Optimal Machinery Replacement under Accelerated Depreciation

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The last several years have seen tax law changes that provide accelerated depreciation for farmers. The most recent tax law is the GO Zone established to help counties in states affected by the 2005 hurricanes. The area in Mississippi offered GO Zone status actually covers two-thirds of the state. Earlier, the Job Creation and Worker Assistance Act of 2002 offered accelerated depreciation. While both these laws are temporary, they did offer farmers the opportunity to take up to a 50 percent depreciation allowance for qualified new property. While the Job Creation and Worker Assistance accelerated depreciation is basically over, the GO Zone accelerated deprecation is still available through 2008.

While the preceding two tax laws are temporary and limited geographically, the 179 deduction is neither. The 179 deduction has been increased from $24,000 to $100,000 ($108,000 for 2006). There are still limits on what property qualifies and whether a farmer can actually use this particular accelerated depreciation method.

Congress seems determined to allow businesses the opportunity to expense the majority of the cost of a new durable asset in the first year of the asset's life. For many farm assets, the 179 deduction allows a farmer to write-off the entire purchase price in one year. Laws such as the GO Zone tax breaks allow additional depreciation beyond what is available under a 179 deduction. While the 50% acceleration allowance has been temporary, this is the second time in five years that Congress has allowed additional accelerated depreciation

These laws seem to be designed to help stimulate the economy by encouraging farmers to purchase more machinery and to replace machinery more often. Farmers do benefit because lower taxes this year are probably better than lower taxes in future years (as long as marginal tax rates are the same). Less clear, however, is whether farmers should actually replace machinery more frequently. In other words, is the optimal lifespan of an asset reduced due to new accelerated depreciation laws?

For most producers, machinery and equipment investments amount to a large percentage of total assets. Given the small profit margins on many farms, replacing machinery at a less than optimal age could significantly affect profitability. Finding the optimal asset age is also important for planning and farm budgeting. This paper analyzes the new accelerated depreciation laws to determine if the expected lifespan of farm machinery should be reduced. In addition, the paper introduces stochastic elements into the model to determine if uncertainty about future costs affects the replacement decision.

Most assets have an optimal lifespan. Financial theory has several ways to calculate the expected optimal lifespan of an asset. These methods examine the purchase price, yearly operating costs and profits, and final salvage value to determine the optimal asset life. These methods all assume that assets become less productive over time or that their operating costs increase each year. In general, as purchase price or yearly profit increases, the optimal lifespan should also increase. By contrast, higher operating cost each year or a lower purchase price should reduce the optimal lifespan.

Most capital purchases by businesses must be expensed over several years rather than expensed all at once when purchased. A depreciation schedule recognizes the yearly expenses of an asset being used up (Oltmans, Klinefelter, and Frey). Ordinary wear and tear, natural deterioration from exposure to the elements, and technical obsolescence all contribute to the yearly decline in asset value (FFSC). Therefore, depreciation is a procedure to match the decline in asset value to the yearly expense taken.

Accelerated depreciation provides more profits in the beginning years which are weighted more due to the time value of money. This has the effect of increasing the net present value of profits. Therefore, accelerated depreciation should reduce the optimal lifespan of an asset. The important question for producers is if this gain is actually enough to change the optimal expected lifespan of farm machinery.

Previous work in this area examined tax law changes that were quite a bit different than the most recent law changes. Much of the earlier work examined changes in investment credits. In addition, the earlier work with optimal asset life used deterministic models.

These previous models that address the asset lifespan questions will be modified to include current accelerated depreciation laws and will also make the variables for future costs stochastic. The model will be applied to cost information about mid-size tractors to determine if the anticipated replacement age changes. Sensitivity analysis will be used to test the robustness of the results. Even though there is some variability with the inputs, farmers are really interested in the lifespan for planning purposes.

Tax deprecation often does not reflect the actual decrease in asset value. Frequently, the tax life of an asset is shorter than the asset's actual life. In addition, many assets will have a salvage value when sold whereas tax depreciation methods often take the book value of the asset down to zero. Accumulated tax depreciation is the basis for an asset's book value and the book value may or may not reflect the asset's true market value.

Background

According to the Farmer's Tax Guide, most types of tangible property can be depreciated. The main exception is land. Purchased breeding livestock can also be depreciated. The main requirements for depreciation are: it must be owned property and used for business purposes, and it must have a determinable useful life of more than one year.

