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LABOUR SUPPLY AND OFF-FARM WORK BY FARMERS: THEORY AND ESTIMATION

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Off-farm employment has become increasingly important as an aspect of resource adjustment and a source of income in Australian agriculture. However, it is surprising that there is a paucity of work on this topic reported in the agricultural economics literature. Therefore, we have drawn upon recent developments in labour economics in order to investigate off-farm employment in Australia. A conceptual model of the allocation of a farmer's labour between farm and off-farm work is developed and applied to cross-sectional data from the Australian Agricultural and Grazing Industries Survey. A Tobit maximum likelihood procedure is utilised to test the influences of the life cycle, level of human capital, wealth, non-wage income and farm income on the off-farm labour supply of farmers.

Introduction

The main strategies adopted by Australian farmers in response to long-term trends in the relative prices of farm products and inputs have revolved around increasing farm size and the adoption of new technology and production services to increase the productivity of resources used in agriculture. Adjustments in farm resource allocation which have resulted from these strategies include a decrease in total labour input and an increase in the use of capital and contractor services. In conjunction with this process of adjustment, some farmers and their families, particularly those who operated small or low-income properties, have left agriculture to take up different occupations.

An alternative to the 'get big or get out' strategy, and one which is important as a source of income, is the partial deployment of farm resources to non-farm uses (e.g. off-farm investment and employment; see Robinson and McMahon 1981). Off-farm employment, which includes work on other farms, has become particularly important as a means of alleviating low farm incomes. The benefits of off-farm employment are not restricted to families operating small or low-income properties. The further capitalisation of Australian farms has had the effect of reducing the labour requirement for many farm tasks, thus making labour a relatively more 'divisible' input. Therefore, labour surplus to requirements on any sized farm may be profitably employed off the farm. In many situations, the returns to labour may be maximised by a combination of farm and off-farm work.

In 1977-78, 26 per cent of farm operators in the Australian grazing industry reported that they had done some off-farm work, earning an average of $4966 in off-farm wages and salaries. In the same period, 35 per cent of farm households had at least one member employed off the

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farm, earning an average of $6078 per household in off-farm wages and salaries (Robinson and McMahon 1980, p. 400).

Surprisingly, little attention has been given to off-farm employment despite its extent and importance. Some work has appeared in the literature overseas and this is discussed in the next section. There are also conceptual advances and developments in estimation techniques evident in recent labour economics literature and which may be used to study this topic.

The primary aim in this paper is to analyse the factors affecting the supply of a farm operator's labour between farm and off-farm work in the Australian context. We begin with a brief review and critique of past conceptual models of off-farm employment prior to developing our preferred model. Then we outline some developments in the estimation of labour supply functions. A discussion of the data, variables and results of our estimated model are presented in succeeding sections, with some conclusions being drawn in the final section.

Theoretical Framework for the Analysis of Off-Farm Employment

Whilst off-farm employment and part-time farming have been studied overseas, particularly in North America and Europe (e.g. Frauendorfer 1966; Betrand 1967; Gasson 1967; Bollman 1973, 1978; OECD 1976; Larson and Hu 1977) and to a lesser extent in Australia (e.g. Tubman 1977; Riethmuller and Spillman 1978; Wills 1978; Sexton and Plunkett 1979; Robinson and McMahon 1980), many authors have used inadequate theoretical frameworks and have concentrated primarily on documenting the extent of off-farm employment and the levels of income generated from off-farm work. The purpose in this section is to review some of the relevant theoretical literature on off-farm employment in order to develop an economic model of the supply of a farm operator's labour in off-farm work.

Literature review

The early approaches to the allocation of labour between farm and non-farm activities were usually couched in terms of the relative returns to labour accruing from different income-earning activities. It was argued that a farmer will allocate his time between farm and off-farm work so that the value of the marginal product of farm work and the off-farm wage rate, net of the costs incurred in off-farm work, are equal (Polzin and MacDonald 1971). As with other farm resources, it can be expected that labour used on the farm is subject to diminishing returns. In the off-farm labour market, labour is paid a constant return per unit of time. However, these authors merely restated the theory of demand for labour facing the operator in farm and off-farm work and had nothing to say about how much time was allocated between farm work, off-farm work and leisure.

Other approaches have incorporated a total time constraint into the theory of the allocation of labour between farm and off-farm activities, whereby the farmer allocates his time between work and leisure to maximise the utility of the resulting income and leisure (e.g. Lee 1965; Sexton 1975; Kerachsky 1977). The approach merely added another dimension to the standard neoclassical leisure goods choice model.

