SELECTING AMONG ALTERNATIVE DEPRECIATION METHODS:

A STOCHASTIC DOMINANCE APPROACH

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Abstract

A whole-firm simulation model (FLIPSIM V) was used to simulate the net present value probability distributions for sixteen alternative tax strategies on equipment depreciation for a rice farm in Texas. Stochastic dominance was used to determine the utility maximizing tax strategy for decision makers in alternative risk preference classes. The most preferred income tax strategy for both risk loving and averse decision makers utilized straight-line cost recovery, Section 179 expensing, maximum I.T.C. with resulting basis reduction, and trade rather than sell on disposition of old equipment.

Selecting Among Alternative Depreciation Methods: A Stochastic Dominance Approach

The changing tax laws during the past several years have coincided with a period of highly variable crop prices, interest rates and inflation rates. The combination of these factors has created an environment where decision makers exposure to risk has been intensified. The volatility of income tax law changes has affected the ability of decision makers to cope with risk.

An area of significant change in the tax law over the past few years is in the area of capital recovery for business assets. Taxpayers after 1980 have several options to choose from in selecting the method and rate at which capital assets may be depreciated. For example, a taxpayer can either use accelerated or straight-line depreciation, elect Section 179 (of the Internal Revenue Code) expensing, or elect full or reduced investment tax credit. The question raised by taxpayers is which strategy maximizes his or her situation given the differing levels of risk associated with each alternative. The purpose of this paper is to demonstrate the use of stochastic dominance with respect to a function for selecting among alternative income tax stragegies available to farm operators.

Methodology

Stochastic dominance is a quantitative approach for determining which strategy (or strategies) maximizes a decision maker's expected utility from uncertain returns. Since each strategy in an uncertain environment is associated with a different net income probability distribution (mean, variance, skewness, and kurtosis), one may couch the strategy selection process in terms of expected utility for net income. Stochastic dominance has been used by economists to compare decision maker choices in an uncertain environment, such as crop insurance (Lemieux, Richardson and Nixon), storage vs. sale (Rister, Skees, and Black), and farm policy preference (Kramer and Pope).

The Firm Level Income Tax and Farm Policy Simulator (FLIPSIM V) was used to generate probability distributions of a farm's net income under alternative depreciation strategies. FLIPSIM V is a firm level, recursive simulation model that simulates the annual production, marketing, financial management, growth, and income tax aspects of a firm over a 10-year planning horizon (Figure 1). The model recursively simulates a firm by using the ending financial position for one year as the beginning position for the next year.

At the beginning of each year, prices and production levels for the firm's enterprises are drawn at random from a user specified, multivariate empirical probability distribution (STOCH in Figure 1). Variable costs of production (VCOSTS) are calculated as a product of inflated per unit production costs and the respective inputs required for each enterprise.

Exogenous fixed costs (FCOSTS) for the firm are calculated by inflating their initial values by the appropriate annual inflation rates provided by the analyst. Existing and new long- and intermediate-term loans are amortized (FINAN) based on their respective loan life's principal owed and annual interest rates. All loans are amortized using the remaining balance method.

The market value of new and used machinery is updated annually (LANDVL). The market value of land is likewise changed on an annual basis. This is done to maintain asset values in market value terms for the market value balance sheet.

Next the simulation model calculates depreciation for each item listed in the machinery complement (DEPREC). For equipment purchased prior to 1981, the model calculates depreciation using either the double declining balance or the straight line method. Equipment placed into service after 1980, is cost recovered using either an accelerated or straight-line method. The recovery life for equipment can be set at 3, 5, or 12 years. Equipment that has reached the end of its economic life is traded in or sold and a replacement piece of equipment is purchased. The owner is permitted to replace an obsolete piece of equipment if sufficient cash is available (including the market value of the old piece of equipment) to meet a 30-percent down payment, and the additional debt does not cause the intermediate-equity ratio to fall below its minimum. First year expensing, applicable under the 1981 Economic Recovery Tax Act, can be taken for all purchases of equipment, as well as the investment tax credit. If all equipment is sold rather than traded-in, depreciation recapture and capital gains or losses realized from the sale are calculated and used in calculating personal income taxes.

Annual cash receipts (RECPTS) are calculated for that portion of the production marketed in the current tax year plus the receipts for selling production stored from previous years. Cash receipts for each enterprise are calculated as the product of stochastic production and prices for the respective enterprise. The firm's net cash income and net cash flows are calculated next (CASHFL).

