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The Income Tax and Allocation of Inputs:

An Investment Model Approach

1984

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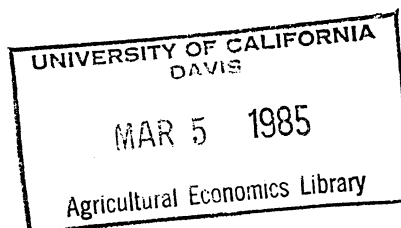
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Submitted as a selected paper to the annual meeting, AAEA,

Cornell University, Ithaca, New York, August 1984.

## The Income Tax and Allocation of Inputs: An Investment Model Approach

The objective of this research is to estimate the effect of investment credit, capital gains on land, excess depreciation and cash basis tax accounting on the annual real cost of labor, non-labor variable expense, machines/buildings expense and land inputs in a micro sample.

### Farm Firm Multiperiod Profit Maximization After Tax

Traditional theory of the firm suggests maximizing after tax profits in equation 1:

$$(1) \text{ After tax profit} = (1 - \text{effective tax rate})(\text{sales revenue} - \text{expense})$$

The above relation implicitly assumes that economic expense equals tax deductions. If correct, this assumption would ensure a neutral tax that does not distort resource allocation as prescribed by the before tax profit maximization model. (The first order conditions equating marginal physical product to the ratio of input/output prices would be identical for both before and after tax situations.) However, there is no particular reason to expect that, e.g., the economic value of depreciation is equal to depreciation tax deductions permitted by tax codes.

This analysis assumes that farmers maximize profits after tax and tax expenditures (or preferences). An after tax expenditure profit maximization model explicitly recognizes possible differences between (a) economic expense and tax deductions arising from the expense, and (b) economic income and taxable income associated with sales revenues. A standard definition of economic income is the amount of funds that can be withdrawn at the end of a time period to leave the firm exactly as well off as at the beginning of the time period, plus any consumption withdrawals during the period. In order to recognize these differences, equation 1 must be factored into several revenue, expense and deduction components. The tax

expenditure profit maximization model employed in this research is presented in equation 2. This model derives from Breckling, Jorgenson & Stephenson, and others; and has been adapted to apply to the tax, market and production constraints faced by single proprietor Minnesota farms with grain enterprises.

(2) After tax cashflow =  $(1 - \text{effective tax rate})(\text{sales revenue}) - \text{gross wages} - \text{variable expense} - \text{annual gross investment in land and machinery} - \text{capital gains tax} + \text{cash value of wage tax deductions} + \text{cash value of variable expense tax deductions} + \text{cash value of capital asset deductions}.$

It is assumed that in the long run, maximization of (net) after-tax cashflow also maximizes profit. In equation 2 tax deductions for expenses such as wages and asset depreciation are not restricted to equal the economic value of such expenses. With a few minor adjustments the above equation distinguishes tax expenditures associated with cash basis tax accounting.

#### Definition of components in the cash flow model

Because of the complexity of agricultural tax expenditures, the following definition of individual components in equation 2 is somewhat lengthy. To facilitate presentation, the time subscript will be explicitly incorporated only if different from the current year (e.g., year  $t-1$ ) as in equation 15.

(3) Sales revenue =  $PQ$

Where:  $P$  = price per unit crop output,  $Q = f(N, E, M, ; Z_j)$ . Inputs in the production function are:  $N$  = hours hired labor,  $E$  = units variable expense (fertilizer, fuel, electricity, etc.),  $M$  = units machinery and buildings,  $L$  = acres land,  $Z_j$  = weather, management ability, family labor and other inputs  $j = 1 \dots J$  (not presumed to be decision variables affected by income tax expenditures).

(4) Gross wages =  $wN\Psi$

$w$  = hourly wage rate,  $\Psi = 1.0 + \text{percent employer paid social security tax (assumed to be part of the employee wage)}.$

(5) Variable expense = cE

c = price per unit variable expense, E = unit variable expense.

