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THE EFFECTS OF INCOME TAX REGULATIONS ON FARM EQUIPMENT REPLACEMENT AGE AND COST*

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The literature of agricultural economics contains a number of articles which develop the theory of asset replacement. For the most part, this theory has been developed without considering income taxes and their effect on the optimum replacement time for a capital asset. Yet it is obvious that farmers and other businessmen operate in an environment where income taxes are an important factor in the decisions they make.

A recent article by Chisholm reports the results of changes in the Australian income tax regulations on the optimum replacement time for a capital asset. Chisholm had data for 11 years and reported an 11-year optimum replacement policy when using U.S. income tax regulations in his model. The exception was for an after tax discount rate of zero when the indicated replacement policy was 8 years. His results were not affected by the depreciation method used nor by the inclusion or non-inclusion of additional first year depreciation and investment credit in the model.

Chisholm's results seem to contradict the replacement patterns followed by farmers. Casual observation would indicate that full-time, commercial farmers tend to replace tractors and self-propelled combines well before 11 years and before the end of their useful life. The purpose of this paper is to report the results of a replacement analysis using U.S. data and U.S. tax regulations and to explore some reasons for the differences in theoretical optimal replacement policy and that observed on many farms.

The model used follows the one developed by Perrin for a tax-free situation and by Chisholm with tax regulations included. Following Perrin's suggestion [p.65] that calculating present values for each possible replacement year may be a better search procedure than evaluating the marginal criterion, the following model was used assuming all expenses, income tax and replacement occur at year-end:[1]

$$PV_n = \frac{1}{1-(1+r)^{-n}} \Big[C_o - C_n[1+r]^{-n}\Big) + (1-T)\Big(\sum_{k=1}^{n} R_k\,[1+r]^{-k}\Big) - T\big(A_n[1+r]^{-1}\big) - T\Big(\sum_{k=1}^{n} D_k\,[1+r]^{-k}\Big) - I_n(1+r)^{-1}\Big]$$

Where:

- PV_n = the present value (cost) of a perpetual replacement policy of n years
- r = after tax discount rate
- C_o = initial cost
- C_n = value at end of n^{th} year in constant dollars
- T = tax rate
- R_k = repair cost in k^{th} year in constant dollars
- A_n = Additional first year depreciation which can be taken with a replacement policy of n years.
- D_k = regular depreciation in k^{th} year
- I_n = investment credit which can be taken with a replacement policy of n years

For convenience, the model assumes salvage value and useful life are correctly anticipated so terms for depreciation recapture and recapture of investment credit are not needed.

Data for remaining value and annual repair cost were generated for a wheeled tractor with a new cost of $15,000. The remaining value at the end of each year as a percent of new cost was estimated from the equation RV=65.6-4.1X using data from a study by Peacock and Brake [p.5] where X is the tractor's age. Annual repair costs for an assumed 800 hours of annual use were calculated from a repair cost function developed by Bowers [p. 32]. Table 1 shows the year-end remaining value and annual repair costs in constant dollars for 14 years.

The results of this analysis are shown in Table 2 for selected combinations of after-tax discount rates and tax rates. Several conclusions can be drawn from these

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[1] In the computer program written to evaluate the present values, additional first year depreciation was not permitted until a 6-year or longer replacement period was being evaluated and the reduced investment credit tax for a 3-6 year useful life was also included in the program.

Table 1. Remaining value and repair cost data for $15,000 tractor

Year	Remaining Value	Annual Repair Costs
0	$15,000	$ 0
1	9,225	310
2	8,610	566
3	7,995	734
4	7,380	869
5	6,765	985
6	6,150	1,090
7	5,535	1,184
8	4,920	1,273
9	4,305	1,355
10	3,690	1,432
11	3,075	1,506
12	2,460	1.576
13	1,845	1,643
14	1,230	1,707
		$16,230

Table 2. Optimal replacement policy in years

		Depreciation Method	
Tax rate	After-tax discount rate	Straight line	Double declining balance
0	0	9	9
0	1	10	10
0	3	11	11
0	5	14	14
0	10	14	14
25	0	8	8
25	1	9	9
25	3	11	11
25	5	14	13
25	10	14	14
50	0	7	7
50	1	8	8
50	3	12	11
50	5	14	13
50	10	14	14

results: 1) the after-tax discount rate has the greatest effect on optimal replacement policy, 2) the tax rate causes only slight differences in optimal replacement policy , 3) the depreciation method used has little effect on replacement age and 4) the optimal replacement age is longer than that normally observed to be followed by full-time, commercial farmers particularly at the higher discount rates. These last two conclusions support Chisholm's results.

A major factor in determining replacement age in the model is the pattern of repair costs. For example, if the pattern of repair costs experienced by farmers is different than the one used here, it may explain some of the difference in replacement age calculated here and that followed by farmers. Annual repair costs calculated by Bower's equation increase at a decreasing rate. To test the effect of another repair cost function, one was generated with annual repairs increasing at an increasing rate but with the total repair cost still $16,230. This repair function caused as much as a 5 year change in the optimal replacement policy. Optimal replacement age was 7 or 8 years for after tax discount rates of 0% and 1% and increased with the discount rate to become 12 or 14 years at a 15% discount rate. Again, these results were affected little by tax rate or depreciation method used.

