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THE IMPACT OF INCOME TAXES ON RESOURCE ALLOCATION AND STRUCTURE OF AGRICULTURE*

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INTRODUCTION

The objective of this chapter is to examine the impact of income tax provisions on resource use in agriculture and their impact on farms associated with different wealth positions. The former is important because income tax provisions are so closely associated with capital and farm size changes are the result of substitutions of capital for labor. Thus, conditions which increase or decrease the substitution of capital for labor in agriculture are important to the understanding of farm size changes. The impact of income taxes on growth is obviously important to the understanding of asset ownership behavior. If farms with particular wealth characteristics have economic incentives for growth over other types of farms because of income tax provisions, the asset ownership structure of agriculture will respond in that direction.

The study of income tax impacts on agriculture has lacked empirical validation because of a number of factors. The economic forces which influence income tax impacts are complex and may, at times, counteract each other. For example, a changing inflation rate may result in an opposite force during the period of time in which a change in tax provisions occurred. Also, the modeling of a number of both tax and general economic equilibria adjustments to changes in economic variables has been a difficult area of study. How, for example, do firms behave with known (phased in) as well as unknown future changes in tax regulations? Similarly, with inflation what is the correct behavioral model of firm optimization? Changes in conditions influencing income tax impacts on agriculture are largely economy wide changes rather than changes unique to the agriculture sector. Thus, the entire economy is influenced which adds additional complexity in isolating agricultural adjustments. Finally, data limitations further limit the opportunity to empirically validate impacts of income tax provisions on agriculture.

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Inferences from analyzing firm behavior has provided the major understanding of tax impacts on agriculture. By modeling firm resource use using capital budgeting, programming, or simulation it is possible to examine tax influences resulting from different tax provisions or economic conditions. Such studies lack important equilibria adjustment behavioral linkages but are still useful in understanding directional effects and relative levels of magnitude effects from alternative tax provisions or different firm settings.

Critics of the increasing capitalization of agriculture have stressed that income tax shelters in agriculture should be eliminated. Their contention is that by eliminating such shelters, capital use will decrease reducing pressure for farm size expansion. Also, in some cases, such critics contend that the reduction of tax progressivity leads to an increasing concentration of wealth in agriculture. Some also conclude that the "artificial" infusion of capital into agriculture beyond that resulting from a neutral tax system leads to agricultural overproduction and consequently lowers product prices. At the same time it has been suggested that erratic capital investments in agriculture are partially the result of tax behavior. Further, some believe that a less capital intensive agriculture would create more vibrant rural communities.

The plan of this chapter is to first note the current setting of tax changes resulting from the 1986 changes in the tax code. Next tax shelters and their impact on costs of capital assets are analyzed. Next is an analysis of the implications of tax progressivity to asset ownership. Following that is a discussion of asset replacement as influenced by tax provisions. Asset replacement is a firm phenomenon exhibiting larger macro effects. Also a discussion of inflation and its impact on capital investment is included. Inflation modifies tax impacts but also creates financing difficulties for borrowers of capital. Finally, a policy summary is included which attempts to isolate the effects of alternative economic conditions and tax provisions.

1986 TAX REVISION

Before analyzing the impacts of income taxes on capital use in agriculture it is convenient to list some changes which have occurred due to the 1986 revision of the Federal tax code. These changes were not all effective in 1987 but some are implemented across time. The major changes affecting this analysis are listed below.

1. Tax brackets have been reduced from 14 to 2, the maximum tax rate has been reduced 50% to 28%, and a 15% bracket exists for lower income.

2. Tax averaging was repealed. For business with variable income, this eliminates a provision to reduce tax across time.

3. Two classes of investors are defined by the 1986 revision, active and passive. Limits are placed on loss deductions from passive participants.

4. Investment tax credit was repealed. Formerly a tax credit was allowed on a percentage of certain classes of investments.

5. The 60% preferential of capital gains was repealed. Formerly, when capital items were sold which had experienced gain, 60% of the gain could be excluded.

6. Depreciation provisions were modified. Depreciable life was extended and effective for 1989, annual depreciation is limited to 150 declining balance.

7. Other changes include an increase in expensing ($5,000 to $10,000), opportunity for year-end capital purchases to reduce taxes was eliminated, standard deductions were increased, and incentives to itemize deductions were reduced.

TAX SHELTER IMPACTS

The purpose of this section is to describe structural forces in agriculture resulting from income tax provisions. The subject of the impact of income taxes has not received a great deal of attention from agricultural economists. Both for micro investment decision making as well as for the understanding of structural effects, income taxes are not neutral and cannot be ignored. At the same time, income tax research is a difficult area of study for a number of reasons. One is the major problem of understanding equilibrium adjustments in response to a host of firm behavioral issues involved with tax impacts. One is the impact of inflation on after-tax discount rates which involves the after-tax behavior of firms. Another is the phenomena involving investment behavior of firms which utilize tax shelters to lower tax brackets. Another complexity is the problem that understanding macro economic structural forces involves a wide range of firms in differing income and size situations. While a representative firm situation may be useful in some situations as a technique to study production and investment behavior, it is very difficult to aggregate these.

It is clear that income taxes have focused on capital compared to other resources, primarily labor. This has led to a capital intensification of agriculture because of lowered capital costs. Again however it must not be necessarily concluded that lowered capital costs impact long-run supply or returns in agriculture. Reductions in other inputs resulting from shifts in resource prices may not significantly affect output supply functions.

Tax Shelters

A description of various tax shelters is provided in this section. A tax shelter can be thought of as a provision which changes before-tax equivalent costs or returns. Thus, under no tax shelter a before-tax cost or return has an associated after-tax equivalent which when converted back to the before-tax equivalent is equal to the original flow cost or return. Under a tax shelter the associated after-tax equivalent is impacted such that after conversion to the before-tax equivalent, the result is different from the original cost or return.

The classification is divided according to those which are not impacted by inflation and those which are.

