'all persons doing farm work for pay during the survey week'. Ideally employment

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1 This method of estimating the structural parameters is only one of many possible methods ranging from simple indirect least squares to full-information techniques. This method was chosen for its efficiency and relative simplicity. The interested reader is referred to Chow (1977) for a full discussion of the possible econometric methods of estimation.

should be measured in hours, but unfortunately only numbers employed were available.

Results

Demand for labour

The estimates of the parameters for the structural form of the model, equations (1) and (2) using $\hat{N}_t^*$ and $\hat{W}_t^*$, are provided in Table 1. The estimated coefficients for the variables in each equation are all of the expected sign and significantly different from zero. There were no outliers and no evidence of autocorrelation; the model appears to fit the data well.

Total demand for labour was found to be sensitive to the prices of non-labour inputs, and the own price elasticity of demand for labour is estimated to be approximately unity. The magnitudes of the parameter estimates indicate that changes in relative input prices will have a significant effect on the amount of labour used in rural production.

Demand for hired labour was found to be particularly elastic, with respect both to wages and to other input prices. The long run elasticity of demand for hired labour with respect to the farm wage rate is estimated to be approximately 1.6. This estimate is consistent with the elasticity of 1.5 reported for Australia by Evans and Lewis (1986). The coefficient of the time trend (usually taken to be a measure of technical progress) indicates an independent reduction in the demand for hired labour in the region of 4 per cent per year. Demand for family labour was found to be less responsive to relative price changes than that for hired labour, but with a similar time trend.

The elasticity of labour demand with respect to prices received can be shown to be the negative of the sum of the elasticities with respect to farm wages and non-labour inputs, both relative to prices received. This simple calculation gives coefficients of -0.37, -0.05 and -0.15 for the demand elasticity of hired, family and total labour respectively. Increases in prices received, whether in the market or by government subsidy, will thus reduce rather than increase farm employment. This result is in accordance with those obtained for Europe (Traill 1982; Stoeckel 1985) and Australia (Evans and Lewis 1986).

Supply of labour

The estimated supply functions indicate that supply of labour is much more responsive to the off-farm wage rate than to the farm wage rate. This result might be expected, given the proportion of non-pecuniary benefits often associated with farm work. A 10 per cent rise in real farm wages will have a much smaller effect on the total value of a package that includes a high proportion of non-pecuniary benefits than will the same percentage wage rise for other work. The estimated elasticities with respect to off-farm wages, of 1.7, 1.3 and 2.9 for total, family and hired labour respectively, might be thought surprisingly high. However, it should be remembered that these are long run values. A sustained off-farm wage rise might induce quite large shifts in farm labour in the long run.

The supply of family labour was found to be less elastic with respect to both farm wages and off-farm wages than the supply of hired labour.

TABLE 1

Estimated Coefficients

Demand (equation 1)

	Hired	Family	Total
log(W/PR)	-1.57	-0.78	-0.96
	(9.53)	(9.69)	(10.08)
log(PNLI/PR)	1.94	0.83	1.11
	(11.85)	(10.42)	(11.67)
Time	-0.04	-0.05	-0.05
	(2.50)	(7.20)	(5.19)
R^2	0.97	0.99	0.99
DW	1.73	1.70	1.73

Supply (equation 2)

	Hired	Family	Total
log(W/CPI)	0.60	0.22	0.31
	(3.72)	(3.61)	(3.48)
log(AWE/CPI)	-2.9	-1.34	-1.69
	(9.78)	(13.76)	(11.12)
Time	-0.01	-0.04	-0.02
	(2.40)	(14.14)	(14.77)
R^2	0.97	1.00	0.99
DW	1.79	2.03	1.95

Figures in parentheses are t-statistics. DW: the Durbin-Watson statistic. The period of estimation is from 1951 to 1984.

Exogenous factors were found to reduce the supply of family labour by about 4 per cent per year, and for hired workers by around 1 per cent per year.

Market adjustment

The estimates of the adjustment parameters of wages and employment are shown in Table 2. All were found to be significantly different from zero, implying that the disequilibrium approach adopted in the estimation of the model was appropriate.

The estimate of the adjustment coefficient for wages (μ_2) is about 0.7, which implies a mean lag of about three years for wages. Adjustment in farm employment is slightly faster, with a mean lag of around 1.5 years for hired

TABLE 2

Adjustment of Employment and Wages

Variable	Parameter(μ)
Wages	0.67
	(5.06)
Total labour	0.57
	(3.61)
Hired labour	0.57
	(3.71)
Family labour	0.67
	(3.90)

Figures in parentheses are t-statistics

and total labour, though of three years for family labour. Thus, although prices of non-labour inputs, non-farm wages and consumer prices have a large influence on equilibrium wages and employment, the effect is slow to filter through to actual wage and employment levels.

Conclusions

The neoclassical framework employed in this paper appears to provide a good description of the US farm labour market at the aggregate level. There are, of course, differences in the production and business organisation of US agriculture between regions and commodities which cannot be incorporated in this aggregate analysis. A further qualification is that the measure of labour input used - numbers rather than hours - is only an approximation to effort. Nevertheless, the results presented are consistent with previous work undertaken in Australia and the United Kingdom. The demand for farm labour, particularly hired labour, is sensitive to relative prices. On the supply side, hired labour is more sensitive to the relative wage rates than is family labour.

The results presented here indicate that the output price elasticity of labour demand is negative, which implies that labour is an 'inferior input'.[2] The similarity of these results for the United States and those presented for Australia by Evans and Lewis (1986) suggest that this may be true of agricultural labour in western countries generally. Where it is true, price support will tend to hasten the decline of employment in agriculture, rather than to protect agricultural employment as intended.

Agricultural price support schemes, then, are of dubious value, in view of their deleterious effects on international trade and their apparent failure to maintain employment levels in agriculture.

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[2] As regards family employment, an alternative explanation of a negative relationship with output prices is that farm families are more inclined to sell their farms during times of boom. However, the much smaller response of family labour to output price changes, compared with hired labour, together with the lags between output price changes and employment numbers, tends to favour the view expressed in this paper.

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