United States
Department of
Agriculture

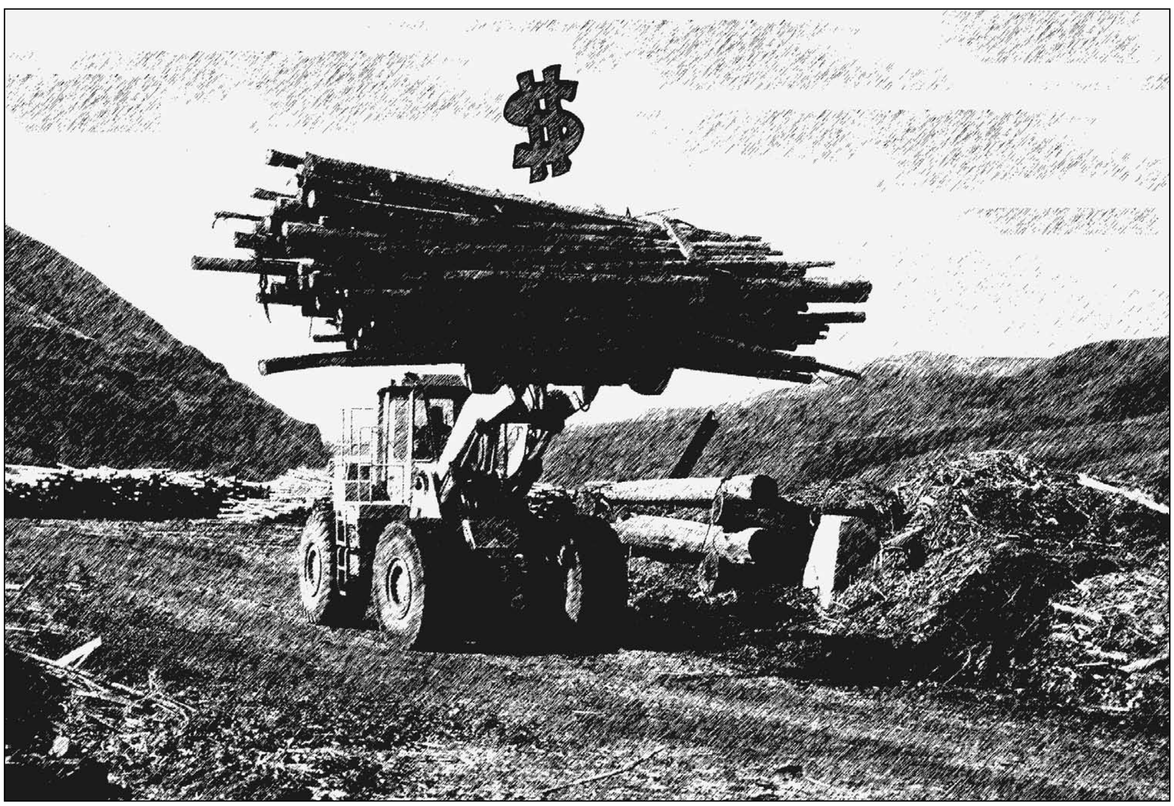
Forest Service

Forest
Products
Laboratory

General
Technical
Report
FPL–GTR–171

CHARGEOUT! Determining Machine and Capital Equipment Charge-Out Rates Using Discounted Cash-Flow Analysis

E.M. (Ted) Bilek



Abstract

The model ChargeOut! was developed to determine charge-out rates or rates of return for machines and capital equipment. This paper introduces a costing methodology and applies it to a piece of capital equipment. Although designed for the forest industry, the methodology is readily transferable to other sectors.

Based on discounted cash-flow analysis, ChargeOut! provides more accurate financial outputs than traditional single-period models. ChargeOut! produces a break-even charge-out rate that will return any specified after-tax real rate of return over the economic life of the capital equipment. Alternatively, given a negotiated charge-out rate, the model produces net present values and real and nominal rates of return before tax and financing, before tax, and after tax. It also compares the negotiated charge-out rate with the calculated break-even rate, incorporates inflation, accounts for depreciation, and automatically conducts a sensitivity analysis. Graphs illustrate the major cost centers and cash flows.

The model is both automated and flexible. Interpretation of ChargeOut!'s results requires some knowledge of discounted cash-flow analysis. The target audience is financial professionals in the logging industry or equipment owners who have some background in engineering economics. ChargeOut! is illustrated using representative data from a logging skidder; however, the methodology could be adapted to find charge-out rates or rates of return for any piece of capital equipment.

Keywords: charge-out rate, break-even analysis, capital equipment costing, machine rate, depreciation, inflation, discounted cash-flow analysis

Where to get more information: Study this manual and the appendixes to become familiar with the terminology and concepts used. A list of references is provided.

For further general information or to obtain assistance with problems you may encounter while using this model contact: E.M. (Ted) Bilek, USDA Forest Service, Forest Products Laboratory, One Gifford Pinchot Drive, Madison, WI, 53726-2398, email: tbilek@fs.fed.us, telephone: (608) 231-9507.

May 2007

Bilek, E.M. (Ted). 2007. ChargeOut! Determining Machine and Capital Equipment Charge-Out Rates Using Discounted Cash-Flow Analysis. General Technical Report FPL-GTR-171. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 33 p.

A limited number of free copies of this publication are available to the public from the Forest Products Laboratory, One Gifford Pinchot Drive, Madison, WI 53726–2398. This publication is also available online at www.fpl.fs.fed.us. Laboratory publications are sent to hundreds of libraries in the United States and elsewhere.

The Forest Products Laboratory is maintained in cooperation with the University of Wisconsin.

Contents

ChargeOut! Determining Machine and Capital Equipment Charge-Out Rates Using Discounted Cash-Flow Analysis

E.M. (Ted) Bilek, Economist
Forest Products Laboratory, Madison, Wisconsin

Introduction

This report presents an improved methodology for determining the charge-out rate for a piece of capital equipment. It provides a single hourly charge-out rate calculated as a true break-even rate over the equipment's economic life. That is, given the cash costs, depreciation, taxes, inflation, and other financial and operating assumptions, the break-even charge-out rate will return to the owner exactly his or her required return on invested capital. The break-even charge-out rate can be used to establish machine charge-out rates or transfer prices for the use of the equipment within a firm.

Capital equipment is important in forestry, especially in harvesting. Capital equipment costs typically comprise a significant component of total harvesting costs, and the industry is becoming ever more capital-intensive as equipment replaces workers in the forests. Yet the basis for calculating capital equipment charge-out rates is poorly developed.

Capital equipment is becoming more important in harvesting operations because of both productivity and safety issues. As log diameters decrease, piece counts must increase to keep total volumes constant. With regard to safety, although timber harvesting remains a hazardous occupation, workers are generally safer inside machines in closed cabins with roll-over protection systems than they are on the forest floor.

Two basic methodologies for calculating charge-out rates are the machine-rate and cash-flow methods. All machine-rate methodologies date back to Matthews (1942). A machine-rate methodology easily adapted for hand calculators was presented by Miyata (1980). An updated version on spreadsheets but using the same machine-rate methodology is presented by Brinker and others (2002). A similar costing methodology is incorporated into Caterpillar Tractor Company (2001) and into Fight and others (2003). All machine-rate methodologies provide single estimations of hourly machine costs that can be used as charge-out rates. All machine-rate methodologies are limited because they do not consider cash flows over time.

Limitations of the machine-rate calculation have been noted by other authors. They were summarized on a USDA Forest Service website (USDA Forest Service 2005):

1. The treatment of depreciation and interest does not consider the effect of compound interest on capital recovery.
2. The machine rate does not consider the effect of tax treatment for various cost categories.
3. Costs are assumed constant (average) for all years of ownership and thus never match actual cash outflows.
4. Most cost factors are based on rules-of-thumb with little supporting data.

Cash-flow analysis for harvesting equipment replacement decisions was proposed by Butler and Dykstra (1981) and Tufts and Mills (1982). A spreadsheet-based cash-flow model was introduced by Burgess and Cubbage (1989). Stenzel and others (1985) have a brief discussion of cash-flow analysis at the end of their book. Caulfield and Tufts (1989) looked at forestry equipment replacement decisions under risk. However, these cash-flow models all have shortcomings in that they do not calculate a single break-even charge-out rate, which is an advantage of the machine-rate model.

The USDA Forest Service (2005) notes, "Neither the machine-rate method nor the cash-flow method explicitly treats additional costs of operation such as overhead, profit, or risk."

ChargeOut! is a discounted cash-flow method that overcomes most of the limitations of the machine-rate calculations. In addition, it explicitly considers overheads and profits, and through sensitivity analysis, risk can be explicitly incorporated.

Cash flows over time are important because of the "time value of money," the fact that the promise of a dollar in 5 years is not the same thing as a dollar in the pocket today. The reason is that today's dollar could probably be invested at a positive interest rate, called a "discount rate" or "alternative rate of return," which would make today's dollar investment worth more than a dollar after 5 years.

The discount rate may be expressed in either nominal or real terms. A nominal discount rate includes inflation. A real discount rate has inflation taken out of the calculation. Discount rates may also be expressed as before tax and finance, before tax, or after tax. For comparative purposes, it is important to know which discount rate is shown.

ChargeOut! enables a user to accurately answer a number of important "what if" questions when considering a machine purchase. For example—

- What is a fair hourly charge-out rate that will provide an acceptable after-tax rate of return over the machine's life?
- Given an hourly charge-out rate, what is the expected rate of return?
- What happens to the charge out if the depreciable life is different than the economic life?
- How do changes in depreciation rates affect the break-even charge-out rate and the rate of return?
- How much does the break-even rate and rate of return change if the number of operating hours per year is not constant?
- How does the amount and cost of financing affect the break-even charge-out rate?
- What happens to the before- and after-tax rate of return under different inflation assumptions?
- What happens to the before- and after-tax rate of return under different cost assumptions?
- As the machine ages, how do increasing repair and maintenance costs affect the break-even charge out and the rate of return?
- What happens to cash flows and charge outs if expensive parts, such as tires, are not replaced annually, but rather every several years?
- Given a charge-out rate, how much can fuel costs increase before break even no longer occurs?
- What are the annual cash flows likely to look like before tax and financing, before tax, and after tax?

ChargeOut! calculates an economic break-even charge-out rate. This rate will return to the owners all of their costs plus exactly their required rate of return on capital. An economic break-even rate, which includes a specified rate of return on capital, may be contrasted with an accounting break-even rate. An accounting break-even rate would eventually return its capital but would provide a rate of return of 0%, not including inflation, and a negative rate of return if a positive inflation rate were deducted.

Technically, the break-even charge-out rate is calculated by taking the annualized discounted present value of all costs and dividing it by the annualized discounted present value of the operating hours or units of output. However, understanding this is not necessary to use the program. ChargeOut!'s break-even rate is calculated per hour and per unit of output (ton, cord). If the negotiated rate is larger than the break-even rate, the owners will earn more than their required return on capital. If it is less than the break-even rate, the owners will earn less than their required return on capital. If it is equal to the break-even rate, the owners will earn exactly their required return on capital.

Profits are positive net present values. They are returns over and above the owner's required return on invested capital. Profits occur if the sum of the discounted costs is less than the sum of the discounted revenue. Losses are returns less than the owner's required return on invested capital. Losses occur if the sum of the discounted costs is greater than the sum of the discounted revenue. Any additional profits appear at the top, and losses would appear at the bottom of the summary costs graph. Break even occurs when the owner covers all costs and in addition earns exactly the required return on invested capital.

Note that ChargeOut! follows an economic definition of profits rather than an accounting definition of profits. In accounting, anything earned over costs is considered profit. In economics, profit is a rate of return greater than what the owners require. In ChargeOut! the owner's required return on invested capital is used. Without a required return, ChargeOut!'s profits would be identical to accounting profits. However, if there is an alternative rate of return, then ChargeOut! will not show profits until that rate is earned. Similarly, the break evens calculated in ChargeOut! incorporate the required return on invested capital, so at the break-even point, the owners will be earning exactly their required after-tax rate of return.

The break-even charge-out rates are calculated using after-tax costs and returns because owners will be concerned about how much money is left in their pockets or how much additional financing is required after all expenses, including taxes, have been paid.

The utilization rate (the percentage of scheduled hours that the machine is actually operating) and the machine's productivity in terms of output per productive hour are both user-entered constants. Note: As with any model, the validity of the outputs depends on how realistic the inputs are. The model's outputs will be quite sensitive to changes in the utilization rate and in expected production. Whereas these are constants, the number of scheduled hours per year can be varied yearly so that the total annual production does not have to be held constant.

Inflation and government tax policies regarding depreciation allowances will have an effect on the after-tax cash flows. Logically, they should also have an effect on break-even charge-out rates. The break-even charge-out rate can be allowed to increase with inflation, as with most other costs. Alternatively, it can be fixed over the machine's economic life.

Rather than calculating a charge-out rate, a rate may already have been negotiated. Given a charge-out rate, the methodology presented calculates rates of return and net present values for the equipment on the basis of before- and after-tax cash flows.

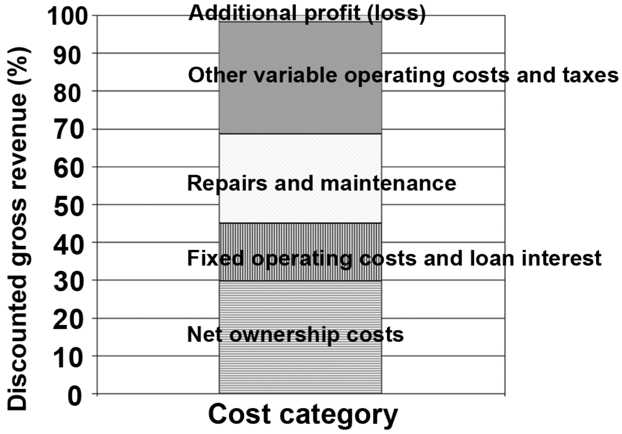


Figure 1—ChargeOut!'s discounted costs and profit (loss) as a percentage of discounted gross revenue. Profit represents a return over and above the owner's cost of capital. Loss represents a return less than the owner's cost of capital. Variable costs are shown with diagonal bars. Fixed costs are shown with horizontal and vertical bars.

