

THE EFFECTS OF CHANGES IN THE TAX STRUCTURE ON AGRICULTURAL ASSET REPLACEMENT

Vincent H. Smith

Abstract

This paper uses a deterministic asset replacement model to examine the implications of the 1986 Tax Reform Act (TRA) for replacement investment in U.S. agriculture. The optimal replacement age for an asset is shown to be inversely related to the size of investment tax credits and the present value of depreciation allowances but generally directly related to marginal tax rate. Simulation results indicate that the net effects of the TRA vary across assets. Replacement ages for assets with relatively long depreciation lives (e.g., farm structures) tend to fall. Those for assets with relatively short depreciation lives rise (e.g., tractors).

Key words: agriculture, investment, replacement, taxes.

The 1986 Tax Reform Act (TRA) radically altered the environment in which farmers make choices about the timing of asset replacements and net investment. This paper is concerned with the effects of three aspects of the new tax laws that directly affect farm asset replacement decisions: (1) the abolition of the investment tax credit, (2) adjustments in the depreciation schedules permitted for tax purposes, and (3) adjustments in the structure of marginal tax rates that are likely to reduce marginal personal income tax rates or marginal corporate tax rates for most farms (Durst).

A theoretical asset replacement model is used to examine the individual effects of each of the above adjustments. The model is similar in its basic structure to those developed by Perrin; Chisholm; Kay and Rister; Bates, Rayner, and Custance; Bates and Rayner; Bartholomew; Reid and Bradford; Trapp; and Lynne. However, an alternative derivation is also provided for the result originally shown by Chisholm (p. 779) that an increase in investment tax credits will reduce optimal asset replacement ages. In addition, two new analytical results are obtained concerning the effects of changes in the structure of

depreciation allowances and marginal tax rates on optimal asset replacement decisions.

The analytical results presented below indicate that, *ceteris paribus*, the abolition of the investment tax credit and reductions in the present values of tax depreciation allowances will increase optimal replacement ages and reduce optimal replacement rates. On the other hand, reductions in marginal tax rates are likely to reduce optimal replacement ages and increase optimal replacement rates. However, the joint effects of the three provisions are analytically ambiguous; therefore, a new simulation technique is used to resolve the issue. The simulation technique is innovative because, in contrast with models used in previous studies, it does not require information about the intertemporal cost and revenue streams associated with a specific asset. The approach is used to assess whether asset replacement rates for three types of assets will increase or decrease as a result of the provisions of the 1986 TRA. The assets examined are (1) equipment and machinery with short tax depreciation schedules (e.g., pickup trucks), (2) equipment and machinery with longer tax depreciation schedules (e.g., tractors), and (3) farm structures. The simulation results suggest that the TRA provisions are likely to decrease asset replacement rates for equipment and machinery, but to increase them for farm structures.

AN ANALYTICAL MODEL OF THE EFFECTS OF THE TRA ON ASSET REPLACEMENT

The analytical model developed here is an asset replacement model similar to the type originally suggested by Perrin that has been utilized by others (with some variations) to examine farm asset replacement decisions in several studies (e.g., Chisholm; Kay and Rister; Bates, Rayner, and Custance; Bartholomew; Bates and Rayner; Reid and Bradford; Trapp; Lynne). In this model, the farm-firm is assumed to maximize the present value of the net income stream associated with a particular category

Vincent H. Smith is an Assistant Professor of Economics at Montana State University.

The author greatly appreciates comments on earlier drafts of this paper by Ron Johnson, Bob Collender, Paul Fackler, Duncan Holthausen, Ray Palmquist, Mike Wohlgenant, Wally Thurman, members of the North Carolina State University Agricultural Economics Workshop, and three anonymous reviewers.

Copyright 1990, Southern Agricultural Economics Association.

of assets over an infinite time horizon. The firm is assumed to be certain about the size of all revenue and cost streams associated with the asset and to be free to replace it with an identical new asset at any moment in time. At the moment of replacement a new sequence of cost and revenue streams is initiated and the sequence is replicated at each subsequent moment of replacement. If the net income stream is defined in nominal terms, assuming constant relative prices and a constant expected rate of inflation, all incomes and outlays (including tax credits and allowances) will increase at the expected rate of inflation. However, the before-tax discount rate will also include an inflationary premium and in real terms each stream of net incomes associated with each new asset will have the same present value over the life of the asset. Changes in the expected rate of inflation will alter optimal replacement ages because (as Bates, Rayner, and Custance have pointed out) investment tax credits, depreciation allowances, and balance charge adjustments are based on historical costs; thus their present value to the firm will change. In this paper, however, only the effects of changes in tax laws are of concern, and thus the analysis can be carried out under the assumption that the inflation rate is constant and that the acquisition of a new asset results in the replication of real income streams.