Non Inflation Shelters

1) Depreciation. The subject of depreciation is a complex one but basically relates to annualizing costs over the lifetime of a depreciable asset. This includes various depreciation concepts such as budgeted depreciation, economic depreciation, accounting or financial depreciation, tax depreciation, and expensing. Conceptually depreciation is made up of three parts - 1) decline in value from use, 2) an obsolescence factor, and 3) aging. Budgeting depreciation relates to expected annual average depreciation over asset life estimated directly by straight-line depreciation. Economic depreciation relates to that flow of reduced asset values determined from amortization of an investment into constant annual costs made up of declining annual capital requirements and increasing annual depreciation. Accounting depreciation is a financial concept in which actual asset value declines are employed. Tax depreciation is the depreciation form of most relevance to this discussion. This form of depreciation is declared by law and has changed across time. At one time several alternative methods were available to the declaration of annual capital expenses, however in recent times, specific methods have been specified. This has varied from the rapid ACRS to the 1986 reform of double declining balance (150% effective in 1989).

Expensing is a depreciation concept that is considerably different than other forms of depreciation. It allows an immediate deduction of the entire cost of a depreciable asset. Compared to other tax depreciation methods, expensing is an extreme depreciation shelter allowing a full deduction in the purchase year. It has sometimes been argued that a depreciable asset should be fully claimed as a business expense in the year of purchase and any departure from that is in violation with economic resource allocation. This argument is based on the belief that the spreading of depreciation across time is biased and that allocation across time lessens depreciation benefits. This is not true and will be examined in a later section.

One interesting feature of depreciation related to tax law is that a depreciable asset can be redepreciated when ownership changes. This allows the possibility for depreciation to exceed initial value. When there are incentives to frequently replace assets, this effect is accentuated. Hence, the cost of depreciable capital can be reduced through the tax system by the originating depreciation shelter as well as secondary effects in redepreciation. However, these impacts influence the used prices of machinery raising them above equilibrium prices observed in absence of depreciation tax shelters counteracting the cost lowering impacts of sheltering.

2) Investment Credit. This has been eliminated in the 1986 tax reform bill. Originally it was provided as an incentive for capital purchases and allowed the investor to reduce his tax liability by a percentage of the capital purchase. As a tax credit it reduced taxes equally for all tax bracket individuals provided tax liability existed. Through both the timing and nature of this provision, it is a major tax shelter with unique structural impacts.

3) Cash Accounting. Cash accounting allows taxable income to be modified by short-run strategies in selling products and input purchases. It is only a short-run phenomenon in that eventually the full long-run accounting of costs or returns is realized. To be effective as a shelter, certain conditions must hold. First the firm must have cash reserves or borrowing potential to sustain the operation across low income years. If it is effective over more than one or two years it must grow, hence it is most relevant to livestock firms. However, a progressive tax acts as a disincentive of this technique. Essentially the allowance for cash accounting has been retained in the 1986 tax modifications. Over time there have been provisions added to reduce the potential to utilize cash accounting. In addition, income averaging has now been eliminated which had provided the potential to delay income and reduce the tax consequences resulting from accumulated growth.

4) Capital Gain. Past tax law has included the provision to exclude a portion of asset value increases when the asset is liquidated. Thus, two sheltering aspects are involved in this area. The first is the exclusion of a portion of the gain - most recently 60%. This exclusion was eliminated in 1986. The second is the delay of the tax until the asset is liquidated. One justification for capital gains treatment is that real capital gains are not common and because taxes are nominally based, the taxing of nominal gains is in essence, the taxing of inflation.

Inflation Impacts on Shelters

In this section those impacts only engaged by inflation are discussed. The income tax system is nominally based, that is, calculations are not adjusted because of inflation. Hence, the inflation impacts the effectiveness of tax shelters.

1) Bracket Creep. Here inflation-caused nominal income increases place individuals in higher brackets increasing taxable income. Some argue that more liberal provisions have counteracted this impact.

2) Under inflation, tax depreciation is maintained at constant levels even though inflation causes true nominal depreciation to increase. That is observed from increased nominal replacement costs. Further, nominal salvage values increase leading to the potential of income recapture when inflation is very high.

3) Capital Gains. This impact is not equivalent to the previous two. On the surface it could be argued that inflation, not real gains results in nominal gains to assets and any

taxing of those nominal gains is simply an inflation tax. As will be shown later such is not the case. The combination of only taxing a portion of the gains and delaying the taxation until liquidation results in a shelter. Further, for some assets, real capital gains do occur.

It has been somewhat commonplace to view the capital gains to land of the early 1980's as a situation in which asset value gains were driven only by expectation of future land value gains while income remained relatively constant. This perspective is faulty on several fronts. First, increased land values were largely nominal changes, not real. Second, per acre real returns did increase over part of the period. The increased expectation of higher real per acre returns led to nominal land values increasing more than that caused only by inflation. Later a readjustment in real per acre return expectations occurred. This issue is important to this discussion because it must be remembered that nominal capital gains fed by inflation creates tax obligations to asset holders. This component of gain is difficult to model because, while inflation results in nominal tax obligations to landowners, holding land may still be preferable from a tax standpoint to other alternatives.

4) Interest. The issue of interest as a tax shelter is interesting. A few suggest that an interest deduction, in itself, is a shelter. Such can be argued for nonbusiness purposes but not for business investments. The cost of credit used in legitimate business is a cost of production and should be considered as such.

Perhaps the setting under which some have argued against the deductibility of business interest is one in which a disassociation of costs and returns occurs due to factors previously discussed. Under inflation where nominal asset values increase, the financing of that asset creates a low or negative income (because of high financing costs) while asset value increases are not taxed until liquidation. This shelter is not a characteristic of interest deductibility but one of capital gains. The elimination of the deductibility of a portion of capital gains in the 1986 reform act eliminates a portion of this incentive and tend to remove a portion of after-tax gain to inflationary impacted asset value gains.

Somewhat associated with this issue is another structural issue surrounding inflationary impacted interest rates. As inflation is incorporated into nominal interest rates the result is a tremendous "front loading" of real interest payments across time of a loan. Those with cash reserves or borrowing capacity are able to take full advantage of tax deductibility of high nominal interest costs. Those unable to meet those interest demands, if refinanced, can deduct those costs only when nominal income increases in later periods. This structural force favoring those which have cash reserves or other borrowing capacity vs. those under pressure from constant nominal interest is not a shelter per se but rather an advantage of one group over another due to institutional factors.

