ESTABLISHING LINKAGES BETWEEN ECONOMIC THEORY AND ENTERPRISE BUDGETING FOR TEACHING AND EXTENSION PROGRAMS

G. L. Bradford and D. L. Debertin

Abstract

Accounting techniques of farm enterprise budgeting are rarely linked to the axioms of static production theory and to capital theory. This paper illustrates how certain linkages may be established. Particular attention is given to handling problems of scale economies, optimal output levels, replacement of durable inputs, inflation, and technological change. Estimates in an illustrative budget are linked to specific points on average cost curves. Budgeting for representative farm situations is compared to budgeting for specific situations.

Key words: enterprise budgeting, economic theory linkages.

Applied economists and management specialists often regard enterprise budgeting as a simple technique that is easily applied and rarely misused. However, a careful examination reveals that enterprise budgeting has theoretical underpinnings in production theory, specifically marginal analysis and capital theory, which are complex and may not be well understood by budget users. This is true even though both marginal analysis and budgeting have been commonly used as a basis for management decisions for many years. A review of several textbooks and extension publications (cited below) indicates that linkages between the two techniques often are not comprehensively and clearly made in extension programs or in undergraduate teaching. This article illustrates how accounting techniques of enterprise budgeting can be linked to static production theory.

There are several dimensions to the problem, summarized under the outline of the following six sets of issues and questions.

(1) The term *enterprise budgeting* should be carefully defined and described. A clear, useful distinction should be made between enterprise budgeting and other kinds of budgeting—including *partial enterprise budgeting, cash flow budgeting, whole farm budgeting,* and *capital budgeting*. Table 1 provides a set of definitions which will serve to focus the discussion of the paper. While it is reasonable to expect that definitions may vary somewhat among analysts, each text or extension document should define and carefully distinguish among various kinds of budgeting. Definitions and uses of budgeting terms should be meaningful to students who desire to apply production theory to a farm firm decision, and to economists who desire to make simple applications of the theory.

(2) How does one account for *different farm firm sizes* and for *size economies* when budgeting for a single farm enterprise?

(3) For a given farm firm size, what *output level* should be selected when developing the basic budget for an enterprise? This is not unrelated to issue (2). Is the output optimal? Alternatively, is the output typical of what is happening on farms?

(4) Is enterprise budgeting a *historical accounting exercise, or a planning document?*

(5) *Should budgeted values be real or nominal?* This issue is related to issue (4). Real dollar budgeting sets aside the problem of projecting price level (inflation) changes and allows budget users to concentrate on technical relationships (e.g., Hinson, pp. 7-9). However, inflation projections often are a key reason for building the budget (e.g., Hunt, p. 64). To deal with these and closely related issues, production theory—specifically theory dealing with production processes through time—should be linked to the budgeting process.

(6) How can farm managers (including producers) make valid effective use of bud-

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TABLE 1. GLOSSARY OF DEFINITIONS USED IN BUDGETING

Enterprise—a single crop or livestock activity having recognizable inputs and measurable outputs or services. One or several production processes may be involved in order to attain the outputs or services.

Budget—a written financial plan for future action, including the quantified anticipated results.

Enterprise Budgeting—the systematic determination and listing of expected output(s), revenue(s), and costs due to the production process(es) required to produce one unit of an enterprise for a specified, future production period.

Partial Enterprise Budgeting—the systematic determination and listing of appropriate changes in expected output(s), revenue(s), and costs due to a particular change (or changes) in specified production stages or processes or in the firm's organization for a specified future production period.

Whole Farm Budgeting—detailed physical and financial planning of the organization and operation of the farm's total business. The total business or firm can be viewed as the combination of all its enterprises.

Cash Flow Budgeting—a systematic, detailed listing of the firm's cash account inflows and outflows for a specified future production period. The cash flow budget may show inflows and outflows for several subperiods within each production period, e.g., months within each year.

Capital Budgeting—frequently used to mean investment analysis, i.e., the procedure for evaluating the effects of the decisionmaker's investment choices on a business's profitability, risk, and liquidity. An alternative use of the term might be the procedure(s) used by the decisionmaker to budget (allocate) the firm's investment funds among several independent investment projects when each project is profitable but the firm does not have access to ample funds to finance all the projects in the time horizon for which the investments are being considered.