The Asset Replacement Model

Using Perrin's notation, the present value (PV) of the net revenue streams associated with a specific unit of the asset may be written as:

$$(1) \quad C[0,s,1] = \int_0^s R(t) e^{-\rho t} dt + M(s)e^{-\rho s} - M(0),$$

where $C[0,s,1]$ is the present value of the stream of residual earnings of one unit of the asset purchased at age 0 and disposed of at age s ; t is time; $\rho = \ln(1+r)$, where ρ is the interest rate which, when compounded continuously, results in an annual growth rate of r ; $M(a)$ is the market value of the asset at age a ; and $R(a)$ is the flow of residual earnings (current revenues less current costs) associated with the asset at age a .¹

If the firm plans to cease the activities associated with the asset after one cycle then the problem reduces to selecting the value for s that maximizes equation (1). On the other hand, if the firm intends to replace the currently held asset with others of the

same type on a continuous basis then the PV of the net income stream is:

$$(2a) \quad C[0,s,\infty] = C[0,s,1] + e^{-\rho s} C[0,s,1] + e^{-2\rho s} C[0,s,1] + \dots,$$

or

$$(2b) \quad C[0,s,\infty] = [1 - e^{-\rho s}]^{-1} C[0,s,1],$$

and s is selected to maximize equation (2).

Perrin's model has to be adjusted to reflect the tax environment that was created by the 1981 Economic Recovery Tax Act (ERTA) and modified under the TRA. The ERTA permitted an investment tax credit at the end of the first period of ownership, a flexible depreciation schedule, and also took account of balancing charge adjustments. Such an adjustment had to be made when the resale value of the asset (for scrap or other purposes) is greater or less than the difference between the original purchase price of the machine and depreciation charges taken for tax purposes over the life of the machine. The excess deficit (balance) charge is subject to tax (tax relief) at the time the asset is scrapped. When the effects of ERTA on net revenues are taken into account, the PV of an asset's income stream becomes:

$$(3) \quad C[0,s,1] = (1 - T) \int_0^s R(t) e^{-\rho t} dt - M(0) + M(s)e^{-\rho s} + Ie^{-\rho} + T \int_0^s D(t) e^{-\rho t} dt - T \left[\int_0^s D(t) dt + M(s) - M(0) \right] e^{-\rho s},$$

where T is the marginal tax rate, $D(a)$ is the tax depreciation permitted for the asset at age a , and I is the investment tax credit taken at the end of the first time period in which the asset is owned. This income stream consists of the present value of the farm's after-tax residual earnings, $(1-T) \int_0^s R(t) e^{-\rho t} dt$, plus the sum of the present values of the investment tax credit obtained a year after purchase, $Ie^{-\rho}$, the depreciation tax credits that accrue over its life, $T \int_0^s D(t) e^{-\rho t} dt$, and its market value at the time of disposal, $M(s)e^{-\rho s}$, less the sum of the acquisition cost of the machine, $M(0)$, and the present value of the tax liabilities associated with the balance charge item

¹In equation (1), the asset's age is equal to t . However, in the infinite horizon model that permits asset replacement, the age of the currently held asset will be less than t if it is not the initial asset. Thus, at the outset, a distinction is made between the age of the asset, a , and the point of time in the firm's planning horizon, t .

$T \left[\int_0^s D(t) dt - M(s) + M(0) \right] e^{-\rho s}$. The balance charge itself consists of the term in brackets, $\int_0^s D(t) dt + M(s) - M(0)$, and is the sum of depreciation allowances and the market value of the machine at the moment of disposal less the original price of the machine.

First Order Conditions for Optimal Replacement Decisions

The first order condition for the solution to the continual asset replacement problem defined by equations (2) and (3) is:

$$(4) \quad \frac{\partial C[0,s,\infty]}{\partial s} = \frac{-\rho e^{-\rho s}}{[1 - e^{-\rho s}]^2} C[0,s,1] + \frac{1}{[1 - e^{-\rho s}]} \frac{\partial C[0,s,1]}{\partial s} = 0.$$

Substituting and rearranging terms, (4) becomes

$$(5a) \quad (1-T)[R(s) + M'(s)] = \frac{\rho}{[1 - e^{-\rho s}]} C[0,s,1] + \rho M(s) - \rho T \left[\int_0^s D(t) dt + M(s) - M(0) \right],$$

or, dividing throughout by $(1-T)$,

$$(5b) \quad R(s) + M'(s) = \frac{\rho}{(1-T)[1 - e^{-\rho s}]} C[0,s,1] + \frac{\rho}{(1-T)} M(s) - \rho \frac{T}{(1-T)} \left[\int_0^s D(t) dt + M(s) - M(0) \right].$$

Equation (5a) can readily be given a straightforward economic interpretation, while (5b) is analytically more convenient.