Personal income taxes and social security taxes are calculated assuming the operator is married, filing a joint income tax return, and itemizing personal deductions (TAXES and TAXTAB). The regular income tax liability is computed using either income averaging (if qualified) or the standard tax rate schedules. The model selects the tax strategy which results in the lower income tax liability. All investment tax credit allowances are deducted from the regular tax liability with the result being compared to the income tax liability under the alternatie minimum tax. The operator pays the excess of the alternative minimum tax over the regular income tax liability after credits. Income tax rate schedules for 1983 and 1984 are included in the model, as well as a procedure to develop tax rate schedules for 1985 and beyond based on changes in the CPI.

The simulation process described above is repeated until the entire planning horizon has been simulated for a given scenario. After simulating each iteration (outer loop in Figure 1), the model calculates after tax net present value[1] for the firm (ITSUMM). Once the last iteration (50th) is completed, the values for net present value are used as an estimate of the cumulative distribution function (cdf) for this variable under the tax alternative being simulated.

Income Tax Strategies

Sixteen alternative income tax strategies (Table 1) for depreciating (cost recovering) machinery are tested by the proposed procedure outlined above. The sixteen strategies assume the depreciable property has a class life of five years. (This is consistent with the class life for the majority of depreciable agricultural assets.) The expensing option under Section 179 allows a $5,000 deduction in 1983, $7,500 in 1984 and 1985, and $10,000 for all tax years after 1985. It is further assumed that all depreciable assets in the five year class qualify for both expensing and investment tax credit (I.T.C.). The taxpayer is allowed to choose between the maximum I.T.C. with a basis reduction and a reduced I.T.C. with no basis reduction. This last option is the result of the Tax Equity and Fiscal Responsibility Act of 1982.

Typical Firm Analyzed

The proposed procedure for evaluating alternative income tax strategies is demonstrated using a commercial rice farm in Texas. The typical

Gulf Coast rice farm selected for this study has 1,700 acres of land, divided equally between pastureland and cropland. The owner-operator has a beginning net worth of $1,067,000, or about 80 percent equity in owned land and machinery (Table 2).

In the local area, rice is planted on the same cropland every other year and idle cropland is leased for grazing. The operator is a part owner and has 80 percent equity in 960 acres of cropland while leasing the remainder on a share lease (Table 2).

The typical farm was simulated recursively with FLIPSIM V over a 10 year planning horizon and the horizon was replicated 50 times using rice prices and yields drawn at random from empirical probability distributions for these variables. The same assumptions regarding beginning equity, off-farm income, family consumption, machinery replacement, inflation rates, interest rates, production costs, crop yield and price distributions, firm growth, and farm programs were used for all tax strategies tested.

Using the first quarter 1983 Chase Econometrics forecast, the model was run assuming all production costs increase an average of 6.9 percent per year throughout the planning horizon. The average rice prices for 1974-1981 (Table 2) were used as the mean prices for the first year in the planning horizon, 1983. The average loan rate and target price for 1976-1981 ($6.98/cwt. and $9.30/cwt., respectively) were used for their respective values in the first year of the planning horizon. Prices, loan rates, and target prices for 1984-1992 were obtained from the Chase Econometrics forecast. (It was assumed the 1981 Farm Program for rice would continue throughout the period simulated.) The replacement cost of new machinery was assumed to increase an average of 6.2 percent per year while the nominal market value of used equipment was assumed to increse 1 percent per year. Annual interest rates were assumed to be 10 percent for current long-term debt, 14.0 percent for current intermediate-term debt, and average 12.5 percent for operating debt over the entire planning horizon. New intermediate- and long- term debt interest rates averaged 15.7 and 14.7 percent for the Chase Econometrics forecast, respectively (Table 2).

A bivariate probability distribution for rice yield (first crop and second crop) was developed from producer's yield records in the Gulf Coast. Actual farm yields for 5 years (1977-1981) were used to develop empirical probability distributions for rice yields.[2] The same bivariate yield distribution was used for all tax scenarios analyzed.

The typical marketing strategy in the area is to sell first crop rice in July and sell second crop rice in January. To simulate this practice, an empirical bivariate probability distribution for July and January rice prices was developed using average monthly cash prices (July and January) observed in the area over the period 1974-1981.[3]

Results

Means and coefficients of variation for the after-tax net present value and present value of ending net worth distributions generated by FLIPSIM V are summarized in Table 3 for each of the tax strategies in Table 1. Strategy I (straight-line cost recovery, first year expensing elected, maximum I.T.C., and trade old machinery) results in the greatest mean after-tax net present value ($313,600) and present value of ending net worth ($1,159,000). The lowest mean after-tax net present value ($270,900) and present value of ending net worth ($1,116,300) for the farm occurs under tax strategy XVI (accelerated cost recovery, no first year expensing, reduced level of I.T.C., and sell used equipment). These results indicate that the income tax strategy used by a firm has a marked affect on the firm's long-run income and wealth position.