One of the factors contributing to the long replacement interval is the rapid depreciation during the first year. The nearly 40% loss in value the first year represents a major cost to be borne by an early replacement policy. Other factors which would be expected to lengthen the replacement age are the 6 year or longer useful life necessary to take additional first year depreciation and a required useful life of 7 years before the full 7% investment credit can be taken. These tax regulations would encourage a replacement age of at least 7 years but investment credit provides no incentive for a longer interval.

Contrary to Chisholm's results we found that additional first year depreciation and investment credit did affect optimal replacement age. Dropping both of these terms from the model caused the optimal replacement age to increase by from 1 to 4 years for the smaller discount rates. There was no change for after-tax discount rates greater than 5 percent and, as would be expected, the differences tended to be larger the higher the tax rate. As can be seen in Table 3, investment credit causes most of the change.

While the tax regulations which permit using double declining balance depreciation and taking additional first year depreciation and investment credit did not have as large an effect on replacement age as might be expected, they also had some effect on the present value (cost) of a particular replacement policy. The values for selected tax rate-discount rate combinations under various tax regulations are shown in Table 3. The effect of these tax regulations is to lower the present value (cost) of any replacement policy. This result has probably encouraged the trend towards larger equipment and the substitution of machinery capital for labor. The net result is a larger overall investment in farm machinery than would have existed without these incentives. Whether the primary intent of these rules was to encourage faster replacement or a larger investment is unknown. It is obvious, however, that the result has been to encourage both faster replacement and a larger capital investment in farm machinery but perhaps neither result was as large as hoped for.

A tax policy specifically designed to encourage faster replacement may in fact be self-defeating. Such a policy when applied only to new equipment would likely depress

Table 3. Present value (cost) under selected tax policies[1]

Tax Rate	Discount Rate	S/L Deprec. Only	DDB Deprec. Only	DDB Deprec. plus AFYD	DDB Deprec. plus InvCr	DDB Deprec. plus AFYD and InvCr
		dollars				
0	1	219759 (11)	219759 (11)	219759 (11)	209156 (10)	209156 (10)
0	3	78886 (13)	78886 (13)	78886 (13)	75509 (11)	75509 (11)
0	5	50651 (14)	50651 (14)	50651 (14)	48631 (14)	48631 (14)
0	10	29974 (14)	29974 (14)	29974 (14)	28679 (14)	28679 (14)
25	1	167241 (11)	166556 (11)	166369 (11)	155684 (11)	155550 (9)
25	3	61450 (14)	60934 (13)	60686 (13)	57509 (11)	57316 (11)
25	5	40334 (14)	39838 (14)	39565 (14)	37795 (13)	37541 (13)
25	10	25002 (14)	24513 (14)	24225 (14)	23217 (14)	22929 (14)
50	1	114663 (12)	113354 (11)	112964 (12)	102053 (8)	101831 (8)
50	3	43992 (14)	42981 (13)	42468 (14)	39478 (10)	39123 (11)
50	5	30016 (14)	29025 (14)	28478 (14)	26904 (12)	26433 (13)
50	10	20030 (14)	19052 (14)	18476 (14)	17756 (14)	17180 (14)

[1] At the optimal replacement years shown in parentheses.

the market for used equipment thereby lowering its price. Once this lower price was incorporated into the replacement decision there may be no or at least not the total desired effect on the optimal replacement age.

To test the effect of lowering the useful life requirements for assets to be eligible for additional first year depreciation and investment credit, results were obtained for the case where both deductions could be taken in full with a 3-year useful life. There was no change in the optimal replacement age when compared to those calculated under the current eligibility rules. However, an increase in the investment credit rate does affect optimal replacement age. Using the 10% rate permitted in 1975 and 1976 caused a 1 or 2 year reduction in the replacement age for after-tax discount rates of 5 percent or less when using double declining balance depreciation.

CONCLUSIONS

U.S. tax policy which permits applying double declining balance depreciation, additional first year depreciation and investment credit to farm equipment has encouraged some changes in optimal replacement age depending on tax bracket and after-tax discount rate. However, the optimal replacement ages calculated by the model are longer than observed on many farms indicating there are factors not included in this model which affect farmers' replacement decisions.

Some possible explanations are: 1) a repair cost pattern which is different than either considered in this study, 2) the desire or need to replace with a larger machine, 3) a desire to replace earlier in order to utilize the improved technology incorporated in the replacement and 4) the loss in reliability as a machine ages.

A lower reliability is caused by older machines having a higher probability of a major breakdown. The cost of a breakdown at critical times of the year in terms of the cost of delayed planting or harvesting may be large. If farmers view this loss of reliability as a cost which increases with age or as a loss in technical efficiency or capacity which increases with age, it would help explain their more rapid replacement policy.

Technology has continued to improve the capacity, efficiency, convenience and operator comfort incorporated in farm equipment. These continual technological improvements undoubtedly contribute to a shorter replacement policy. When the authors showed the results of this study to a farmer and then asked him why he traded tractors at a much earlier age, his immediate response was, "because the new one is always better."

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