Progressivity

The 1986 tax reform bill has dramatically reduced the apparent progressivity of the income tax system from several brackets, including a maximum bracket of 50%, to two brackets 15% and 28%. However, due to the removal of many shelters, the effective progressivity may have increased. It has been believed by most that progressive taxes reduce the concentration of wealth for those in higher tax brackets paying proportionality higher levels of taxes. However, there are several problems with this perspective. One is that the participation in tax shelters reduces taxes because the maximum tax bracket is reduced. Second, because of tax shelters those in higher tax brackets have higher after-tax investment-related returns from identical investments that those in lower brackets. This means that those in higher brackets have greater incentive to make investments compared to those in lower brackets. This does not mean that those firms associated with individuals in higher tax brackets necessarily accumulate wealth more rapidly than those with lower brackets, only that tax sheltered investments are of greater relative benefit to those in higher brackets, encouraging growths.

Thus, tax sheltering encourages investment growth and roll-over for those in higher tax brackets. This may be more of an asset control issue rather than a wealth issue. The reduction of tax brackets (in 1986) reduces the tax bracket effect (the use of tax shelters to reduce tax brackets). Similarly the reduction of tax shelters reduces the incentive to invest for the same purpose. Also, the reduction of brackets removes the incentive of those in higher brackets to invest in tax sheltered investments relative to those in lower brackets.

Inflation Equilibria

Under conditions of inflation, the equilibrium adjustments in interest rates are one of the most difficult yet important issues facing economic analysis. When discount rates are utilized in analysis of tax consequences, appropriate discount rates must be used. Thus, real after-tax interest rate adjustment phenomena are critical to separating inflationary-tax impacts from noninflationary-tax impacts.

Under noninflationary conditions an after-tax nominal interest rate can be defined as

1) $\bar{i} = i(1-t)$

where $\bar{i}$ = nominal after-tax discount rate

i is the nominal before tax interest rate and
t is the marginal tax rate

For inflation the before-tax real interest rate is $i' = \frac{1+i}{1+f} - 1$ where f is the rate of inflation.

The conventional Fisher definition for the real interest rate under inflation is

$$2)\quad \bar{i} = \frac{1+i(1-t)}{1+f} - 1$$

where $\bar{i}'$ is the real after-tax interest rate

This formulation easily allows for negative real after-tax interest rates either by high levels of inflation or high tax rates. This allowance for negative real after tax interest rates has caused concern about the formulation. An alternative formulation is by Darby based on the concept that capital gains behavior influences the tax and may never be paid. If, for example, the nominal before-tax rate is 6% and after tax rate is 5.1% (15% tax bracket), 10% inflation would yield an 18.37% nominal before tax interest rate. It works "backward" from the relationship

$$3)\quad \frac{1+i(1-t)}{1+f} = 1+i(1-t)$$

An intermediate formulation is one by Gondolphi assuming capital gains are delayed or a portion excluded. This lies between the Fisher situation of full taxation and the Darby effect of no taxation of the asset. With regard to inflation, the concept of a pivotal tax bracket is useful. Inflation permits lower bid prices for assets for those in higher tax brackets but lower bid prices for those in lower brackets.

For the remainder of the paper a Fisher effect is assumed.

Tax Shelter Impacts

In this subsection the value of tax shelter influences are estimated for alternative situations. A capital budgeting method is used. Three analytical methods can be used in estimating the influence of tax shelters. These are capital budgeting, programming, and simulation. Each involves a major abstraction from a wide range of influences that may occur as alternatives are examined.

Capital budgeting is an appealing technique due to its ease. It can be employed to estimate the impact of alternative tax provisions for different tax brackets. However, it utilizes a given discount rate and a given tax bracket which abstracts from some endogenized behavior. Further, wealth impacts cannot be examined as growth occurs. However, it is still a useful tool in tax analysis and used here to examine tax impacts.

Programming allows endogenization of discount rates and bracket behavior due to its optimizing character. However, for it to be accurate it must be multiperiod in character. The increased accessibility of Integer Programming programs suggests this to be a more important methodology for studying tax influences. Still, a large number of periods need to be provided to remove cutoff biases.

Simulation has been a common technique in studying tax influences. Its advantages are its computational ease. Also, a growth framework can be embodied allowing after tax influences to be examined in terms of capital accumulation.

Here capital budgeting is employed in examining alternative tax provisions under no inflation and inflationary conditions and two tax brackets (15 and 28%). One analysis is completed for a nondepreciable $1000 investment (land) where bid prices are estimated for each situation after examining tax impacts. A second analysis is completed for a $50,000 depreciable investment where annualized costs are estimated. A $3000 salvage value for a 10-year period is used.

With capital budgeting, costs or returns or both can be evaluated in present or future values or the often more convenient form of annualized flows. A before-tax analysis simply ignores taxes and employs a before-tax discount rate in discounting before-tax flows to a present value. A tax analysis requires that after-tax flows be discounted by an after-tax discount. Because tax provisions are nominally based a nominal after-tax discount rate is appropriate to discount after-tax nominal flows occurring at different time points. Once present values are determined they can be retained as present values or be annualized either on a real or nominal after-tax basis. A real basis is preferred. Such after tax annualized costs or returns can be converted to before-tax equivalents by dividing by one minus the marginal tax rate.

Nondepreciable Asset

For this analysis some provisions of older tax provisions and the 1986 reform law are used. The results are directed to a $1000 land investment yielding a 6% return. For the inflationary setting a 10% inflation rate and a 16.6% nominal discount rate is assumed (6% real discount rate). The bid prices for alternative settings are presented in Table 1. The settings include two tax brackets, a 3 year and 10 year sale, annual taxes on land value gains vs. gains at end of period, and gain taxed at ordinary income vs. a 60% exclusion.

Under no inflation before-tax bid prices equal after-tax bid prices for both tax brackets. However, under inflation differences emerge. When gains are fully taxable, a higher tax bracket has no effect when gains are taxed annually but results in higher bid prices when gains are taxed at period's end. When gains are partially taxable a mixed influence occurs. For a short period higher tax brackets result in higher bid prices (whether taxed annually or at end) while for longer periods, higher tax brackets result in lower bid prices.

The analysis demonstrates that even when gains are fully taxed, a long period results in significantly increased bid prices and significant differences between tax brackets. For long held periods the 60% exclusion is important significantly increasing bid values.