Sources: These definitions are based in part on the definitions in Osburn and Schneeberger (pp. 164-81 and 202-22) and in Kay (pp. 60-113).

TABLE 2. CORN PRODUCTION, CONVENTIONAL TILLAGE: ESTIMATED COSTS AND RETURNS PER ACRE

Item	Dollars per acre	Dollars per bushel—(line segment in Figure 1)
FIXED COSTS[a]		
Depreciation of buildings and machinery	36.28	
Interest on investment in buildings and machinery	13.39	
Interest on land investment	75.00	
Taxes on real estate	7.09	
	131.76	1.32 (BC)
VARIABLE COSTS[a]		
Fertilizer and lime	53.40	
Seed	17.25	
Chemicals	15.00	
Insurance on buildings and machinery	5.00	
Repairs—buildings and machinery	12.00	
Fuel and operating costs, machinery	18.61	
Marketing expenses (hauling, sales fees)	17.50	
Labor—5 hrs. @ $3/hr.	31.50	
	170.26	1.70 (BD)
RETURNS		
Gross sales: (100 bu/acre) × (3.25/bu)	325.00	3.25 (BF)
Net returns above variable costs (net to capital investment, management and entrepreneurship)	154.74	1.55 (DF)
Net returns above variable and fixed costs (net to management and entrepreneurship)	22.98	.23

[a]In this example, the magnitude of fixed costs is identical to overhead costs and the magnitude of variable costs is identical to operating costs. See the discussion for a definition of overhead costs and operating costs, the distinction between overhead and fixed costs, and the distinction between operating and variable costs.

gets for modal or representative situations illustrated in extension publications if, in fact, the *technology varies widely* for each enterprise among farms and across years? Alternatively, what value to users are response surface results from production economics studies in such *dynamic situations?*

These issues have not been resolved, at least not in a single textbook or a single extension publication. An examination of contemporary farm management and production economics textbooks reflects their existence. Farm management texts such as Kay, Forster and Erven, Harsh et al., Osburn and Schneeberger, and Calkins and DiPietre commonly contain two or three introductory chapters on marginal analysis. Subsequent chapters on enterprise budgeting, whole farm budgeting, cash flow budgeting, and capital budgeting are largely independent. Little if any linkage to the theory is established.[1] Texts which deal with applications of marginal analysis to agriculture, such as Doll and Orazem, Bishop and Toussaint, and Cramer and Jensen do not deal directly with most of the aforementioned issues. Perhaps most text-

[1] Calkins and DiPietre (p. 114) draw an analogy between budgets and points on the production function, but their discussion is brief and does not deal directly with unit cost curves. Moreover, their discussion includes no formal treatment of issues (2), (4), and (5).

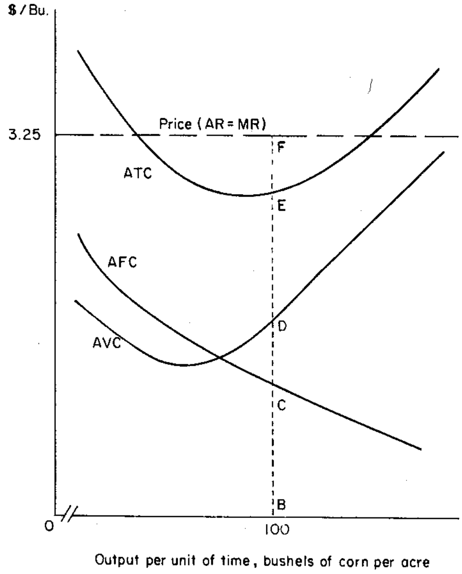

Figure 1. Hypothetical Unit Cost and Revenue Curves for Corn Production.

book authors believe it is the budget user's responsibility to delineate specifics of linkages. Even so, with the exception of a single chapter in Bishop and Toussaint's introductory text, there appears to be no single production economics text which contains sections on the applications of production and cost theory to enterprise budgeting.

The definitional issue, (1), may continue to be resolved through clearer exposition. This issue is woven throughout the other five issues. In this paper, issues (2)-(6) are discussed under the headings: *discrete output problems* (2), *planning period problems* (3), *accounting problems* (4), *time-money and inflation problems* (5), and *inference problems* (6). Each issue is briefly outlined with specific observations and suggestions for resolvement or improvement advanced through means of an illustrative corn enterprise budget and the associated cost curves for corn production, Table 2 and Figure 1.