Equation (5a) can be interpreted as follows. The term on the left hand side (LHS) of (5a), $(1-T)[R(s) + M'(s)]$, represents the after-tax net marginal benefit of holding the asset at age s (the asset's net revenue, $R(s)$, plus the change in its value, $M'(s)$, adjusted for tax liabilities). The terms on the right hand side (RHS) have the following interpretations.

The first term $\frac{\rho}{[1 - e^{-\rho s}]} C[0,s,1]$, represents the cost at age s of delaying receipt of net income streams from subsequently held assets. It is the interest charge, ρ , on the present value of those future streams, $\frac{1}{[1 - e^{-\rho s}]} C[0,s,1]$. The second term, $\rho M(s)$, is the interest charge associated with holding

the asset itself at s while the third term, $-\rho T \left[\int_0^s D(t) dt + M(s) - M(0) \right]$, represents the interest yield on the balance adjustment tax liabilities avoided at s by delaying disposal of the asset. Consequently, the RHS of (5a) represents the opportunity cost for the firm of holding the assets at s and the first order condition simply requires that at s the marginal revenue from the asset be equal to the marginal cost of holding it.

Effects of Changes in the Tax Structure on Optimal Replacement Decisions

Equation (5b) can be used more conveniently to examine how changes in the tax structure affect the selection of the optimal replacement age. The LHS of (5b) is unaffected by changes in any element of the tax structure but is assumed to be inversely related to changes in s ; that is, as equipment ages, either the marginal cost of operating the asset rises, or its marginal product declines, or both phenomena occur (and at a rate sufficient to offset any reductions in the rate at which the remaining value of the equipment declines)—plausible assumptions for a wide range of physical assets. Thus any changes in the tax laws that increase the value of the right hand side of equation (5b) will reduce the optimal value for s . The tax code adjustments examined here include changes in the investment tax credit, the present value of depreciation allowances and the marginal tax rate.

The effect of changes in the investment tax credit can be determined by differentiating the RHS of (5b) with respect to I to obtain:

$$(6) \quad \left[\frac{\rho}{(1-T)(1 - e^{-\rho s})} \right] e^{-\rho s}.$$

This term is unambiguously positive for $\rho > 0$ and $T < 1$. Thus, as originally shown by Chisholm (p. 779), a reduction in the investment tax credit increases the optimal value of s and decreases replacement investment because it reduces the annuity that represents the average return from new assets (and therefore the opportunity costs of holding the current asset).

A similar procedure can be used to assess the effects of changes in depreciation schedules. First, note that the 1986 TRA schedule changes do not alter the total amount of depreciation that can be taken for tax purposes. Thus the term $\int_0^s D(t) dt$ remains the same. However, the changes in the depreciation schedule do alter the present value of

the tax rebates, $\int_0^s D(t)e^{-\rho t} dt$. Differentiating the RHS of (5b) with respect to that term yields:

$$(7) \quad \rho T ([1-T] [1-e^{-\rho s}])^{-1}.$$

The sign of this expression is also positive if $\rho > 0$ and $T < 1$. Any adjustments in the depreciation schedule that reduce the present value of the associated tax credits also reduce the annuity that represents average returns from new assets and, therefore, the opportunity cost of holding the current asset. As a result, the optimal value of s increases.

The effects of a change in the marginal tax rate, T , on the asset's optimal replacement age depend on whether the tax change alters the after-tax discount rate faced by the farmer. It can be argued that the before-tax discount rate is likely to change in the same direction as the tax change. Reductions in marginal tax rates are likely to have small (and possibly negative) effects on the demand for loanable funds because the after-tax cost of those funds to borrowers rises. At the same time, the supply of loanable funds is likely to increase because after-tax returns to lenders rise. The net effect of a reduction in marginal tax rates on the before-tax discount rate is therefore likely to be negative. The degree to which the after-tax discount rate changes depends on the elasticities of demand and supply for loanable funds.