Depreciable Asset

Table 2 demonstrates costs of a depreciable investment under no inflation and the same inflationary conditions of Table 1. Economic depreciable is seen to result in equivalent costs as a before tax analysis under no inflation with 1986 tax provisions (200% declining balance here) as well as expensing yielding lower annualized costs. Higher tax brackets result in lower costs.

Inflation removes the advantages of higher tax brackets and results in higher costs than the before-tax cost. This demonstrates a "negative" tax shelter influence. Only economic depreciation under no inflationary condition yields the appropriate before-tax equivalent cost.

TAXES AND ASSET OWNERSHIP

It is well documented that the income tax system and inflation distort investment and production patterns.[1] This section focuses on how the value of an investment to an investor (and investment choice) is influenced by the investor's tax rate interacting with the income stream generated by the investment. We are not concerned with the effect of tax rate progressivity on individual investors, but why individuals facing different marginal tax brackets choose investments with different characteristics, abstracting from the effects of accelerated depreciation, tax credits, and other "tax gimmicks." The following assumptions are made to simplify the analysis. Investments are made to generate an income stream which is taxable as generated. The tax brackets of the individuals are sufficiently large such that the current investment will not affect the individual's marginal tax rate. A variety of investors exist, differentiated only by their marginal tax rate. Two investment alternatives exist, both of which generate an infinite lifed income stream. One investment generates a constant before-tax rate of return, i, and is considered the opportunity cost of the second investment. The second investment generates an income stream, Y(x), which may change or is a function of time. An investment once made is assumed to be held into perpetuity. Investment choice is based on the imputed value of the alternatives.

The imputed value of the investment with income stream, Y(x), evaluated at tax rate t is

$$4)\quad V = \int_0^n Y(x)(1-t)e^{-i(1-t)x}dx$$

We are interested in how changes in Y(x) interacting with t affect V. The change in Y(x), $\delta Y(x)/\delta x = Y'(x)$, is introduced into (4) by integrating by parts so

$$5) \quad V = \frac{1}{i} [Y(0) - Y(n)e^{-i(1-t)n} + \int_0^n Y'(x)e^{-i(1-t)x}dx].$$

Assuming that Y(x) increases at a rate proportionately less than i(1-t) for large values of x, then

$$6) \quad \lim_{n \to \infty} V = \frac{1}{i} [Y(0) + \int_E^\infty Y'(x)e^{-i(1-t)x}dx] \equiv V.$$

The effect of the tax rate on the investment value is

$$7) \quad \delta V/\delta t = \int_0^n Y'(x)xe^{-i(1-t)x}dx.^2$$

Equation 7 provides the insights we are investigating. If the income stream is constant through time, then Y'(x) equals 0, and, as expected, taxes have no effect on the investment value. If the income stream is monotonically increasing through time, then the value of the investment increases with the tax rate (i.e., if $Y'(x) > 0$ then $\delta V/\delta t > 0$).

The effect of the interaction of the tax rate interacting with the time path of the income stream is illustrated in the following two cases.

Case I: A bond will produce an annual constant income stream of $1000 for an infinite period. The interest rate is 10%. The imputed value of the bond can be evaluated by the familiar capitalization formula as

$$V = \frac{1000(1-t)}{.10(1-t)} = 10{,}000.$$

Note that the value of the bond is independent of the tax rate.

Case II: A land investment is expected to generate an income stream of $1000 initially which increases 4% annually. Y(x) in (1) becomes $1000e^{.04x}$ and assuming the interest rate is 10%, (1) simplifies to

$$V = \frac{1000(1-t)}{.10(1-t) - .04}.$$

The imputed value of the land is affected by the tax rate. At a zero tax rate the imputed value is $16,666 and at a 50% tax rate the value is $50,000.

Therefore, high tax bracket investors will be attracted to investments whose income streams have the greatest growth rates, leaving investments with little income growth to those in lower tax brackets. The implications of these tax induced investment incentives will be discussed later. Now we turn to providing a tax prescription which will reduce the tax impact on imputed values.

A tax adjustment could make the value of investments independent of the tax rates. Such an adjustment could be desirable for both equity and efficiency reasons. The adjustment would result in investors in different tax brackets valuing investments equally, ceteris paribus, and the bias in relative values introduced by the tax system would be ameliorated. Following an approach offered by Samuelson, such an adjustment can be found. To facilitate development of the tax adjustment which will leave the value of the investment invariant with taxes, the beginning of the investment period will be generalized from 0 to a point in time m. The tax adjustment which leaves the asset value invariant with regard to taxes will be denoted g(x). The imputed value function becomes

$$8)\quad V(m) = \int_m^n \{Y(x) - t[Y(x) + g(x)]\} e^{-i(1-t)(x-m)} dx.$$

Taking the derivative with regard to m

$$9)\quad \frac{\delta V(m)}{\delta m} = V'(m) = -Y(m)(1-t) + g(m)t + i(1-t)V(m).$$

Recall our objective is to find a tax adjustment, g(m), such that the value of the asset is invariant with the tax rate; that is, find g(m) such that $\delta V(m)/\delta t = \delta V'(m)/\delta t = 0$. Rearranging (9)

$$10)\quad V(m) = \frac{Y(m)(1-t) + V'(m) + g(m)t}{i(1-t)}$$

so

$$11)\quad \frac{\delta V(m)}{\delta t} = \frac{-Y(m) + \frac{\delta V'(m)}{\delta t} + g(m) + [Y(m)(1-t) + V'(m) - g(m)t]i}{[i(1=t)]^2}$$

Setting $\delta V(m)/\delta t = \delta V'(m)/\delta t = 0$ and solving for g(m) yields

$$12)\quad g(m) = -V'(m).$$

To make the value of the asset invariant with the tax rate, (12) implies that the changes in asset value should be taxed as they occur.

Similar results have been used to justify tax deductions for depreciation. However, taxation of capital gains as they accrue and at the same rate as ordinary income could be justified analogously. From a tax accounting perspective, this adjustment is convenient since it is independent of the tax rate. However, changes in value as they occur may be difficult to accurately estimate (without an actual sale) and so an ad hoc approach may be appropriate (such as traditional accounting depreciation methods with some modification).

Currently, capital gains are taxed when they are realized, not as they accrue (and at reduced rates).[3] Therefore, capital gains taxes may be prolonged (or never paid). The previously discussed relationship between valuation, taxes, and income paths coupled with the manner in which capital gains are currently taxed, may have implications for control of productive assets.