DISCRETE OUTPUT PROBLEMS

Neoclassical production theory assumes that the decisionmaker faces a continuous array of choices with respect to the combinations of productive factors and products. Optimization within a marginal framework yields continuous-based solutions with respect to the combinations and amounts of factors to be used and the amounts of outputs to be produced.

Enterprise budgets, in contrast, are inherently discrete. Each budget provides only one solution with respect to the amounts and combinations of productive factors to be used. This solution could be the result of some formal optimization process. Often, the budget numbers seem to be approximations of optimal factor levels and combinations. Such solutions may or may not be representative of farmers producing a particular product.

Enterprise budgeting can yield an approximately equivalent solution to marginal analysis, if an array of budgets can be prepared corresponding to the relevant range of outputs and input combinations for the enterprise. This array would consist, in theory, of a set of budgets for each relevant farm firm size. Then, for each firm size, there will be a series of budgets covering the range of feasible, and possibly optimal, output levels. The budget analyst thus can attempt to approximate the optimal output level for each enterprise through prior use of a multi-product marginal analysis or through an *ad hoc* multi-product optimization procedure. For each selected output level, the analyst will then proceed to prepare each budget consistent with the continuous average cost curves. To illustrate the essentials of linkages to economic theory, consider Table 2 in relation to Figure 1.

Figure 1 links a set of points on unit cost curves to estimates in a corn enterprise budget, Table 2. This budget is hypothetical and is prepared for the most profitable corn output level. This is estimated to be 100 bushels per acre by equating expected marginal cost with expected marginal revenue (the $3.25 corn price). The marginal cost curve is not shown in order to simplify the linkage of points on the average cost curves to the enterprise budget numbers. For an output of 100 bushels, average fixed cost (AFC) is equal to $1.32 (line segment BC) and average variable cost (AVC) equals $1.70 (line segment BD). Average total cost (ATC), thus, equals $3.02 (line segment BE) and net returns above variable costs equals $1.55 (DF). Net returns above all costs (returns to risk taking) equals $0.23 (EF).

The AVC curve in Figure 1 is based upon a set of variable inputs that are assumed to be combined in a least cost manner to produce 100 bushels of corn. That is, in the language of production theorists, the expansion path and optimization conditions are being met. Of course, budgeted variable cost estimates actually lie on the AVC curve if and only if the inputs are budgeted in a least cost manner, a reality which cannot be known. As a practical matter, however, many inputs are combined in very nearly fixed proportions. Corn enterprise labor requirements, for example, vary closely with the amount of seed and chemicals used. Also, the data used to prepare enterprise budgets frequently are rooted in actual production experiences or based on proven economic-engineering estimates. As a result, many decisionmakers are likely combining the inputs at close to least cost combinations and selecting output levels which are near the profit maximizing level.

The AFC curve represents a selected size of plant, that is, size of farm and size of the enterprise. In Figure 1, for example, the selected (fixed) size could be 300 acres of corn on a 900 acre farm. The farm's set of buildings, other land improvements, and machinery complements are a part of this size. Their periodic (time-allocated) costs to the corn enterprise are revealed by the AFC curve. The 100-bushel yield level is assumed to be an *average yield per acre* (across the 300-acre enterprise size); or, alternatively, the horizontal axis of the figure could be scaled and read as "output per unit of time, bushels of corn per 300 acres." When expressing costs on a per acre basis (or, for livestock, on a per animal unit basis), the budget analyst should specify the sizes of the enterprise and farm firm which have been pre-selected. This specification, of course, can be and often is made in the fixed cost section of the budget and/or is in a supplementary table of details on the costs of land, buildings, and machinery inputs.

Some budget analysts would contend that the selected size should be optimal, i.e., the optimal enterprise size and farm firm size. However, in practice, as many economies-of-size studies have shown, it is very difficult to know which exact size is optimal (Madden and Partenheimer). Perhaps this is not of upmost importance. What is crucial is that the budget analyst clearly delineates each selected firm size and output level for this size, including reasons why it is selected. Specific linkages to theory should be described. At least the conceptual underpinnings should be noted. Otherwise, the budget has only limited economic meaning.