In the analysis  $wN$  and  $cE$  will each be one value obtained directly as a farm record entry. However, for analytical purposes, it is useful to divide these expenses into both price per unit and quantity units.

$$(6) \text{ Gross investment} = h(L_{t+1} - L) + q \overset{\substack{\text{net} \\ \text{investment}}}{(M_{t+1} - M)} + \overset{\substack{\text{replacement} \\ \text{investment}}}{\delta M}$$

Where:  $h$  = per acre price of farm land,  $L$  = quantity acres,  $q$  = composite price per unit machines and buildings,  $M$  = units machines and buildings,  $\delta$  = constant rate of depreciation, the analysis will again use gross asset values for  $qM$ . The assumption of a constant proportionate rate of economic depreciation is not crucial to the multiperiod theory of the firm. Observe also that the above investment relation adjusts for net sales of land and machine assets as well (i.e., gross investment becomes negative). Thus, while tax on capital gains is a separate item in equation 2, the capital gain revenue is a component of asset sales in the above gross investment equality.

(7) Capital gains tax =  $u\gamma(ghL + jqM)$ 

Where:  $u$  = effective tax rate,  $\gamma$  = ratio of taxable to nominal capital gains on total capital assets,  $g$  = appreciation rate on land (i.e., percent increases in per acre value of land),  $j$  = appreciation rate on buildings and machines (i.e. percent annual increase in value of buildings and machines). The appreciation rate on machinery ( $j$ ) may be expected to occur only on purchases of used machinery, which in infrequent instances actually appreciate in value.

(8) Cash value of wage expense deductions:  $uw'N\Psi + \mu(uwN\Psi)$ 

Where  $\mu = (1 - S)r(1 + r)^{-1}$ , the percent share of the wage deduction

resulting from cash basis tax accounting,  $r$  = interest rate,  $S$  = share of crop production sold in year produced,  $(1-S)$  = share of crop production sold in year following harvest,  $w' = w(1 - \mu)$ , the real wage deduction after adjustment for the cash tax accounting benefit. The mathematical development of the above expression is detailed in Hanson, Appendix 2.1 and 2.2.

Cash tax accounting essentially defers a tax liability for one tax reporting period. Since the tax expenditure associated with this is the interest on the deferred tax liability, the expression for,  $\mu$  above, is the discounted interest on the inventory share of current production:  $(1-S)r(1+r)^{-1}$ .

(9) Cash value of variable expense tax deductions =  $uc'E + \mu(ucE)$

$c' = c(1 - \mu)$ , the real price of variable inputs after adjustment by the cash basis accounting tax expenditure. The above discussion of  $w'$  can be analogously applied to  $c'$ .

(10) Cash value of capital asset tax deductions =  $u(rd(qM + hL) + v\delta qM) + \phi q(M_{t+1} - M + \delta M)$

Where:  $d$  = ratio of total firm debt to total firm assets,  $v$  = ratio of depreciation tax deduction to economic depreciation,  $\phi$  = rate of investment tax credit. The above relation depicts the following deductions:  $rd(qM + hL)$  - is the interest deduction on machinery and land;  $v\delta qM$  - is the machinery depreciation deduction, and  $\phi q(M_{t+1} - M + \delta M)$  - is the investment tax credit. Since the investment tax credit is deducted from taxes payable rather than from income before tax, this item is not reduced through multiplication, by the tax rate  $u$ . All components of equation 2 have been defined and are listed in equation 11. Equation 12 algebraically expresses the same basic tax expenditure relation (equations 2, 11) after rearrangement. Recall that  $R$  is cash flow after taxes and tax expenditures.

$$\begin{aligned}
 (11) \quad R = & (1 - u)Pf(N, E, M, L; Z_j) - wN\Psi - cE - h(L_{t+1} - L) \\
 & - q(M_{t+1} - M + \delta M) - u\gamma(ghL + jqM) \\
 & + uw'N\Psi + \mu(uwN\Psi) + uc'E + \mu(ucE) \\
 & + u(rd(qM + hL) + v\delta qM) + \phi q(M_{t+1} - M + \delta M)
 \end{aligned}$$

$$\begin{aligned}
 (12) \quad R = & (1 - u)(Pf(N, E, M, L; Z_j) - wN\Psi - cE) - h(L_{t+1} - L) \\
 & - q(1 - \phi)(M_{t+1} - M + \delta M) + u((rd(qM + hL) + v\delta qM) \\
 & - \gamma(ghL + jqM))
 \end{aligned}$$

Equation 12 abstracts from the cash basis accounting tax expenditure. This tax expenditure will be evaluated in the context of equation 11.

The resource employment decision in the after tax cash flow model.