Assume that all income streams can be either typified as being constant in nominal or real terms. Coincidentally, it appears that those investments which are expected to generate a constant real income stream, i.e., income changes with inflation, are those in which the owners (at least theoretically) have some control over production. For instance, nominal income from real estate and common stocks is likely to increase through time under inflation. On the other hand, many financial investments such as saving accounts, money market accounts, and most bonds, yield a constant nominal return. These types of investments generally do not result in control over production. Those assets which have constant real returns (increasing nominal returns) would be valued more highly by investors in high tax brackets leaving investments with a constant nominal return to those in lower tax brackets. As a result those in higher tax brackets are expected to have more control over productive assets.

Certainly there are counter examples to these relationships. For instance, bonds paying one lump sum at maturity would be expected to appeal to those in higher tax brackets. Furthermore, the income stream of a bond may be structured to increase through time to approximate the path of an income stream from an investment involving some production control. Whether the perceived current situation (control associated with investment where the income path increases with inflation versus limited and no control associated with income paths constant in nominal terms) has developed due to the desires of the investors or whether this phenomena is intrinsic to the nature of the investment is beyond the scope of this paper but is deserving of analysis.

Our discussion suggests a deeper and more complex issue. The seller of an asset should be able to package the income stream in a variety of manners. Assume, for instance, that an asset generates a constant income stream Y so the present value of the stream is

$$13)\quad V_1 = \int_0^{\infty} Ye^{-ix}dx = \frac{Y}{i}$$

and the seller elects to repackage the income stream such that the income to the buyer is initially at level z and increases at rate α so that

$$14)\quad V_2 = \int_0^\infty ze^{\alpha x}e^{-ix}dx = \frac{z}{i-\alpha}.$$

In order for the constant income stream to service the increasing stream the present value of the two streams must be equal or

$$15)\quad \frac{Y}{i} = \frac{z}{i-\alpha}.$$

The purchaser of the stream, however, faces an income tax system which must be included in his/her valuation of the investment. The constant stream will be evaluated at

$$16)\quad \bar{V}_1 = \int_0^\infty (1-t)Ye^{-i(1-t)x}dx = \frac{Y(1-t)}{i(1-t)} = \frac{Y}{i}$$

and the increasing stream at

$$17)\quad \bar{V}_2 = \int_0^\infty (1-t)ze^{\alpha x}e^{-i(1-t)x}dx = \frac{z(1-t)}{i(1-t)-\alpha}\ .$$

From our previous analysis it should be clear that if $t > 0$ then

$$18)\quad \frac{Y}{i} < \frac{z(1-t)}{i(1-t)-\alpha}$$

The results imply that sellers should attempt to package the income stream so that the income stream increases through time. This will result in an increased value to the buyer. The increased value to the buyer should result in a higher selling price of the investment, making the seller better off.

Casual observation indicates that manipulation of the income stream in this manner to increase its value is not common. Possibly the argument is flawed or the increased risk of high future payments is prohibitive.

Conclusion

We offer a basis for expecting different portfolio mixes based upon the income tax rate of the investors due to interaction of the tax rate and the generated income stream. We have shown that those in high tax brackets are expected to choose investments with growing income streams, leaving investments whose income stream grows at lower levels to those in lower tax brackets.

If changes in investment value were taxed as they occur, the value of the investment would be invariant with the tax rate (ignoring tax gimmicks, e.g., tax credits and accelerated depreciation) and would relieve the incentive for those in higher tax brackets to choose investments with increasing income streams.

If management control is linked to investments with growing income streams, then investors in higher tax brackets are expected to exert a disproportionate control over production. However, such a link is very tentative and deserves much more analysis.

ASSET REPLACEMENT

The 1986 Tax Reform Act (hereafter termed TRA) radically altered the environment in which farmers make choices about the timing of asset replacements and net investment. This section 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; Bartholmew; 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 is analytically ambiguous and so a new simulation technique is used to resolve the issue. The simulation technique is innovative because, in contrast to 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., pick up 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; Bartholmew; Bates and Rayner; Reid and Bradford; Trapp; and Lynne). In this model, the farm-firm is assumed to maximize the present value of the net income stream associated with a particular category 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 and thus their present value to the farm will change. Here, however, we are only concerned with the effects of changes in tax laws 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:

$$19)\quad C[0,s,1] = \int_0^s R(t)e^{-\rho t}dt + M(s)e^{-\rho s} - M(0),$$

where C[0,s,1] is the present value of the stream of residual earning of one unit of the asset purchased at age 0 and disposed of at age s; t is time; 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.[4]

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 (19). 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:

$$20)\quad C[0,s,\infty] = C[0,s,1] + e^{-\rho s}C[0,s,1] + e^{-2\rho s}C[0,s,1] + \ldots,$$

or

$$21)\quad C[0,s,\infty] = [1 - e^{-\rho s}]^{-1}\; C[0,s,1],$$

and s is selected to maximize (20).

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 has 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:

$$22)\quad C[0,s,1] = (1-T)\int_0^s R(t)e^{-\rho t}dt - M(0)\; M(s)e^{-\rho s} + Ie^{-\rho}$$

$$+\; T\int_0^s D(t)e^{-\rho t}dt - T[\int_0^s D(t)d(t) + M(s) - M(0)]e^{-\rho s},$$

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, $(1\text{-}T)\int_0^s R(t)e^{-\rho t}dt$, plus the sum of the present values of the investment tax credit which is 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. $M(s)e^{-\rho t}$; 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, $T[\int_0^s D(t)dt - M(s) + M(0)]e^{-\rho s}$. 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 (18) and (21) is:

$$23)\ \frac{\partial\ C[0,s,\infty]}{\delta s} = \frac{-\rho e^{-\rho s}}{[1-e^{-\rho s}]^2} C[0,s,1] + \frac{1}{[1-e^{-\rho s}]} \frac{\partial\ C[0,s,1]}{\partial s} = 0$$

Substituting and rearranging terms (23) becomes

$$24)\ (1-T)\ [R(s) + M(s)] = \frac{\rho}{[1-e^{-\rho s}} C[0,s,1] + p\ M(s) - \rho\ T[\int_0^s D(t)dt + M(s) - M(0)],$$

or, dividing throughout by (1-T),

$$25)\ R(s) + M(s) = \frac{\rho}{(1-T)[1-e^{-\rho s}]} C[0,s,1] + \frac{\rho}{(1-T)} M(s) - \rho\ \frac{T}{(1-T)} [\int_0^s D(t)dt + M(s) - M(0)].$$

Equation 24 can readily be given a straightforward economic interpretation while (25) is analytically more convenient.