Bollman (1979) introduced further arguments other than the wage and the value of marginal product in the demand schedule facing the individual. He developed a kinked demand function for labour which, in conjunction with the labour supply function, determines the equilibrium quantity of work and value of time. He argued that this demand function is not only a function of the price of labour on farm, the prices of all other inputs and the price of farm output, but also a function of the expected off-farm wage, which itself is a function of operator skills and the cost of commuting.

The effective total demand curve for labour facing the operator, as postulated by Bollman, is a kinked curve that is downward sloping when the price of the operator's labour in farm work exceeds the expected off-farm wage, and is a horizontal curve when the expected off-farm wage is higher than the price of the operator's labour in farm work, assuming that the operator is indifferent between farm and off-farm work.[1]

Bollman, however, used a reasonably standard approach to labour supply. He assumed a one-period, individual-utility, individual-budget constraint model, rather than a family-utility, family-budget constraint model. Other family income and the labour supply activities of other family members were not mentioned by Bollman. Only the non-labour income of the farm operator was incorporated into his model. All non-work activities are 'leisure'[2] and the composite commodity theorem is invoked for consumption goods. Bollman postulated that the operator maximises a utility function which is determined by the level of consumption income and the amount of leisure, subject to a full income budget constraint. Bollman (1979, pp. 40-1) argued that 'the operator's total supply of labour is a function of the price of the consumption good, the price of the operator's leisure and non-earned income'. The supply curve is upward sloping and the equilibrium quantity of time worked is given by the intersection of the demand and supply curves.

Huffman (1980) adopted a more useful approach to the supply of labour to off-farm work. First, he assumed a family-utility, family-budget constraint model. However, whilst he also assumed a two-commodity model with goods and leisure, he did allude to the interconnection between family size and labour supply, and introduced elements of human capital and life cycle influences on labour supply. Thus, in an *ad hoc* way, Huffman introduced many of the arguments suggested in the new home economics literature (e.g. Becker 1965).

Huffman (1980) postulated household utility to be a function of leisure and consumption, given member's age and education and household size. He argued that household utility maximisation is constrained by the time

[1] Whilst Bollman argued that the effective demand schedule facing the individual is a horizontal straight line below the kink, there is little reason why it should be necessarily so. The hours-wage function could also be upward sloping in the off-farm labour market reflecting overtime and penalty rates (e.g. Wickens 1974) or downward sloping reflecting the wage differential between casual and permanent employment. However, the assumption that off-farm employment involves a constant wage-hours relationship is probably not a serious departure from reality.

[2] The assumption of a composite good called 'leisure' for farmers may not be such a serious departure from reality. However, if the utility maximised were that of the family and not that of the individual, such an assumption would be too rigid. This is particularly important with respect to the usefulness of the model in explaining the labour supply of other family members.

endowments of members which are allocated between farm work, off-farm work and leisure; by household income (including off-farm wages, net farm income and other household income) which limits consumption; and by farm output (which is determined by the member's farm labour inputs, purchased inputs and, indirectly, by education, research and extension) which limits the potential size of the household's budget. Thus, the total labour supply of a household member was postulated to be a function of the off-farm wage rate, the price of farm output and farm inputs other than the member's labour, the price of household consumption, other household income, household size, age, education, extension and time endowments. Huffman (1980, p. 16) argued that:

> . . . because the labour supply function is the total time endowment of members less leisure time (i.e. total work time), the off-farm labour supply function is also the labour supply function less the demand function for the member's farm labour, i.e. an excess supply function.

Huffman's contribution partly overcame a major criticism of the conventional approach, namely, that it was static and no consideration was given to future time periods where a farmer may prefer to work longer hours in the current period in order to have more leisure and income in future time periods. Robinson and McMahon (1981) found that most of the farmers who reported some off-farm work were in the early married stage of the life cycle with young families. (The early married, middle married and late married life cycle stages were defined by Nalson 1964.) Age has also been found to be important, with younger farmers generally working more hours off farm than older farmers (Hanson 1972; Sexton 1975; Huffman 1980).

Huffman (1980) also argued that human capital (education, job skills and work experience) may affect off-farm work decisions through efficiency effects. Most theoretical treatments do not account for the influence of human capital on the allocation of labour for off-farm work other than on the demand side. Human capital is an indicator of an individual's productivity and, therefore, it can be expected to exert a positive influence on the demand for an operator's labour in off-farm work by increasing the remuneration obtained from off-farm employment and by increasing the probability of obtaining a job (Hanson 1972; Hanson and Spitze 1974; Bollman 1979). Huffman argued that, on the supply side, human capital can be expected to have an 'allocative effect' since human capital contributes to production in a dynamic environment with imperfect information and enhances an individual's ability to acquire and process information (Huffman 1974). It could also be argued that human capital not only influences the type of job the individual may be able to obtain, but also the non-pecuniary returns to employment which, in some cases, may be at least as important as the money wage offered.