PLANNING PERIOD PROBLEMS

The format of Table 2 deliberately lists fixed costs in the top section of the budget in order to reflect a 1-year planning horizon and the fact that the manager has committed certain resources to corn production. Hence, consistent with the usual definition, the manager will not be concerned with the magnitude of these costs unless the time horizon is lengthened.

Some texts (e.g., Bishop and Toussaint, p. 131) adopt a "purist" view and contend that only variable cost items should be listed in each budget. Technically this is correct. However, it allows the enterprise budgeter to set aside several issues faced by the farm firm manager or extension budget analyst. In reality, the planning horizon shifts from one moment to the next; that is, what is variable versus what is fixed can quickly change. At the same time, firm managers and budget analysts frequently need to make use of information in a single budget for several decisions over a number of short, intermediate, and long runs. If, for example, the horizon is suddenly shortened to consider only immediate corn hauling and sales fees, then all previous items listed in the variable cost section of Table 2 are considered to be fixed. Alternatively, if the horizon is suddenly lengthened by the decisionmaker to consider a possible purchase of a new truck for hauling corn, the truck ownership costs clearly are not fixed.

Problems associated with classifying costs only as fixed or variable make it desirable to employ an alternative classification of costs. Accordingly, the costs in Table 2 could be classified as *overhead costs* or as *operating costs*. The costs of inputs that provide services for more than one production period (year) are designated as *overhead*; that is, overhead costs are the annual costs of durable input services. The costs of inputs which will provide services for only the next (planning) production period (year) are designated as *operating*; that is, operating costs are the annual costs of nondurable input services.

By design, in Table 2 the planning horizon is selected to be one complete production period (viz., 1 year), so that in this case fixed costs are identical to overhead costs and variable costs are identical to operating costs. This example, however, covers only what is ordinarily assumed to be the most common situation. If the planning horizon is significantly lengthened, say to 5 years, then depreciation and interest on machines and buildings likely would be considered to be variable costs; interest and taxes on the land, however, likely would still be considered to be fixed costs. Even so, since the inputs in question are considered to be durable (by the foregoing definition), their expected levels of depreciation, interest costs, and property taxes would still be classified as overhead costs. Indeed, as the planning horizon is lengthened and, as a result, the decision alternatives are enlarged, most (and finally all) overhead costs will be considered to be variable costs.

Likewise, if the planning horizon is shortened, say to the latter half of the planning year, some of the costs shown to be variable in Table 2 must be considered to be fixed. Even so, again according to the foregoing overhead-operating cost classification, all of the tabled variable costs would still be classified as operating costs. An overhead-operating cost classification of this sort is consistent with the multiperiod production theory presented in a number of production theory texts, e.g., Carlson, pp. 103-109. Unfortunately, most farm management textbooks and extension publications dealing with budgeting, perhaps due partly to space limitations, present only budgets for the common, one-period planning horizon.

The distinction between *overhead* and *fixed* costs, and between *operating* and *variable* costs, is made clearer if the cost items (lines in the budget) are ordered according to when they are likely to be incurred within each period (year) and across production periods. Accordingly, in Table 2, from the top to the bottom of the budget, a time pattern of cash flows is revealed. Indeed, farm enterprise products usually are not sold nor are returns obtained until the end of each production period. This is a reason for placing all revenue items, gross and net, together at the bottom of the budget. Such a format allows all revenue items and all cost items to appear in separate, distinct portions of the table. Yet, it does not violate the usual reasons for estimating expected gross and net returns.

Any cost classification scheme—overhead-operating, fixed-variable, or both—leaves the budget analyst and user with some problems. The validity and usefulness of including overhead and operating cost items in the same enterprise budget hinges on the budget analyst's procedures for allocating these costs across time and perhaps among enterprises. Allocation across time involves selecting the length of the planning horizon as well as selecting the set of enterprises to be considered. As previously mentioned, the budget analyst may elect to use an *ad hoc* multiproduct optimization technique to determine the expected quantity of each enterprise as well as the expected maximum net value to the fixed resources. But such a determination usually is relatively tentative and often unique to the particular farm firm situation which is stipulated. For any one enterprise, the farm size or enterprise size which is selected can be justified by assuming either that size economies are not significant or that the budget applies only to a particular range of farm sizes (Madden and Partenheimer). Selection of a single future year for the planning horizon places the emphasis on that year's nondurable inputs and operating costs. But this practice does not preclude expanding the time horizon in order to focus on durable inputs, what is usually called capital budgeting.