Stochastic dominance with respect to a function was used to rank the sixteen tax strategies listed in Table 1. Two risk aversion levels were selected for demonstration purposes: risk loving (-0.00001 to 0.0) and risk averse (0.0 to 0.00001). The results of the stochastic dominance analysis are summarized in Table 4. Strategy I is first degree stochastic dominate over all of the remaining fifteen strategies since this strategy is in the most preferred set by all three risk preference classes.

By preferring Strategy I, straight-line cost recovery is preferred to accelerated cost recovery, despite conventional thought on the subject. It is hypothesized that when a decision maker's taxable income is associated with risk (uncertainty) he is better off to schedule cost recovery tax deductions uniformly over the asset's life. Given that taxable income is uncertain, large cost recovery deductions are more likely to occur when taxable income is low and these deductions can not be fully utilized in the year incurred. These excess deductions can be carried forward in the form of an operating loss carryforward, but the time value of money largely erodes the benefits of these income tax deductions in succeeding years. In terms of trade vs. sell, the taxpayer prefers trading to selling machinery since the former allows avoidence of depreciation recapture. By selecting Strategy I, the taxpayer prefers maximum I.T.C. over reduced I.T.C. It is hypothesized that this occurs because under maximum I.T.C. the decision maker is able to generate the greatest tax reduction benefits during the early life of the asset. Similarly, first year expensing is preferred to not expensing since the present value of income tax benefits on this relatively small amount (i.e., $5,000 in 1983 with average machinery purchases of $90,000) were greater than the benefits of further spreading the cost recovery deduction for each asset.

In a risk-free environment decision makers would clearly choose expensing over not expensing based solely on the time value of money, assuming no change in income tax brackets. Also, in a risk free environment, decision makers may prefer accelerated cost recovery to straight-line recovery. However, one must recognize decision makers do not operate in a risk free environment and the tax strategies selected by decision makers must explicitly account for risk.

If Strategy I is not available, decision makers in both risk preference classes would prefer strategy III (Table 4). The decision maker's preference for tax strategies, other than strategies I and III, differ across risk preference classes. Risk averse decision makers are indifferent between strategies V and VII and would prefer these two strategies over all of the remaining strategies.

Summary and Conclusions

By incorporating measures of risk into tax decision making models, taxpayers can evaluate the relative benefits of alternative tax strategies on their after-tax income and wealth position. Stochastic dominance was used in this study since it allows decision makers to rank alternative tax strategies from most preferred to least preferred based on their risk aversion level and the expected utility for each strategy.

Sixteen income tax strategies involving all combinations of cost recovery (straight-line vs. accelerated), Section 179 expensing (yes or no), amount of I.T.C. claimed (maximum vs. reduced), and disposition of old equipment (trade vs. sell) were evaluated with a whole firm simulation model (FLIPSIM V). The model simulated each strategy over a common 10 year planning horizon using random yields and prices for a typical Texas

Gulf Coast rice farm. The planning horizon was repeated 50 times to generate values for a sample probability distribution of after-tax net present values under each tax strategy.

The results of comparing the cdf's for alternative tax strategies using stochastic dominance indicate risk averse and risk loving decision makers would prefer a strategy of "straight-line cost recovery, first year expensing, maximum I.T.C., and trade old equipment" to the other fifteen strategies tested. If this strategy was not available, the second most preferred strategy by risk averse and loving decision makers was "straight-line cost recovery, first year expensing, reduced I.T.C., and trade old equipment."

The results of this study should not be generalized to commercial crop farmers in other regions of the country since the level of risk they face will result in different cdf's for net present value and thus possibly different tax strategy rankings. However, the results suggest that the effects of uncertain incomes should be considered when making recommendations as to machinery cost recovery strategies for farm operators.

Footnotes

[1]After-tax net present value is the present value of net operator withdrawals plus the present value of the change in net worth over the 10 year planning horizon. An after-tax discount rate of 8 percent was used to compute after-tax net present value and the present value of ending net worth.

[2]The empirical yield distribution was developed by computing the deviations about the mean for each crop's (first crop and second crop) annual yield. The resulting distribution consisted of 5 deviations about the mean for 1977-1981 for each crop. Simulation techniques were used to interpolate each distribution and expand it to the 10 deviations about the mean. The advantage of using the empirical distribution is that it allows the researcher to use the actual distribution experienced by farm operators rather than assuming an a prior distribution (e.g., normal, uniform, triangular, or Beta).

