Income tax

1978

TAX AND INFLATION ADJUSTMENTS TO MACHINERY COST MODELS*

by

Myles J. Watts and Glenn A. Helmers**

The correct specification of time related flows in economic models is critical to their use and interpretation. Cost-benefit analysis, polyperiod linear programming analysis, land appraisal, and firm investment models are examples of analyses requiring an exact and consistent expression of the nature of costs and/or benefits in future time periods. In recent years increased emphasis has been placed on specifying the cost of production of agricultural commodities. Where intermediate and long-run resources are used in the production processes of such products, the expression of the cost of those resources over a period of time becomes important.

For firm analysis the consideration of income tax is important for time related investment models. Timing of income tax costs and benefits can be an important consideration in investment decisions such as replacement of farm machinery. Capital budgeting has advantages in treating income tax aspects of investments compared to conventional or traditional cost budgeting. Inflation further complicates investment analysis. In earlier times of lower inflation it could and usually was ignored. Consideration of both income tax and inflation effects require a consistent context of analysis. While the impact of these influences is more obvious in application

*Paper Number 5607, Journal Series, Nebraska Agricultural Experiment Station presented at Amer. Agr. Econ. Assn. Meetings, Aug. 6-9, 1978, Blacksburg, Va.

**Assistant Professor, Montana State University and Professor, University of Nebraska respectively.

of capital budgeting models even simple budgeting models are implicitly influenced by income tax and inflation considerations.

In this paper various capital budgeting models adjusted for inflation and income taxes are developed and used to estimate annual cost for a two-wheel drive tractor. The results are compared to traditional machinery cost budgeting models. Modifications of traditional budgeting techniques to deal with inflation are then suggested. While purchase of farm machinery is used as an example, the concepts have implications for many economic models involving time.

Traditional vs. Capital Budgeting

Traditional machinery budgeting can be defined as the expression of machinery costs on an annual basis using straight line depreciation and basing other fixed costs on the mid-value of the machine. The other fixed costs include opportunity cost of capital, insurance and taxes, and repairs and maintenance.

Capital budgeting discounts positive and negative flows over the ownership life of the investment to estimate the net present cost (or benefit). Capital budgeting has an obvious advantage through its inclusion of positive income tax credits and deductions (investment credit and depreciation). Including these items and adjusting deductible expenses to an after-tax basis places the analysis on an after-tax basis. The net present cost can then be translated to an annual basis by amortizing the net present cost (dividing the net present cost by $\frac{1 - \frac{1}{(1 + r)^n}}{r}$ where r is the discount rate). While this alone can be useful as a framework for viewing investment costs, the analysis can be translated to a before-tax basis by dividing by the complement of the marginal income tax rate. Thus, capital budgeting can be directly compared to traditional budgeting with both expressed on an annual before-tax basis. The exact reconciliation of the two methods becomes quite complex since the two methods differ on the concept of when depreciation is claimed and opportunity cost occurs, and certain compounding features.[1]

Income Tax Adjustments

A weakness of traditional budgeting is its inability to consider income tax aspects, specifically investment credit and the timing and compounding aspects of depreciation. Capital budgeting directly considers such positive flows. It is sometimes suggested that a before-tax capital budgeting analysis is transformed to an after-tax basis by simple tax adjustment of net earnings. However, it must be remembered that to correctly express opportunity cost the discounting basis must be consistent with the flow basis. Hence, a before-tax discount rate is changed to an after-tax discount rate by multiplying by the complement of the marginal tax rate. Thus, a 10 percent before-tax discount rate becomes a 7.2 per cent discount rate under a 28 per cent marginal tax rate.

Inflation

Inflation enters both traditional and capital budgeting models because future dollars are less valuable due to inflationary conditions. Inflation directly affects opportunity cost under traditional budgeting and the discount rate under capital budgeting.