If the before-tax discount rate (which can be defined as $\frac{\rho}{[1-T]}$) remains constant, differentiating the RHS of (5b) with respect to T and allowing for the effects of a change in T on ρ yields the following expression:

$$(8) \quad \frac{\rho}{[1-T]^2 [1-e^{-\rho s}]} \left[Ie^{-\rho} + \int_0^s D(t)e^{-\rho t} dt - M(0) \right] \\ + \frac{\rho}{[1-T]^2} \left[\frac{e^{-\rho s}}{[1-e^{-\rho s}]} + 1 \right] \left[M(0) - \int_0^s D(t) dt \right] \\ - \frac{\rho}{[1-T]} \left[\frac{[1-e^{-\rho s}(1+\rho s)]}{[1-T] [1-e^{-\rho s}]^2} C[0,s,1] \right. \\ \left. + \frac{\rho}{[1-T] [1-e^{-\rho s}]} \frac{\partial C[0,s,1]}{\partial \rho} + M(s) \right. \\ \left. - \frac{T}{[1-T]} \left[\int_0^s D(t) dt - M(0) \right] \right].$$

The direct effects of T on the components of the revenue stream in equation (5b) consist of the first two terms in equation (8); that is,

$$(9) \quad \frac{\rho}{[1-T]^2 [1-e^{-\rho s}]} \left[Ie^{-\rho} + \int_0^s D(t)e^{-\rho t} dt - M(0) \right] \\ + \frac{1}{[1-T]^2} \left[\frac{e^{-\rho s}}{[1-e^{-\rho s}]} + \rho \right] \left[M(0) - \int_0^s D(t) dt \right].$$

The remaining terms,

$$(10) \quad - \frac{\rho}{[1-T]} \left[\frac{[1-e^{-\rho s}(1+\rho s)]}{[1-T] [1-e^{-\rho s}]^2} C[0,s,1] \right. \\ \left. + \frac{\rho}{[1-T] [1-e^{-\rho s}]} \frac{\partial C[0,s,1]}{\partial \rho} + M(s) \right. \\ \left. - \frac{T}{[1-T]} \left[\int_0^s D(t) dt - M(0) \right] \right]$$

represent the effects of T on the RHS of (5b) via the after-tax discount rate. The part of equation (10) in the large square brackets:

$$(11) \quad \frac{[1-e^{-\rho s}(1+\rho s)]}{[1-T] [1-e^{-\rho s}]^2} C[0,s,1] + \frac{\rho}{[1-T] [1-e^{-\rho s}]}$$

$$\frac{\partial C[0,s,1]}{\partial \rho} + M(s) - \frac{T}{[1-T]} \left[\int_0^s D(t) dt - M(0) \right]$$

is the derivative of the LHS of (5b) with respect to ρ .

Perrin showed that the sign of equation (11) and, therefore, the effects of a change in the after-tax discount rate on the optimal replacement age are ambiguous. An increase in ρ , for example, decreases the capital recovery factor (reflected in the first term of equation (11) involving $C[0,s,1]$) and has the effect of increasing s . On the other hand, to the extent that the annuity associated with the ownership of future units of assets decreases, an effect reflected in the second term, the opportunity cost of holding the current asset one period longer rises and s tends to decrease.

If, in fact, the after-tax discount rate does not change (or change measurably) as a result of changes in marginal tax rates, the effects of a change in marginal tax rates on optimal replacement rates can be determined by examining equation (9). In that expression the first term $(Ie^{-\rho} + \int_0^s D(t)e^{-\rho t} dt - M(0))$ represents the present value of the difference between the sum of the depreciation allowances and investment tax credits associated with the asset and its purchase price over a period of length s . The term will be negative if the present value of investment tax credits and depreciation allowances is less than the purchase price of the asset. If, for example, a tractor subject to a 10 percent investment tax credit were fully depreciated over a five year period using the 1981 ERTA U.S. tax code accelerated cost recovery system (which

was much more generous than the current scheme), then the nominal discount rate would have to be less than 4.48 percent for the term to be positive. Under the 1986 modified accumulated cost recovery scheme, depreciation allowances would have to be spread over eight years (allowing for the effects of the half-year rule under which a firm can take only half of the first year depreciation allowance in the year of purchase) and the nominal discount rate would then have to be less than 3 percent for the term to be positive. Since the 1960s both actual and expected nominal before-tax and after-tax market discount rates have typically been substantially greater than 5 percent and thus the term has generally been negative.²

The second term in equation (9) contains the expression $M(0) - \int_0^s D(t)dt$. This expression represents the difference between the price of the asset and the total amount of depreciation claimed for tax purposes over the life of the asset. The term is zero under all of the depreciation schemes permitted in the U.S. since 1981 if the asset is held for longer than its tax life.