The methodology is flexible. Key variables do not have to be constant over each year of the machine's economic life. Operating hours may fluctuate. In reality, they usually do. For example, Caufield and Tufts (1989) studied a company's 136-horsepower, 4-wheel drive, articulated-frame, rubber-tired grapple skidders and found that average hours worked per machine declined from 1,328 hours per year for 1-year-old machines to 703 hours per year for 5-year-old machines.

Repairs and maintenance may vary. The loan term may be different than the machine's economic life, which in turn may be different than the machine's depreciable life. Depreciation is not just limited to the straight-line method.

The methodology is incorporated into a computer spreadsheet model, ChargeOut! The methodology is presented using a logging skidder as an example, but it may be applied to any piece of capital equipment.

The methodology should be of interest to logging contractors and accountants involved with the logging industry. The resulting calculated charge-out rates can be incorporated into such programs as LogCost to evaluate the economics of different harvesting systems.[1]

The focus of this paper is to describe the ChargeOut! methodology and how to run the program. In using ChargeOut! to aid in formulating a job bid, a contractor would use the program to calculate the break-even rate for each piece of capital equipment employed in the job. To this total would be added costs for wages and any administrative overheads. ChargeOut! may be incorporated into a full job costing program in the future.

[1] USDA Forest Service, Pacific Northwest Region website—www.fs.fed.us/r6/nr/fp/FPWebPage/ForestProducts/ForestProducts.htm

The remainder of the paper is organized into five sections:

1. Listing of ChargeOut!'s key features
2. Brief description of the ChargeOut! computer model
3. Base case using realistic data[2] included to illustrate the model's utility
4. ChargeOut!'s limitations
5. General summary and discussion

In addition, three appendixes are included: Appendix 1: ChargeOut!'s outputs; Appendix 2: inputs required to run ChargeOut!; and Appendix 3: a printout of ChargeOut!'s main worksheet. Cells in boldface type appear on the printout; these cells appear in blue type in the Microsoft Excel (Microsoft Corporation, Redmond, Washington) spreadsheet.

ChargeOut! Features

ChargeOut! has many built-in and powerful features:

- Automatic calculations and recalculations
  - Cash flows, net present values, and internal rates of return before tax and finance, before tax, and after tax[3]
  - After-tax break-even charge-out rate
  - Comparisons between the equalized annual year 1 negotiated rate and the after-tax break-even charge-out rate
  - Periodic loan repayments
- Flexible production schedules
  - The number of scheduled hours per year may be constant.
  - The scheduled hours per year may be varied throughout the machine's economic life.
  - Flexible charge-out rates are automatically inflation-adjusted or individually entered each year.
- Variable machine economic life (1 to 8 years)
  - may be different than depreciable life
  - may be different than the loan life
- With variable loan terms,

[2] Note: the numbers presented here should not be taken as conclusive proof that a skidder is a worthwhile investment under all conditions. Anyone considering the purchase of a skidder should ensure that the inputs are representative of their financial situation.

[3] Before any financing or tax adjustments have been incorporated is "before tax and finance." After any borrowing or incorporating principal repayments and interest payments is "before tax." After financing and tax payments have been incorporated is "after tax."

    - payments may be annual, semi-annual, quarterly, or monthly,
    - loan term does not have to match economic life or depreciable life, and
    - annual percentage rates are automatically converted into equivalent annual interest rates.
- Automatic inflation adjustments
- Machine residual salvage values that can be automatically inflation-adjusted
- Built-in standard depreciation schedules using either the General Depreciation System or the Alternative Depreciation System (IRS 2005). The depreciation schedules include the following:
    - Declining balance, with automatic conversion to straight-line depreciation when it is most advantageous
    - Straight-line depreciation
- Two non-standard depreciation schedules
    - Straight-line depreciation over the machine's economic life (not an IRS-approved method)
    - A custom depreciation schedule, if the built-in depreciation schedules are not appropriate (may also not be IRS-approved)
- Three tax treatments that allow yearly losses to either flow through, be carried forward, or be lost
- Two built-in maintenance and repair schedules, both indexed to inflation and to the productive hours:
    - "Estimated" schedules based on a constant percentage of straight-line depreciation
    - "Custom" maintenance and repair schedules, if the user has more accurate data or if the estimated schedule is not accurate
- *Ad valorem* (property) tax valuations that may be based on average capital invested, straight-line book values, or custom valuations
- Periodic parts replacements when the parts are expected to wear out, not averaged over the machine's life
- Extensive built-in error and warning messages
- Extensive built-in notes explaining the purpose and utility of various cells

ChargeOut! provides built-in adjustments to cash flows if the owner takes the Section 179 deduction and/or the special first-year depreciation allowance. Section 179 deductions were introduced in 2000. For 2006, the deduction limit is $108,000. There are restrictions and asset value limitations for this deduction. See Internal Revenue Service Publication 946, How to Depreciate Property (IRS 2005).

The special first-year depreciation allowance was put in place by the Job Creation and Worker Assistance Act of 2002. It is in addition to ordinary depreciation. It is calculated after any Section 179 deduction. If taken, it may be either 50% or 30% of the adjusted book value (that is, the purchase price less any Section 179 deduction).

There are additional write-offs available under both the Section 179 deduction and the special first-year depreciation allowance, if the assets are located in certain areas of the country.

ChargeOut! Workbook

A Microsoft Excel workbook containing ChargeOut! may be found on the web at the following URL: http://www.fpl.fs.fed.us/documnts/fplgtr/fpl_gtr171/fpl_gtr171--chargeout.xls. The workbook is organized into four worksheets: the ChargeOut! model (Screenshot 1, ChargeOut! tab), a chart showing the breakdown of the different cost categories (Screenshot 2, Summary costs chart), a chart showing the summary cash flows over time (Screenshot 2, ChargeOut! tab), and a worksheet containing optional fuel and oil calculations.

The workbook contains extensive notes explaining the utility of various cells. It also contains extensive built-in warnings and error messages to help an analyst reject unrealistic solutions. Nonetheless, the spreadsheet model is a tool, and like all tools, it may be misused. If a solution appears to be incorrect, it may well be. If that occurs, the analyst should investigate further and find out why the answers came out the way they did. See the general disclaimers inside the cover page.

ChargeOut! Organization

The ChargeOut! worksheet is organized with the most important information on top: summary financial information along with the negotiated charge-out rate (an input variable), summary cash flows, and summary annual production. In a printout, this information will appear on the first page. The negotiated charge-out rate variable is on the first page rather than with the other input variables because this is probably the most important single input variable. The analyst will want to see how this variable compares with the break-even rate and what effect changes in the negotiated rate will have on the rate of return and cash flows. Appendix 1 of this paper gives a detailed description of ChargeOut!'s outputs followed by a full printout of those outputs.

Machine Cost Groupings

Machine costs may be divided into three groups: fixed costs, variable costs, and income taxes. Fixed costs do not change with the level of production. Variable costs do change with production. Income taxes are related to variable costs in that they are a function of pre-tax income. In the summary graph, income taxes are grouped with other variable operating costs because they make up such a small portion of discounted gross revenue.

Fixed costs include ownership costs, fixed operating costs, and loan interest. Ownership costs represent the cost of owning the equipment. They are calculated by discounting the cash flow consisting of the equipment cost, less any initial equipment loan and the equipment salvage value, plus loan principal repayments. Whereas these ownership costs are fixed, they are not directly tax deductible. Traditional machine-rate costing models include depreciation as a cost of ownership. Depreciation expense is not a cost of ownership. It is an accounting device. It will only relate to the cost of ownership by coincidence. The ownership cost that must be recovered is more accurately calculated using the cash flows associated with that ownership and the owner's required rate of return, rather than by an arbitrary accounting formula. ChargeOut! incorporates depreciation expense in the income tax calculations. The only ownership cost that can be affected by inflation is the equipment residual salvage value.

Salvage estimates may vary considerably. Early authors recommended a constant rule-of-thumb to estimate salvage values. Miyata (1980) recommended that salvage should be 20% of the initial purchase price. Werblow and Cubbage (1986) recommended 25%, based on higher new equipment prices. Cubbage and others (1991) used regression analysis to compute resale values of various classes of logging equipment by year. Their main findings were the following:

- Age is the most significant variable in resale value.
- Equipment condition becomes a statistically significant factor only when older equipment (5 to 10 years old) is considered.
- Resale values level off after about 5 years at values of 20% to 30% of the original purchase price.
- Old rules-of-thumb are generally too conservative.

Findings from Cubbage and others (1991) on 5-year resale values are shown in Table 1.

ChargeOut! offers the option to index or not to index the salvage estimate to inflation. All the works on salvage values referenced above used nominal salvage estimates. For example, Cubbage and others' (1991) regression-based estimate of 30% for all logging equipment incorporates an implicit inflation adjustment; a salvage estimate based on that percentage should not be further indexed for inflation. On the other hand, if current prices for used logging equipment are used for salvage estimates for new equipment, those prices may be expected to increase with inflation over the years. A salvage estimate based on current used equipment prices should be inflation-indexed.

Table 1—Rule-of-thumb and regression-based 5-year nominal resale values for selected logging equipment as a percentage of original purchase price[a]

	Percentage of purchase price	
Equipment type	Rule-of-thumb	Regression-based
Rubber-tired feller–buncher	20	29
Grapple skidder	25	30
Cable skidder	20	35
Knuckleboom loader	30	49
All equipment	20	30

[a]Cubbage and others (1991).

Operating costs are tax deductible. Fixed operating costs must be paid each year as long as the equipment is owned, no matter how much or how little the machine operates. Stuart and Grace [N.D.] argue, "While equipment and overhead costs may be fixed for time periods as short as a day or the time required to harvest a particular tract, they are variable within years and between years."

Although owners may reconfigure their equipment ownership over a very short time period, ChargeOut! may be modified to account for the shorter time periods by allowing the time period to represent months or weeks rather than years. If this is done, then a custom depreciation schedule should be used, along with appropriate interest rates (monthly or weekly rates).

Fixed operating costs include insurance, *ad valorem* taxes, and other fixed costs. All fixed operating costs are affected by inflation. Note that for cash-flow purposes, depreciation is not a fixed operating cost because annual depreciation expense does not result in cash outflows. The outflows occur when the machine is purchased and when loan payments are made. There may be a cash inflow when the machine is sold at the end of its economic life.

If a loan is taken out, then loan interest must be paid. Interest is the cost of money and is tax deductible. A loan may be either fixed-rate or variable-rate. The interest rate on a fixed-rate loan will not be affected by changes in the inflation rate. A variable-rate loan will change with inflation rate changes. For a more comprehensive discussion on the effect of loans and loan interest on charge-out rates, see the section on financial gearing that follows.

Variable costs are all operating costs. These costs are expected to vary with the number of hours that the machine is operated each year. Fuel, tires, oil, and lubricants are examples. Variable operating costs are also increased automatically by the annual inflation rate.

For timber harvesting equipment, maintenance and repair together will probably be the most significant variable operating costs, so they are treated separately from other variable operating costs. ChargeOut! allows these costs to be entered directly each year using a custom entry for the functions. Alternatively, the function's forms may be estimated. Maintenance and repair forecasts should be entered as "Custom" to provide more accurate costings.

The "Estimated" maintenance and repair functions in ChargeOut! follow the logic of the formulas presented in Butler and LeDoux (1980) and Butler and Dykstra (1981). Both sets of authors note that maintenance costs are typically fairly constant over time, but may show a moderate increase in real terms. They further note that if initial, usually higher, repair costs are covered under a guarantee, it is reasonable to assume that expected repair costs will increase with time. As evidence of this, Tufts and Mills (1989) found that hourly repair and maintenance costs for a company's skidders increased from $7.22 for 1-year-old machines to $22.04 for 5-year-old machines.

Butler and LeDoux (1980) and Butler and Dykstra (1981) allow for initial maintenance and repair costs to be increased exponentially over a number of time periods. The time is based on the number of periods until periodic maintenance cost increases 50%, a reasonable but arbitrary percentage. The formulas used in ChargeOut! to calculate estimated maintenance and repair costs C in year n follow the form:

$$C(n) = C_1 \times ((1.5)^{(H_2/H_1)})$$

where

- C_1 is the initial maintenance or repair cost (a user-specified percentage of straight-line depreciation),
- H_1 the user-specified number of productive hours until the machine's maintenance or repair costs increase by 50%, and
- H_2 the cumulative number of productive hours that the machine has operated from the time it was purchased.

Within the main cash-flow table, both maintenance and repair costs are further adjusted by the variable operating costs sensitivity factor, discussed later, and by the inflation rate.

LeDoux (1980) and Butler and Dykstra (1981) use initial costs and time as the variables; however, maintenance and repair costs are more accurately linked to usage rather than a machine's age. If the number of machine hours is not constant from year to year, one would not expect to see uniformly increasing maintenance and repair functions as would occur if costs were linked to time in the original formulas provided by Butler and LeDoux (1980) and Butler and Dykstra (1981). For this reason, if estimated maintenance and repair functions are used, ChargeOut! requires the number of productive hours until both costs have increased by 50%. This ensures that maintenance and repair costs will increase as the machine is used. However, users should be aware that actual maintenance and repair costs will probably occur sporadically and there may be lags between usage and costs. Therefore, the actual cost curves may not follow the curves that ChargeOut! calculates.

If it is expected that maintenance and repair costs will be constant per hour, then a very large number (e.g., 1,000,000,000 hours) should be entered as the number of productive hours until the costs will increase by 50%.

Other variable operating costs include fuel, lubrication, tires, etc. Tires are a special type of variable operating cost.