In equation (1) the inflationary adjustment to place the capital budgeting after-tax discount rate on a real dollar basis is shown as developed by Stermole. (1) $r' = \frac{1 + r\ (1 - MTR)}{1 + g} - 1$

Therefore, a 10 percent before-tax discount rate (r) becomes a 1.13 per cent deflated after-tax discount rate (r') under a 6 percent rate of inflation

(g) and a 28 per cent marginal tax rate (MTR). It is interesting to note that if the inflation rate is identical to the before-tax discount rate, say each is .10, the result is a -2.55 per cent deflated after-tax discount rate. In this particular case the deflated after-tax discount rate is negative due to the influence of income taxes.

In addition to discount/opportunity cost rate adjustments, it may be necessary to adjust flows for inflation. While the problem tends to be more obvious in capital budgeting, the same difficulties are also implicit in traditional budgeting. The manner in which costs are projected over an inflationary period becomes significant. Under inflation specific nominal or actual dollar amounts for future years are estimated, costs will be paid or credit received in inflated dollars. These items need to be deflated to a constant real dollar basis and then discounted by the after-tax deflated discount rate in capital budgeting models. If, on the other hand, costs are estimated in real dollars (perhaps estimates were made from data for periods where inflation did not occur), or expressed in real dollars, no deflation of costs is necessary. Comparable adjustments need to be made in traditional budgeting. The specific machinery example contains both real and nominal initial estimates of flows and will be used to demonstrate this issue.

Salvage Value

Capital budgeting and traditional budgeting often differ in the treatment of salvage values or used prices. Capital budgeting specifies estimates of actual flows, hence the selling price of the used machine is considered a credit at the end of the ownership period. Generally, traditional budgeting specifies an arbitrary salvage value for depreciation purposes.

In periods of inflation the salvage value has been lower than the used selling price. Thus, traditional budgeting analysis of machinery costs should consider an expected selling price of the used machine rather than the commonly used salvage value. Not only is depreciation affected by this adjustment but any cost based on the mid-value of the machine is also affected.

Example

To illustrate the impact of previously discussed influences on budgeted costs, costs were budgeted for a new $20,000 tractor by traditional and capital budgeting. Furthermore the impact of the recommended modification in traditional budgeting is illustrated via the example. Assumptions under all examples include a 10-year ownership life or period, 6 gallons of fuel consumption per hour of use, 600 hours of annual machine use, and fuel priced at $0.40 per gallon.

Assumptions for all capital budgeting models

Double declining balance and additional first year depreciation were assumed to be elected in all capital budgeting models along with an 8-year depreciable life, $2,000 salvage value, and investment credit. The salvage value was used to cut off depreciation at $2,000 book value and calculate depreciation recapture tax at the end of 10 years. A nominal before-tax discount rate of 10 per cent, a general inflation rate of 6 per cent, and a marginal tax rate of 28 per cent were assumed. Repair and maintenance costs were estimated as a function of the new price of the machine and hours of use (Agricultural Engineers Yearbook). The used price of the machine was assumed to decline at a rate of 2 per cent of the new price per year.[2] Insurance and taxes were estimated at 2 per cent of the mid-year value of the machine.

Insurance and taxes, used price, depreciation, and depreciation recapture were estimated or occurred such that they initially are expressed on a nominal basis. Fuel and repair and maintenance costs were initially estimated on a real dollar basis.

All costs and benefits were placed on an after-tax basis, discounted, and amortized at the appropriate (in terms of consistency) discount rate to estimate equivalent annual costs on an after-tax basis. Annual after-tax costs were transformed to a before-tax basis by dividing by the complement of the marginal tax rate.

Capital Budgeting 1. All costs and benefits are placed on a real dollar basis by deflation of those flows estimated in nominal dollars. An after-tax real discount rate and amortization rate is applied to real flows to estimate annual machinery costs.

Capital Budgeting 2. All costs and benefits are used as estimated initially (none are deflated or inflated to attain consistency). A nominal after-tax discount rate and amortization rate is used. Even though this approach is obviously incorrect, it helps illustrate the importance of using a consistent basis.