ACCOUNTING PROBLEMS

Most agricultural economists contend that decisionmakers, when formulating enterprise budgets, are estimating expected (future) costs and returns. This is the stance which is consistent with neoclassical production theory and modern capital investment theory. Even so, farm records and other historical roots of budgets are sometimes emphasized to the point that linkages to decisionmaking theory are set aside. In the extreme, budgets are portrayed primarily as a summary of the past that should provide only approximate clues or guidelines about the future, not formal estimates of means and their variances.

Unfortunately, the historical portrayal of budgeting lends credibility to the idea that well defined linkages to production and capital theory are not needed. A number of fundamental problems are simply passed over. Perhaps most serious are the problems related to making annual cost estimates for durable (capital) inputs, Figure 2.

The budget analyst must first recognize, as Figure 2 suggests, the future situation for

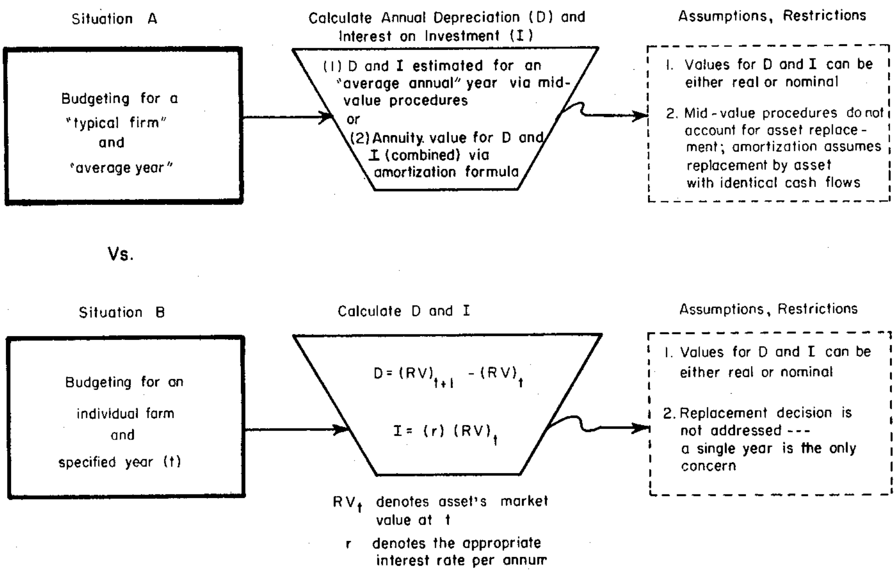

Figure 2. Schematic of Enterprise Budgeting, Capital Item Accounting.

which the budget is being prepared. Farm management textbooks and extension publications, it seems, have stressed generality, budgeting only for a representative situation (such as situation A in Figure 2). However, the individual farm manager is faced with the preparation of budgets for a particular year on an individual farm (situation B). Procedures for calculating (estimating) annual capital costs under situation A will be distinctly different than the procedures for situation B.

For situation A, expected depreciation and interest costs traditionally have been estimated using mid-value procedures. Some textbooks (e.g., Osburn and Schneeberger, pp. 68-74) formally stress calculating the average investment value. Others (e.g., Forster and Erven, pp. 160-172) are not as formal. However, in using a constant annual percentage, the mid-value procedure is in effect adopted. Extension publications sometimes mention the calculation of expected depreciation and interest costs via a capital recovery factor (annuity value) or some other amortization procedure, but the method of allocating capital investment costs among production periods is almost always some version of the mid-value procedure.

For situation B, accurate estimation of actual (economic) depreciation requires good estimates for each capital asset's value at the beginning and end (RV_t and RV_{t+1}) of the period (year) in question. Accurate estimation of interest cost for the enterprise depends upon an accurate estimate of the asset's beginning value (RV_t) and the appropriate interest rate (r). The appropriate interest rate can be determined by equating the expected rate of return of the capital in its next best enterprise (activity) with the marginal cost of the capital to the farm firm.[2] Both debt and equity capital sources should be reflected in the marginal cost, with the common practice being to use the weighted average cost of capital to the firm.