> When machinery is so designed that certain parts that are subject to the greatest wear can be easily replaced without effect upon the general mechanical condition of the machine, the depreciation should be charged against the original cost of the equipment less the cost of such replaceable parts. The replacement would then be carried as an operating cost. This applies particularly to truck tires. (Matthews 1942, p. 55)

In practice, trucks, skidders, and other machines are delivered with tires and at the end of their economic lives are sold with tires. Depreciation expense is taken on the full machine cost, including tires. Tires will be replaced when they wear out or are no longer repairable. Replacement costs may not be annual, but tires do have expected operating lives. Tire replacements are operating costs in the year in which they occur. ChargeOut! compares the expected life of tires with productive hours the machine is used. When productive hours exceed the expected tire life, tires are automatically replaced. This means that the cost of tires is not a uniform annual charge, but rather is intermittent, reflecting actual timing on expected tire expenditures.

Income taxes are at the specified rate. This rate should be a composite rate, including both federal and state income taxes. Income taxes are taken on the taxable cash flow. The taxable cash flow is the gross income less the fixed and variable operating expenses, less tax adjustments. Tax adjustments include the Section 179 federal income tax deduction, the special first-year depreciation allowance, regular depreciation expense, and any taxable gain or loss on the salvage value of the equipment at the end of its economic life. Note that the Internal Revenue Service does not allow depreciation expense to be taken in the year in which an asset is disposed of or sold. Technically, the asset should be sold at the beginning of the next year after the end of its economic life. This will make no difference in the discounted cash-flow analysis.

If income tax credits result from tax losses, ChargeOut! allows these losses to either "flow through" to other parts of the business that would otherwise owe taxes on income, or they may "carry forward" until a year in which taxes are owed on income. Flow through is the best in terms of maximizing the return on investment. The worst case is that the tax losses are lost. This occurs if the tax loss treatment equals "None."

Financial Gearing or Leverage

What effect does financing have on break evens? In theory, the investment decision—whether or not a particular investment is worthwhile—should be independent from the financing decision (whether the investment is financed with equity or debt) and what percentage of debt is used. However, in practice, for a contractor owning one or two large pieces of equipment, the equipment's financing may constitute most of the firm's liabilities, so the investment and financing decisions are closely linked.

"Gearing" or "leverage" are the terms used to describe how much of a firm is financed with debt. Gearing may have a large effect on the contractor's after-tax rate of return. The amount of debt being carried by the contractor is important for two reasons:

1. Debt affects the rate of return the contractor earns on equity capital at any given charge-out rate. Looked at another way, the amount of debt affects the rates the contractor must charge to earn a given rate on equity capital. Therefore, gearing affects the break-even charge-out rate.
2. Debt increases the contractor's financial risk. Financial risk is the risk that the contractor will not be able to pay fixed obligations, such as loan payments. If a firm cannot pay its fixed obligations, it will go bankrupt. A firm financed entirely with equity capital will have little financial risk. On the other hand, an all-equity-financed firm will also provide its owners with a lower rate of return on equity because interest expense is generally less expensive than equity financing. Alternatively, an all-equity-financed firm would have to charge more for its production to provide a given return on equity.

Interest expense is usually cheaper than equity financing for two reasons: (1) in the United States, business interest expense is deductible for tax purposes whereas dividend payments on equity are not; (2) interest expense must be paid before dividends if the firm is incorporated, and bond holders have a priority claim on a firm's assets in case of bankruptcy. As a result, the return on lending is safer than the return on equity funding. Therefore, debt holders usually require a lower rate of return than equity holders.

ChargeOut! provides the option for a user to choose either a constant or a variable (inflation-adjusted) loan rate. ChargeOut! provides the ability to incorporate financing of any percentage of the purchase price, although if the percentage is less than 0% or greater than 100%, warning messages will appear.[4]

The loan term may be varied and may be different than the machine's economic life. The number of loan payments per year may also be varied. ChargeOut! automatically recalculates the loan cost, the payment amount, and interest payments.

If the loan interest rate is variable, it changes with inflation. The rate you enter here is real (it does not include inflation). Use this option if the interest rate is not locked in, but the effect of changing inflation rates on the break-even charge-out rate or the rate of return is being tested.

Whereas loan payments are rarely easy to make, it is a great advantage that the interest portion is tax deductible. ChargeOut! keeps track of the interest portion of each loan payment and shows the total as a deductible expense each year. Just as the initial borrowing is a cash inflow and untaxed, the principal repayment portion of each loan payment is a non-deductible cash outflow.

Caution: Be wary of selecting a piece of equipment based on the specific financing available. The equipment financing can affect the firm's overall ability to borrow. So the discount rate that is applied

[4] ChargeOut's flexibility means that it would be possible to set the loan interest rate as a function of the gearing level, if such detail were warranted.

Maintenance and repairs: equating the functions

Since maintenance and repairs can comprise such a significant portion of annual cash flows, they can also have a large effect on the numbers in the financial summary. If a user does not know the form of the maintenance and repair function but wants to ensure that the effects of both maintenance functions and both repair functions are the same in the summary financial figures and break-even calculations, then the present values of the two sets of functions' costs should be made identical. This can be done by adjusting the "fudge factors" in the maintenance and repair costing templates below the main cash-flow table. Then while the annual cash flows will change with the different maintenance and repair functions, the choice of using either "Custom" or "Estimated" maintenance and repair functions will have no effect on the net present values (NPV), internal rate of returns (IRR), and break-even charge-out rate.

To summarize, if the user has a good basis for estimating maintenance and repair expenses, then a custom function should be used. That should be the first choice. The estimated functions are rules-of-thumb. In any case, the chosen maintenance and repair cash-flow functions should reflect the user's experiences. Finally, actual maintenance and repair expenses for the new machine should be monitored closely.

Inflation and interest rates

Most loan interest rates quoted by banks and finance companies have inflation incorporated into them. That is, once the money is borrowed, even if the inflation rate changes, the loan interest rate will not change. The interest rate is fixed when the money is borrowed. For that reason, one should be cautious about changing the inflation rate without changing the associated loan interest rate, unless the money is already borrowed and the impact of changing inflation on the real rate of return is being evaluated. If inflation rates change, banks and finance companies can be expected to change their interest rates on new loans correspondingly.

ChargeOut! allows loan interest rates to be fixed or variable.

If the loan interest rate is fixed, it does not change, no matter the inflation rate. The interest rate entered here is nominal (it includes inflation). Use this option if the loan interest rate is locked in, but the effect of changing inflation rates on the break-even charge-out rate or the rate of return is being tested.

to a project should reflect the firm's overall cost of capital and not be project specific.

All inputs to ChargeOut! appear in the spreadsheet in **boldface**. The only inputs on the first page are a title or run number to identify the output and the negotiated charge-out rate, and the units (tons, million board feet). In the ChargeOut! model, the most important basic assumptions follow the summary outputs. Appendix 2 of this paper contains a full printout of ChargeOut!'s main inputs, followed by a description of those inputs. The only other inputs appear in the custom areas of the expense templates for depreciation, repair and maintenance, and *ad valorem* tax valuations, and the sensitivity analysis tables.

Base Case: ChargeOut! for a Logging Skidder

Background

A skidder is a piece of heavy equipment used to haul (skid) logs out of a forest. While skidders and similar equipment (forwarders, loaders, feller-bunchers, delimbers) are necessary for most ground-based harvesting operations, the basis for establishing charge-out rates for such capital equipment is not firmly based in current financial theory. While the example illustrating ChargeOut! is constructed for a logging skidder, the model may be easily adopted for any piece of capital equipment that is a cost center.

The key assumptions used in the sample base case financial analysis for a logging skidder are shown below.

Negotiated charge out	$45.00/hour
The negotiated rate changes annually with…	Inflation
Purchase price (excluding tires)	$180,000
Salvage estimate (includes inflation)	$55,800
Economic life	5 years
Gearing (% of total purchase price financed)	60%
Loan term	3 years
Fixed loan interest rate (APR)	8%
Expected hourly production	10 tons
Inflation	3%
Engine type	Diesel
Horsepower	135 HP
Repair and maintenance percentage	60%
Utilization rate	67%
Standard productive time	2,000 hours
Income tax rate	33%
Expected risk premium on invested capital*	7%

*This risk premium is added onto the bank's equivalent annual deposit interest rate to arrive at the before-tax nominal (including inflation) required return on invested capital.

The scheduled annual operating time goes from 1,850 hours in the first year to 2,000 hours in the second year, and then 2,500 hours in years three to five. The productive utilization rate is 67%. Data used for the base case are not representative of any specific skidder, so should be used with caution in the analysis of any piece of equipment. They are presented to illustrate the model. The full base case inputs and a description of ChargeOut!'s inputs are in Appendix 2.

Summary financial details for the base case are below (Table 2). These base case outputs along with other outputs are provided in Appendix 1.

Summary Financial Information

By the financial criteria provided, the base case appears to be a worthwhile investment. While the before-tax and finance and before-tax NPVs are negative, the after-tax NPV is positive, and the after-tax IRRs are all greater than their respective required returns on invested capital (Table 2).

This information by itself would be important and valuable for a contractor wanting to purchase this skidder. But perhaps even more important than the summary financial information are the break-even calculations and the sensitivity (or "what if") analysis. In addition, the owner and his or her banker should be interested in the expected cash flows and the assumptions behind them.

Table 2—Summary financial information for the base case

	Before tax and finance	Before tax	After tax
Net present value	$(6,331)	$(559)	$7,849
Internal rate of return (real)	5.7%	6.7%	6.5%
Internal rate of return (nominal)	8.9%	9.9%	9.7%

Table 3—Year 1 charge-out rates for the base case

	Charge-out rate ($)		
Unit	Inflation adjusted	Break even	Difference
Scheduled hour	45.00	43.81	1.19
Productive hour	67.16	65.39	1.77
Ton	6.72	6.54	0.18

Break-Even Calculations

Break-even figures indicate the values for key variables at which the owner will earn exactly the required return on invested capital. When a variable is at break even, the net present value is $0 and the internal rate of return is exactly equal to the required return on invested capital. Break-even figures provide the investor with an indication of just how much key values could change before the investment would no longer earn the required rate.

ChargeOut! automatically calculates the break-even charge-out rate. The break-even charge-out rate is also compared with the negotiated rate in the ChargeOut! printout (Appendix 3) and in Table 3.

Since the negotiated charge-out rate is greater than the break-even rate (Table 3), the investment should make money. The owner may use these numbers as a guideline on whether the machine is likely to achieve its required rate of return.

Built into the break-even charge-out rate calculation is an assumption that this rate will increase yearly at the specified inflation rate. If you specify in the model that the annual hourly rates will increase with negotiation rather than inflation, then this calculated break-even rate may not return to the owner the required after-tax return on invested capital. This option is included to allow for constant charge-out rates or for rates that change by a different amount each year.

Sensitivity Analysis

The sensitivity analysis is closely related to the break-even calculations. The sensitivity analysis shows the effects on the rates of return, break-even scheduled operating hours, and break-even charge-out rates if certain variables change.

ChargeOut! contains two powerful input variables in the Basic Assumptions table that greatly simplify a sensitivity analysis: the fixed operating costs sensitivity and the variable operating costs sensitivity (Appendix 2). These two numbers make it simple to increase either fixed or variable operating costs by a given percentage. The default for each should be 100%. By changing both of these to 120%, all fixed and variable operating costs in the Cash Flow table are increased by 20% over the levels you provide in the Basic Assumptions table. The resulting impacts on rates of return and break-even calculations are immediately shown.

The fixed operating costs include insurance, *ad valorem* taxes, and other fixed costs. They do not include loan repayments, which are handled separately. In the basic example, if fixed operating costs increase by 20%, then the after-tax real IRR drops to 3.9%, and the break-even charge-out increases to $44.89. It still looks like a reasonable investment, but not by much.

Variable operating costs include repair and maintenance, tires, additional periodic consumables, fuel, engine oil, other lubricants, and other variable operating costs. In the basic example, if fixed costs remain at 100%, but if variable operating costs increase by 20%, then the after-tax real IRR drops to –5.4% and the break-even charge out increases to $48.52. If variable operating costs increase by this much, then the owner would not achieve the required return on invested capital. This would suggest that variable operating costs should be monitored very closely.

More extensive sensitivity analysis tables are also generated. Tables showing the impact on rates of return by varying purchase price, charge-out rates, gearing, depreciation methods, risk premium, and inflation are automatically generated by ChargeOut! and appear at the bottom of the ChargeOut! worksheet. A printout of these tables is included at the bottom of the model outputs (Appendix 1).

Given a negotiated charge-out rate, the purchase price will have a significant impact on the rate of return, if the price has not already been established. At higher purchase prices, the rate of return decreases and the charge-out rate required to break even increases. The relationships are shown in Figure 2. The full table showing the relationship between purchase price and the rate of return and break-even charge-out rate is at the bottom of the ChargeOut! worksheet in the sensitivity analysis and is included in Appendix 1.

After a machine is purchased, the charge-out rate itself will have the greatest impact on the break-even scheduled operating hours. As the charge-out rate increases, the hours required to break even decrease (Fig. 3). The full set of figures is provided in the sensitivity analysis included in the printout in Appendix 3. The relationship between the charge-out rate is calculated automatically using whatever increment you specify in the sensitivity analysis table. The default increment is $1.00.

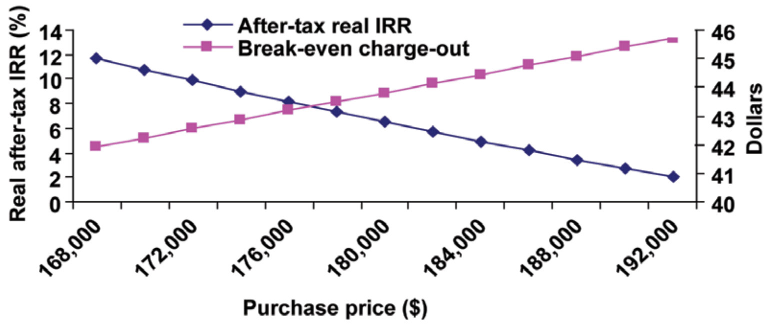


Figure 2—Effect of purchase price on the real after-tax IRR (internal rate of return) and break-even charge-out rates.