Capital Budgeting 3. All costs and benefits are placed on a nominal basis by inflating those costs initially estimated on a real dollar basis. A nominal after-tax discount and amortization rate is applied to the nominal flows to estimate costs.

Annual flows for each capital budgeting model are shown in Table 1.

Assumptions for all traditional budgeting models

Depreciation, fuel, insurance and taxes, opportunity cost, and repair and maintenance costs are included in all traditional models. Straight line depreciation was used and found by subtracting the salvage value or used price (depending on the model) from the new price ($20,000) and dividing by the ownership period (10 years). Insurance and taxes were assumed to be 2 per cent of the machine mid-value. Average annual repair and maintenance cost for the entire ownership period is used (Agricultural Engineers Yearbook). The opportunity cost was 10 per cent of the mid-value which is obviously on a nominal basis (due to the use of the nominal opportunity cost rate and salvage value). Further adjustments for inflation were made relating to the particular traditional model.

Traditional Budgeting 1. This model included the $16,000 used selling price; and depreciation, opportunity cost, and insurance and taxes were deflated to a real basis. Again, fuel and repair and maintenance costs were initially estimated on a real dollar basis, hence did not require deflation.

To place depreciation on a real dollar basis the nominal salvage value must be deflated. Depreciation is then calculated in the usual manner. Likewise, the salvage value must be placed on a real basis in the machine mid-value when determining opportunity cost. The real or deflated opportunity cost rate is applied to the mid-value when calculating annual opportunity cost. Nominal yearly estimates of insurance and taxes were 2 per cent of the mid-year value of the machine. This nominal annuity was adjusted to a real annuity.[3]

Traditional Budgeting 2. This model features a $2,000 salvage value and a nominal 10 per cent opportunity cost rate. No adjustments are made for inflation.

Traditional Budgeting 3. The used selling price was increased to $16,000 to correspond with the capital budgeting models. A nominal 10 per cent opportunity cost rate was employed. Repair and maintneance and fuel cost were inflated to a nominal basis.

Annual cost estimates for the three traditional budgeting models are shown by item in Table 2.

Cost Comparisons

The total before-tax cost estimate for each model is presented in Table 3. Capital budgeting 1 can be compared with traditional budgeting 1 and capital budgeting 3 with traditional budgeting 3. Capital budgeting model 1 and traditional budgeting model 1 estimate costs on a real basis while capital budgeting model 3 and traditional budgeting model 3 are on a nominal basis. The differences in cost estimates between capital budgeting models 1, 3, and traditional budgeting models 1, 3 respectively are due to investment credit, timing of depreciation and other flows, and the effects of compounding. The authors contend that capital budgeting models estimate cost more accurately than traditional budgeting models because they include more of the influences affecting costs. The authors further contend that a real dollar cost estimate is more relevant than a nominal cost estimate since in most instances the cost to be estimated is the average actual cost to the firm and for a cost estimate to be meaningful it must have a time basis. An average nominal dollar cost to the firm infers changing actual cost and much of the usefulness of the estimate is lost.

Capital budgeting model 2 is included only to illustrate the importance of consistency in the analysis. Traditional budgeting model 2 parallels much conventional machinery cost budgeting. As can be seen there is a wide difference between estimated costs between this model and traditional model 1 where inflationary adjustments have been made. Further, a significant difference exists between traditional model 1 and capital budgeting model 1. This difference is largely due to income tax aspects.

Conclusions

The correct basis upon which cash flows are expressed is very important to their use. In this paper capital budgeting models are developed for cost expression of a tractor. Capital budgeting models are adjusted to account for income tax and inflation. These models are compared to traditional budgeting models.

Capital budgeting models, including income tax aspects and adjusted for inflation, are suggested as the most precise expression of actual cost to the firm on a consistent basis over time. Traditional budgeting with modification in procedures to account for inflation is seen to nearly compare with capital budgeting except for the significant income tax aspects.

Table 1. Yearly flow estimates for capital budgeting models expressed on a non-discounted before-tax basis (for each year each of the three models are respectively listed).