Overall, therefore, if the after-tax discount rate remains constant or its effects are negligible, a reduction in the marginal tax rate generally reduces the optimal age of the asset and by implication is likely to increase replacement investment. The reason is that the net effect of the tax cut is to increase the present value to the firm of the after-tax earnings from future assets (net of depreciation allowances) by more than it reduces the present value of the depreciation allowances associated with the asset. Thus, future assets become more attractive. At the lower marginal tax rate, the firm wants to acquire the larger net revenue streams associated with the new assets sooner and so replaces existing assets more quickly.

Effects of Changes in the Tax Structure on Optimal Scrapping Decisions

The firm also may consider scrapping the asset (not replacing it). Formally, its problem then is to select the value for s that maximizes the "one cycle"

present value of holding the asset; that is, $C[0,s,1]$. The first order condition obtained by differentiating equation (3) with respect to s may be written as:

$$(12) \quad R(s) + M'(s) = \rho M(s) - \rho \frac{T}{(1-T)} \left[\int_0^s D(t)dt - M(0) \right]$$

The asset will be disposed of at the moment in time when the before-tax net marginal benefit of holding the asset [the net revenue from the asset, $R(s)$, plus the change in value, $M'(s)$], is equal to the holding charge, $\rho M(s)$, less the interest yield obtained by avoiding tax liabilities associated with the balance

adjustment term $\left[\rho \frac{T}{(1-T)} \left[\int_0^s D(t)dt - M(0) \right] \right]$. In

this case the investment tax credit has no effect on the timing of the scrapping decision. Moreover, tax and depreciation allowance adjustments play a role only if the balance adjustment term is nonzero. Changes in the tax code will therefore have either no effect or very little effect on most scrapping decisions. Thus, only replacement decisions are examined in the simulations presented below.

SIMULATIONS

The analytical results indicate that the net effects of the 1986 TRA provision on optimal replacement ages are ambiguous. The TRA abolished the investment tax credit and reduced the present value of depreciation tax credits. The analytical results suggest that both provisions presented in equations (6) and (7) tend to increase optimal replacement ages and reduce replacement investment. On the other hand, equations (8) through (11) indicate that lower marginal tax rates tend to reduce optimal replacement ages and increase replacement investment. In this section, therefore, a simulation technique is used to assess whether the 1986 TRA is likely to increase or reduce optimal replacement ages for farm assets.

Assuming that the after-tax discount rate remains constant, the 1986 TRA tax adjustments can be shown to affect only the following components of the RHS of equation (5b):³

²Between 1970 and 1987, for example, annual average nominal before-tax interest rates charged on new loans by the Federal Land Banks never fell below 7.42 percent [United States Department of Agriculture]. In all except three of those years rates were greater than 8 percent and between 1980 and 1987 were in the range of 10.39 to 12.1 percent. Nominal after-tax discount rates for the vast majority of farmers were thus considerably greater than 5 percent for most of the 18 year period. Since 1980, even farms in the highest marginal corporate and income tax brackets (which at their maximums were, respectively, 46 percent and 50 percent) have faced after-tax discount rates in excess of 5 percent.

³Details of the proof for this result are available from the author. Note that the changes in the 1986 TRA rules directly affect all terms in equation (5b) other than residual earnings, the $R(t)$'s, and the resale price of the asset, $M(s)$. In fact, it is quite conceivable that indirect or secondary effects on the behavior of agricultural commodity and asset markets could occur. However, such feedback effects cannot be accounted for in this type of asset replacement model.

$$(13) \frac{\rho}{[1-e^{-\rho s}][1-T]} \left[-M(0) + Ie^{-\rho} + T \int_0^s D(t)e^{-\rho t} dt \right. \\ \left. - T \left[\int_0^s D(t) dt - M(0) \right] e^{-\rho s} \right] \\ - \frac{\rho T}{(1-T)} \left[\int_0^s D(t) dt - M(0) \right].$$

In addition to the marginal tax rate (T), the expression depends on the assumed after-tax discount rate (ρ), the optimal replacement age of the asset (s), and its purchase price ($M(0)$). The simulations were carried out in the following manner. In each case, an initial optimal replacement age was assumed for an asset with an arbitrarily selected purchase price, $M(0)$, owned by a farm facing an initial marginal tax rate and a fixed after-tax discount rate. The farm-firm was assumed initially to be operating under the provisions of ERTA that permitted a 10 percent investment tax credit and use of the ACRS depreciation tax allowances.⁴ An initial value for equation (13) was computed using these assumptions. The value of equation (13) was then recomputed using several new marginal tax rates under the assumption that the farm used the TRA depreciation schedules and could not claim any investment tax credits. Through this process it was possible to identify the marginal tax rate that left the value of equation (13) unchanged and therefore also left the optimal replacement age for the asset unchanged. If the farm was likely to face a smaller (larger) decrease in its tax rate than the one required to leave the asset's replacement age unchanged then, from equation (5b), the optimal replacement age for the asset would rise (fall).