Using the power of the spreadsheet, any variable can be increased or decreased to test the effect on rate of return and break-even points.

Cash Flows

Based on the inputs, ChargeOut! produces annual cash flows that may be used for budgeting and financial planning. The summary cash flows appear close to the top of the ChargeOut! worksheet (see the base case financial outputs). The full cash-flow analysis is included in Appendix 3. One of the assumptions built into the cash-flow table is that all costs, except for depreciation, will increase at the specified inflation rate. In addition, the estimated machine salvage value (if any) will also increase at the specified inflation rate. Revenues may or may not increase with inflation, depending on what you specify in the input table.

The cash-flow table shows the years in which surplus cash is expected and also the years in which there will be a cash-flow deficit. This information should facilitate financial planning.

Limitations

ChargeOut! is based on modeling cash flows over a machine's life. As with all discounted cash-flow models, the accuracy of the predicted financial returns will depend on the accuracy of the cash flows that the user has forecast.

The cash flows and book values correspond to the years of machine operation, not to financial or calendar years. In other words, Year 1 represents the cash flows for a full year of machine operation, not a portion of a year. If a machine was acquired half-way through a financial year, then ChargeOut!'s Year 1 cash flows represent cash flows for the second half of the first financial year and the first half of the second financial year. This will change allowable depreciation write-offs.

Depreciation in ChargeOut! is only an approximation. The Internal Revenue Service has numerous depreciation schedules that vary, depending on when an asset was purchased. ChargeOut!'s approximation should not be material if a firm submits its taxes on a quarterly basis. If a firm submits its taxes on an annual basis, there could be some differences between modeled cash flows and actual cash flows for the machine's first year and for its last year of operation (IRS 2005).

As with most discounted cash-flow analyses, built into ChargeOut! is an implicit assumption that all cash flows occur at the end of each year of the machine's life. Year 0 represents right now, today. Year 1 is exactly 1 year from today. Year 2 is exactly 2 years from today, etc. Although this is clearly not realistic, a more accurate representation of the cash flows throughout the years would only add spurious accuracy to the solution while greatly complicating the mathematics.

From a business operations perspective, more frequent monthly or weekly cash flows should be forecast, at least for 1 year in advance (Howe and Bratkovich 2005). ChargeOut! does not provide such flows but can be used to help estab-lish the basis of those more frequent estimates.

ChargeOut! does not include an operator's wages. Because of this, it does not include social security or other taxes, general liability insurance rates, other labor-related overhead charges, etc. To calculate the full amount that a contractor would have to charge, these costs must be added to the machine costs. Some of these costs could be approximated in ChargeOut!'s "Other variable costs ($/scheduled hour)" and "Other fixed costs ($/year)" categories in the Basic Assumptions table, but the purpose of this program is to calculate machine costs, demonstrating this cash-flow methodology. ChargeOut! is not intended to be a full-blown job costing program.

The final limitation is that ChargeOut! does not calculate the additional value an extra machine could add to a total operation by, for example, freeing up a bottleneck or increasing reliability of a specific breakdown-prone operation.

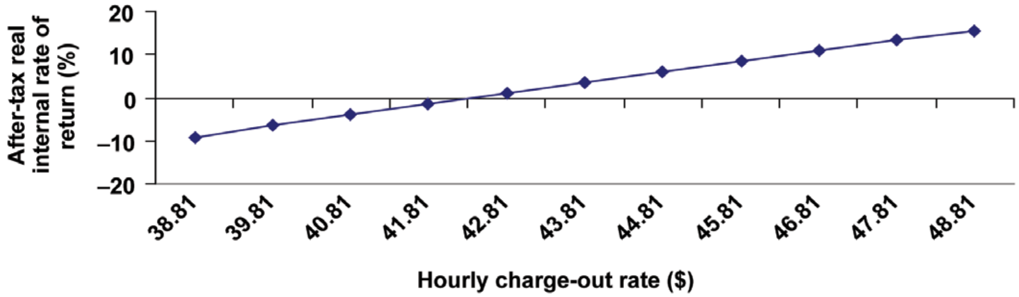


Figure 3—Effect of charge-out rates on rate of return.

Summary and Discussion

The ability of a model to predict the rate of return earned on any project will depend on how well the model's assumptions are met in practice. ChargeOut! is a model that incorporates a full discounted cash-flow analysis in the calculation of break-even charge-out rates and break-even scheduled operating hours. The model's strength is that it combines cash flows into single hourly rates and compares the negotiated rate with the break-even rate. The model's flexibility allows a user to use either built-in rules of thumb or custom cost functions.

In practice, many things will affect a machine's operating costs, not the least of which are the terrain where it is operated and the skill and care of its crew. ChargeOut! enables an analyst to identify key costs, predict cash flows, and determine appropriate charge-out rates for capital equipment. The break-even charge-out rate provides a single sound economic benchmark against which investment and costing decisions may be judged.

The forest products industry is entering a time when much more capital investment will be required in logging and harvesting. It is also a time when more critical examination must be made of capital investments. ChargeOut! is a flexible and powerful tool now available to perform such analysis. And it can be run by owners rather than by specialist programmers to provide immediate answers to questions as they arise and as conditions change.

References

Brealey, R.A.; Myers, S.C. 1991. Principles of corporate finance. Fourth Edition. International Edition. New York: McGraw-Hill, Inc. 924 p.

Brinker, R.W.; Kinard, J.; Rummer, R.; Lanford, R. 2002. Machine rates for selected harvesting machines. Circular 296 (rev.) Auburn, AL: University of Auburn, School of Forestry and Wildlife Sciences. www.sfws.auburn.edu/extension/publications.htm

Burgess, J.A.; Cubbage, F.W. 1989. Comparison of machine rate and cash flow approaches for estimating forest harvesting equipment costs. ASAE paper 89-7548, revised 2/12/90. New Orleans, LA: American Society of Agricultural Engineers. December. 24 p. www.srs.fs.usda.gov/forestops/downloads/Pub269.pdf

Butler, D.A.; Dykstra, D.P. 1981. Logging equipment replacement: a quantitative approach. Forest Science 27(1):2–12.

Butler, D.A.; LeDoux, C.B. 1980. Scheduling replacement of logging equipment: some quantitative quidelines. Research Bulletin 32. Corvalis: Oregon State University, Forest Research Laboratory. 22 p.

Caterpillar Tractor Company. 2001. Caterpillar performance handbook. Edition 32. October. Peoria, IL.

Caulfield, J.P.; Tufts, R.M. 1989. Forestry equipment replacement decisions under risk. Forest Products Journal 39(9):49–54.

Cubbage, F.W. 1981. Machine rate calculations and productivity rate tables for harvesting southern pine. Staff Paper Series 24. Department of Forest Resources. St. Paul, MN: University of Minnesota. 120 p.

Cubbage, F.W.; Burgess, J.A.; Stokes, B.J. 1991. Cross-sectional estimates of logging equipment resale values. Forest Products Journal 41(10):16–22. www.srs.fs.usda.gov/forestops/downloads/Pub300.pdf

Fight, R.D.; Zhang, X.; Hartsough, B.R. 2003. Users guide for STHARVEST: software to estimate the cost of harvesting small timber. General Technical Report PNW–GTR–582. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 12 p.

Howe, J.; Bratkovich, S. 2005. A planning guide for small and medium size wood products companies. NA-TP-03-05. Second edition. Newtown Square, PA: USDA Forest Service. Northeastern Area, State and Private Forestry.

Internal Revenue Service. 2005. How to depreciate property. Publication 946. Washington, DC: Department of the Treasury, Internal Revenue Service. www.irs.gov

Internal Revenue Service. 2004. Tax incentives for distressed communities. Publication 954. Washington, DC:

Department of the Treasury, Internal Revenue Service. www.irs.gov/pub/irs-pdf/p954.pdf

Internal Revenue Service. 2006. Taxpayers affected by Hurricanes Katrina, Rita, and Wilma. Publication 4492. Washington, DC: Department of the Treasury, Internal Revenue Service. www.irs.gov/pubs/irs-pdf/p4492.pdf

Matthews, D.M. 1942. Cost control in the logging industry. New York: McGraw-Hill Book Company. 374 p. Esp. Chapter III: Unit costs and machine rates. p. 45–69.

Miyata, E.S. 1980. Determining fixed and operating costs of logging equipment. General Technical Report NC-55. St. Paul, MN: USDA Forest Service, North Central Forest Experiment Station. 16 p.

Miyata, E.S.; Steinhilb, H.M. 1981. Logging system cost analysis: comparison of methods used. Research Paper NC-208. St. Paul, MN: USDA Forest Service, North Central Forest Experiment Station. 15 p.

Raymond, O. 1976. Logging: how to accurately estimate your machine costs. Australian Forest Industries Journal. July. p. 26, 28, 30.

Stenzel, G.; Walbridge, T.A.; Pearce, K. 1985. Logging and pulpwood production. 2nd Ed. New York: John Wiley and Sons. 358 p.

Stuart, W.B.; Grace, L.A. [N.D.] Checking our foundations II: are fixed costs of forest operations really fixed? (or have we broken them?) Mississippi State University, Department of Forestry. Unpublished.

Tufts, R.A.; Mills, W.L. 1982. Financial analysis of equipment replacement. Forest Products Journal 32(10):45–52.

USDA Forest Service. 2005. Forest Operations Research webpage.www.srs.fs.usda.gov/forestops/mach_costs.htm

Werblow, D.A.; Cubbage, F.W. 1986. Forest harvesting equipment ownership and operating costs in 1984. Southern Journal of Applied Forestry 10(1):10–15.

Appendix 1—ChargeOut!'s Outputs

Summary Financial Measures

Present net value (NPV) (cells B8:D8): sum of the discounted cash inflows less the sum of the discounted cash outflows. The formula to calculate NPV is

$$\text{NPV} = \sum_{t=0}^{n} \frac{(R_t - C_t)}{(1 + \text{ROIC})^t}$$

where

R_t	is	returns in year t,
C_t		costs in year t, and
ROIC		required return on invested capital. This is an interest rate, in decimal form, representing the next best alternative investment rate at comparable risk.

If the NPV is positive, it represents the additional amount of money the investor could put in at the start of the project and still earn the required return on invested capital (ROIC). If the NPV is negative, it represents how much less the investor must put in at the start of the project to earn the required ROIC. Alternatively, a negative NPV represents how much of a subsidy the investor would require to earn the required ROIC. If the NPV is zero, it means that the investor is earning exactly the required ROIC. If NPV = $0, then ROIC = IRR (see below).

- Other literature may refer to this calculation as the net present worth (NPW or PNW). In either case, the formulas to calculate the figure are identical.
- Since NPV is identical in either real or inflation-adjusted terms, only one set of NPV figures is shown. To illustrate why this is so, $10 in your pocket right now will purchase $10 of goods right now. It does not matter if the inflation rate is 2% or 20%. Right now, $10 will buy $10 worth of goods. If that $10 were to be in your pocket one year from now, the inflation rate would matter. The NVP means "right now."

Investment's internal rate of return (IRR) (cells B9: D10):

This is a discount rate at which the sum of the investment's discounted cash inflows is equal to the sum of the investment's discounted cash outflows. In other words, it is a discount rate at which NPV is $0. Using the formula and definitions for NPV as above and if d is in decimal form …

$$\text{if...} \quad \$0 = \sum_{t=0}^{n} \frac{(R_t - C_t)}{(1 + d)^t}$$

$$\text{then...} \quad d = \text{IRR}$$

The IRR will vary depending on whether it is considered in real terms (over and above inflation) or nominal terms (including inflation). If inflation is positive, the real IRR will be less than the nominal IRR.

Depending on cash flows, IRR may be zero, positive, negative, or infinite (infinitely positive, or infinitely negative). In addition, a single series of cash flows may have multiple IRRs. The drawbacks of IRR are well known. For a thorough discussion, see Brealey and Myers (1991), pages 79–88.

Before tax & finance (cells B8:B10)

This is the return based only on the cash flows of the investment without taking into account taxes or financing. This is the conventional measure for evaluating investments. In theory, the investment decision should be separate from the finance decision. The rate of return before tax and finance does not change with different tax rates or finance options.

Before tax (cells C8:C10)

This return includes the cash flows resulting from the investment's financing. If the before-tax rate of return is greater than the before tax and finance rate of return, then there is a favorable gearing effect. In other words, financing the equipment with loan money is an advantage to the investor.[5]

After-tax (cells D8:D10)

This return includes all the cash flows associated with the investment and the financing chosen. It is assumed that if the investment suffers a tax loss in any given year, income will be available from other sources against which the loss may be deducted.

Year 1 Charge-Out Rates

Charge-out rates are given per scheduled hour, per productive hour, and per unit (ton, million board feet, cord). The calculations per productive hour are a function of the calculations per scheduled hour times the input utilization rate. The calculations per unit are a function of the total revenue divided by the input number of units produced.

Inflation-adjusted charge-out or equivalent negotiated charge out (cells J8:L8)

Year 1 charge-out rates come from the annual hourly charge-out rates input template at the bottom of the Basic Assumptions table. The inflation-adjusted charge-out takes the negotiated Year 1 charge out and increases it by the specified inflation rate for each year of the machine's economic life.

The equivalent negotiated charge-out calculation takes the negotiated rates over the machine's economic life weighted by the scheduled annual operating hours per year and converts those rates into a single equalized annual rate, which if it were charged and if it increased annually at the specified inflation rate, would produce an identical discount net benefits stream to the inflation-adjusted rate. To illustrate this, go the ChargeOut! worksheet and make Year 1 inflation-adjusted rate (cell C101) equal to the equalized annual negotiated rate (cell K100). Then go to the Year 1 Charge-Out Rates table at the top of page 1 to cell L13 and change "Inflation" to "Negotiation." The numbers in the Year 1 Charge-Out rates table should not change, proving that the calculated equivalent negotiated rate is correct.