A present value framework permits extension of the one period model of the planning horizon. The discounted sum of future cash flows ( $V$ ), where interest rates ( $r$ ) are permitted to fluctuate over time ( $t$ ), is as follows:

(13)

$$V = R_0 + \frac{R_1}{(1+r_1)} + \frac{R_2}{(1+r_1)(1+r_2)} + \dots + \frac{R_T}{(1+r_1)(1+r_2)\dots(1+r_t)\dots(1+r_T)}$$

To generalize the cash flow maximization investment decision to any time period, compound ahead to any particular period  $t$  flows that occur before  $t$  and discount back to  $t$  those flows that occur after  $t$ :

(14)

$$\begin{aligned}
 \bar{V} = & (1+r_1)(1+r_2)\dots(1+r_t) R_0 + \frac{(1+r_1)(1+r_2)\dots(1+r_t)R_1}{(1+r_1)} + \dots \\
 & + \frac{(1+r_1)(1+r_2) + \dots + (1+r_{t-1})(1+r_t)R_{t-1}}{(1+r_1)(1+r_2) + \dots + (1+r_{t-1})} + \frac{(1+r_1)(1+r_2)\dots(1+r_t)R_t}{(1+r_1)(1+r_2)\dots(1+r_t)} \\
 & + \frac{(1+r_1)(1+r_2) + \dots + (1+r_{t-1})(1+r_t)R_{t+1}}{(1+r_1)(1+r_2) + \dots + (1+r_t)(1+r_{t+1})} + \dots
 \end{aligned}$$

$$+ \frac{(1+r_1)(1+r_2)\dots(1+r_t)R_T}{(1+r_1)(1+r_2)\dots(1+r_t)\dots(1+r_T)}$$

As shown in equation 15, maximization of  $V$  with respect to changes in input levels in year  $t$  requires only focusing upon periods  $t$  and  $t-1$ . This is because two periods,  $t$  and  $t+1$ , are present in the land and machine components of the investment relations. Substituting equation 12 into equation 14 and applying the appropriate subscripts:

(15)

(period  $t - 1$ )

$$\begin{aligned} V = & \dots (1+r_t) [(1-u_{t-1})(P_{t-1}f(N_{t-1}, E_{t-1}, M_{t-1}, L_{t-1}; Z_{j,t-1}) \\ & - w_{t-1}N_{t-1}\psi - C_{t-1}E_{t-1}) \\ & - h_{t-1}(L - L_{t-1}) - q_{t-1}(1-\phi)(M - M_{t-1} + \delta M_{t-1}) \\ & + u_{t-1}((r_{t-1}d_{t-1}(q_{t-1}M_{t-1} + h_{t-1}L_{t-1}) + v\delta q_{t-1}M_{t-1}) \\ & - \psi(g_{t-1}h_{t-1}L_{t-1} + j_{t-1}q_{t-1}M_{t-1})))] \end{aligned}$$

(period  $t$ )

$$\begin{aligned} & + (1-u)(Pf(N, E, M, L; Z_j) - wN\psi - cE) - h(L_{t+1} - L) \\ & - q(1-\phi)(M_{t+1} - M + \delta M) + u((rd(qM + hL) + v\delta qM) \\ & - \gamma(ghL + jqM)) \end{aligned}$$



It will be observed that the first two decision variables of the production function,  $N_t$  (hired labor) and  $E_t$  (variable expense), are not present in the period  $t-1$ ; while due to the nature of the gross investment equation,  $M_t$  and  $L_t$  are present in both periods  $t$  and  $t-1$ . Thus, profit maximization results in the following first-order conditions:

$$(16) \quad \frac{\partial \bar{V}}{\partial N} = (1 - u)(Pf_N(M^*, E^*, N^*, L^*; Z_j) - w\Psi) = 0$$

$$(17) \quad f_N(N^*, E^*, M^*, L^*; Z_j) = \frac{w\Psi}{p}$$

$$(18) \quad f'_N(N^*, E^*, M^*, L^*; Z_j) = \frac{w\Psi(1 - u\mu)}{p}$$

As indicated above the real wage after the cash basis accounting tax expenditure is  $w(1 - u\mu)$ . Thus Equation 18 indicates the consequent profit-maximizing condition. Analogous to Equation 18, the real cost of variable inputs after the cash accounting tax expenditure is given in 19.

$$(19) \quad f_E(N^*, E^*, M^*, L^*; Z_j) = \frac{c(1 - u\mu)}{p}$$

The after-tax first-order condition for land is given in Equation 20 and simplified in Equation 21.