The provisions that affect personal income tax rates may be most important for the agricultural sector as (according to the 1982 U.S. Census of Agriculture) 86.9 percent of all farms were owned by an individual or family and 10.4 percent by partnerships. Only 2.7 percent of all farms were owned by corporations. In addition, 86.2 percent of all farm acreage was operated by proprietorships and partnerships and only 13.8 percent by corporations. In most cases, the effects of the 1986 TRA were to reduce marginal tax rates for farmers. The USDA estimates that, in 1986, more than half of all farmers faced marginal personal income tax rates in

excess of 15 percent (Durst). As a result of the TRA, over 75 percent of all farmers face a marginal income tax rate of 15 percent. The 1986 TRA also reduced corporate tax rates for all firms except those earning profits of less than \$25,000. The largest reduction in corporate tax rates was from 46 percent to 34 percent for firms with profits in excess of \$100,000.

Three broad categories or classes of assets were considered in the simulations: (1) light trucks and machinery with tax depreciation lives adjusted from three years to five years, (2) heavy machinery and equipment (e.g., tractors) with tax depreciation lives adjusted from five to seven years and (3) farm structures with tax depreciation lives adjusted from 18 years to 20 years. In all cases the assets are no longer subject to investment tax credits on the accelerated capital recovery schedules (ACRS) with optimal switching to straight line depreciation permitted under the Economic Recovery Tax Act (ERTA). Under the TRA, the first two classes of assets became subject to the modified accelerated capital recovery schedules (MACRS) double declining balance with optimal switching depreciation schedules and the half-year rule that spreads tax depreciation allowances over an additional year. The third type of asset also became subject to the half-year rule and 1.5 accelerated depreciation with optimal switching. Although each firm is permitted to expense up to \$10,000 of investment outlays each year, that expensing option does not apply to each asset the firm acquires, only to its total outlays on all new assets. In this analysis, it was assumed that the asset being acquired was a marginal asset that did not provide the firm with the opportunity to expense its outlays. If, however, expensing is permitted on an asset because it is genuinely marginal then, depending on the initial acquisition cost of the asset, the expensing option might be worth more than the investment tax credit it replaced. In all other cases, expensing only provides a windfall gain to the firm that (if the industry is perfectly competitive) will be competed away over time through the entry of new firms (or a slow down in the exit of existing firms).

The results of the simulations are presented in Tables 1 and 2 for each class of asset under the assumption of a 10 percent discount rate⁵ and an arbitrarily selected initial value for the asset of \$10,000. Table 1 shows the new marginal tax rate

⁴ Accelerated Cost Recovery Schedules were defined under the 1981 ERTA and a firm was permitted to switch to straight-line depreciation at the optimal moment (in terms of maximizing the present value of depreciation allowances).

⁵ The results are not very sensitive to changes in this assumption, which is not surprising given the ambiguity associated with the effects of the changes in the discount rate on optimal scrapping ages indicated by equation (11).

Table 1. Marginal Tax Rates Required to Leave Optimal Replacement Ages Unchanged for Three Classes of Assets Under the Provisions of the 1986 TRA.

Class Of Assets	Initial 1981 Marginal Tax Rate (%)	1986 TRA Marginal Tax Rates (%)										
		Optimal Replacement Age (Years)										
		S=5	S=6	S=7	S=8	S=9	S=10	S=15	S=20	S=25	S=30	
Class 1 Assets	50	12	11	10	10	9	8					
	45	4	3	2	2	1	0					
	40	N	N	N	N	N	N					
Class 2 Assets	50							24	23	22		
	45							17	16	15		
	40							10	9	8		
	35							2	1	0		
Class 3 Assets	50									45	45	44
	40									34	34	33
	30									23	22	22
	20									11	11	11
	10									0	0	0

Note that S denotes the optimal replacement age of an asset and that the 1986 TRA marginal tax rate is the marginal tax rate that leaves the optimal replacement age constant. Also, N denotes that no positive or zero tax rate will leave the optimal replacement age constant under the 1986 TRA rules.

at which the optimal replacement age for an asset remained constant for each of the cases considered. Table 2 shows the change in the marginal tax rate required to keep the optimal replacement age constant (i.e., the initial marginal tax rate less the new marginal tax rate). Initial optimal asset lives of five to ten years were considered for the first class of asset (light trucks and machinery); initial optimal lives of 10, 15, and 20 years were considered for the second class (heavy machinery and tractors); initial optimal lives of 20, 25, and 30 years were considered for the third class (farm structures). If a farm experienced a shift to a higher marginal tax rate than the one indicated in the table, the optimal replacement age for the asset would increase and replacement investment rates would decline. If the farm shifted to a lower marginal tax rate than the one indicated then the optimal replacement age would fall and replacement investment rates would increase.

