Ag Decision Maker
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Capital Budgeting and Decision Making

Capital budgeting can be used to analyze a wide variety of investments in capital assets (assets lasting multiple years). A sample of capital budgeting decisions is presented below.

Allocating Limited Funds

In many situations, the investment decision is to allocate a limited amount of funds among a variety of potential investments. Because there is not enough money to fund all of the investments, a decision is required to determine which investments to fund.

When conducting this kind of analysis, all of the investments being considered must be "stand alone" investments and not connected or impacted by any other investments. Also, each of the investments must have the same expected life.

Divisible Investments

The type of analysis used in making this decision is based on whether the investments are divisible or indivisible. Divisible investments are those that can be partially funded and will create economic benefits equivalent to the amount invested. For example, if an investment is funded at only 50% of the total investment, it will create 50% of the benefits.

Four alternative investments are shown in Table 1. $300,000 is available to invest in one or more of the investments. To rank the investments, the profitability index for each investment is computed. In essence, the index shows the amount of discounted cash inflow per dollar of discounted cash outflow. In the example, Project C has the highest ranking of 1.57. Of the $300,000 of funds available for investment, the first $120,000 is invested in Project C. The remainder is invested in the next highest ranked investment, which is Project D. So, the investment computation is $120,000 invested in Project C and $180,000 invested in Project D ($300,000 – $120,000 = $180,000).

Indivisible Investments

Many investments are not divisible. The entire investment is required before any returns are generated. In the example in Table 2, investments are grouped to allow funding of up to $300,000. Investments A and B, A and C, and B and C are grouped. Because of the large size of investment D, it cannot be combined with another investment. The investment (or grouping of investments) with the highest net present value is selected. Based on the grouping with the highest net present value, the funding should be made in the grouping that contains investments A and C.

The analysis assumes there is no return on funds remaining after the investments. For example, investment grouping B + C uses only $200,000 of the available funds ($100,000 remains). If the excess funds can be investments in a liquid asset (e.g., bank CDs) or other form of divisible investment, the returns from this additional investment should be included in the analysis and may result in a different decision.

Table 1. Allocation of Limited Funds Among Alternative Divisible Investments.
Available Funds = $300,000.

Investment	Amount	Net Present Value	Profitability Index	Rank
A	$150,000	$19,700	1.13	4
B	$80,000	$11,300	1.14	3
C	$120,000	$68,400	1.57	1
D	$300,000	$69,000	1.23	2

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Iowa State University
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Table 2. Allocation of Limited Funds Among Alternative Indivisible Investments.
Available funds = $300,000.

Capital Investment	Amount	Net Present Value	
A	$150,000	$19,700	
B	$80,000	$11,300	
C	$120,000	$68,400	
D	$300,000	$69,000	
Capital Investment	**Amount**	**Net Present Value**	**Rank**
A + B	$230,000	$31,000	4
A + C	$270,000	$88,100	1
B + C	$200,000	$79,700	2
D	$300,000	$69,000	3

Buy versus Lease Decisions

Capital budgeting is commonly used to compare alternative methods of accessing a machine or an item of equipment. In the analysis below, three methods of obtaining the use of a machine are compared. The machine can be purchased with no outside financing, purchased with outside financing, or it can be leased. Although the machine can be accessed in various ways, the operating expenses, level of output, and other features are the same for all three alternatives. Therefore, these aspects are not relevant to the comparative analysis and are not included.

The discount rate in this analysis represents the opportunity cost of capital. For example, the funds could be used to reduce existing business debt (thereby reducing interest cost), invested elsewhere in the business (thereby generating additional profits), or invested outside of the business (thereby generating interest income).

The machine purchase with no credit alternative is shown in Table 3. The machine is depreciated over seven years. Although depreciation is not a cash flow item, the income tax impact of the depreciation tax deduction is a cash flow item. In the Table 3

Table 3. Machine Purchase with No Credit.
Purchase price = $350,000
Life = 7 years
Sale price = $100,000
Depreciation = Straight line over 7 years, no salvage value
Discount rate = 7.5%

Year	Purchase Price	Sale Price	Depreciation	Tax Savings [1/]	Net Cash Flow	Present Value of Net Cash Flow
0	-$350,000	$0	$0	$0	-$350,000	-$350,000
1	$0	$0	$50,000	$15,000	$15,000	$13,953
2	$0	$0	$50,000	$15,000	$15,000	$12,980
3	$0	$0	$50,000	$15,000	$15,000	$12,074
4	$0	$0	$50,000	$15,000	$15,000	$11,232
5	$0	$0	$50,000	$15,000	$15,000	$10,448
6	$0	$0	$50,000	$15,000	$15,000	$9,719
7	$0	$100,000	$50,000	-$15,000	$85,000	$69,317
Total	**-$350,000**	**$100,000**	**$350,000**	**$75,000**	**-$175,000**	**-$228,358**

[1/] The 30% marginal tax rate multiplied by depreciation.

example, annual depreciation is $50,000. With a marginal tax rate of 30%, the annual reduction in taxes is $15,000 ($50,000 × 30% = $15,000). This is a cash benefit resulting from the purchase of the machine. Furthermore, if the machine is depreciated to zero at the end of the seventh year and the machine is sold for $100,000 at the end of the seventh year, $100,000 of depreciation is repaid. This results in a net of $15,000 of additional taxes paid in year seven ($50,000 of depreciation less $100,000 of recaptured depreciation = $50,000 of added taxable income × 30% = $15,000 of additional income tax).