$$(20) \quad \frac{\partial \bar{V}}{\partial L} = -(1+r)h_{t-1} + (1-u)Pf_L(N^*, E^*, M^*, L^*; Z_j) + h(1+u(rd-\gamma g)) = 0$$

The above expression can be simplified by noting that percent changes in the per acre price equal the capital gain rate:

$$g = \frac{h - h_{t-1}}{h_{t-1}}$$

$$h_{t-1} = \frac{h}{(1+g)}$$

The ratio  $(1+r)/(1+g)$  can be approximated by  $(1+r-g)$ , where  $g^2$  and  $rg$  become arbitrarily small as the time period is shortened:

$$\frac{(1+r)(1-g)}{(1+g)(1-g)} = \frac{1+r-g-rg}{1-g^2} = 1 + r - g$$

Equation 20 thus becomes

$$\frac{\partial \bar{V}}{\partial L} = -h(1+r-g-1-u(rd+\gamma g)) + (1-u)Pf_L(N^*, E^*, M^*, L^*; Z_j) = 0$$

or, rearranging,

$$(21) \quad f_L(N^*, E^*, M^*, L^*; Z_j) = \frac{h}{P(1-u)} (r(1-ud) - g(1-u\gamma)).$$

The first-order condition for machinery is developed with simplification analogous to that above:

$$(22) \quad \frac{\partial \bar{V}}{\partial M} = -(1+r)(1-\phi)q_{t-1} + (1-u)Pf_M(N^*, E^*, M^*, L^*; Z_j)$$

$$+ q(1-\phi)(1-\delta) + uq((rd+v\delta) - \gamma j) = 0$$

$$\text{or:} \quad (1-u)Pf_M(N^*, E^*, M^*, L^*; Z_j) = q(1+r-j)(1-\phi)$$

$$- q(1-\phi)(1-\delta) - uq(rd+v\delta) - \gamma j$$

$$\text{or:} \quad (1-u)Pf_M(N^*, E^*, M^*, L^*; Z_j) = q[(1-\phi)(r+\delta-j) - urd - uv\delta + u\gamma j]$$

Collecting terms,

$$(23) \quad f_M(N^*, E^*, M^*, L^*; Z_j) = \frac{q}{P(1-u)} [r(1-\phi-ud) + \delta(1-\phi-uv) - j(1-\phi-u\gamma)].$$

Optimal resource use requires that Equations 18, 19, 21 and 23 must obtain for all time periods; i.e., that profit-maximizing first order conditions are satisfied.

### The Data and Estimation Method

Farm records analyzed in this study originate in allied farm management associations in a prime agricultural region of Minnesota during 1967-78. Criteria for inclusion in the study were that a record was completed each year of the study, the farm was an unincorporated single proprietorship and the identity of the record filer did not change during the 12 year study period. These criteria were satisfied by 76 farms. During the study period average sales were \$87,500 and average total operator assets were \$299,700.

A computer accounting model of state and federal income and social security tax provisions (TAXMODEL) analyzed the farm data. Changes that occurred in tax laws during the 1967-78 period were incorporated in the three-tax model. All basic tax provisions were modeled including income averaging, investment credit, net operating losses, carryovers, personal deductions, etc. Actual tax paid information was used to verify the accuracy of the model. The model estimated tax liabilities, taxes saved by each tax saving provision (based on the detailed farm record information), and remaining (unused) tax credits and deductions.

### Tax Expenditures Effects Upon Real Input Rentals

Input rentals based upon the average marginal tax rate. Real input rental prices, after tax expenditures, are estimated in Table 1. The decline of rentals between 1967-70 and 1975-78 is general. In the case of labor and cash expenses, the reduction is very limited. The approximately 6 percent employer paid Social Security Tax (raising labor cost from 1.0 to 1.06) still more than offsets the cash basis tax expenditure in 1975-78. Because of this tax expenditure, labor costs 2.6 and 4 percentage points less (than the 1.06 level) for small and large farms, respectively, in 1975-78. A second general trend is that agricultural tax expenditures give a competitive edge to producers with relatively higher tax exposure, the large farmers. This trend is violated only by land when the

capital gain rate is based on 1967-70.