Break-even charge out (cells J9:L9): Break-even annual income divided by the equalized annual scheduled hours.

The amount must be charged for the machine in Year 1 to provide the investor with exactly the expected return on invested capital. For this rate to provide a break-even return over the machine's life, this charge out, along with all costs (apart from depreciation) will have to increase at the rate of inflation. In addition, the scheduled annual operating hours will have to be worked.

To illustrate that this is the true break-even rate, go the the ChargeOut! worksheet and make Year 11 inflation-adjusted rate (cell C101) equal to the break-even charge out (cell J9). In the Year 1 Charge-out Rates table at the top of page 1 make sure that cell L13 is labeled "Inflation." The after-tax NPV in the Summary Financial Measures table should be $0 (cell D8), and the calculated after-tax real and nominal IRRs (cells D9 and D10) earned on the project's cash flows should be equal to those specified in the Required Returns on Invested Capital table (cells H18 and H19), proving that the calculated break-even charge-out rate (cell J9) is correct.

Difference (cells J10:L10)

This shows how much room there is per scheduled hour, productive hour, or unit of output between the negotiated rate and the break-even rate. If this number is positive, it shows how much room there is for unexpected expenses to increase before the machine would no longer be earning its required rate of return. If this difference is negative, it shows how much more would have to be charged for the machine to earn exactly its required rate of return on invested capital.

Other Financial Information

Loan principal (cell B17) the initial loan

This will reduce the initial negative cash flow; however, it will require repayment. It is calculated according to the following formula:

Loan principal = (Purchase price + Tire cost) × Gearing percentage

[5] This statement assumes that the skidder is the investor's major investment, that this loan rate represents the investor's average cost of borrowed capital, and that this borrowing will not affect the investor's ability to borrow for other worthy investments.

Table 4—Loan repayment schedule

Quarter	Beginning principal	Interest[a]	Principal repayment[b]	Ending principal[c]
1	$50,000	$1,000	3,728	$46,272
2	46,272	925	3,803	42,469
3	42,469	849	3,879	38,591
4	38,591	772	3,956	34,635
5	34,635	693	4,035	30,599
6	30,599	612	4,116	26,483
7	26,483	530	4,198	22,285
8	22,285	446	4,282	18,003
9	18,003	360	4,368	13,635
10	13,635	273	4,455	9,180
11	9,180	184	4,544	4,635
12	4,635	93	4,635	(0)

[a]Interest due = Beginning principal × Periodic loan interest rate. For example: $1,000 = $50,000 × 0.02.
[b]Principal repayment = Loan payment – Interest due For example: $3,728 = $4,728 – $1,000.
[c]Ending principal = Beginning principal – Principal repayment For example: $46,272 = $50,000 – $3,728.

Periodic loan payments (cell B18)

The payments shown here are constant throughout the life of the loan. Payments and the amount of interest paid will vary depending on the loan principal, the interest rate, and the length of the loan in years, plus how frequently the loan payments are made. Loan payments include interest as well as principal repayments. Periodic loan and payments may be calculated using the following formula:

$$\text{Payment} = \text{Principal} \times \left[\frac{i \times (1+i)^n}{(1-i)^n - 1}\right]$$

where

Principal	is	the original loan principal,
i		the bank's annual percentage rate in decimal form, and
n		the life of the loan in years.

If there is more than one payment per year, then both n and i need to be adjusted. If p is the number of payments per year,

…in place of n, use

$$n \times p$$

…and in place of i, use r where

$$r = \frac{i}{p}$$

For example, to calculate the payment required on a $50,000 loan to be repaid over 3 years quarterly at an annual percentage rate of 8% per year, first calculate the quarterly interest rate:

$$r = \frac{0.08}{4}$$

$$r = 0.02$$

Putting this quarterly interest rate into the periodic payment formula gives

$$\text{Payment} = \$50{,}000 \times \left[\frac{0.02 \times (1+0.02)^{(3\times 4)}}{(1+0.02)^{(3\times 4)} - 1}\right]$$

$$\text{Payment} = \$4{,}727.98$$

Although the payment (Interest + Principal repayment) remains constant throughout the loan life, the portion of the payment allocated to interest and the portion allocated to principal repayment changes throughout the life of the loan.

Equivalent annual loan interest (cell B19)

This formula converts the loan interest rate, normally given as an annual percentage rate (APR), which is simply the periodic rate times the number of periods per year, into an equivalent annual rate.

$$\text{Equivalent annual loan interest} = \left(+\frac{\text{Annual percentage rate}}{\text{Payments per year}}\right)^{\text{Payments per year}} - 1$$

For example, if the annual percentage rate is 6%, then:

$$\text{Equivalent annual loan interest} = \left(1 + \frac{0.06}{12}\right)^{12} - 1$$

Equivalent annual loan interest is 0.0617 = 6.17%

Equivalent annual deposit interest (cell B20)

This formula converts the deposit interest rate, normally given as an annual percentage rate, into an equivalent annual rate. For an example of the calculations, see the example under the equivalent annual loan interest, above.

Average capital invested (ACI) (cell B21)

This number is provided because it is traditionally used for insurance and property tax calculations. See, for example, Miyata (1980).

$$\text{ACI} = \frac{(\text{Purchase price} - \text{Salvage estimate}) \times (\text{Economic life} + 1)}{(2 \times \text{Economic life})} + \text{Salvage estimate}$$

Required Returns on Invested Capital (ROIC)

Required returns on invested capital (cells G18:H22) are presented both in terms of equivalent annual interest rates and annual percentage rates. In turn, both equivalent annual interest rates and annual percentage rates are presented both in real terms, not including inflation, and nominal terms, including inflation. Both are also presented before tax and after tax.

The equivalent annual rates are interest rates as if they were compounded once each year.

The real before-tax required ROIC in terms of an equivalent annual interest rate is calculated as follows:

$$\text{Real before-tax required ROIC}_{EAIR} = \frac{(1 + \text{EADIR} + \text{ERIC})}{(1 + \text{Inflation})} - 1$$

where

EADIR is Equivalent annual deposit interest rate
ERPIC Expected risk premium on invested capital

Note: EADIR + ERIC = Nominal required return on invested capital

For example, if

EADIR is 3.04%

ERPIC 7%

Inflation 3%

$$\text{Real before-tax required ROIC}_{EAIR} = \frac{(1 + 0.07 + 0.0304)}{(1 + 0.03)} - 1$$

Real before-tax required ROIC_{EAIR} is 0.0683 = 6.83%

The real after-tax ROIC in terms of an equivalent annual interest rate simply takes taxes out of the before-tax rate. It is calculated as follows:

$$\text{Real after-tax required ROIC}_{EAIR} = \frac{(1 + ((\text{EADIR} + \text{ERPIC}) \times (1 - \text{Tax rate})))}{(1 + \text{Inflation})} - 1$$

In addition to the above example data, if taxes = 33%

$$\text{Real after-tax required ROIC}_{EAIR} = \frac{(1 + ((0.07 + 0.0304) \times (1 - 0.33)))}{(1 + 0.03)} - 1$$

Real after-tax required ROIC_{EAIR} is 0.0362 = 3.62%

The nominal before-tax required ROIC in terms of an equivalent annual interest rate is calculated as follows:

Nominal before-tax required ROIC_{EAIR} is EADIR + ERPIC

Nominal before-tax required ROIC_{EAIR} is 0.07 + 0.03

Nominal before-tax required ROIC_{EAIR} is 0.10 = 10%

The nominal after-tax required ROIC in terms of an equivalent annual interest rate is calculated as follows:

$$\text{Nominal after-tax required ROIC}_{EAIR} = (1 + \text{After-tax real required ROIC}) \times (1 + \text{Inflation}) - 1$$

$$\text{Nominal after-tax required ROIC}_{EAIR} = (1 + 0.0362) \times (1 + 0.03) - 1$$

Nominal after-tax required ROIC_{EAIR} = 0.0673 = 6.73%

Annual Percentage Rates (APR)

This is periodic interest rates multiplied by the number of periods per year. Annual percentage rates do not take into consideration the effect of compounding more than once each year. They will be less than equivalent annual interest rates that are compounded more than once a year. The APR for the expected ROIC are provided for information only. Since APRs are theoretically incorrect to use in discounted cash flow analysis, ChargeOut! does not use them for further calculations.

The real before-tax ROIC in terms of an APR is calculated as follows:

$$\text{Real before-tax required ROIC}_{APR} = \text{Payments/year} \times ((1+\text{Equivalent annual real before-tax required ROIC})^{(1/\text{Payments/year})} - 1)$$

If payments are monthly, using the information from the equivalent annual interest rates above:

$$\text{Real before-tax required ROIC}_{APR} = 12 \times ((1 + 0.0.0683)^{(1/12)} - 1)$$

Real before-tax required ROIC_{APR} = 0.0663 = 6.63%

$$\text{Real after-tax required ROIC}_{APR} = \text{Payments/year} \times ((1+\text{Equivalent annual real after-tax required ROIC})^{(1/\text{Payments/year})} - 1)$$

$$\text{Real after-tax required ROIC}_{APR} = 12 \times ((1 + 0.0.0673)^{(1/12)} - 1)$$

Real after-tax required ROIC_{APR} = 3.56%

The nominal before-tax required ROIC in terms of an APR is calculated as follows:

$$\text{Nominal required ROIC}_{APR} = \text{Payments/year} \times ((1 + \text{Equivalent annual nominal required ROIC})^{(1/\text{Payments/ year})} - 1)$$

If payments are monthly, using the information from the equivalent annual interest rates above:

$$\text{Nominal required ROIC}_{APR} = 12 \times ((1+0.0.10)^{(1/12)} - 1)$$

Nominal required ROIC_{APR} = 0.0961 = 9.61%

The nominal after-tax required ROICl in terms of an APR is calculated as follows:

$$\text{Nominal required ROIC}_{APR} = 12 \times ((1 + 0.0.0673)^{(1/12)} - 1)$$

Nominal after-tax required ROIC_{APR} = 0.0653 = 6.53%

Annualized Revenue Calculations

Equalized annual actual revenue (cell C27): Charge-out rate times the equalized annual scheduled hours

Equalized annual break-even revenue (cell C28): Annual revenue required to break even at the alternative rate of return.

Given the investment's cash flows and the after-tax alternative rate of return that could be earned on invested funds, this is the annual revenue required, assuming that all cash outflows and inflows are affected equally by inflation.

The calculation essentially takes the net present value of the after-tax costs and then converts this NPV into an annuity.

Note that implicit in this calculation is that the hourly charge out incorporated in the break-even annual gross revenue will increase at the specified inflation rate.

Percentage of Discounted Gross Revenue

These are the percentages that appear in the "costs chart" worksheet.

All costs and gross revenue are discounted by the after-tax nominal required ROIC. The costs are grouped and divided by discounted gross revenue (cell K112) and multiplied by 100% to turn the ratios into percentages.

Net ownership costs (cell L24): Purchase price (with tires) less salvage value, less loan principal, plus loan principal repayments.

Fixed operating costs & loan interest (cell L25): Insurance plus *ad valorem* taxes plus other fixed costs plus loan interest.

Repair & maintenance (cell L26): Repairs plus maintenance

Other variable operating costs and taxes (cell L27): Total variable operating costs less (repairs plus maintenance) plus income taxes.

Additional profit (loss) (cell L28): After-tax NPV (cell D8) divided by discounted total gross revenue.

Profits appear at the top of the costs chart. Losses appear at the bottom of the costs chart.

Appendix 2—Inputs Required to Run ChargeOut!

Summary Financial Measures

IRR seed (cell E10)

A number that may be varied if you suspect that the cash flows may have multiple IRRs. This would happen if there were more than one change in signs in the cash flows (e.g., if they started out negative, turned positive, turned back negative, and then returned positive). According to Descartes's "rule of signs," there can be as many different solutions to a polynomial as there are changes in signs. In the example above, there could be as many as three IRRs. All, by definition, would be correct.

Base case: 10%

Year 1 Charge-Out Rates Table

Charge-out rates change annually by… [Negotiation or Inflation] (cell L13)

If charge-out rates change by negotiation, then the "negotiated" annual hourly charge-out rates at the bottom of the Basic Assumptions table are used. These are on page 3 of the ChargeOut! worksheet. If charge-out rates change by inflation, then the "Inflation-adjusted" annual charge-out rates are used.

Base case: Inflation

Basic Assumptions

Purchase price (cell B45)

The initial cash price of the machine that must be either paid or financed when the machine is purchased. To make the model compatible with the conventional model presented by Miyata (1980), the purchase price does not include the cost of tires, although by convention, the first set of tires is depreciated along with the purchase price.

Base case: $180,000

Salvage estimate (cell B46)

This is the percentage of the purchase price (with tires) that will be recoverable at the end of the machine's economic life. The salvage estimate is in today's dollars. Built into ChargeOut! is an assumption that the actual amount recovered will increase with whatever inflation rate is specified.

Base case: 30% × (purchase price + tire cost) = $55,800

Index the salvage estimate to inflation (cell B47): Yes or No

Either indexes the above salvage estimate to inflation or enters it directly as estimated. Note that traditional rules-of-thumb and Cubbage and others (1991) base their residual value percentages on nominal resale values, which means that their percentages implicitly include an unspecified inflation component and are already inflation-indexed. If such estimates are used, choose "No." If current prices for older equipment are used for salvage estimates, those prices may be expected to increase with inflation over the years. If this is the case, choose "Yes."

Base case: "No"

Gearing (cell B48): Percentage of the purchase price + tire cost that may be financed.

Base case: 60%

Loan term (cell B49): the length of the loan, in years.

Base case: 3 years

Loan and deposit payments per year (cell B50)

This is the number of payments that must be made each year and the number of times per year that interest is compounded. For example, for monthly repayments enter 12 (2005).

Base case: 12 payments per year

General depreciation system (GDS) life (cell B51): Calculates the life of the machine under the GDS.