Year	Depreciation	Insurance and Taxes	Repairs and Maintenance	Fuel	Investment Credit	Used Price	New Price*	Depreciation Recapture
1	$7,547	$ 374	$ 268	$1,440	$1,887	0	$20,000	0
	$8,000	$ 396	$ 268	$1,440	$2,000	0	$20,000	0
	$8,000	$ 396	$ 284	$1,526	$2,000	0	$20,000	0
2	$2,670	$ 345	$ 491	$1,440	0	0	0	0
	$3,000	$ 388	$ 491	$1,440	0	0	0	0
	$3,000	$ 388	$ 552	$1,618	0	0	0	0
3	$1,889	$ 319	$ 635	$1,440	0	0	0	0
	$2,250	$ 380	$ 635	$1,440	0	0	0	0
	$2,250	$ 380	$ 756	$1,715	0	0	0	0
4	$1,337	$ 295	$ 752	$1,440	0	0	0	0
	$1,688	$ 372	$ 752	$1,440	0	0	0	0
	$1,688	$ 372	$ 949	$1,818	0	0	0	0
5	$ 946	$ 272	$ 853	$1,440	0	0	0	0
	$1,266	$ 364	$ 853	$1,440	0	0	0	0
	$1,266	$ 364	$1,142	$1,927	0	0	0	0
6	$ 669	$ 251	$ 944	$1,440	0	0	0	0
	$ 949	$ 356	$ 944	$1,440	0	0	0	0
	$ 949	$ 356	$1,339	$2,043	0	0	0	0
7	$ 473	$ 231	$1,026	$1,440	0	0	0	0
	$ 712	$ 348	$1,026	$1,440	0	0	0	0
	$ 712	$ 348	$1,543	$2,165	0	0	0	0
8	$ 85	$ 213	$1,102	$1,440	0	0	0	0
	$ 136	$ 340	$1,102	$1,440	0	0	0	0
	$ 136	$ 340	$1,756	$2,295	0	0	0	0
9	0	$ 197	$1,173	$1,440	0	0	0	0
	0	$ 332	$1,173	$1,440	0	0	0	0
	0	$ 332	$1,982	$2,433	0	0	0	0
10	0	$ 181	$1,240	$1,440	0	$ 8,934	0	$ 8,287
	0	$ 324	$1,240	$1,440	0	$16,000	0	$14,000
	0	$ 324	$2,221	$2,578	0	$16,000	0	$14,000

* Actually paid at time point zero.

Table 2. Breakdown of cost estimates for three traditional budgeting models.

Item	Model 1	Model 2	Model 3
Fuel	$1,440	$1,440	$1,978
Repair and maintenance	$ 849	$ 849	$1,166
Depreciation	$1,107	$1,800	$ 400
Insurance and taxes	$ 270	$ 220	$ 360
Opportunity cost	$ 546	$1,100	$1,800
Total	$4,211	$5,409	$5,704

Table 3. Before-tax cost estimates for capital budgeting and traditional budgeting models.

Model	Cost Estimate
Capital Budgeting 1	$3,707
Capital Budgeting 2	$4,161
Capital Budgeting 3	$5,011
Traditional Budgeting 1	$4,211
Traditional Budgeting 2	$5,409
Traditional Budgeting 3	$5,704

Footnote

1. For a more complete discussion of this issue, contact the authors.

2. Preliminary statistical analysis indicates that the used price of farm machinery declined at a rate of 2 per cent per year of its new price over the 1957-76 time period.

3. In general a nominal annuity can be transformed to an equivalent real annuity by the following transformation:

$$V' = \frac{V\ AF}{AF'}$$

where

V = nominal annuity

V' = equivalent real annuity

AF = amortization factor using a nominal discount rate (r)

AF' = amortization factor using a real discount rate (r') where according to Stermole $r' = \frac{1 + r}{1 + g} - 1$

References

1. Agricultural Engineers Yearbook, 1975. p. 350.

2. Stermole, Franklin J. Economic Evaluation and Investment Methods. Investment Evaluation Corp., 1974. pp. 169-170.