A conceptual model of off-farm labour supply

A conceptual framework for the estimation of the supply of a farm operator's labour in off-farm work can be developed by utilising some of the theoretical and empirical findings of the studies reviewed in the previous section, particularly Bollman (1979) and Huffman (1980).

The main assumptions made are that perfect competition exists so that the operator perceives his labour allocation decisions as having no influence on aggregate demand, supply or prices of labour, and that management skills in farm or off-farm work are a component of labour. Expected, rather than actual, returns to labour are incorporated into the model of the demand for and supply of labour since, in an uncertain environment, it is postulated that a farm operator will normally make decisions about how best to allocate his time between farm and off-farm work on the basis of *expected* returns from his labour from farming and from off-farm work.

The operator perceives different demand functions for on-farm and off-farm labour. The production of farm output is postulated to be a function of the level of an operator's labour in farm work and all other farm inputs, including hired labour, other family labour, land and capital. Therefore, by maximising profits subject to given input and output prices and a given stock of fixed inputs, the demand for an operator's labour on the farm is a function of the price of his labour in farm work, the price of farm output, the prices of all other farm inputs and the stock of fixed inputs. The demand for the operator's labour in farm work can be written as:

$$D_f = D_f(P_f;\ P_q, P_x,\ X), \tag{1}$$

where D_f = demand for an operator's labour in farm work;
P_f = price of the operator's labour in farm work;
P_q = price of farm output;
P_x = price of all other inputs; and
X = stock of fixed inputs.

Assuming a concave production function, the operator faces a downward sloping demand curve for his labour in farm work. If he is indifferent between farm and off-farm work he will utilise his labour in farm work up to the point where the value of the marginal product of his labour in farm work and the off-farm wage rate are equal. Changes in the price of farm output or the prices of all other inputs will result in a shift in the demand curve for an operator's labour in farm work.

The operator is a price taker in the off-farm labour market and is assumed to be able to work as many hours as is desired at the available net off-farm wage rate, subject to institutional constraints which may limit the opportunity for off-farm work, and given the state of the economy as it affects the demand for labour. The demand perceived by the operator for his labour in off-farm work can be written as:

$$D_o = D_o(EW_o;\ E, I), \tag{2}$$

where D_o = demand for an operator's labour in off-farm work;
EW_o = expected off-farm wage rate;
E = state of the economy; and
I = institutional constraints which affect off-farm work.

The operator receives constant returns per unit of time in the off-farm labour market such that the demand curve for an operator's off-farm work is a horizontal straight line.[3] The expected off-farm wage rate is,

[3] As argued previously, this assumption does not necessarily hold, although it is not a serious departure from reality when the unit of labour supply is hours.

itself, a function of the operator's human capital and of the cost of commuting:

$$EW_o = EW_o(H, TC), \tag{3}$$

where H = operator's human capital; and
TC = cost of commuting.

The effective total demand curve for labour perceived by the operator is a kinked curve, composed of a downward sloping demand curve for his labour in farm work and a horizontal curve for his labour in off-farm work.

The farm operator's labour supply decisions are determined by maximising a utility function subject to time and income constraints. More formally, the operator is postulated to maximise a utility function which is a function of consumption and leisure:

$$U = U(C, Le), \tag{4}$$

where U = operator's utility;
C = consumption; and
Le = leisure.

This is maximised subject to the constraint that total time is allocated between farm work, off-farm work and leisure:

$$T = T_f + T_o + T_{le}, \tag{5}$$

where T = total time;
T_f = time spent in farm work;
T_o = time spent in off-farm work; and
T_{le} = leisure time.

There is also an expected income constraint on future consumption which is composed of expected off-farm wage and salary earnings, the expected return to his labour in farming and the expected other income[4]:

$$EY = T_o EW_o + T_f P_f + Y, \tag{6}$$

where EY = operator's expected income constraint on future consumption;
$T_o EW_o$ = operator's expected off-farm wage and salary earnings (net of the money costs of labour market entry);
$T_f P_f$ = operator's expected total return to labour from farming; and
Y = operator's expected income from all other sources (including the wage and non-wage income of all other family members).