[3]The empirical price distribution was developed in the same manner as the distribution for rice yields but data for the past 10 years was used.

References

Arrow, K. J. *Essays in the Theory of Risk Bearing.* Markham Publishing Company. Chicago, Illinois. 1971.

Hadar, J. and W. R. Russell. "Rules for Ordering Uncertain Prospects." *American Economic Review.* 59(1969):25-34.

Kramer, R. A. and R. D. Pope. "Participating in Farm Commotidy Programs: A Stochastic Dominance Analysis." *American Journal of Agricultural Economics,* 63(1981): 119-28.

Lemieux, C. M., J. W. Richardson and C. J. Nixon. "Federal Crop Insurance vs. ASCS Disaster Assistance for Texas High Plains Cotton Producers: An Application of Whole Farm Simulation." *Western Journal of Agricultural Economics,* 7(1982):141-153.

Meyer, J. "Second Degree Stochastic Dominance With Respect to a Function." *International Economic Review.* 18(1977):477-87.

Pratt, J. W. "Risk Aversion In the Small and In the Large." *Econometrica.* 32(1964):122-36.

Prentice-Hall, Inc. *Complete Internal Revenue Code of 1954, 1983 Edition,* Englewood Cliffs, N.J., June 1, 1983.

Rister, M. E., J. R. Skees and J. R. Black, "Evaluating Post-Harvest Marketing Strategies for Grain Sorghum in the Texas Coastal Bend." Dept. Agricultural Economics, Texas A&M University (mimeo). 1984.

Table 1. Summary of the Cost Recovery Strategies Tested.

I.	Straight-line Cost Recovery, Expensing, Maximum I.T.C., Trade Old Equipment
II.	Straight-line Cost Recovery, Expensing, Maximum I.T.C., Sell Old Equipment
III.	Straight-line Cost Recovery, Expensing, Reduced I.T.C., Trade Old Equipment
IV.	Straight-line Cost Recovery, Expensing, Reduced I.T.C., Sell Old Equipment
V.	Straight-line Cost Recovery, No Expensing, Maximum I.T.C., Trade Old Equipment
VI.	Straight-line Cost Recovery, No Expensing, Maximum I.T.C., Sell Old Equipment
VII.	Straight-line Cost Recovery, No Expensing, Reduced I.T.C., Trade Old Equipment
VIII.	Straight-line Cost Recovery, No Expensing, Reduced I.T.C., Sell Old Equipment
IX.	Accelerated Cost Recovery, Expensing, Maximum I.T.C., Trade Old Equipment
X.	Accelerated Cost Recovery, Expensing, Maximum I.T.C., Sell Old Machinery
XI.	Accelerated Cost Recovery, Expensing, Reduced I.T.C., Trade Old Equipment
XII.	Accelerated Cost Recovery, Expensing, Reduced I.T.C., Sell Old Machinery
XIII.	Accelerated Cost Recovery, No Expensing, Maximum I.T.C., Trade Old Machinery
XIV.	Accelerated Cost Recovery, No Expensing, Maximum I.T.C., Sell Old Machinery
XV.	Accelerated Cost Recovery, No Expensing, Reduced I.T.C., Trade Old Equipment
XVI.	Accelerated Cost Recovery, No Expensing, Reduced I.T.C., Sell Old Machinery

Table 2. Summary of the Typical Gulf Coast Rice Farm Selected for the Analysis

Cropland owned (acres)	960.
Cropland leased (acres)	756.
Value of cropland owned	$956,500.
Other investments	3,000.
Cash on hand	100,000.
Value of machinery	247,700.
Long-term liabilities	190,700.
Intermediate-term liabilities	49,500.
Beginning net worth	1,067,000.
Annual family living expenses	25,000.
Interest rates:	
Current long-term debts	0.100
New long-term debts	0.147
Current intermediate-term debts	0.140
New intermediate-term debts	0.157
Operating loans	0.125
Average annual inflation rates for 10 years[1]	
New farm machinery	0.062
Input costs	0.069
Wages	0.064
Fixed costs	0.061
Land values	0.056

[1]Source: 1983 first quarter forecast from Chase Econometrics

Table 3. After-tax Net Present Value and the Present Value of Ending Net Worth for a Typical Texas Rice Farm under Alternative Income Tax Strategies.