[2] This rule works well theoretically when the cost of capital is the same for each and every enterprise. However, if the cost of capital depends upon the size of the total capital budget for the firm (and vice versa), the budget analyst probably is forced to guess the cost of capital for any particular single enterprise. One alternative to pure guessing is to conduct a dynamic programming analysis prior to the enterprise budgeting. However, basic elements of an entire set of enterprise budgets are needed to structure the programming model. In short, this problem is still being studied by theorists.

TIME-MONEY AND INFLATION PROBLEMS

Regardless of the method used to calculate expected annual depreciation and interest on investment, budget analysts are faced with other theoretically-based accounting problems. Two stand out: (1) whether to use nominal or real dollar units and (2) what procedure to use to account for the replacement of durable inputs. Since budgets by definition are planning devices, both of these difficulties are closely tied to the problem of how to appropriately account for inflation in cost and revenue line items.

Dollar values in a budget can either be real or nominal, but to maintain theoretical validity all items in a particular budget should be in one or the other. Units for the illustrative budget for corn, Table 2, were purposely not specified, but they can be either real or nominal. An enterprise budget can be prepared for a selected single future year (situation B, Figure 2); or, as is frequently the case, the budget is prepared for a "typical future year" (situation A, Figure 2). Given the difficulty of forecasting inflation patterns, it may be presumptuous to prepare a nominal dollar budget for a specified future year or even for a "typical year." Input price inflation is rarely uniform among inputs over time. Consequently, the argument for real dollar budgeting is appealing for practical reasons.

Perhaps the most common error made by students when preparing budgets in farm business management courses is to mix real and nominal dollar units. This is particularly true when estimating depreciation and interest costs (both interest on investment and operating interest costs) for farm machines. Students can be instructed on how the following rule applies: *overhead cost accounting should be in real dollar units if the operating cost accounting is real, or in nominal dollar units if the operating cost accounting is nominal* . This rule sounds straightforward, but it is easy to violate. For example, students understand that the capital investment amount for a used tractor could be its estimated market value at the start of the budget period. The market value quoted in a machine resale value guide is often much higher than the tractor's farm record (undepreciated) value—which is usually calculated in real units. Comparison of the two values is deceptive, because it may lead the student to mistakenly believe that the tractor's market value at the beginning of the budget period (RV_t in Figure 2) is not a real dollar accounting value. But, in fact, at that point in time the market value is both real and nominal, *provided* the budget's base time point is defined as the beginning of that particular production period. The fact that the tractor was purchased by the firm several years prior to the budget period does not change this situation, unless the budget's base point-in-time is the same time that the tractor was purchased. If so, this base time must then apply to the dollar accounting for all durable and nondurable inputs shown in the budget.

The rule applies whether the budget analyst estimates annual depreciation and interest costs (D + I) by using the traditional farm management mid-value technique, or costs are estimated by amortizing the original capital investment less the discounted salvage value across the tractor's economic life (Watts and Helmers). With the capital budgeting technique, separate values for D + I are difficult to obtain, a definite disadvantage for users who wish to convert the estimates to after-tax units.

A major and often overlooked advantage of the capital budgeting method is that it accounts for replacement costs of the tractor. In contrast, the traditional mid-value method accounts for annual D + I only for a single rotation; that is, replacement possibilities are ignored. With the traditional method, expectations are formed for a fixed, terminal economic life which is not consistent with the fact that the capital value of a durable input should reflect opportunity costs with respect to time as well as opportunity costs within a single life span (number of years).[3]

[3] The usual marginal criterion for replacement of a depreciable asset is: replace the old asset at the beginning of the year when the expected values of (a) annualized net returns from the new (replacement) asset plus (b) annual interest proceeds on funds invested from the sale of the old asset *exceed* (c) the realized net income in that year from the old asset less (d) that year's depreciation of the old asset. See Perrin for a complete exposition and example of this rule (pp. 64-67).

Assuming a fixed, terminal economic life, as opposed to considering replacement opportunities, means that the budget analyst is ignoring component (a). That is, time opportunity costs are ignored.

The marginal criterion can be shown to be the first order optimality condition resulting from optimization of the present value condition (Perrin, pp. 61-62). Thus, the marginal condition and the capital budgeting method will yield the same replacement decision strategy.