The operator's expected return to labour is given by his expected value of farm output less the costs of all other inputs such that the expected income constraint can also be written as:

[4] In a dynamic life cycle model, utility is maximised subject to the lifetime accumulation of wealth and human capital constraints (e.g. Ghez and Becker 1975, Blinder and Weiss 1976). In a static model such as ours we would then expect the 'other income' term to include actual and imputed income flows from assets as well as transfer payments and so forth.

$$EY = T_o EW_o + (EP_q Q - P_x X) + Y, \tag{7}$$

where $EP_q Q$ = expected value of farm output.

The operator's total labour supply function is determined by maximising his individual utility function subject to the constraints of time and expected income. Although an individual-utility, individual-budget constraint approach is adopted here, the influence of the labour market activities of other family members on the operator's off-farm labour supply is recognised implicitly by treating the 'other income' term as representing total family income from all sources less the operator's off-farm wage and salary earnings and his return to labour from farming.

Human capital is also expected to have an 'allocative effect' on the operator's labour supply and the stage of the operator's life cycle is expected to reflect the shape of the operator's income-leisure indifference curve. Summarising, the operator's total labour supply function can be written as:

$$S_l = S_l(EW_o,\ Y,\ P_c,\ P_{le};\ P_q,\ P_x,\ X,\ H,\ LC) < T_w, \tag{8}$$

where S_l = operator's total labour supply function;
P_c = price of consumption goods;
P_{le} = price of the operator's leisure;
LC = operator's life cycle stage; and
T_w = time available for work.

The operator's total labour supply function is composed of his supply of labour to farm work and his supply of labour to off-farm work. The supply of operator's labour for farm work is simultaneously determined with, and equal to, the demand function for his labour in farm work. Since he will supply and demand his labour up to the equilibrium point where the value of the marginal product in farm work equals the off-farm wage rate, the operator's off-farm labour supply function is an excess supply function being equal to his total labour supply function less his on-farm labour demand function, that is:

$$S_o = S_o\,(EW_o,\ Y,\ P_c,\ P_{le};\ P_q,\ P_x,\ X, H, LC) < T_w, \tag{9}$$

where $\partial S_o/\partial EW_o > 0$; $\partial S_o/\partial P_q < 0$;
$\partial S_o/\partial P_x < 0$; $\partial S_o/\partial P_c \gtrless 0$;
$\partial S_o/\partial P_{le} < 0$; $\partial S_o/\partial H > 0$;
$\partial S_o/\partial LC \gtrless 0$; and $\partial S_o/\partial Y < 0$.

The operator's off-farm labour supply curve is upward sloping as an increase in the expected off-farm wage rate will lead to an increase in the quantity of the operator's labour supplied for off-farm work, *ceteris paribus*. An increase in the operator's level of human capital will shift the off-farm labour supply curve to the right. Increases in the prices of farm output and other farm inputs, by shifting the total demand schedule to the right, will shift the off-farm labour supply curve to the left. Increases in the price of leisure and in other income will also shift the off-farm labour supply curve to the left. The qualitative result of the influence of the life cycle on the operator's off-farm labour supply curve is ambiguous, depending on which stage of the life cycle the operator is in.

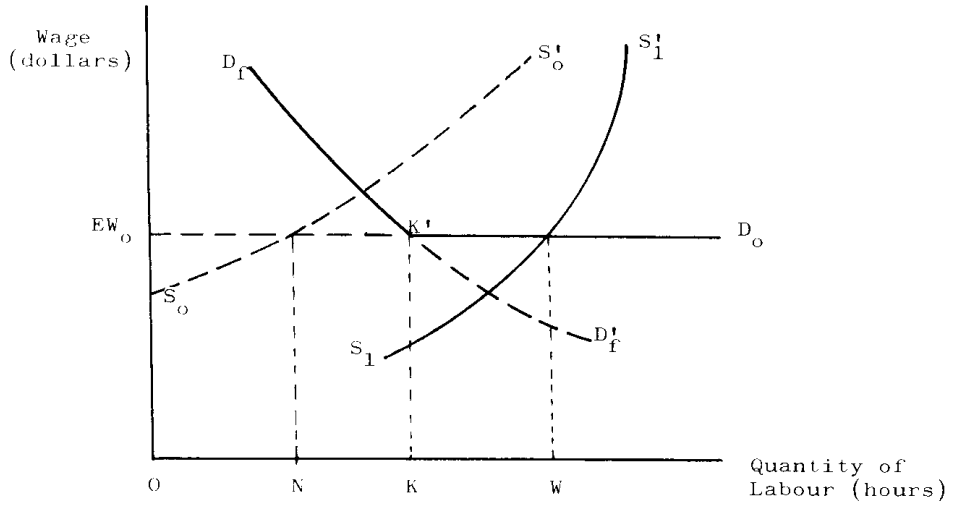

FIGURE 1 — The Demand and Supply of the Farm Operator's Labour

Changes in the price of consumption goods are also ambiguous, depending on whether consumption is a substitute for, or complement to, leisure.