Equation 24 can be interpreted as follows. The term on the left hand side (LHS) of (24), (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, ρM(s), is the interest charge associated with holding the asset itself at s while the third term, -ρT[$\int_0^s$ D(t)dt + M(s) = M(0)], represents the interest yield on the balance adjustment tax liabilities avoided at s by delaying disposal of the asset. Consequently, the RHS of (24) 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 assets be equal to the marginal cost of holding it.

Effects of Changes in the Tax Structure on Optimal Replacement Decisions

Equation 25 can be used more conveniently to examine how changes in the tax structure affect the selection of the optimal replacement age. The LHS of (25) 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 produce 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 (25) 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 (25) with respect to I to obtain:

$$26) \quad \frac{\rho}{[1-T][1-e^{-\rho s}]} e^{-\rho}.$$

The term is unambiguously positive for $\rho > 0$ and $T < 1$. Thus, as originally shown by Chisholm (p. 779), a reduction in the vestment tax credit increases the optimal value of s and decreases replacement investment because it reduced 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 (25) with respect to that term yields:

$$27) \quad \rho T \left([1-T][1-e^{-\rho s}]^{-1}\right.$$

The sign of this expression is also positive if $\rho > 0$ and $T < k1$. 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 ρ/ρ1-T]) remains constant, differentiating the RHS of (25) with respect to T and allowing for the effects of a change in T on ρ yields the following expression:

$$28)\quad \frac{\rho}{[1-T]^2[1-e^{-\rho s}]}[Ie^{-\rho} + \int_o^s D(t)e^{-\rho t}dt - M(0)]$$

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

$$- \frac{\rho}{[1-T]}\left[\frac{[1-e^{-\rho s}(1+\rho s)]}{[1-T][1-e^{-\rho s}]^2}C[0,s,1] + \frac{\rho}{[1-T][1-e^{-\rho s}]}\frac{\partial C[0,s,1]}{\partial \rho}\right.$$

$$\left. + M(s) - \frac{T}{[1-T]}[\int_o^s D(t)dt - M(0)]\right].$$

The direct effects of T on the components of the revenue stream in (25) consist of the first two terms in (28); that is,

$$29)\quad \frac{\rho}{[1-T]^2[1-e^{-\rho s}]}[Ie^{-\rho} + \int_o^s D(t)e^{-\rho t}dt - M(0)]$$

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

The remaining terms,

$$30)\quad -\frac{\rho}{[1-t]}\left[\frac{[1-e^{-\rho s}(1-\rho s)]}{[1-T][1-e^{-\rho s}]^2}C[0,s,1]+\frac{\rho}{[1-T][1-e^{-\rho s}]}\frac{\partial C[0,s,1]}{\partial\rho}\right.$$

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

represents the effects of T on the RHS of (25) via the after-tax discount rate. The part of (30) in the large square brackets:

$$31)\quad \frac{[1-e^{-\rho s}(1+\rho s)]\ C[0,s,1]}{[1-T][1-e^{-\rho s}]^2}+\frac{\rho}{[1-T][1-e^{-\rho s}]}\frac{\partial C[0,s,1]}{\partial\rho}$$

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

is the derivative of the LHS of 25 with respect to ρ.

Perrin showed that the sign of (31) 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 (31) 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 s by examining (29). 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% 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% 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% for the term to be positive. Since the 1960's both actual and expected nominal before-tax and after-tax market discount rates have typically been substantially greater than 5% and thus the term has generally been negative.[5]

The second term in (29) 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[-,s,1]. The first order condition obtained by differentiating (22) with respect to s may be written as:

$$32) \quad R(s) + M'(s) = \rho M(s) - \rho \frac{T}{(1-T)} [\int_0^s D(t)dt + M(s) - M(0)].$$

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, $\rho\ T/(1-T) \int_0^s D(t)dt + M(0)$. In this case the investment tax credit has no effect on the timing of the scrapping decision. Moreover, tax and depreciation allowance adjustments only play a role 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 provision presented in (26) and (27) tend to increase optimal replacement ages and reduce replacement investment. On the other hand, Equations 24-27 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, it can be shown that the 1986 TRA tax adjustments will affect only the following components of the RHS of (25):[6]

$$33)\quad \frac{\rho}{[1-e^{-\rho s}][1-T]}\,[-M(0) + Ie^{-\rho} + T\int_0^s D(t)\,e^{-\rho t}\,dt$$

$$- T\,[\int_0^s D(t)\,dt - M(0)]e^{-\rho s}]$$

$$- \frac{\rho T}{(1-T)}\,[\int_0^s D(t)\,dt - M(0)].$$

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 are carried out in the following manner. In each case, an initial optimal replacement age ids 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 is assumed initially to be operating under the provisions of ERTA which permitted a 10% investment tax credit and use of the ACRS depreciation tax allowances.[7] An initial value for (33) is computed using these assumptions. The value of (33) is then recomputed using several new marginal tax rates under the assumption that the farm uses the TRA depreciation schedules and cannot claim any investment tax credits. Through this process it is possible to identify the marginal tax rate that leaves the value of (33) unchanged and therefore also leaves the optimal replacement age for the asset unchanged. If the farm is 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 (25), the optimal replacement age for the asset will 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% of all farms were owned by an individual or family and 10.4% by partnerships. Only 2.7% of all farms were owned by corporations. In addition, 86.2% of all farm acreage was operated by proprietorships and partnerships and only 13.8% 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% (Durst, 1987). As a result of the TRA, over 75% of all farmers will face a marginal income tax rate of 15%. The 1986 TRA also reduced corporate tax rates for all firms except those earning profits of less than 25 thousand dollars. The largest reduction in corporate tax rates was from 46% to 34% for firms with profits in excess of 100 thousand dollars.