The following farm machine example emphasizes some key aspects of accounting for replacement of durable inputs when preparing the overhead or fixed cost section of an enterprise budget.

Original investment Cost (t = 0)	$= C_0 =$	$55,000.
Salvage value (t = N)	$= RV_N =$	$5,000.
Tractor's economic life (estimated optimal replacement age)	= N =	5 years.
Depreciation in the tractor market	= D =	$10,000 per year.
Straight line depreciation accounting amount	= Dm =	$10,000 per year.
Appropriate real rate of interest	= r	= 5% per year.

The example assumes that all expectations are certain, i.e., perfect knowledge of the planning horizon.[4] Hence, in this case, the calculated expected value for D_m (above) will equal the actual market depreciation (D). Data are assumed to be in real dollar units. The subscript m denotes annual depreciation (D_m) or interest costs (I_m) calculated via mid-value techniques. The subscript c denotes annual depreciation (D_c) or interest costs (I_c) calculated via capital budgeting techniques.

Using the traditional mid-value technique D_m equals $10,000 per year, the straight line amount. Average annual interest (I_m) equals $1,500. That is:

$$I_m = \frac{(\$55{,}000 + \$5{,}000)}{2} (0.05) = \$1{,}500.$$

Thus, expected annual depreciation (D_m) plus the real interest cost (I_m) equals $11,500 each year.

In contrast, by the capital budgeting method, annual depreciation and interest (D_c and I_c combined) are calculated as follows:

$D_c + I_c =$ (capital recovery factor) (present value of the tractor investment cost)
$D_c + I_c = [0.05 / (1 - 1.05^{-5})]\ [\$55{,}000 - (\$5{,}000)(1.05^{-5})]$
$= (0.231)(\$51{,}082) = \$11{,}800$ per year, which is $300 larger than D + I by the mid-value method.

The compound interest effect is a common explanation for the $300 larger estimate of D + I. This is true, but the explanation is much more complete and theoretically meaningful to assert that $D_c + I_c$ allows for an infinite series of tractors purchased and replaced (in this example) at 5-year intervals; whereas $D_m + I_m$ – the mid-value technique's estimate – accounts only for tractor ownership during only the first replacement (tractor) series in the infinite series of possible replacements.

One way to understand this important distinction is to examine both the numerator and denominator of the capital recovery factor as two parts of a product. First, examine the denominator divided into one (1). That is, $(1) / (1 - 1.05^{-5}) = \$4.6195$, in the example, is the present value of a $1 annuity paid at the beginning of each and every 5 years for perpetuity. Second, understand that multiplication by the interest rate of 5 percent annualizes or amortizes the $4.6195 present value amount to the end of each year of the 5-year finite horizon, i.e., $(\$4.6195)(0.05) = \$0.2310$ at the end of each year.

In using the capital-recovery-factor technique, one usually focuses on the actual (economic) depreciation for the machine's economic life. This, of course, does not preclude accounting for the tax shelter values due to using an Accelerated Capital Recovery System (ACRS) tax depreciation schedule (and other tax shelter values under new tax laws). All appropriate tax shelter values and economic depreciation should be incorporated into any replacement model which is used to determine the replacement interval (age), estimated to be 5 years in this tractor example.

Also, in using the capital-recovery-factor technique, simplifying assumptions about inflation are made with the annuity formula. Essentially, this approach does not allow for differential rates of inflation between used machine prices, new machine prices, and

[4] The discussion in this article is not intended to be sufficient in length or complexity to thoroughly address all aspects of replacement problems, which are actually a host of problems each deserving separate treatment. However, what is presented calls attention to the recurring theme of the article—more linkages need to be forged between enterprise budgeting and theory of the firm—thus between replacement theory and enterprise budgeting. In this respect, the essentials of the issues listed at the outset are especially apparent. Extension publications and management teaching textbooks seem to ignore replacement concepts when discussing budgeting—whether capital, partial or enterprise budgets—as do production theory textbooks.

machine operating costs across time. Conflicting implications have been drawn in some research literature, but a closer examination will show that a more complete technique is needed to account for differential inflation rates for these price variables. The capital-recovery-factor technique does, however, allow for a general rate of inflation by using a nominal interest rate that is constant across terms in the infinite series of cash flows.