Note that assets included in class 24.1, "Cutting of timber," consist of "logging machinery and equipment and roadbuilding equipment used by logging and sawmill operators and pulp manufacturers for their own account." The IRS specifies that such assets have a GDS recovery period of 5 years.

Base case: 5 years

Alternative depreciation system (ADS) life (cell B52): life of the machine under the ADS.

See: Internal Revenue Service Publication 946, How to Depreciate Property (2005). The IRS specifies that assets included in class 24.1 have an ADS recovery period of 6 years.

Base case: 6 years

Economic life (cell B53): Expected useful life of the equipment.

Note: This spreadsheet is set up for a machine with a maximum useful life of 8 years. If a machine with a longer life expectancy is used, the spreadsheet will have to be extended.

Base case: 5 years

Depreciation code (cell B54): Method of depreciation that should be applied to the investment. A depreciation template is provided so that depreciation formulas may be modified if necessary.

- DB is declining balance depreciation, which allows for larger depreciation write-offs early in the machine's life. If DB is chosen, the next line will require the declining balance factor (either 200% or 150%).
- SLGDS is straight-line general depreciation system. It is straight-line depreciation over the machine's (shorter) depreciable life as specified in the GDS.
- SLADS is straight-line alternative depreciation system. It is straight-line depreciation over the machine's (longer) depreciable life as specified in the ADS.
- SLEL is straight-line economic life. Note that this method is straight-line depreciation over the machine's economic life and is provided for comparison only. IMPORTANT! The IRS may not allow depreciation over an asset's economic life.

Custom: a custom depreciation schedule

This allows the user to enter any depreciation schedule desired in the depreciation expense template below the cash flow table.

IMPORTANT! The IRS may not allow a custom depreciation schedule.

Base case: DB

Declining balance factor (cell B55): Required only if DB is chosen above.

This factor should be either 200% or 150%.

Base case: 200%

Section 179 deduction (cell B56)

This is an optional allowable first-year deduction based on the price of the asset. The name refers to Section 179 of the tax code. See Internal Revenue Service Publication 946, How to Depreciate Property, and any supplements for instructions on how much may be deducted.

Section 179 deductions allow some qualifying property to be written off more quickly for tax purposes. Generally, a Section 179 deduction is the cost of the qualifying property. However, it is subject to a dollar and an income limit. Section 179 deductions were introduced in 2000 and are as follows:

2000	$ 20,000
2001–2002	$ 24,000
2003	$100,000
2004	$102,000
2005	$105,000
2006	$108,000

Increased Section 179 deductions are available to enterprise zone businesses, renewal community businesses for qualified zone property, qualified renewal property placed in service in an empowerment zone or renewal community, or for qualified Section 179 GO (Gulf Opportunity) Zone property (Hurricane Katrina disaster area specified by the Federal Emergency Management Agency). See: IRS Publication 946 (2005) for definitions and tax incentives for distressed communities and Publication 4492 (2006) for GO Zone information.

Base case: $108,000

Note that Section 179 deductions are reduced by one dollar for each dollar that the total cost of qualifying section 179 property placed in service that year exceed a specified threshold. Those are as follows:

2003 – $400,000
2004 – $410,000
2005 – $420,000
2006 – $430,000

See Internal Revenue Service Publication 946, How to Depreciate Property (IRS 2005)

Special first-year depreciation allowance (cell B57)

This is an additional optional allowable first-year deduction of 50% or 30% based on the price of the asset less any Section 179 deduction. This was brought in under the Job Creation and Worker Assistance Act of 2002.

See Internal Revenue Service Publication 946, How to Depreciate Property, and the Supplement to Publication 946.

Base case: 50%

Loan interest rate is… (cell B58): "Fixed" or "Variable"

If the loan interest rate is "Fixed," it does not change, no matter what the inflation rate. The rate you enter here is NOMINAL (it includes inflation). Use this option if you have locked in the loan interest rate, but want to test the impact of changing inflation rates on your break-even charge-out rate or your rate of return.

If the loan interest rate is "Variable," it changes with inflation. The rate you enter here is REAL (it does not include inflation). Use this option if you have not locked in the loan interest rate, but want to test the impact of changing inflation rates on your break-even charge-out rate or your rate of return.

Base case: Fixed

Fixed or variable loan interest rate (APR) (cell B59): Before-tax interest rate that the bank or finance company charges on equipment loans.

The rate is an annual percentage rate. If you specify that the loan interest rate is "Fixed" (below), then the loan interest rate is NOMINAL (it includes inflation). If you specify that the loan interest rate is "Variable," then the loan interest rate is REAL (it does not include inflation).

Base case: 9% (fixed)

Deposit interest rate (APR) (cell B60): Before-tax nominal interest rate that the bank pays annually on deposits. The rate is a percentage. This represents the base for determining the owner's required return on invested capital.

Base case: 3%

Expected risk premium on invested capital (cell B61): Before-tax nominal interest rate that is added to the deposit equivalent annual interest rate to determine the required return on invested capital.

Base case: 7%

Inflation (cell B62): the annual inflation rate

This rate should represent inflation in the logging industry. A suggested guide is the producers' price index. Note that if inflation rates change, although variable interest rates change from their base, and variable loan rates change automatically, the deposit interest rate may also need to be changed as may the expected risk premium on invested capital.

Base case: 3%

Income tax rate (cell B63)

This marginal tax rate on the machine's net earnings should be an aggregation of federal, state, and city income taxes, if applicable.

Base case: 33%

Tax loss treatment… (cell B64): "Flow through," "Carry forward," "None"

If there are operating losses, negative income taxes occur. These are tax credits. If these credits can be applied against positive income from other operations in the same year they are incurred, they should be allowed to "Flow through," and negative cash flows will be reduced immediately by the associated tax credit. This is usually the most favorable tax treatment from a discounted cash-flow perspective.

If losses can "Carry forward," then they will not reduce income taxes until years in which positive operating income occurs.

If either there is no tax loss treatment or the firm's circumstances mean that the credits will be lost (i.e., Tax loss treatment = "None"), then in years that losses occur, taxes will be $0, but there will be no future credits resulting from the losses.

Note that if the tax loss treatment is "Carry forward," or "None," then the automatic break-even calculation does not work correctly. However, break-even can still be calculated using Excel's "Goal Seek" function (see the instructions in the documentation on how to do this).

***Ad valorem* (property) tax mill rate (cell B65):** Rate ($/$1,000 value) assessed on property.

Note that this rate may be 0 for logging equipment in some states.

Base case: 30

***Ad valorem* (property) tax valuation basis (cell B66):** Basis for the property tax valuation.

Average capital invested (ACI)

If this method is chosen, the annual property taxes will be approximately constant, adjusted only for inflation.

Straight-line book (SLB) method

If this method is chosen, the annual property taxes will be based on the equipment's book value, depreciated over the alternative depreciation system life using straight-line depreciation.

Custom

A custom valuation schedule allows the user to enter any valuation schedule desired into the *ad valorem* tax valuation template below the cash-flow table.

Base case: ACI

Fixed operating costs sensitivity factor (cell B67)

This allows the user to change all fixed operating costs by a given percentage. The default should be 100%. For example, by setting this at 105%, all fixed operating costs are increased by 5%.

Base case: 100%

Variable operating costs sensitivity factor (cell B68)

This allows the user to change all variable operating costs by a given percentage. The default should be 100%. For example, by setting this at 105%, all variable operating costs are increased by 5%.

Base case: 100%

Engine type (cell H45): "Diesel" or "Gasoline"

The engine type in part will determine the fuel and oil consumption. It is not linked in this model to productivity or to maintenance and repair costs.

Base case: Diesel

Horsepower (cell H46)

The horsepower will help determine the fuel and oil consumption. In this model, horsepower is not linked to productivity or to machine cost. See the ChargeOut! model worksheet labeled Appendix 2 for the relationship between fuel and oil consumption and net engine horsepower.

Base case: 135

Maintenance and repair functions' forms (cell H47): "Custom" or "Estimated"

Maintenance and repair functions may be either "Custom" or "Estimated." If there are good maintenance and repair records for similar machines and the new machine is expected to follow similar patterns, then these costs should be entered as "Custom" functions. If they are "Custom," then the user must enter maintenance and repair cash flows for each year in the template below the main cash-flow table.

The "Estimated" functions are based on standardized percentages of straight line depreciation. The shape of the "Estimated" functions depends on the number of productive hours until the costs increase by 50%.

In the cash-flow table, both the "Custom" and the "Estimated" functions are increased automatically by the inflation rate.

WARNING! Actual maintenance and repair expenses will depend on many factors including the machine, the operator, and the terrain.

The present value of all the maintenance and repair costs may be made equal by using the "fudge factor" in the maintenance and repair costing template below the main cash-flow table. If this is done, then the chosen maintenance and repair function will not have an effect on the calculated break-even charge-out rate.

In any case, the chosen maintenance and repair cash flow should reflect the user's actual experience and should be monitored closely.

Initial maintenance as a percentage of straight-line depreciation (cell H48)

This establishes the initial maintenance cost for the machine. See ChargeOut! Appendix 1, Table 2, for some combined repair and maintenance percentages. See Miyata (1980), p. 8, and Butler and LeDoux (1980), p. 6.

Base case: 10%

Productive hours until maintenance costs increase by 50% (cell H49)

If maintenance costs remain roughly constant, increasing only by inflation over the machine's life, enter a very large number (e.g., 1,000,000,000).

Base case: 4,000 hours

Initial repairs as a pct. of straight-line depreciation (cell H50)

This establishes the initial repair cost for the machine. See ChargeOut! Appendix 1, Table 2, for some combined repair and maintenance percentages. See Miyata (1980), p. 8, and Butler and LeDoux (1980), p. 6.

Base case: 40%

Productive hours until repair costs increase by 50% (cell H51)

If repair costs remain roughly constant, increasing only by inflation over the machine's life, enter a very large number (e.g., 1,000,000,000).

Base case: 3,000 hours

Utilization rate (cell H52): Percentage of the scheduled operating time during which the equipment actually operates. Miyata (1980) noted some factors for various types of equipment. These are located in the ChargeOut! spreadsheet, Appendix 1, Table 1.

Annual productive hours = Annual scheduled hours × Utilization rate

Base case: 67%

Crankcase oil capacity (cell H53): Number of gallons in the crankcase.

Base case: 10 gallons

Time between oil changes (cell H54): Number of productive hours before the oil requires changing.

Base case: 120 hours

Other lubricants (% of engine oil) (cell H55): Cost of other lubricants as a percentage of the engine oil cost.

Base case: 50%

Fuel consumption (gallons/hour) (cell H56)

The consumption rate of the machine during its productive hours. Note that a calculation in Miyata (1980) estimates fuel consumption. That calculation is included in the ChargeOut! model in the worksheet labeled "Appendix 2."

Base case: 4.958 gallons/hour

Oil consumption (gallons/hour) (cell H57)

The consumption rate of the machine during its productive hours. This consumption is in addition to scheduled oil changes. Note that there is a calculation in Miyata (1980) that estimates oil consumption. That calculation is included in the ChargeOut! model in the worksheet labeled "Appendix 2."

Base case: 0.154 gallons/hour

Fuel cost ($/gallon) (cell H58): cost of diesel or gasoline

This should not include any road-use taxes.

Base case: $2.90

Oil cost ($/gallon) (cell H59): cost of oil

Base case: $4.38

Tire cost (per set) (cell H60): cost of tires, excluding installation

Note that the initial depreciable value of the machine includes the value of tires without the extra installation cost.

Base case: $6,000

Tire life (cell H61): Expected life of the tires in productive hours.

Base case: 3,000 hours

Tire installation factor (cell H62)

A percentage of the tire cost to pay for the added expense of labor to replace malfunctioning tires.

Base case: 15%

Additional periodic consumables cost (cell H63)

The cost of any significant additional consumables (main rope, chokers, etc.).

Base case: $0

Additional periodic consumables life (cell H64)

The expected life of the additional consumables above, in productive hours.

Base case: 0

Annual insurance percentage (cell H65)

A fixed percentage of average capital invested to pay for insurance. This amount will increase with inflation.

Base case: 3%

Other annual fixed costs (cell H66)

Any other annual fixed costs. They will increase with inflation.

Base case: $4,000

Other annual variable costs (cell H67)

Any other annual variable costs. They will vary with scheduled operating hours and will increase with inflation.

Base case: $1/hour

Expected production (tons/hour) (cell H68)

The equipment's expected productivity.

Base case: 10 tons/hour

Annual Operating and Productive Time Template

Scheduled operating time (hours/year) (cells C93:J93)

Scheduled hours are required for each year of the asset's economic life.

Base case: 1,850; 2,000; 2,500; 2,500; 2,500

Annual productive time (hours/year) (calculated) (cells C94:J94)

These are computed using the formula

Annual productive time = Scheduled operating time × Utilization rate

Annual Hourly Charge-Out Rates Template

Annual negotiated hourly charge-out rates (cells C100: J100)

These yearly negotiated rates are only required if the option that "Charge-out rates change annually by… Negotiation" has been chosen in the Basic Assumptions table. Note that only the values in the machine's economic life will be used.

Note that if these rates increase with inflation, this adjustment has to be entered directly into the cells in this table.

To increase a value for inflation use the formula:

$$FV = PV \times (1 + \text{Inflation})^{\text{Period}}$$

where:

FV is	the future inflation-adjusted value
PV	the value in today's dollars
Inflation	the annual inflation rate in decimal form
Period	the number of years into the future.

For example, if the present hourly cost of $45/hour increases at the 3% rate of inflation, after 5 years the cost will be

$$\$45 \times (1 + 0.03)^5 = \$52.17$$

Annual inflation-adjusted charge-out rates (calculated)

These formulas adjust the initial negotiated hourly charge-out rate (in cell C101) for inflation. These rates are only used if the option that "Charge-out rates change annually by… Inflation" has been chosen in the Basic Assumptions table above.