Three broad categories or classes of assets are 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 dollars 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 is assumed that the asset being acquired is a marginal asset that does 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 which (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 3 and 4 for each class of asset under the assumption of a 10% discount rate[8] and an arbitrarily selected initial value for the asset of $10,000. Table 3 shows the new marginal tax rate at which the optimal replacement age for an asset remains constant for each of the cases considered. Table 4 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 are considered for the first class of asset (light trucks and machinery); initial optimal lives of 10, 15, and 20 years are considered for the second class (heavy machinery and tractors), and initial optimal lives of 20, 25, and 30 years are considered for the third class (farm structures). If a farm experiences a shift to a higher marginal tax rate than the one indicated in the table, the optimal replacement age for the asset will increase and replacement investment rates will decline. If the farm shifts to a lower marginal tax rate than the one indicated then the optimal replacement age will fall and replacement investment rates will increase.

In the case of class 1 assets, Table 3 shows that farms facing 50% marginal tax rates under the 1981 ERTA would have to experience marginal tax rates of between 8% and 12% 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 4, their marginal tax rates would have to fall by between 38% and 42%. Similarly large marginal tax rate declines would have to be experienced by farms with initial marginal tax rates of 45%. For farms facing marginal tax rates of less than 40% 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 adjustment s required for neutrality are more modest.

In marked contract, tax cuts required to leave the optimal replacement ages of class 3 assets (farm structures) unchanged are much smaller. Table 4 shows that the sizes of the cuts lie in the range of 5 to 9% 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 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 who 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 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 are in excess of 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 depreciation 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 simultaneously examine 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 which 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.

INFLATION AND CAPITAL IN AGRICULTURE

It has been earlier noted that inflation interacts directly with various tax shelter provisions. It reduces the impact of depreciation shelters but increases capital gain shelters. Again, for a given depreciation allowance there exists an inflation rate which eliminates the sheltering impact. Also, with a constant real return per acre on land (an a constant real value per acre), a land investment which increases in nominal value has a sheltering impact because nominal gains are not taxed as they accrue. With returns received from investments which yield annually taxed inflation-impacted returns, taxes are paid as they accrue.

In addition, another phenomenon related to inflation may seriously impact capital use in agriculture thereby, farm size changes. Its aggregate impact is difficult to isolate because its importance is dependent upon the degree of well functioning capital markets, the degree of downward price adjustment in capital resources, or previous anticipatory pricing behavior. This phenomenon is the impact of inflation on capital borrowing.

The result of the conditions resulting from a dramatically increased repayment resulting from loan payments for inflation-impacted interest rates requirement vs. a cash inflow increasing under inflation rates has been described by Helmers, et al., Robison and Brake, Seagraves, and Watts and Johnson. For borrowers this results in major cash flow difficulties early in the amortization period under conventional amortization schedules. As inflation increases and nominal interest rates increase, the disassociation of outflows and inflows increase. These cash flow deficits are not necessarily reflective of economic deficits, nevertheless creditors may view these as such.

The impacts of this phenomenon are difficult to assess. Agriculture as well as some other industries are heavily capital intensive. This accentuates the problem of inflationary impacts on capital borrowers while industries which are less capital intensive are less prone to cash flow credit-caused deficits. It is commonplace to suggest that those agricultural firms with lower relative debt are better able to withstand these inflationary difficulties. Yet inflation also enables capital gains advantages to be enjoyed. Further, inflation is often difficult to predict. With agricultural capital so heavily held by operator-management, the agricultural industry is prone to financial difficulty under inflation. This is a complex issue which is deserving of greater concern in terms of what institutional mechanisms may be useful in moderating agricultural instability under inflation. As mentioned earlier there is another potential structural effect resulting from inflationary-impacted interest rates. Those firms with high cash reserves or high borrowing capacity are enabled to utilize the high tax deductibility of high interest payments. Other firms are forced to lower debt payments and curtail growth because they are forced to meet cash flow requirements.

POLICY ALTERNATIVES

This section summarizes the previous discussions of the various complex impacts and interactive forces caused by tax shelters, inflation, and tax progressivity. To the degree possible, each is discussed separately.

Tax shelters are presently of two kinds, depreciation and capital gains. Depreciation shelters are directed to depreciable assets and are most effective under low inflation. Those in higher tax brackets are most favored by depreciation shelters. The 1986 revision to the U.S. Federal tax code lengthened the depreciable period and eliminated investment tax credit. Further for 1989, annual depreciation is limited to 150% declining balance rather than 200%. While inflation has been reduced from the early part of the 1980 decade, the overall impact would appear to result in depreciation shelters having less impact now than formerly. This is particularly true when it is recalled that tax brackets have been reduced from 14 to 2 and the maximum tax bracket reduced from 50% to 28%. For depreciable assets, it would appear that induced investment behavior caused by depreciation shelters directed to capital acquisition and replacement will be lowered relative to the earlier years of the 1980 decade. One difficulty in isolating this impact in historical context is the financial crisis of the mid 1980 decade which independently affected capital replacement.

Capital gains shelters are only implemented by inflation. The 1986 revision removed the 60% of gains except from taxation treating gains as ordinary income. With presently only moderate inflation and gain taxed as ordinary income, the incentive to invest in land as an inflationary hedge has been reduced.

Reduction in inflation has resulted in differential impacts as described above. With lowered inflation depreciable tax shelters are of greater benefit to larger farms (assuming larger farms are in a higher tax bracket). Countering this has been the reduction in depreciation allowances and tax bracket differences. Lowered inflation has also reduced capital gains behavior and this has been accentuated by the reduction in tax levels and brackets. Inflationary reductions have also lessened the credit disassociation of cash flow over earlier periods. The overall combination of lowered inflation, tax shelter changes, and lowered progressivity is difficult to assess, however it would appear to reduce depreciable capital demand and likely reduce demand for land.

Tax progressivity is perhaps the most misunderstood of policy instruments affecting agricultural structure. It has been shown that those in higher tax brackets are better enabled to make investments which have accompanying tax shelters. Thus, while higher tax brackets are often viewed as a policy devise to limit capital concentration, the effective result may be opposite to this. The "bracket reduction" technique is especially alluring under conditions of high tax brackets as the investment not only receives tax shelter but enables the recipient to move to a lower bracket. One difficulty in evaluating the impact of lowered progressivity is that depreciable tax shelters have also been reduced which already reduces the impact of progressivity. Overall, some of the influences of income taxes toward over capitalization and differential investment favoring large farms appears to be lessened by the combination of lowered inflation, reduction in tax shelters, and lower progressivity.