The net cash cost for the machine is the $350,000 outflow for the purchase price less the $100,000 inflow from the sale price at the end of seven years plus $15,000 annual inflow from the tax savings (except for year seven). The net cash cost of the machine is $175,000.

The present value cash cost is $228,358, substantially more than the nominal cash cost of $175,000. The present value cost is higher because the large purchase price cash outlay occurs at the beginning of the period and is not discounted while the cash inflows occur over the seven-year period and are discounted.

The machine purchase with borrowed money alternative is shown in Table 4. The analysis is similar to Table 3 except that a significant portion of the purchase price is financed with borrowed money. So, the annual principal and interest payments are included in the analysis and only the down payment is paid at the time of purchase. As with depreciation, interest payments are also tax deductible. So the annual tax savings is computed by multiplying the marginal tax rate times the interest payment and depreciation. For example, in year one, the interest payment and depreciation total $74,000 so the tax saving is $22,200 ($74,000 × 30% = $22,200).

Table 4. Machine Purchase on Credit.

Purchase price = $350,000
Amount borrowed = $200,000
Term = 5 years
Life = 7 years
Sale price = $100,000
Depreciation = Straight line over 7 years, no salvage value
Discount rate = 7.5%

Year	Down Payment	Sale Price	Debt Payments		Depreciation	Tax Savings [2/]	Net Cash Flow	Present Value of Net Cash Flow
			Principal	Interest [1/]				
0	-$150,000	$0	$0	$0		$0	-$150,000	-$150,000
1	$0	$0	-$40,000	-$24,000	$50,000	$22,200	-$41,800	-$38,884
2	$0	$0	-$40,000	-$19,200	$50,000	$20,760	-$38,440	-$33,263
3	$0	$0	-$40,000	-$14,400	$50,000	$19,320	-$35,080	-$28,238
4	$0	$0	-$40,000	-$9,600	$50,000	$17,880	-$31,720	-$23,752
5	$0	$0	-$40,000	-$4,800	$50,000	$16,440	-$28,360	-$19,754
6	$0	$0	$0	$0	$50,000	$15,000	$15,000	$9,719
7	$0	$100,000	$0	$0	$50,000	-$15,000	$85,000	$51,234
Total	**-$150,000**	**$100,000**	**-$200,000**	**-$72,000**	**$350,000**	**$96,600**	**-$225,400**	**-$232,938**

[1/] Interest rate of 12%.
[2/] The 30% marginal tax rate multiplied by the interest payment and depreciation.

Table 5. Machine Lease.

Annual lease payment (beginning of year) = $60,000
Discount rate = 7.5%

Year	Lease Payment	Tax Savings [1/]	Net Cash Flow	Present Value of Net Cash Flow
0	-$60,000	$18,000	$0	-$60,000
1	-$60,000	$18,000	-$42,000	-$39,070
2	-$60,000	$18,000	-$42,000	-$36,344
3	-$60,000	$18,000	-$42,000	-$33,808
4	-$60,000	$18,000	-$42,000	-$31,450
5	-$60,000	$18,000	-$42,000	-$29,255
6	-$60,000	$18,000	-$42,000	-$24,214
7	$0	$0	-$42,000	$10,850
Total	**-$420,000**	**$126,000**	**-$294,000**	**-$246,292**

[1/] The 30% marginal tax rate multiplied by the lease payment.

Table 6. Comparison of Machine Access under Alternative Discount Rates.

	Net Cash Flow	Present Value of Net Cash Flow		
		5%	7.5%	10%
Purchase with no Credit	-$175,000	-$213,457	-$228,358	-$241,053
Purchase with Credit	-$225,400	-$231,695	-$232,938	-$233,314
Lease	-$294,000	-$260,387	-$246,292	-$233,684

The nominal cash cost of owning the machine is $225,400. This is significantly higher than the nominal cash cost of purchasing the machine using no debt ($175,000). However, the present value cash cost is $232,938, only slightly higher than the nominal cash cost of $225,400 and similar to the present value cash cost of $228,358 of the alternative in Table 3. The present value amount is similar to the nominal amount because both the cash inflows and outflows are spread over the seven-year period so discounting has nearly the same effect on both of them.