Depreciation Expense Template

Custom (cells C219:J219)

Depreciation rates are required here only if the "Custom" depreciation option has been chosen in the Basic Assumptions.

Maintenance and Repair Expenses Templates

Custom maintenance and repair expenses (cells C226: J226 and C235:J235)

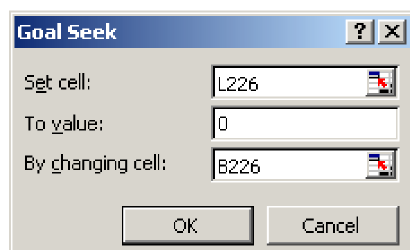
These are only necessary if the "Custom" maintenance and repairs has been selected in the Basic Assumptions table. Note that in the cash-flow table, the maintenance expenses will be increased automatically by the inflation rate.

If you want to use the fudge factors to make the estimated and custom maintenance and repair costs equal in terms of present values, make sure that your Custom cost cells in these tables are all multiplied by the Custom fudge factors before you use Goal Seek, setting the differences between the two PVs equal to 0.

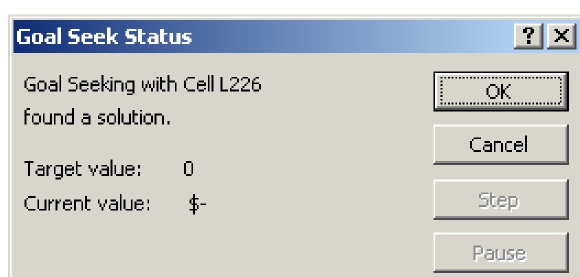
Fudge factors (cells B225:B226 and B234:B235)

These are only necessary if the analyst wishes to adjust the estimated or custom expenses upwards or downwards. If no adjustment is desired, set these factors equal to 1.00. Since maintenance and repairs can comprise such a significant portion of annual cash flows, they can also have a large impact on the numbers in the financial summary. If a user does not know the form of the maintenance and repair function, but wants to ensure that the impacts of both the estimated and custom maintenance functions and repair functions are the same in the summary financial figures and break-even calculations, then the present values of the estimated and custom functions' costs should be made identical. If this is done, then it will not matter if the maintenance or repair expense function is estimated or custom. Although the cash flows may be different, the summary financial figures and break-even calculations will be identical.

To equate the estimated and custom maintenance functions and repair functions, adjust the "fudge factors" in the maintenance and repair costing templates below the main cash-flow table (cells B225 and B226 in the maintenance expense template and cells B234 and B235 in the repair expense template).



After selecting "OK," if the formulas in the expense cells have been set up properly, Excel will return the following message:



If the difference between the estimated and custom functions is $0, then while the annual cash flows will change with the different maintenance and repair functions, the choice of using either Custom or Estimated maintenance and repair functions will have no impact on the NPVs, IRRs, and break-even charge-out rate.

Ad Valorem (Property) Tax Valuation Template

Custom (cells C265:J265)

Custom property tax valuations need to be entered here only if the “Custom” property tax valuation has been chosen in the Basic Assumptions table.

Sensitivity Analysis tables

Optional variables (in **boldface**) provide inputs to change the various sensitivity analyses in terms of their starting points and their ranges.

Appendix 3—ChargeOut!’s Main Worksheet

Microsoft Excel screenshots from ChargeOut!’s main worksheet.

CHARGEOUT! A financial analysis approach to machine costing   version 1.02   26-Oct-06

E.M. Bilek   USDA Forest Service, Forest Products Laboratory, Madison, Wisconsin 53726-2398   email: tbilek@fs.fed.us

Cells in **BOLD** may be changed.

Rubber-tired grapple skidder   Demonstration data

Summary Financial Measures:

	Before-tax & finance	Before-tax	After-tax	
NPV	$ (6,331)	$ (559)	$ 7,849	
IRR (real)	5.7%	6.7%	6.5%	*IRR Seed*
IRR (nominal)	8.9%	9.9%	9.7%	**10%**

Year 1 Charge-out Rates:

Per...	*scheduled hour*	*productive hour*	***ton***
Inflation-adjusted charge-out	$ 45.00	$ 67.16	$ 6.72
B-E charge-out	43.81	65.39	$ 6.54
Difference	$ 1.19	$ 1.77	$ 0.18

Charge-out rates change annually by... **Inflation**

WARNING! These financial measures are subject to your ability to take an immediate tax credit in at least one of your operating years. See the taxes in the cash flow ta

Other Financial Information:

Loan principal	$ 111,600
Monthly loan payments	$ 3,549
Equivalent annual loan interest rate	9.38%
Equivalent annual deposit interest rate	3.04%
Average capital invested (ACI) †	$ 130,320

Required Returns on Invested Capital (ROIC):

Equivalent annual...	*Before-tax*	*After-tax*
Real required ROIC	6.84%	3.62%
Nominal required ROIC	10.04%	6.727869%
Annual percentage rate (APR)...		
Real required ROIC	6.63%	3.56%
Nominal required ROIC	9.61%	6.53%

Percent of Discounted Gross Revenue:

Net ownership costs	29.7%
Fixed operating costs & loan interest	15.3%
Repairs & maintenance	23.7%
Other variable op. costs and taxes	29.5%
Additional profit (loss)	1.8%
Total	100.0%

Annualized Revenue Calculations:

	Gross revenue
Equalized annual actual	$ 101,570
Equalized annual break-even	98,888
Difference	$ 2,682

Summary Cash Flows

Year	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Cash flow before tax and financing	$ (186,000)	$ 33,794	$ 36,910	$ 43,385	$ 46,325	$ 87,659	$ -	$ -	$ -
Cash flow before tax	$ (74,400)	$ (8,793)	$ (5,676)	$ 799	$ 46,325	$ 87,659	$ -	$ -	$ -
Cash flow after tax	$ (74,400)	$ 36,574	$ (12,958)	$ (11,003)	$ 32,427	$ 60,122	$ -	$ -	$ -

WARNING! You are getting a tax credit in year 1. See the taxes in the cash flow table. In order to take the Section 179 deduction and Special first-year depreciation allowance, you must have sufficient taxes due on income from other sources to take the resulting first-year tax credit.
WARNING! Because you have negative cash flows in multiple years, you may have more than one internal rate of return.

Summary Annual Production (tons)	12,395	13,400	16,750	16,750	16,750	-	-	-

Screenshot 1—CHARGEOUT! model

Basic Assumptions (continued on next page)

Purchase price (excluding tires)	$ 180,000	*Engine type*	**Diesel**
Salvage estimate	$ 55,800	*Horsepower*	**135 HP**
Index the salvage estimate to inflation	**No**	*Maintenance and repairs functions' forms*	**Estimated**
Gearing (% of total purchase price financed)	**60%**	*Initial maintenance as a pct. of straight-line depreciation*	**10.0%**
Loan term	**3 years**	*Productive hours until maintenance costs increase by 50%*	**4,000**
Loan and deposit payments per year	**12**	*Initial repairs as a pct. of straight-line depreciation*	**40.0%**
General depreciation system (GDS) life	**5 years**	*Productive hours until repairs costs increase by 50%*	**3,000**
Alternative depreciation system (ADS) life	**6 years**	*Utilization rate*	**67.0%**
Economic life	**5 years** See warning or error message below.	*Crankcase oil capacity*	**10 gallons**
Depreciation code	**DB**	*Time between oil changes*	**120 hours**
Declining balance factor	**200%**	*Other lubricants (% of engine oil cost)*	**50.0%**
Section 179 deduction	$ **108,000**	*Diesel fuel consumption (gallons/hour)*	**4.958**
Special first-year depreciation allowance	**50%**	*Oil consumption (gallons/hour)*	**0.154**
Loan interest rate is…	**Fixed**	*Fuel cost (per gallon)*	$ **2.900**
Fixed loan interest rate (APR)	**9.00%**	*Oil cost (per gallon)*	$ **4.380**
Deposit interest rate (APR)	**3.00%**	*Tire cost (per set)*	$ **6,000**
Expected risk premium on invested capital	**7.00%**	*Tire life*	**3,000 hours**
Inflation	**3.0%**	*Tire installation factor*	**15%**
Income tax rate	**33.0%**	***Additional periodic consumables*** *cost*	$ -
Tax loss treatment	**Flow through**	*Additional periodic consumables* *life*	**0 hours**
Ad valorem *(property) tax mill rate*	**30**	*Annual insurance percent*	**3.0%**
Ad valorem (property) tax valuation basis	**ACI**	***Other fixed costs*** *($/year)*	$ **4,000**
Fixed operating costs sensitivity factor	**100%**	***Other variable costs*** *($/scheduled hr.)*	$ **1.000**
Variable operating costs sensitivity factor	**100%**	*Expected production* *(ton/productive hour)*	**10**

WARNING! You have scheduled operating time (below) in years beyond your Economic life (above).

WARNING! You are getting a flow-through tax credit in year 1. See the taxes in the cash flow table. In order to take the Section 179 deduction and Special first-year depreciation allowance, you must have sufficient taxes due on income from other sources to take the resulting first-year tax credit.

Basic Assumptions (continued)

	Year 0	1	2	3	4	5	6	7	8	Equalized annual
Annual operating and productive time										
Scheduled operating time (hours/year)		**1,850**	**2,000**	**2,500**	**2,500**	**2,500**	**2,500**	**2,500**	**2,500**	2,257
Annual productive time (hours/year)		1,240	1,340	1,675	1,675	1,675	-	-	-	1,512
WARNING! You have annual operating hours in years past your stated Economic life above. These are not used in subsequent calculations.										
Annual hourly charge-out rates										
Negotiated		**$ 45.00**	**$ 46.00**	**$ 47.50**	**$ 49.00**	**$ 51.00**	**$ 52.50**	**$ 53.50**	**$ 55.00**	44.92
Inflation-adjusted		**$ 45.00**	$ 46.35	$ 47.74	$ 49.17	$ 50.65	$ -	$ -	$ -	45.00
IMPORTANT! Because your charge-out rates change annually with inflation (cell L13), you need to provide the Year-1 hourly rate (cell C101).										

CASH FLOW ANALYSIS

Cash Flow Table (continued on next page)

Analysis in Current Dollars	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Discounted total	Percent total
GROSS REVENUE		$ 83,250	$ 92,700	$ 119,351	$ 122,932	$ 126,620	$ -	$ -	$ -	$ 443,736	100%
OWNERSHIP COSTS (purchase & salvage)											
Purchase price (including tires)	$ (186,000)									$ (186,000)	-42%
Salvage value		-	-	-	-	55,800	-	-	-	40,294	9%
FIXED OPERATING COSTS											
Insurance		(4,027)	(4,148)	(4,272)	(4,400)	(4,532)	-	-	-	(17,593)	-4%
Ad valorem *(property) taxes*		(4,027)	(4,148)	(4,272)	(4,400)	(4,532)	-	-	-	(17,593)	-4%
Other fixed costs		(4,120)	(4,244)	(4,371)	(4,502)	(4,637)	-	-	-	(17,999)	-4%
Subtotal: fixed operating costs		$ (12,174)	$ (12,539)	$ (12,915)	$ (13,303)	$ (13,702)	$ -	$ -	$ -	$ (53,184)	-12%
VARIABLE OPERATING COSTS											
Maintenance		(3,041)	(3,588)	(4,380)	(5,346)	(6,525)	-	-	-	(18,434)	-4%
Repairs		(12,685)	(15,660)	(20,227)	(26,127)	(33,748)	-	-	-	(86,778)	-20%
Tires		-	-	(7,540)	-	(7,999)	-	-	-	(11,978)	-3%
Additional periodic consumables		-	-	-	-	-	-	-	-	-	0%
Fuel		(18,355)	(20,439)	(26,315)	(27,104)	(27,917)	-	-	-	(97,835)	-22%
Engine oil		(864)	(962)	(1,238)	(1,276)	(1,314)	-	-	-	(4,604)	-1%
Other lubricants		(432)	(481)	(619)	(638)	(657)	-	-	-	(2,302)	-1%
Other variable operating costs		(1,906)	(2,122)	(2,732)	(2,814)	(2,898)	-	-	-	(10,157)	-2%
Subtotal: variable operating costs		$ (37,283)	$ (43,251)	$ (63,051)	$ (63,305)	$ (81,059)	$ -	$ -	$ -	$ (232,089)	-52%
Subtotal: fixed and variable operating costs		$ (49,456)	$ (55,790)	$ (75,966)	$ (76,607)	$ (94,760)	$ -	$ -	$ -	$ (285,274)	-64%
Cash flow before tax & financing	$ (186,000)	$ 33,794	$ 36,910	$ 43,385	$ 46,325	$ 87,659	$ -	$ -	$ -	$ 12,757	3%
FINANCING											
Loan principal	$ 111,600									$ 111,600	25%
Total loan interest payments		$ (8,668)	$ (5,486)	$ (2,005)	$ -	$ -	$ -	$ -	$ -	(14,587)	-3%
Total loan principal repayment		(33,919)	(37,101)	(40,581)	-	-	-	-	-	(97,731)	-22%
Cash fow before tax	$ (74,400)	$ (8,793)	$ (5,676)	$ 799	$ 46,325	$ 87,659	$ -	$ -	$ -	$ 12,039	3%

Cash Flow Table (continued)	Year 0	1	2	3	4	5	6	7	8		
Cash fow before tax	$ (74,400)	$ (8,793)	$ (5,676)	$ 799	$ 46,325	$ 87,659	$ -	$ -	$ -	$ 12,039	3%
TAX ADJUSTMENTS											
Section 179 deduction		$ (108,000)								$ (101,192)	-23%
Special first-year depreciation allowance		(39,000)								(36,542)	-8%
Depreciation expense		(15,600)	$ (9,360)	$ (5,616)	$ (4,212)	$ (4,212)	$ -	$ -	$ -	(33,741)	-8%
Taxable gain (loss) on salvage †		-	-	-	-	55,800	-	-	-	40,294	9%
Subtotal: tax adjustments		$ (162,600)	$ (9,360)	$ (5,616)	$ (4,212)	$ 51,588	$ -	$ -	$ -	$ (131,180)	-30%
Taxable cash flow		$ (137,474)	$ 22,064	$ 35,764	$ 42,113	$ 83,447	$ -	$ -	$ -	$ 12,696	3%
Taxes ††		45,366	(7,281)	(11,802)	(13,897)	(27,538)	-	-	-	(4,190)	-1%
After tax cash flow	$ (74,400)	$ 36,574	$ (12,958)	$ (11,003)	$ 32,427	$ 60,122	$ -	$ -	$ -	$ 7,849	2%

WARNING! You are getting a tax credit in year 1. In order to take the Section 179 deduction and Special first-year tax deductions, you must have other taxable income.