The equilibrium quantity of time worked is given by the intersection of the operator's total demand for labour curve, which is the kinked curve D_fD_o, with the operator's total labour supply curve S_1S_1', as shown in Figure 1. The total quantity of time worked by the operator is OW. The operator will work OK hours on the farm (because the value of the marginal product in farm work exceeds the off-farm wage rate up to point K' on the demand curve), and KW hours off the farm (because the expected off-farm wage rate exceeds the value of the marginal product in farm work past point K' on the demand curve). Alternatively, the equilibrium quantity of time worked off the farm by the operator is given by the intersection of the demand curve for the operator's labour in off-farm work, EW_oD_o, with the operator's off-farm labour supply curve S_oS_o'. The equilibrium quantity of time worked off the farm by the operator is ON hours (which is equal to KW hours). If the operator's total labour supply curve intersects the downward sloping part of the labour demand curve, then the operator will only work on the farm.

Empirical Modelling of Labour Supply Decisions

A number of problems arise in empirically modelling off-farm labour supply. The first is the problem of translating the theoretical model into an estimable model. Whilst the conceptual framework was couched in terms of factors determining the allocation of hours, the available data are in terms of weeks worked per year. Some would contend that the arguments in the labour supply function are the same whatever the measure of labour supply. However, for off-farm labour supply, the weeks worked per year may be different from the hours dimension at any point in time. The off-farm, weeks-worked wage schedule may not be linear or horizontal, particularly for those farmers whose off-farm labour supply varies seasonally. A complex market process may exist

where the individual faces not a single market wage offer but a set of wage offers over the year, each with differing costs of working in terms of time and money, which necessarily change over time.

Another problem arises in that each individual's decision is determined in a unique situation which is very difficult to capture in the data. Probably the most important factors are individual preferences (e.g. with regard to farm/non-farm employment), but the measurement of these preferences is very difficult. Similarly, the labour market in many rural areas, especially for part-time work, is not characterised by perfect competition and instantaneous labour mobility. Differences in the choices available to different individuals cannot be captured adequately by such statistics as regional unemployment rates. Thus, it is difficult to conceive of a model providing a complete explanation of labour supply. Rather, we have presented a model which may be used to analyse the contribution of various 'objective' factors to a decision which will be partially determined by intangible or subjective considerations.

The third major difficulty arises because the dependent variables (weeks supplied and off-farm wages) are bounded below by zero and that the majority of farmers do not in fact work off the farm or earn off-farm wage income in a given year. This suggests a model of the form:

$$(10) \qquad \begin{aligned} y &= \beta' x + \epsilon && \text{if } \beta' x + \epsilon > 0; \text{ and} \\ y &= 0 && \text{otherwise, for both the weeks supplied and off-farm wage equations.} \end{aligned}$$

The parameters of this model have been estimated elsewhere by OLS (e.g. Lee 1965; Sexton 1975; Larson and Hu 1977; Sexton and Plunkett 1979) using either the entire data set or only those observations with $y>0$. Both procedures yield biased results. In the first case, the reason is obvious: $E(y)>E(\beta' x)$. In the second case, the bias is introduced because observations with positive ϵ are more likely to be included, that is, $E[\epsilon \mid y>0]>0$. Thus, the βs are biased toward zero. Sample selection bias has been discussed elsewhere in the labour economics literature, for example, Heckman (1974, 1976), Hanoch (1980), Heckman and Macurdy (1980), Schultz (1980), Smith (1980), and Wales and Woodland (1980).

Another complication arises in terms of the estimation strategy employed. It is not clear whether a market demand-wage equation and a supply equation should be estimated simultaneously or whether a reduced form equation should be estimated. Whilst a wage-unit of labour equation could be estimated jointly with a labour supply function as part of a simultaneous system, prohibitive complexity and costs preclude this method (see Hanoch 1980). However, as argued earlier, a complex market mechanism may be involved which also involves preferences such that a net wage-unit of labour relationship may be an additional reason complicating modelling regardless of the data problems.