Tax expenditure effects upon the price of the land input are particularly instructive. In the all farm category, 1967-70, the price of the land input increases after tax expenditures; this is shown by the increase in the tax neutral value from .039 to .047. The cause of this increase is, of course, the fact that the debt ratio is much less than 1.0, and thus the opportunity cost of capital invested in land is not fully deductible. Had the value of the debt ratio been 1.0, the input price of land would be .032, less than the tax neutral value of .039 (reflecting the capital gain tax expenditures). Also in the earlier period, the cost of the land input increases marginally as size increases, from .045 to .049.

The size effect upon land costs (and also the relation of the land cost post-tax expenditures to pre-tax expenditures) is reversed in 1975-78 as compared to 1967-70. The debt ratio, tax rate and capital gain rate have each increased between periods, however, the principal cause of the change from positive to negative land costs is the large increase in the appreciation rate on land from .035 to .206. Note as well that the cost becomes slightly more negative as size increases, from -.169 to -.184.

The final row under the land heading in Table 1 indicates the land rental value if the rate of land appreciation in 1975-78 had equaled the rate estimated for 1967-70 (.035). Compared to 1967-70, the land rental increases from .045 - .049 to values of .059 - .061. This change was caused by increases in tax and interest rates between the two periods. Thus, the size of the land appreciation rate dominated the other parameters in 1975-78.

Machinery/buildings is the only input that exhibited a strong farm size effect. In 1967-70 there is a small decline in the factor weight from .136 to .133 as size increases. The all-farm after tax expenditure rental of .135 is about 93 percent of the magnitude of the pretax weight, .145. In 1975-78 the average after

tax weight, .117, falls to 74 percent of the pretax weight of .159. Moreover, the difference between small and large farms becomes 1.6 percentage points (.125 - .109) as compared to .3 percentage points in 1967-70 (.136 - .133).

#### CONCLUSION

This research has utilized farm record data and a neoclassical investment model approach to explore the effects of tax expenditures (i.e. tax subsidies or preferences) on farm investment in labor, non-labor variable costs, machine/buildings and land inputs. Tax expenditure effects upon the land and machinery rentals were most prominent. Very high estimated land appreciation rates during 1975-78 resulted in a negative tax neutral rental of  $-.118$  for the sample as a whole based upon the average marginal tax rate. Tax expenditure effects reduced this rental to  $-.175$ . The negative values are weights on the real input price. The product of weight times input price is the rental, or annual real cost of the input. The negative values thus indicate that the annual cost of land after tax savings and unrealized capital gains, was negative. Tax expenditures exhibited a marked effect upon the machine/buildings rental during 1975-78, causing an average reduction in the tax neutral rental of from 21 to 31 percent for small and the large farms, respectively. For 1967-70, this reduction was only 6 percent for small and 8 percent for large size farms.

This analysis suggests that agricultural tax expenditures profoundly affect the real after tax cost of land and machinery/building inputs. Furthermore, these tax savings may contribute to land price appreciation (since land is the limiting input in farm expansion) and thus partially account for the negative real cost of land during the study period. All farm sizes benefited from agricultural tax expenditures. However, the largest size farms received the greatest tax motivated reductions in real input prices. Finally, the methodology provides a realistic approach to analyzing complex tax effects upon input allocation in agriculture.

Table 1. Tax Expenditure Factors In Input Rental Prices For a Sample of Minnesota Farms 1967-70, 1975-78.

Input	Tax Factor	Farm Size							
		All		Small		Medium		Large	
		1967-70	1975-78	1967-70	1975-78	1967-70	1975-78	1967-70	1975-78
Labor	$(1-u\mu)$	1.031	1.028	1.036	1.034	1.030	1.028	1.029	1.02
Cash Expense	$(1-u\mu)$	.990	.970	.990	.976	.984	.969	.984	.964
Land	$\frac{r(1-ud) - g(1-u\gamma)}{1-u}$	.047	-.175	.045	-.169	.047	-.171	.049	-.184
	Tax neutral: $r-g$	.039	-.118						
	Capital gain rate = .035		.060		.059		.059		.061
Machines & Buildings	$\frac{r(1-\phi-ud) + \delta(1-\phi-uv)}{1-u}$	.135	.117	.136	.125	.135	.120	.133	.109
	Tax neutral: $r + \delta$	.145	.159						

Note: If the input rental for labor and cash expense exceeds 1.0, the combination of taxes and tax subsidies results in an input cost higher than in a tax neutral model. If the rental is less than 1.0, imposition of taxes and tax subsidies has reduced the real annual cost of the farm input. For land and machines/buildings inputs, similar comparison must be made with the tax neutral level.

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