In the case of class 1 assets, Table 1 shows that farms facing 50 percent marginal tax rates under the 1981 ERTA would have to experience marginal tax rates of between 8 percent and 12 percent under the 1986 TRA (depending on the initial optimal age of the asset) in order for the optimal replacement age for the asset to be unchanged. In other words, as shown in Table 2, their marginal tax rates would have to fall by between 38 and 42 percent. Similarly large marginal tax rate declines would have to be experienced by farms with initial marginal tax rates of 45 percent. For farms facing marginal tax rates

of less than 40 percent under the 1981 ERTA, the marginal tax rates have to become negative in order to leave optimal replacement ages for class 1 assets unchanged. In fact, virtually all farms are likely to have experienced smaller tax rate cuts under the 1986 TRA than those required to keep class 1 asset optimal replacement ages constant. Replacement ages for such assets therefore are likely to increase and replacement investment rates to decline. A similar situation exists in the case of class 2 assets (tractors and heavy machinery) even though the tax rate adjustments required for neutrality are more modest.

In marked contrast, tax cuts required to leave the optimal replacement ages of class 3 assets (farm structures) unchanged are much smaller. Table 2 shows that the sizes of the cuts lie in the range of 5 to 9 percent depending on the initial optimal replacement age for the asset and the initial tax bracket for the farm. The actual marginal tax rate changes experienced by many farms under the terms of the 1986 TRA are likely to exceed those required for replacement age "neutrality." Thus, as a result of the 1986 TRA, on average optimal replacement ages for farm structures are likely to fall and replacement investment rates to increase. The major reason for the different conclusion with respect to class 3 assets is that the 1986 TRA caused much smaller changes in the present value of depreciation tax credits for assets with long tax lives than for assets with short tax lives. Thus, larger assets required much smaller

Table 2. Changes in Marginal Tax Rates Required to Leave Optimal Replacement Ages Unchanged Under the 1986 TRA.

Class Of Assets	Initial 1981 Marginal Tax Rate (%)	1986 TRA Marginal Tax Rates (%)										
		Optimal Replacement Age (Years)										
		S=5	S=6	S=7	S=8	S=9	S=10	S=15	S=20	S=25	S=30	
Class 1 Assets	50	38	39	40	40	41	42					
	45	41	42	43	43	44	45					
	40	>40	>40	>40	>40	>40	>40					
Class 2 Assets	50							26	27	28		
	45							28	29	30		
	40							30	31	32		
	35							33	34	35		
Class 3 Assets	50									5	5	6
	40									6	6	7
	30									7	8	8
	20									9	9	9
	10									10	10	10

Note that S denotes the optimal scrapping age of an asset.

marginal tax rate adjustments to keep their optimal replacement ages constant.

The above simulations were carried out under the assumption of an initial optimal replacement age for the asset in question and examine the direction in which the optimal age will move from that original level. A recent paper by Lynne demonstrates that multiple optimal replacement ages are possible. If the number of optimal replacement ages is not changed, the conclusions presented here will still hold. Each of the multiple optimal replacement ages will change in the same direction (though probably by differing amounts) given the assumptions about other parameters in the simulations. Problems arise only if the number of equilibrium replacement ages changes. It is conceivable that the TRA could result in the removal of an intermediate optimal replacement age. All of the remaining equilibria could have increased, but a switch to a lower optimal replacement age by those firms that previously selected the now defunct intermediate equilibrium age could reduce the average replacement age across all firms for assets of that type. However, that outcome seems unlikely. Lynne suggests that multiple equilibrium replacement ages occur when the expensing option is available and that the expensing option is responsible for optima that occur earlier rather than later. Although he does not examine the investment tax credit, it has effects similar to those of the expensing option on the net revenue streams associated with an asset. The TRA removes investment tax credits and its expensing option does not affect the purchase of many assets. Thus, Lynne's findings

suggest that on average the TRA is more likely to discourage early replacement than to encourage it.