The leasing alternative is relatively straight forward and is shown in Table 5. The lease payment is $60,000 per year with the first payment due when the lease is signed and subsequent payments made at the beginning of each year.

Because the lease payments are tax deductible, there is a tax saving at the end of each year. The nominal cash cost is $294,000 and substantially higher than the other two alternatives ($175,000 and $225,400) in Tables 4 and 5. However, the cash outflows are spread over the seven-year period and are discounted, so the present value cash cost is $246,292, only slightly higher than the other two alternatives ($228,358 and $232,938).

A comparison of the three alternatives under three discount rates is shown in Table 6. The purchase with no credit is the least cost alternative, followed by purchase with credit. The lease alternative is the highest cost. Although substantial differences occur between the nominal cash flows of the three alternatives, the differences narrow substantially when the cash flows are discounted at 5% or 7.5%.

The ranking changes if a higher discount rate is used (e.g., 10%). In this case, the purchase with no credit alternative becomes the highest cost and the two other alternatives are essentially the same cost.

Comparing Investments with Different Lives (replacement chain)

A common capital budgeting problem is comparing alternative investments with different lives. To accurately compare two investments using discounted cash flows, the lives of both investments need to be the same. So how do you compare investments with different lives? A method called the "replacement chain" can be used.

For example, assume you are considering purchasing a machine for your business that will replace a worn-out machine. One option is to purchase a "deluxe" machine that will last for 10 years and cost $250,000. The other option is to purchase a cheaper "economy" machine that costs only $160,000 but will last for only five years.

We can use the "replacement chain" process to compare these alternatives. We replicate the use and replacement of these machines until both chains have the same end point. In the example here, we construct a replacement chain where both investments reach the end point after 10 years. The deluxe machine does not have to be replaced because it has a life of 10 years. However, the economy machine has to be replaced because it has a life of only five years. But after one replacement it has a life of 10 years (2 machines × 5 year life = 10 years total) to match the 10-year period of the deluxe machine.

The analysis for the deluxe machine is shown in Table 7. The machine will create net cash flows of $60,000 annually over the 10-year period for a nominal net cash flow of $350,000 over the 10-year period. The $118,674 present value of these cash flows is substantially less than the nominal amount because the cash outflow occurs at the beginning of the period but the inflows are spread over the entire period and are discounted.

Table 7. Present Value of a Deluxe Machine.

Purchase price = $250,000
Annual net cash flows = $60,000
Life = 10 years
Discount rate = 10%
Terminal value of machine = $0

Year	Net Cash Flow	Present Value
0	-$250,000	-$250,000
1	$60,000	$54,545
2	$60,000	$49,587
3	$60,000	$45,079
4	$60,000	$40,981
5	$60,000	$37,255
6	$60,000	$33,868
7	$60,000	$30,789
8	$60,000	$27,990
9	$60,000	$25,446
10	$60,000	$23,133
Total	**$350,000**	**$118,674**

Table 8. Present Value of an Economy Machine.

Purchase price = $160,000
Annual net cash flows = $60,000
Life = 5 years
Discount rate = 10%
Terminal value of machine = $0

Year	Replacement Chain Net Cash Flow		Combined Replacement Chain Net Cash Flow	Present Value
0	-$160,000	$0	-$160,000	-$160,000
1	$60,000	$0	$60,000	$54,545
2	$60,000	$0	$60,000	$49,587
3	$60,000	$0	$60,000	$45,079
4	$60,000	$0	$60,000	$40,981
5	$60,000	-$160,000	-$100,000	-$62,092
6	$0	$60,000	$60,000	$33,868
7	$0	$60,000	$60,000	$30,789
8	$0	$60,000	$60,000	$27,990
9	$0	$60,000	$60,000	$25,446
10	$0	$60,000	$60,000	$23,133
Total	**$140,000**	**$140,000**	**$280,000**	**$109,327**

The analysis for the economy machine is shown in Table 8. The machine is purchased at the beginning of the period and replaced at the end of five years with an identical machine. As a result, the life of the economy machine replacement chain is the same as the life of the one deluxe machine.

The deluxe machine will generate a higher present value cash flow ($118,674) than the economy machine ($109,327). As shown in Table 9, the relative advantage of the deluxe machine is even greater when a 5% discount rate is used. However, the economy machine has a higher present value cash flow when a 15% discount rate is used.

Table 9. Replacement Chain Present Value Comparison of Alternative Machines with Alternative Discount Rates.

	5%	10%	15%
Deluxe Machine	$213,304	$118,674	$51,126
Economy Machine	$177,940	$109,327	$61,578

Although the combined price of the two economy machines ($160,000 × 2 = $320,000) is greater than the cost of one deluxe machine ($250,000), the discounted value of the second economy machine is reduced enough with a 15% discount rate to offset the higher cost of the two economy machines.

Additional Resources on capital budgeting may be found on the Ag Decision Maker website, www.extension.iastate.edu/agdm/vdoperations.html.

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