Most property is depreciated under the Modified Accelerated Cost Recovery System (MACRS) method. With MACRS, it is important to determine the asset's placed-in-service date and the recovery period. The depreciation scheduled can be easily calculated with this information. For machinery, the recovery period is seven years. This paper assumes the half-year convention when placed in service (Costin). This means machinery is assumed to be purchased midyear. A seven year recovery period and a midyear start date results in a MACRS depreciation schedule of 10.71% in year one, 19.13% in year two, 15.03% in year three, 12.25% in years four through seven, and 6.13% in year six. As can be seen, the partial year convention actually adds another year to the depreciation schedule.

The last several years have seen tax law changes that provide accelerated depreciation for farmers. These changes allow farmers the opportunity to take more depreciation in the year the asset is purchased. The most recent tax law is the Job Creation and Worker Assistance Act of 2002[4]. With this law, two methods of accelerated deduction have been increased. First, the 179 deduction has been changed from $24,000 to $100,000. In addition, the threshold for using the 179 deduction has increased from $200,000 to $400,000. Therefore, as long as a farmer does not acquire more than $400,000 in section 179 eligible property, he or she can take up to the $100,000 in 179 deduction expenses. Acquiring more than $400,000 in 179 eligible properties reduces the amount of 179 expenses a farmer can take. There are still limits on what property qualifies and whether a farmer can actually use this particular accelerated depreciation method.

The other major depreciation change is a special 50 percent depreciation allowance for qualified new property placed in service after May 5, 2003 (Job Creation and Worker Assistance Act of 2002). New property placed in service before May 5th can still use the 30 percent special deprecation allowance that was enacted after 9/11. However, farmers cannot use both the 50 percent special depreciation allowance and the 30 percent allowance together. They can though use both the special 50 percent allowance and the 179 deduction together. The only caveat is that the 179 deduction is taken first and the 50 percent special allowance is applied to the remainder. In general, the special 50 percent depreciation allowance has fewer restrictions on its use than does the 179 deduction.

<u>Model</u>

Most assets have an optimal lifespan. Financial theory has several ways to calculate the expected optimal lifespan of an asset. These methods examine the purchase price, yearly operating costs and profits, and final salvage value to determine the optimal asset life. These methods all assume that assets become less productive over time or that their operating costs increase each year. In general, as purchase price or yearly profit increases, the optimal lifespan should also increase. By contrast, higher operating cost each year or a lower purchase price should reduce the optimal lifespan. Accelerated depreciation laws, by lowering profits in later years and shifting the profits to earlier years, have the potential to reduce the optimal life of an asset.

Previous work by both Perrin and Barry show how net present value rules can be used to evaluate a replacement decision. Assets must be replaced when they wear out but often the optimal replacement occurs earlier because either the productivity drops off or the repairs and maintenance become increasing prohibitive. The model presented in Barry uses the asset cost, yearly asset value, and yearly returns or costs to analyze the replacement decision. The model in Barry is shown in equation 1.

$$(1) \qquad V_0 = \frac{1}{1-(1+i)^{-S}} \cdot \left[\sum_{n=1}^{S} \frac{R_n}{(1+i)^n} + \frac{M_S}{(1+i)^S} - M_0 \right]$$

This model does not specify taxes or how the tax shield of depreciation would affect the decision. Modifying the model to include taxes and deprecation is given in equation 2.

$$(2) \qquad V_0 = \frac{1}{1-(1+i)^{-S}} \cdot \left[\sum_{n=1}^{S} \left(\frac{R_n \cdot (1-t) + D_n \cdot t}{(1+i)^n} \right) + \frac{M_S - (M_S - B_S) \cdot t}{(1+i)^S} - M_0 \right]$$

where

V_0 = present value of perpetual annuity received every S years

S = year of replacement

R_n = return (cost) in year n

M_S = asset value in year S

M_0 = original asset value or purchase price

i = discount rate

t = ordinary income tax rate

D_n = tax depreciation in year n

B_S = asset basis in year S

To find the optimal lifespan of an asset in either equation 1 or 2, the equation must be solved for each possible year (i.e., S = 1 to maximum possible asset life). The year that provides the greatest present value is the year the asset should be replaced.

There are three differences between equations 1 and 2. First, equation 2 allows for taxes on the yearly return provided by the asset, $R_n \cdot (1-t)$. This income tax term is independent of depreciation and may have been implied in Equation 1. Next, Equation 2 provides for the tax shield of depreciation, $D_n \cdot t$, in each year. Depreciation varies each year and in dependent upon the depreciation method used. Finally, the term, $(M_S - B_S)\cdot t$, represents the recovery of depreciation if the asset is sold for more than the asset basis or book value. This gain is taxed as ordinary income as long as the asset ending value is not above the original purchase price.