An alternative approach to estimating a wage-unit of labour and supply of labour function simultaneously is to impute a wage for non-participants in off-farm work. The off-farm wage of participants can be regressed on certain characteristics, such as age, education and work experience. The parameters of this estimated wage function can be used to compute an 'imputed wage' for non-participants to supplement the observed data of the actual wages of off-farm work participants for in-

clusion in the supply equation to be estimated. However, as mentioned previously, OLS estimates of the wage function obtained from a sample limited to participants in off-farm work will have undesirable statistical properties, and imputed wages for non-participants will also have undesirable properties unless the estimation procedure used specifically corrects for sample selection bias.

A number of other approaches are described in Wales and Woodland (1980). One of these approaches is to specify a wage equation, in which the wage offered is explained by individual characteristics such as age and education, and by factors which affect the demand for labour, and to estimate this equation along with equation (10) using maximum likelihood methods such as those of Heckman (1974) and Hanoch (1980). Alternatively, a Probit model may be used to estimate the probability that an individual will be employed. This may be incorporated into equation (10) in a manner which will permit unbiased estimates to be made by OLS using only the data for employed individuals. Neither of these approaches was used in this study, mainly because of the lack of adequate wage data.

A second problem with the imputed wage approach is that it is assumed that the offered wage is a parameter which is independent of the units of labour supplied. Bearing in mind the variation in commuting costs between different jobs, this is unlikely to be the case, particularly in a model where the units of labour supply are weeks worked off the farm in a year. For this reason, a reduced form equation was estimated containing factors which are likely to influence both the demand for and supply of off-farm labour. To account for problems arising from bounds on the dependent variable, a maximum likelihood approach was adopted. The estimation technique chosen was Tobit (Tobin 1958; Maddala 1977).

An unrestricted reduced form equation in which market wages are replaced by instruments that are thought to determine market wages avoids selection and specification bias caused by the wage computation procedure, although a loss of efficiency is presumed to occur. It also has the benefit of avoiding the problem of combining simultaneous equation methods with the Tobit nonlinear estimation approach, since the explanatory variables are now all exogenous. However, the cost of the exercise is that the structural relationships determining market and non-market effects are inseparable so that no inferences can be drawn about how off-farm labour market behaviour responds to policy changes operating through market wage rates or taxes and subsidies. In addition, variables that we have argued may enter both the demand and supply functions (such as the human capital variable) are revealed only as *net* effects.

Data

The significance of several economic factors on the supply of the operator's off-farm work were examined in this study using farm-level, cross-sectional data from the Australian Agricultural and Grazing Industries Survey for 1977-78. Only farm operators' labour, rather than the labour of all family members, was investigated since the incidence of off-farm employment amongst farm operators is substantially higher than for farmers' wives or for other members of the farmers' household

(see Robinson and McMahon 1980, p. 400), and because some data limitations precluded a detailed study of the supply of total farm labour for off-farm work. The sample included all full-time (or potentially full-time) farm operators who were able to provide complete information about off-farm work in 1977-78. Company farms, hobby farms, small farms with less than 50 cattle or 200 sheep or 40 hectares of wheat, and properties where the operator was not able to provide complete information about off-farm activities were excluded from the analysis. Operators who were self-employed off the farm, that is, those working off-farm other than for wages and salaries, were also excluded from the analysis as information on income earned from this activity was not collected. These exclusions resulted in a sample of 1058 farm operators. Further details about the Australian Agricultural and Grazing Industries Survey are given in BAE (1982). Some regional labour market data collected in the ABS (1976) Census of Population and Housing were also used in this study.

The unit of labour supply used is the number of weeks worked off the farm by the operator. Information on the operator's expected returns from farming and from off-farm work does not exist. The proportion of property total cash receipts going to the farm operator's household is used as a proxy for the operator's expected return from farming.[5]

Information on the operator's work experience and job skills component of human capital was not available. Therefore, the operator's education was used as a proxy for human capital as measured by the number of years of schooling the operator has received. The measurement of the operator's age was straightforward. The stage in the life cycle was incorporated in the model by entering the age of the farm operator in quadratic form to capture the inverted U-shape relationship on off-farm labour supply. Other income (excluding the operator's wage and salary earnings) of farm households was used to capture the time and income effects of the off-farm labour supply of other family members and non-wage income.[6]

The relationship between farm assets and off-farm labour supply was captured using the capital value of the farm. Ideally, total assets would better capture the influence of wealth, although data again were unavailable on off-farm wealth. One would expect capital values to enter

[5] Net cash income is a more appropriate proxy for the operator's expected return from farming. However, this variable was used unsuccessfully in our preliminary estimation. The difficulties we encountered are thought to stem from the inseparability of BAE imputed cash labour costs from other cash costs. Rather than ignore the variable altogether, total cash receipts were included. Total cash receipts is a measure of the cash returns accruing to the labour and capital used on the farm. No data were available to isolate the returns to labour component of this measure. However, the proportion of these returns accruing to any other households on the survey farm were excluded. Unfortunately, information about the income sharing arrangements between household members which would be required to attribute accurately the proportion of these returns accruing to the operator was not available.