INFERENCE PROBLEMS

Budget analysts must recognize that enterprise costs and returns can vary widely among locations and years. Production functions change because of changes in technology. Factor cost functions change because of shifts in factor market supply-demand determinants. Different soil conditions and management levels can account for a spectrum of within-year locational differences. Changing weather and market conditions can account for a large portion of the differences among years. Thus, an enterprise budget, even as a set of expectations, is sometimes more aptly entitled "a cost and returns guide." Accordingly, the unit cost curves in Figure 1 will shift upward or downward as production and market conditions (thus expectations) vary.

If shifting locations, changing years, or changing technology lead to frequent shifts in the cost curves, a dilemma arises. Of what value are marginal analysis curves and the corresponding set of enterprise budgets in drawing inferences about optimal or expected behavior? Strictly interpreted, of course, the answer is "no use." But this is the classic problem of trying to apply static production theory to the dynamic world of actual enterprise conditions. An answer advocated by some theorists is to construct and apply the axioms of Bayesian decision theory. However, in reality there may be reasons to argue that shifts in production functions, technology and factor supply conditions, and the weather are often very small in magnitude, at least in any given year. Therefore, an enterprise budget can be reasonably applied to a stipulated range of technology, weather conditions, and market conditions. Wider applicability can be enhanced by supplementing information in the basic budget, Table 2, by detailed information on production coefficients, labor requirements, and capital investment requirements. Other supplementary tables may be useful.

As there are technical improvements in production processes, production theory tells us that the cost curves will shift downward. These cost reductions, when adopted by many producers, will lead to increases in the supply at each price level. This causes the product price and marginal revenue curves to shift downward, and will leave budgeted net returns for individual producing firms no greater than before the technological change. However, this theory is of little value to the enterprise budget analyst who must guess the magnitude and timing of shifts in the curves.

To obtain good information about the range of production surfaces and cost relationships presents continuing problems of data sources and accurate measurement. Moreover, these are problems which production researchers (economists and others) and enterprise budget analysts increasingly seem to ignore, perhaps because such problems are routine and have lost their professional glamor and payoff. But there is still a theoretical challenge. For example, if all farmers are profit maximizers, how can cost relationships be quantified using survey data, Figure 1? Farm records data, for example, either for 1 year (cross-sectional), or for several years on the same farm (time-series), or for some combination usually consists of different points on the vertical plane of Figure 1, each point lying on a different AVC or ATC curve (Doll).

The problem of continuing to update cost relations or enterprise budgets is the challenge of continuing to revise measurements. With enough research time or research funds, several points on the same AVC curve can be generated via controlled experiments. Or, more practically and less costly, analysts can resort to simulating points along each curve using judgments based on farm records or engineering data. The year and/or location effects may be removed using statistical techniques such as covariates in an OLS model.

CONCLUDING REMARKS

Motivation for this paper grew from the realization that linkages between enterprise budgeting and marginal analysis are not explicitly delineated in textbooks on farm production economics and farm management. Also, extension publications do not deal with these problems. A review of several texts in these areas revealed that the linkages to capital theory are not well developed.

This paper illustrates how certain basic accounting techniques of enterprise budgeting can be linked to static production theory, especially to marginal analysis and capital investment analysis. Estimates in an illustrative corn production enterprise budget are linked to specific points on average cost curves. Budgeting for costs associated with services from durable inputs is discussed in light of the problem of classifying costs as either *fixed* or *variable* versus classifying costs as either *overhead* or *operating*. The problem of viewing budgeting as a planning exercise rather than as an historical accounting technique is linked to the problem of updating budgets so that more useful inferences may be drawn. In turn, these problems are linked to the problem of dealing with expected changes in inflation patterns and expected changes in technology.

Beyond the establishment of logical linkages between budgeting and production-capital theory, there are several problems of implementing these linkages in teaching and extension programs. The computer budget generators now in use at most land-grant universities and by the USDA provide the capability of more efficiently constructing budgets which have applications to an assortment of farm types and economic situations. These budgets, ideally, could be quickly altered to fit individual farm situations by their transformation to any number of microcomputer programs. However, the sheer power to manipulate vast arrays of numbers is no substitute for a more complete structure of linkages between budgeting in practice and budgeting in economic theory.

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