The basis, B_S, in a given year can be defined as:

(3) $$B_S = M_0 - \sum_{n=1}^{S} D_n .$$

Specifying the model in Equation 2 requires two assumptions. First, the asset does not appreciate in value. If depreciation did occur, then capital gains would need to be added to the model to account for the asset value increase. Appreciation was not specifically modeled in Equation 2. The other assumption is that market value is always greater than the asset basis (i.e., $M_S > B_S$).

To make the model stochastic, a triangular distribution is used for the value of the tractor in each year. A triangular distribution is used because data exists about the low, high, and mid-point values of used tractors but little other information is known. To make the model more realistic, the yearly values are correlated. Again, not much information is known about correlations between years so a 12 year correlation table was assumed. This correlation table has a 0.9 correlation between the first year and second year, 0.8 correlation between the first year and third year, and so on.

Data and Methods

To use the model in Equation 2 to evaluate the lifespan of a tractor, information is needed about the price of a replacement tractor, repair and maintenance costs each year, the value of the tractor at the end of each year, the interest rate, the marginal tax rate, and the tax depreciation method. Information about new and used tractor prices comes from the *Dealer Edition of the Winter 2006 Official Guide*. This guide lists the current value of new and used equipment for each machine model. In this paper, a John Deere 7420 tractor is used to test the model. This tractor is a 115 horse power tractor. Because John Deere changes models frequently, models 7410 and 7400 are used to complete the series and give 12 years of data. These older models are quite similar to the 7420 tractor.

Four depreciation methods are tested. One is the standard seven-year tax depreciation. Typically, assets are considered to be put into service at the midpoint of the year. Thus, normal seven-year tax depreciation actually results in eight years of depreciation. The first and last years are only one-half of normal. The second tax depreciation method uses the 50% special depreciation allowance in the first year with the remaining value deducted following the typical depreciation schedule. Because the only difference between normal and the 50% special depreciation is an extra first year deduction, the tractor is still depreciated over eight years.

The third depreciation method tested is the 179 special depreciation allowance. The entire cost of the tractor could be depreciated in year one if all the requirements are meant. Because the limits have been raised on 179 deductions, more farmers can use this method than before. In this paper, we assume the use of the 179 deduction takes the tractor's value to zero in year one. Depending upon the total assets purchased, the 179 deduction could be eliminated or reduced.

The last depreciation method is one where the tax depreciation matches the economic depreciation. A test model is also included that ignores the tax benefits of depreciation.

Each set of prices from each year of data are tested to see if the tax depreciation method does make a difference in the year the tractor should be sold. The data set is somewhat constrained by the lack of good long-term information about repair and maintenance costs.

Results

Figure 1 shows the results for the five depreciation methods at a 7% interest rate. As the figure shows, trading tractors in year 12 is optimal for the all the depreciation methods, even when there are no tax benefits to depreciation. This figure is based on the expected value of the yearly distribution. Figure 2 shows the results of how the stochastic tractor value affects the results. The stochastic elements do not affect the year to trade

Conclusions

The results should be useful to anyone connected agriculture. Farmers can improve their profitability by planning to replace their machinery at an optimal age. Lenders can manage operating and other farmer loans better if they know how often assets are to be turned over. Policy makers and Extension workers will have more knowledge about what kind of recommendations to make to farmers. Finally, the results should show if accelerated depreciation laws do help farm input suppliers sell more to farmers.

The accelerated depreciation is a benefit to farmer as it lowers their yearly cost (mainly due to getting money earlier rather than later). However, the accelerated depreciation methods do not affect the year the asset should be sold.