† If the salvage value is less than the purchase price less the accumulated depreciation, the firm takes a book loss on the investment and gets a tax credit.
If the salvage value is greater than the skidder cost less its accumulated depreciation, the firm pays income tax tax on recovery of excess depreciation.
Technically, the asset should be sold at the beginning of the next year following the end of its economic life, to allow the last depreciation expense to be taken..

†† If the firm suffers a tax loss, the model assumes that there is other income in the current period against which the loss may be deducted.

Tax calculation table with tax loss carry-forwards (used only if tax losses "Carry forward")

	1	2	3	4	5	6	7	8
Taxable cash flow	$ (137,474)	$ 22,064	$ 35,764	$ 42,113	$ 83,447	$ -	$ -	$ -
Tax credit (taxes due) on taxable cash flow	45,366	(7,281)	(11,802)	(13,897)	(27,538)	-	-	-
Plus: beginning carryover tax credits	-	45,366	38,085	26,283	12,386	-	-	-
Ending carryover tax credits	$ 45,366	$ 38,085	$ 26,283	$ 12,386	$ -	$ -	$ -	$ -
Taxes payable	$ -	$ -	$ -	$ -	$ (15,152)	$ -	$ -	$ -

Tax calculation table with no treatment of losses (used only if tax losses are lost, therefore Tax treatment = "None")

	1	2	3	4	5	6	7	8
Taxable cash flow	$ -	$ (7,281)	$ (11,802)	$ (13,897)	$ (27,538)	$ -	$ -	$ -

	Year 0	1	2	3	4	5	6	7	8
Analysis in Real Dollars									
Before tax & finance cash flow (nominal)	$ (186,000)	$ 33,794	$ 36,910	$ 43,385	$ 46,325	$ 87,659	$ -	$ -	$ -
Before tax & finance cash flow (real)	$ (186,000)	$ 32,809	$ 34,791	$ 39,703	$ 41,159	$ 75,616	$ -	$ -	$ -
Before tax cash flow (nominal)	$ (74,400)	$ (8,793)	$ (5,676)	$ 799	$ 46,325	$ 87,659	$ -	$ -	$ -
Before tax cash flow (real)	$ (74,400)	$ (8,536)	$ (5,351)	$ 731	$ 41,159	$ 75,616	$ -	$ -	$ -
After tax cash flow (nominal)	$ (74,400)	$ 36,574	$ (12,958)	$ (11,003)	$ 32,427	$ 60,122	$ -	$ -	$ -
After tax cash flow (real)	$ (74,400)	$ 35,509	$ (12,214)	$ (10,069)	$ 28,811	$ 51,862	$ -	$ -	$ -

CALCULATIONS AND EXPENSE TEMPLATES

	Year 0	1	2	3	4	5	6	7	8
Gross Revenue Calculations									
Negotiated annual hourly charge-out rates		$ 83,250	$ 92,000	$ 118,750	$ 122,500	$ 127,500	$ 131,250	$ 133,750	$ 137,500
Inflation-adjusted annual hourly charge-out rates		$ 83,250	$ 92,700	$ 119,351	$ 122,932	$ 126,620	$ -	$ -	$ -

	Year 0	1	2	3	4	5	6	7	8
Depreciation Calculations									
Beginning book value		$ 186,000	$ 23,400	$ 14,040	$ 8,424	$ 4,212	$ -	$ -	$ -
Less:									
Section 179 deduction		$ (108,000)							
Special first-year depreciation allowance		(39,000)							
Depreciable value	$ 186,000	$ 39,000	$ 23,400	$ 14,040	$ 8,424	$ 4,212	$ -	$ -	$ -
Depreciation expense		(15,600)	(9,360)	(5,616)	(4,212)	(4,212)	-	-	-
Salvage write-off		-	-	-	-	-	-	-	-
Ending book value	$ 186,000	$ 23,400	$ 14,040	$ 8,424	$ 4,212	$ -	$ -	$ -	$ -
Accumulated depreciation		$ (54,600)	$ (63,960)	$ (69,576)	$ (73,788)	$ (78,000)	$ -	$ -	$ -
Depreciation Expense Templates									
Declining balance [DB]		$ (15,600)	$ (9,360)	$ (5,616)	$ (4,212)	$ (4,212)	$ -	$ -	$ -
Straight line (GDS life: Accelerated) [SLGDS]		$ (7,800)	$ (5,850)	$ (4,680)	$ (4,212)	$ (4,212)	$ -	$ -	$ -
Straight line (ADS life) [SLADS]		$ (6,500)	$ (4,680)	$ (3,510)	$ (2,808)	$ (2,106)	$ -	$ -	$ -
Straight line (economic life) [SLEL]		$ 3,461	$ 3,565	$ 3,672	$ 3,782	$ 3,895	$ -	$ -	$ -
Custom		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -

Maintenance Expense Template	Fudge Factor[†]									PV	Difference
Estimated	**1.00**	$ (2,953)	$ (3,382)	$ (4,008)	$ (4,750)	$ (5,629)	$ -	$ -	$ -	$ (16,758)	$ -
Custom	**0.45**	$ **(923)**	$ **(1,651)**	$ **(3,057)**	$ **(5,660)**	$ **(10,479)**	$ -	$ -	$ -	$ (16,758)	$ -

† The Fudge Factor may be used to ensure that the NPV's of the distributions are equal so that costing differences between models are not due to inequalities in maintenance assumptions.

To make the NPV's equal, set one Fudge Factor equal to 1.00 and use "Goal Seek" to find the second Fudge Factor that makes the difference between the NPV's = $0.

Repairs Expense Template	Fudge Factor[†]									PV	Difference
Estimated	**1.00**	$ (12,316)	$ (14,761)	$ (18,511)	$ (23,214)	$ (29,111)	$ -	$ -	$ -	$ (78,637)	$ -
Custom	**0.0010242**	$ **(8,766)**	$ **(11,646)**	$ **(20,583)**	$ **(25,812)**	$ **(32,370)**	$ -	$ -	$ -	$ (78,637)	$ -

† The Fudge Factor may be used to ensure that the NPV's of the distributions are equal so that costing differences between models are not due to inequalities in repairs assumptions.

To make the NPV's equal, set one Fudge Factor equal to 1.00 and use "Goal Seek" to find the second Fudge Factor that makes the difference between the NPV's = $0.

Tire Replacement Calculations									
Beginning tire life (hours)	3,000	3,000	1,761	421	1,746	71	1,396	1,396	1,396
Replacement tire hours	-	-	-	3,000	-	3,000	-	-	-
Annual productive time		1,240	1,340	1,675	1,675	1,675	-	-	-
Remaining tire life (hours)	3,000	1,761	421	1,746	71	1,396	1,396	1,396	1,396
Tire replacements (number/year)		-	-	1	-	1	-	-	-

CALCULATIONS AND EXPENSE TEMPLATES (continued)

	Year								
	0	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Additional periodic consumables	Replacement calculations								
Beginning life (hours)	-	-	-	-	-	-	-	-	-
Replacement hours	-	-	-	-	-	-	-	-	-
Annual productive time (hours)	-	-	-	-	-	-	-	-	-
Remaining life (hours)	-	-	-	-	-	-	-	-	-
Total replacements (number/year)	-	-	-	-	-	-	-	-	-

Ad valorem (property) tax valuation									
Straight-line book value (SLB)		$ 180,000	$ 159,300	$ 138,600	$ 117,900	$ 97,200	$ 76,500	$ 55,800	$ 35,100
Average capital invested (ACI)		$ 130,320	$ 130,320	$ 130,320	$ 130,320	$ 130,320	$ 130,320	$ 130,320	$ 130,320
Custom		**$ 169,650**	**$ 148,950**	**$ 128,250**	**$ 107,550**	**$ 86,850**	**$ 66,150**	**$ 45,450**	**$ 17,550**

ChargeOut! Sensitivity Analysis

Use Data, Table, Column Input Cell = Whatever cell is variable (eg: Inflation Rate, Gearing, ARR, etc.)

Purchase Price	Nominal IRR After-tax	Real IRR After-tax	Break-even Chargeout
$168,000	15.0%	11.7%	$ 41.91
$170,000	14.1%	10.8%	$ 42.23
$172,000	13.2%	9.9%	$ 42.55
$174,000	12.3%	9.0%	$ 42.86
$176,000	11.4%	8.2%	$ 43.18
$178,000	10.6%	7.3%	$ 43.50
$180,000	9.7%	6.5%	$ 43.81
$182,000	8.9%	5.7%	$ 44.13
$184,000	8.1%	5.0%	$ 44.44
$186,000	7.3%	4.2%	$ 44.76
$188,000	6.5%	3.4%	$ 45.08
$190,000	5.8%	2.7%	$ 45.39
$192,000	5.0%	2.0%	$ 45.71

Purchase price increment change = **$2,000**

Risk Premium	Break-even Chargeout
-3%	$ 41.22
-2%	$ 41.47
-1%	$ 41.73
0%	$ 41.99
1%	$ 42.25
2%	$ 42.51
3%	$ 42.76
4%	$ 43.03
5%	$ 43.29
6%	$ 43.55
7%	$ 43.81
8%	$ 44.08
9%	$ 44.34
10%	$ 44.61

Risk premium increment change = **1%**

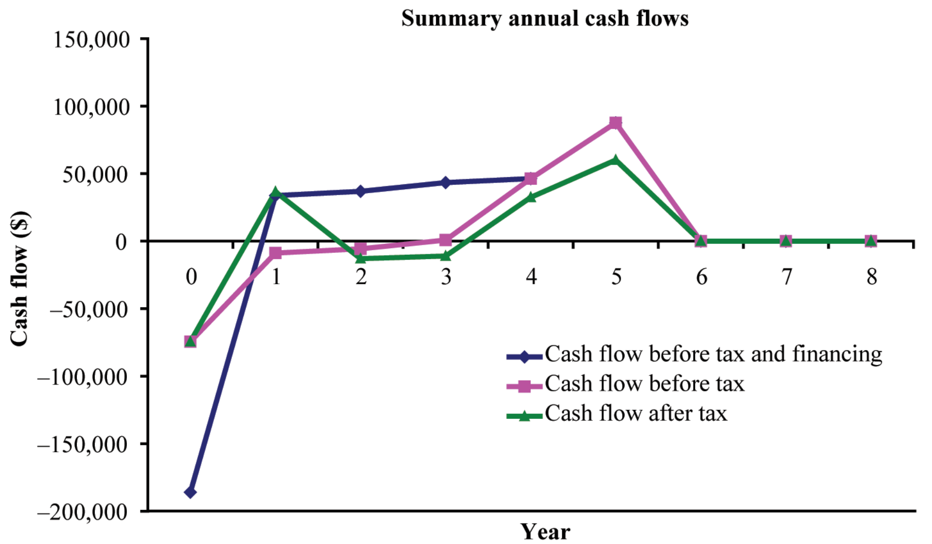
Charge-out rate	Nominal IRR After-tax	Real IRR After-tax
$ 38.81	-6.4%	-9.1%
$ 39.81	-3.7%	-6.5%
$ 40.81	-1.0%	-3.9%
$ 41.81	1.6%	-1.4%
$ 42.81	4.2%	1.1%
$ 43.81	6.7%	3.6%
$ 44.81	9.3%	6.1%
$ 45.81	11.8%	8.5%
$ 46.81	14.2%	10.9%
$ 47.81	16.7%	13.3%
$ 48.81	19.1%	15.6%

Charge-out increment change = $ **1.00**

Gearing	Nominal IRR After-tax	Real IRR After-tax	Break-even Chargeout
0%	7.5%	4.4%	$ 44.43
10%	7.7%	4.6%	$ 44.33
20%	8.0%	4.9%	$ 44.23
30%	8.3%	5.1%	$ 44.12
40%	8.7%	5.5%	$ 44.02
50%	9.1%	6.0%	$ 43.92
60%	9.7%	6.5%	$ 43.81
70%	10.5%	7.3%	$ 43.71
80%	11.6%	8.4%	$ 43.61
90%	13.4%	10.1%	$ 43.50

Depreciation code	Nominal IRR After-tax	Real IRR After-tax	Break-even Chargeout
DB	9.7%	6.5%	$ 43.81
SLGDS	9.5%	6.3%	$ 43.89
SLADS	9.3%	6.2%	$ 43.92
SLEL	8.6%	5.4%	$ 44.18
Custom	8.8%	5.7%	$ 44.09

Inflation	Nominal IRR After-tax	Real IRR After-tax	Break-even Chargeout
-1.0%	9.5%	10.6%	$ 43.84
0.0%	9.6%	9.6%	$ 43.82
1.0%	9.6%	8.6%	$ 43.81
2.0%	9.7%	7.5%	$ 43.81
3.0%	9.7%	6.5%	$ 43.81
4.0%	9.8%	5.5%	$ 43.82
5.0%	9.8%	4.5%	$ 43.84
6.0%	9.7%	3.5%	$ 43.86
7.0%	9.7%	2.5%	$ 43.89
8.0%	9.7%	1.5%	$ 43.93
9.0%	9.6%	0.5%	$ 43.97
10.0%	9.5%	-0.4%	$ 44.02
		Inflation starting point =	**-1.0%**
		Inflation increment change =	**1.0%**



Screenshot 2—Summary cost chart