CONCLUSIONS

Provisions of the 1986 TRA that resulted in the abolition of the investment tax credit and reductions in the present values of tax depreciation allowances will increase optimal replacement and scrapping ages for physical assets. On the other hand, cuts in marginal income and corporate tax rates associated with the TRA will reduce optimal replacement and scrapping ages and increase replacement investment rates. The results of simulations indicate that the combined effects of the provisions to abolish the investment tax credit and to restructure depreciation allowances will dominate the effects of the cuts in marginal tax rates on optimal replacement ages for class 1 and class 2 assets, physical assets with tax depreciation lives of less than seven years. Thus optimal replacement ages for those assets will increase. Such assets include almost all equipment and machinery. In contrast, the reverse holds true for class 3 assets such as farm structures whose tax depreciation lives exceed 20 years.

Ceteris paribus, suppliers of farm equipment and machinery are likely to face lower rates of demand for their products over the long run. The outcome, however, depends on the impact of the 1986 TRA on the price of capital services relative to the prices of other agricultural inputs. If the 1986 TRA raises the price of machinery and equipment services relative to the prices of other farm inputs because of the loss of the investment tax credit and lower de-

preciation allowances (but does not alter measurably the price of agricultural products relative to other products) then the demand for services from machinery and equipment is likely to decline in each future time period, implying reductions in optimal levels of net investment as well as optimal levels of replacement investment. The story with respect to farm structures is different. The results presented here suggest that optimal replacement lives for such assets will fall, implying higher rates of replacement investment.

One important extension of this research would be to examine simultaneously farm decisions about replacement and net investment. A second extension would be to provide a clear link between the analysis and the literature on asset fixity. Clearly, an increase (decrease) in the optimal replacement age for a physical asset would increase (decrease) the apparent fixity of that asset on the farm. Whether that is good or bad is entirely another matter. A third useful extension would be to quantify the size of the effects of the TRA on replacement ages and rates for each type of asset. However, this

type of analysis would require considerable amounts of accurate data on residual earnings streams and asset acquisition and resale prices that are often difficult to obtain. An exception is Lynne's study of sugar cane. A more extensive analysis should also account for the effects of uncertainty about future input and output prices, yields, and tax policies. Prices, yields, and Federal government tax policies are likely to vary a great deal over the farmer's planning horizon. In the case of government tax programs, for example, since 1980 there have been three major revisions in the tax code concerning depreciation allowances (The 1981 ERTA, revisions to the ACRS that were implemented in 1984 and the 1986 TRA). The marginal income tax rate schedules have been adjusted on at least four occasions. Since 1950, the investment tax credit has appeared, been expanded, and disappeared so frequently that now it almost seems to exhibit the properties of the Cheshire cat—once observed it immediately begins to fade away. The effects of changes in tax policy as a source of uncertainty require special attention in future asset replacement studies.

References

- Bartholomew, R.B. "Inflation and Farm Tractor Replacement in the U.S.: Comment." *Am. J. Agr. Econ.*, 62 (1980):830-831.
- Bates, J.M., A.J. Rayner, and P.R. Custance. "Inflation and Farm Tractor Replacement in the U.S.: A Simulation Model." *Am. J. Agr. Econ.*, 61(1979):355-358.
- Bates, J.M. and A.J. Rayner. "Inflation and Farm Tractor Replacement in the U.S.: A Simulation Model: Reply." *Am. J. Agr. Econ.*, 56(1980):832-833.
- Chisholm, A.H. "Effects of Tax Depreciation Policy and Investment Incentives on Optimal Replacement Decisions." *Am. J. Agr. Econ.*, 56(1974):776-783.
- Durst, R. "The New Tax Law and Its Effects on Farmers." *USDA Ag Outlook*, November, 1986.
- Kay, R.D., and E. Rister. "Effects of Tax Depreciation Policy and Investment Incentives on Optimal Equipment Replacement Decisions: Comment." *Am. J. Agr. Econ.*, 58(1976):355-358.
- Lynne, G.D. "Machinery Replacement, Multiple Optima and the 1986 Tax Reform Act." *So. J. Agr. Econ.*, 20(1988):179-188.
- Perrin, R.K. "Asset Replacement Principles." *Am. J. Agr. Econ.*, 54(1972):60-67.
- Reid, D.W. and G.L. Bradford. "On Optimal Replacement of Farm Tractors." *Am. J. Agr. Econ.*, 65(1983):326-331.
- Trapp, J.N. "Investment and Disinvestment Principles with Nonconstant Prices and Varying Firm Size Applied to Beef-Breeding Herds." *Am. J. Agr. Econ.*, 68(1986):692-703.
- U.S. Department of Agriculture. *Agricultural Statistics*. Washington, various issues.
- U.S. Department of Commerce, Bureau of the Census. *1982 Census of Agriculture*. Washington, 1985.