[6] An expected off-farm weekly wage rate for each operator was calculated using a weighted average of average off-farm wage rates for different regions and average off-farm wage rates for different age and education categories. The regional wage rates are sample means of actual off-farm wages for different statistical divisions. The wage rates for different age and education categories are also sample means of the actual off-farm wages of grazing industry farmers. Unfortunately, ABS 1976 *Population Census* data do not enable the calculation of rural non-farm wage earnings by region, or the calculation of wage rates for different age and education categories.

into the model in two ways. With respect to demand, the expected earnings on farm are equal to the value of the marginal product, given the capital stock. With respect to supply, it was argued earlier that other income should include actual and imputed income flows from all assets. In most empirical studies of labour supply, the separate influences of the life cycle and wealth on labour supply have been noted, but there have been problems in identifying assets which are exogenous and independent of life cycle behaviour. However, in Australian agriculture, large differences in initial assets due to large inheritances will ensure different consumption behaviour between any two individuals with different initial assets over the life cycle. It still remains, however, that young farmers will tend to work and invest to accumulate wealth whilst older farmers, on average, will tend to consume more of both leisure and consumption goods yielding the familiar life cycle earnings and savings profiles. Finally, the regional ratios of males employed in agriculture to total males employed was used to capture the regional demand for labour in non-farm work.[7]

The Results

The specific functional form used to estimate the hypothesised reduced form relationship between the supply of the operator's labour to off-farm work and its various contributing factors was:

$$(11) \quad SOF = a_1 + b_1\, OPRET + b_2\, EDUC + b_3\, EXPEDUC + b_4\, AGE + b_5\, AGESQ + b_6\, OTHINC + b_7\, KV + b_8\, AGEMP,$$

if $W > 0$; and $SOF = 0$ otherwise,

where
- SOF = number of weeks worked off the farm by the operator;
- W = off-farm wage rate;
- $OPRET$ = proportion of total farm cash receipts, in dollars, accruing to the farm operator's household;
- $EDUC$ = operator's years of formal education;
- $EXPEDUC$ = exponential of the $EDUC$ term;
- AGE = operator's years of age;
- $AGESQ$ = square of the operator's age;
- $OTHINC$ = income other than W and $OPRET$ accruing to the farm household;
- KV = capital value of the farm; and
- $AGEMP$ = regional ratio of males employed in agriculture to total males employed.

The results of the estimated model using the Tobit procedure are shown in Table 1.

The coefficient of *OPRET*, the proxy for the operator's expected returns in farming, was significant at the five per cent level and had the expected sign. This suggests that the supply of a farm operator's labour to off-farm work is decreased if returns from farming increase.

[7] The use of regional unemployment rate statistics was considered. However, unemployment rates are poor indicators of labour demand and, upon examination across regions, there was little variation in unemployment rates. Therefore, it was considered that the ratio of males employed in agriculture to total males employed would better capture differences in employment opportunities across regions.

TABLE 1

Estimates of Parameters of the Off-farm Labour Supply Model

Independent variable	Coefficient	*t*-value
Constant	−0.281	−0.02
OPRET	$-0.266 \div 10^3$	−3.29
EDUC	0.890	1.17
EXPEDUC	0.301	2.41
AGE	−0.070	−0.18
AGESQ	−0.037	−2.50
OTHINC	−0.006	−1.18
KV	$-0.026 \div 10^3$	−2.39
AGEMP	−61.468	−3.73

The variables *EDUC* and *EXPEDUC* were both entered into the model to capture the effects of human capital. Although the coefficient of *EDUC* was not significant, the coefficient of *EXPEDUC*, the exponential of the farm operator's years of formal education, was significant and had the expected sign.[8] A higher level of human capital was associated with more labour supplied to off-farm work. The coefficient of the operator's age, *AGE*, was not significant at the five per cent level. However, the coefficient of the quadratic term, *AGESQ*, was significant.[9] It appears that the operator's stage in the life cycle is important in the off-farm labour supply decision. The negative sign of *AGESQ* suggested an inverted U-shape relationship on off-farm labour supply with a turning point of 29 years of age. A farm operator was likely to increase his off-farm labour supply up to the age of 29 and to decrease his off-farm labour supply beyond that age. The results were consistent with overseas findings that younger farmers work more time off the farm than older farmers (Hanson 1972; Sexton 1975; Huffman 1980).