Income Tax Strategies	After-Tax Net Present Value		Present Value of Ending Net Worth	
	mean	C.V.[1]	mean	C.V.
	($1,000)	(%)	($1,000)	(%)
I	313.6	74.9	1,159.0	20.3
II	297.5	78.6	1,142.9	20.4
III	313.2	74.9	1,158.6	20.3
IV	295.2	78.9	1,140.6	20.4
V	300.6	76.5	1,146.0	20.1
VI	282.4	80.8	1,127.8	20.2
VII	300.7	76.6	1,146.1	20.0
VIII	280.5	80.9	1,125.9	20.2
IX	297.0	78.3	1,142.4	20.4
X	284.2	82.7	1,129.6	20.8
XI	296.5	78.4	1,141.9	20.4
XII	282.4	82.9	1,127.8	20.8
XIII	283.9	80.3	1,129.3	20.2
XIV	272.4	84.3	1,117.8	20.5
XV	283.3	80.3	1,128.8	20.2
XVI	270.9	84.5	1,116.3	20.5

[1]C.V. is the coeficient of variation, or the ratio of the standard deviation and the mean expressed as a percentage.

Table 4. Predicted Preference for Selected Tax Strategies

	Risk Preference Class[1]	
Preference Sets[2]	Risk Lover	Risk Averse
Most	I	I
Second	III	III
Third	II,V,VII	V,VII
Fourth	IV,IX	II,IX
Fifth	XI	XI,IV
Sixth	X	XIII
Seventh	XII,XIII	VI,X,XV
Eighth	VI,XIV	VIII
Ninth	VIII	XII
Tenth	XIV	XIV
Eleventh	XVI	XVI

[1]Risk aversion coefficients were (-0.00001 to 0.0) for risk loving and (0.0 to 0.00001) for risk averse.

[2]The second most preferred set is developed assuming the strategies in the most preferred set were not available. Next the strategies in sets one and two were excluded when selecting strategies for the third most.

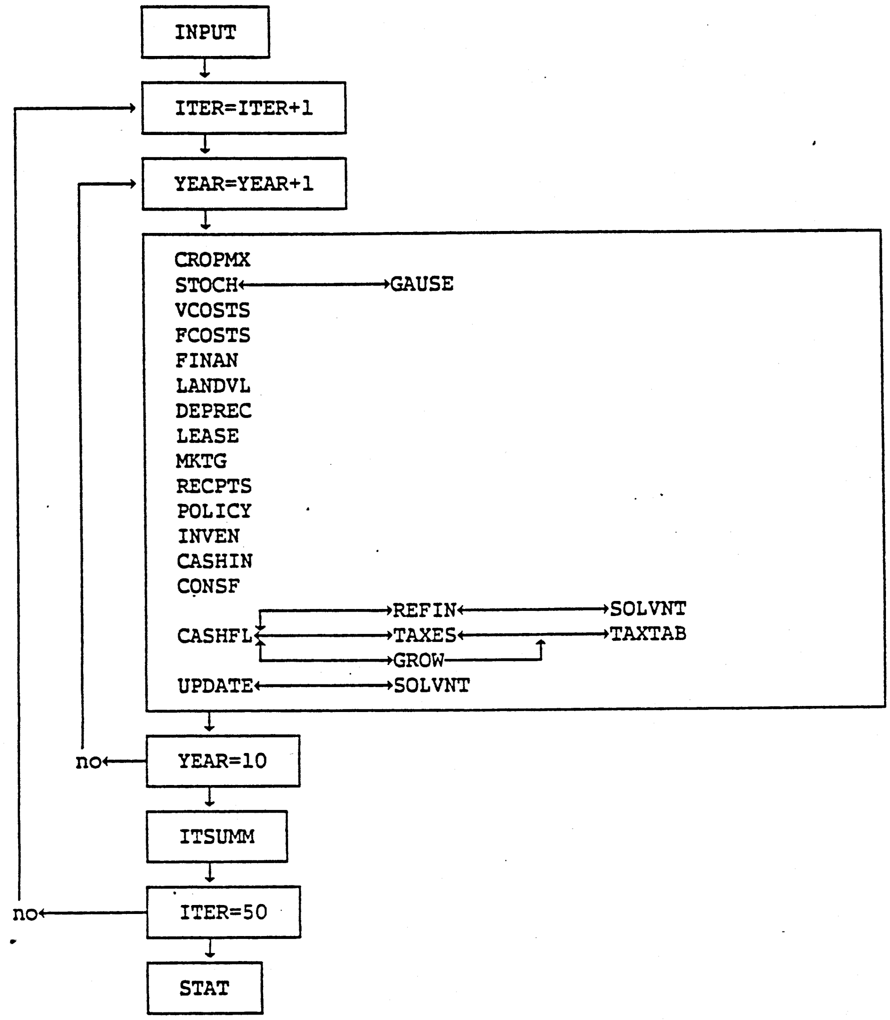

FIGURE 1. Diagram of the Firm Level Income Tax Simulator