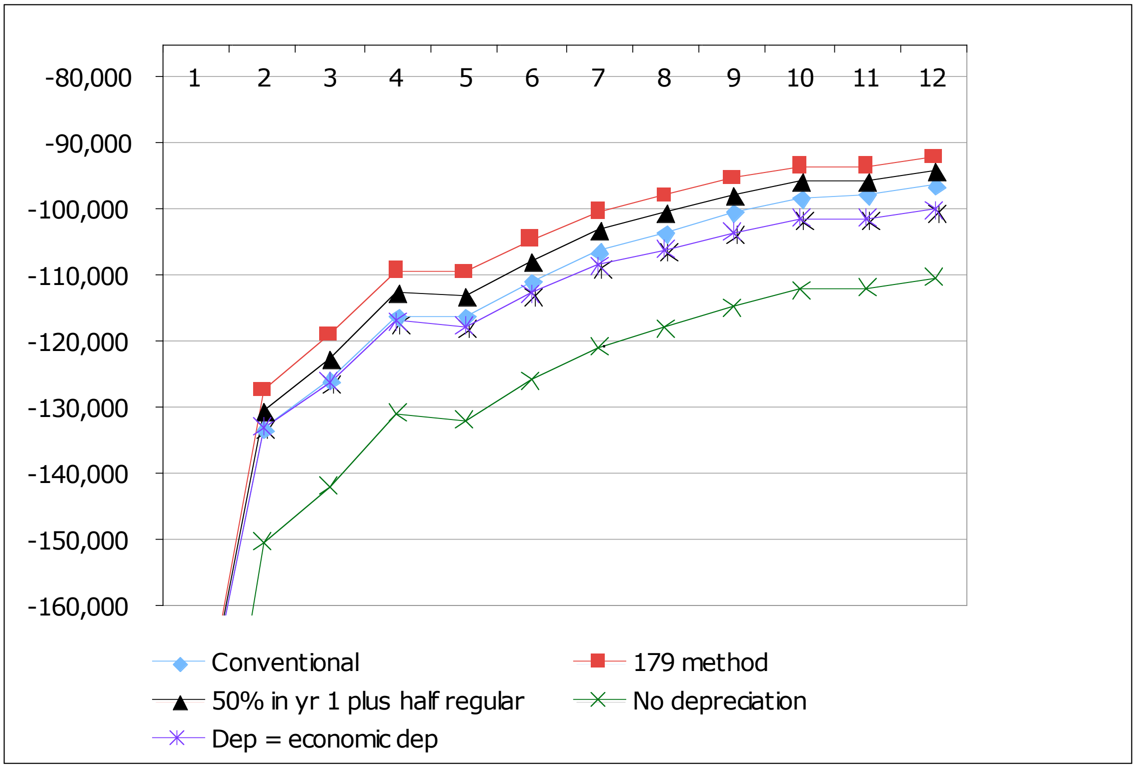
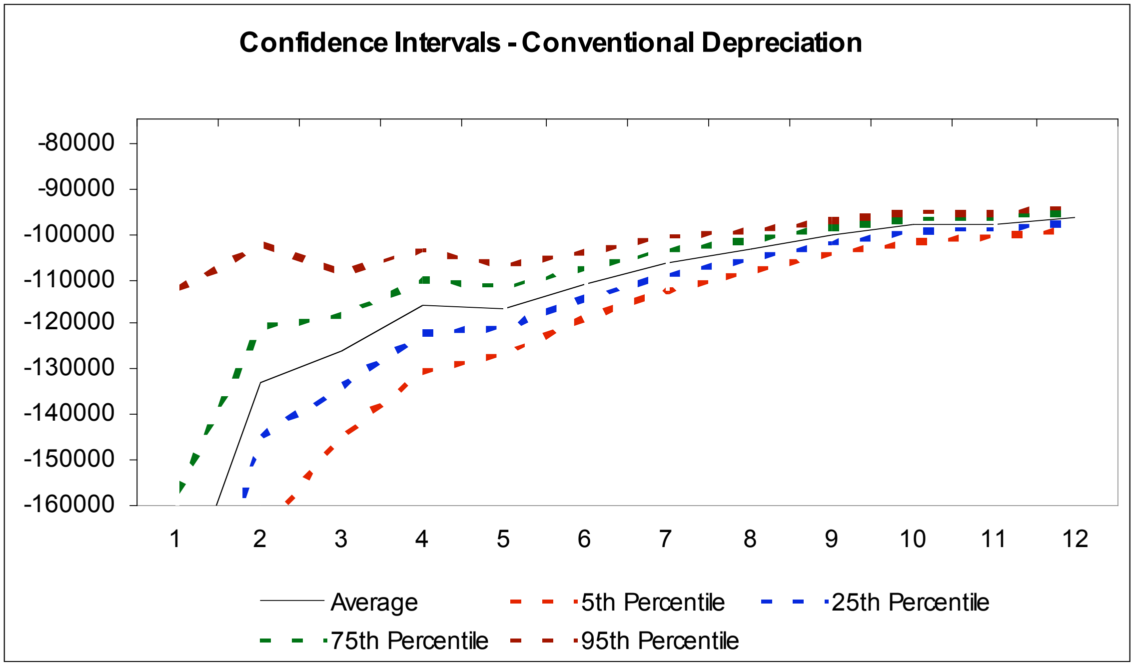


Figure 1. Machinery Costs from Trading in Different Years



Confidence Intervals - Conventional Depreciation
-80000
-90000
-100000
-110000
-120000
-130000
-140000
-150000
-160000
1
2
3
4
5
6
7
8
9
10
11
12
Average
5th Percentile
25th Percentile
75th Percentile
95th Percentile

Figure 2

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