Table 1. Bid Prices for a $1000 Land Investment on a Before and After-Tax Basis for Alternative Tax Provisions and Conditions of Inflation (0 and 10%).

	No Inflation	Inflation
Before Tax	1000	
After Tax		
15%	1000	
28%	1000	
100% Taxable-Annually		
3 year		
15%		1000
28%		1000
10 year		
15%		1000
28%		1000
100% Taxable-End		
3 year		
15%		1005
28%		1008
10 year		
15%		1048
28%		1087
40% Taxable-Annually		
3 year		
15%		1023
28%		1044
10 year		
15%		1087
28%		1174
40% Taxable-End		
3 year		
15%		1025
28%		1047
10 year		
15%		1087
28%		1174

Table 2. Annualized Costs for a $50,000 Depreciable Investment on a Before and After-Tax Basis for Alternative Tax Provisions and Conditions of Inflation (0 and 10%).

	No Inflation	Inflation
Before Tax	6386	6386
1986 Depreciation		
15%	6300	6084
28%	6219	5776
Expensing		
15%	6267	6004
28%	6156	5667
Economic		
15%	6386	6208
28%	6386	6044

Table 3. Marginal Tax Rates Required to Leave Optimal Replacement Ages Unchanged for Three Classes of Assets Under the Provisions of the 1986 TRA.

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

Table 4. Changes in Marginal Tax Rates Required to Leave Optimal Replacement Ages Unchanged Under the 1986 TRA.

Class Of Assets	Initial 1981 Marginal Tax Rate (%)	Change in Marginal Tax Rates (%) — Optimal Replacement Age 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.

Footnotes

[1]Distortions due to accelerated depreciation, tax credits, and lower tax rates on capital gains are well recognized. Effects of these special tax provisions on investment in machinery and equipment, housing, input mix, and portfolio choice have been analyzed. See, for instance, Feldstein (1980); Feldstein and Summers; and Feldstein, green, and Sheshinski. The influence of the tax system on interest rates has received considerable attention. See Darby, Gondolfi, Tonzi, and Feldstein (1976).

[2]Earlier it was assumed that the tax brackets are large implying that (3) is not continuous in t. Therefore, taking the partial derivative in (4) is technically incorrect.

[3]Bailey estimates that the annual rate of realizing capital gains or losses is about 15%. However, there is a tax incentive to realize capital losses and postpone capital gains which results in greater sensitivity of the imputed value of the asset to tax situations of the investor.

[4]In 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.

[5]Between 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% [United States Department of Agriculture]. In all but three of those years they were greater than 8% and between 1980 and 1987 were in the range of 10.39% and 12.1%. Nominal after-tax discount rates for the vast majority of farmers were thus considerably greater than 5% for most of the eighteen year period. Since 1980, even farms in the highest marginal corporate and income tax brackets (which at their maximums were respectively 46% and 50%) have faced after-tax discount rates in excess of 5%.

[6]Details of the proof for this result are available from the authors. Note that the changes in the 1986 TRA rules directly affect all terms in Equation 25 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.

[7]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).

[8]The results are not very sensitive to changes in this assumption, which is not too surprising given the ambiguity associated with the effects of the changes in the discount rate on optimal scrapping ages indicated by Equation 11.

References

Bailey, M.J. "Capital Gains and Income Taxation." The Taxation of Income From Capital, The Brooking Institution, 1969: 11-49.

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.

Darby, M.R. "The Financial and Tax Effects of Monetary Policy on Interest Rates." Econ. Inquiry, June 1982, 13, 216-227.

Durst, R. "The New Tax Law and Its Effects on Farmers." U.S.D.A. Agr. Outlook, November, 1986.

Feldstein, M. "Inflation, Income Taxes, and the Rate of Interest: A Theoretical Analysis." The Am. Econ. Rev., Dec. 1976, 66, 809-820.

Feldstein, M. "Inflation, Portfolio Choice, and the Prices of Land and Corporate Stock." Am. J. Agr. Econ., Dec. 1980, 62, 910-916.

Feldstein, M., J. Green, and E. Sheshinski. "Inflation and Taxes in a Growing Economy with Debt and Equity Finance." J. of Pol. Econ., 1978, 86, 553-570.

Feldstein, M. and L. Summers. "Inflation and the Taxation of Capital Income in the Corporate Sector." Nat. Tax J., 1979, 32, 445-470.

Gondolfi, A. "Inflation, Taxation, and Interest Rates." The J. of Fin., June 1972, 37, 797-807.

Helmers, G.A., M.J. Watts, and J. Atwood. "Relevancy of Cash Flow in Firm Financial Management." Agribusiness - An International Journal, Nov. 1985.

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." S. 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.

Robison, L.J. and J.R. Brake. "Inflation, Cash Flows, and Growth: Some Implications for the Farm Firm." S. J. Agr. Econ. 12(1980) No. 2: 131-137.

Samuelson, P. "Tax Deductibility of Economic Depreciation to Insure Invariant Valuations." J. of Pol. Econ., 1964, 72, 604-606.

Seagraves, J.A. "Some Effects of Inflation on Interest Rates and Financial Instruments Used by Farmers." Working Paper No. 69, Department of Economics and Business, North Carolina State University, 1985.

Tanzi, V. "Inflationary Expectations, Economic Activity, Taxes, and Interest Rates." The Am. Econ. Rev., 1980, 70, 12-21.

Trapp, J.N. "Investment and Disinvestment Principles with Nonconstant Prices and Varying Firm Size Applied to Beef-Feeding Herds." Am. J. Agr. Econ. 68(1986): 692-703.

United States Department of Agriculture. "Agricultural Statistics." Washington, D.C., various issues.

United States Department of Commerce, Bureau of the Census. "1982 Census of Agriculture." Washington, D.C., 1985.

Watts, M.J. and J.B. Johnson. "The Relationship of Inflation to Agricultural Income, Asset Values, and Firm Financial Analysis." Staff Paper No. 85-6, Department of Agricultural Economics and Economics, Montana State University, 1985.