The coefficient of *OTHINC*, which is household non-farm income from all sources except the operator's off-farm wages and salaries, was insignificant at the five per cent level. This may mean that the labour supply decisions of other family members were unimportant in determining the amount of time supplied by farm operators to off-farm work, although this requires further investigation. Household non-earned income may be related to past family savings and investments and may be associated with past and current labour force behaviour. However, we do not know of any examples of where a satisfactory theory of life cycle savings has been incorporated with a model of labour market behaviour. Here, *KV*, the capital value of the farm, which is a measure of wealth, was significant and may be picking up the effect of *OTHINC*. The higher the value of farm capital, the less labour was supplied to off-farm work. This may mean that, when a farmer is young and building up his farm resources, he will supply his labour off the farm in order to earn income to enable farm buildup. An alternative, and probably more important,

[8] In preliminary estimation, the *EDUC* variable was entered separately from the *EXPEDUC* variable and was statistically significant at the five per cent level.

[9] The coefficient on *AGE* was significant when the *AGESQ* term was omitted. Both were included jointly in the equation to pick up the life cycle effect.

interpretation is that wealth has a negative effect on off-farm labour supply so that the more wealthy a farmer and the more resources he has committed to agriculture, the less likely he is to seek off-farm employment.

The variable *AGEMP* had a negative coefficient which is significant at the five per cent level. This probably means that, in areas where a greater proportion of the labour force is employed in agriculture, there are less off-farm work opportunities available to farm operators. It is also likely that higher costs of labour market entry (both time and money costs) are incurred in areas where a greater proportion of the labour force is employed in agriculture. Consequently, less labour is supplied to off-farm work in these areas.

Conclusions

The deployment of labour resources off the farm constitutes an important aspect of resource use in Australian agriculture. There is no reason to suggest why off-farm employment should not be treated as the outcome of an efficient resource allocation decision. It can be viewed as another form of adjustment in the rural sector and for many farmers, it is an alternative to other more conventional adjustments. We should, therefore, be aware of what factors are important in explaining this aspect of the adjustment process.

In this paper the focus was on examining the factors important in explaining off-farm labour supply. Our findings suggest that the farm operator's decision to allocate his labour between farm and off-farm employment is influenced by his stage of life cycle, his level of human capital, his wealth and, importantly, the level of income accruing to his labour that he could generate on the farm *vis-a-vis* off the farm. We also found that off-farm employment increases as the proportion of the labour force employed in agriculture in the region decreases.

However, the interpretation of our results needs to be approached with caution for a number of reasons outlined in the paper. We have deliberately refrained from a discussion of the magnitudes of the coefficients on the variables and instead have discussed only the direction of effect of the variables on off-farm labour supply. Similarly, we have been cautious about drawing inferences on how off-farm labour market behaviour responds to policy changes operating through market wage rates or taxes and subsidies.

The factor contributing most to the limitation of the usefulness of our results is the translation of the theoretical model to the estimated model taking account of data limitations. Given the importance of off-farm labour supply in agriculture, greater emphasis needs to be given to the collection of reliable and useful data.

Despite the limitations of our results, some important conclusions can be reached. First, the conventional approach in the agricultural economics literature to the theory of off-farm work has generally been static. No consideration has been given to future time periods where a farmer may prefer to work longer hours in the current period to raise both his income and leisure in future time periods. On the basis of our results the stage of the life cycle does influence off-farm labour supply.

Second, off-farm employment is one adjustment option open to

farmers to enable them to increase their income and the efficiency with which their labour is allocated. Although the benefits of off-farm employment are not necessarily limited to low-income farming situations, it seems likely that off-farm employment is a more feasible option in these circumstances as high farm capital values and cash returns from farming were found to have a negative effect on off-farm labour supply.

Finally, a number of factors may militate against the adoption of off-farm employment as an adjustment strategy. The effects of these factors, some of which are market determined and others institutionally determined, may be accentuated for low-income farmers. For instance, the provision of subsidies or assistance to low-income farmers, which is conditional on full-time work in farming, will serve to increase a farmer's off-farm reservation wage, thereby inhibiting participation in off-farm labour markets. More importantly, when the labour market is depressed, some farmers may not be able to obtain an off-farm job. In this situation, human capital plays an important role in enhancing the prospects of obtaining an off-farm job. In regions where the range of off-farm job opportunities is limited, as evidenced by a high porportion of the regional labour force being employed in agriculture, the 'discouraged worker effect' is likely to be a significant problem.

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