Lecture 6

Net Present Value and Capital Budgeting

Net Present Value and Capital Budgeting

Incremental Cash Flows

The Baldwin Company: An Example

The Boeing 777: A Real-World Example

Inflation and Capital Budgeting

Investments of Unequal Lives: The Equivalent Annual Cost Method

Incremental Cash Flows

- Cash flows matter—not accounting earnings.
- Sunk costs don't matter.
- *Incremental* cash flows matter.
- Opportunity costs matter.
- Side effects like cannibalism and erosion matter.
- Taxes matter: we want incremental after-tax cash flows.
- Inflation matters.

Cash Flows—Not Accounting Earnings.

- Consider depreciation expense.
- You never write a check made out to “depreciation”.
- Much of the work in evaluating a project lies in taking accounting numbers and generating cash flows.

Incremental Cash Flows

- Sunk costs are not relevant
  - Just because "we have come this far" does not mean that we should continue to throw good money after bad.
- Opportunity costs *do* matter. Just because a project has a positive NPV that does not mean that it should also have automatic acceptance. Specifically if another project with a higher NPV would have to be passed up we should not proceed.

Incremental Cash Flows

- Side effects matter.
  - Erosion and cannibalism are both bad things. If our new product causes existing customers to demand less of current products, we need to recognize that.

Estimating Cash Flows

- Cash Flows from Operations
  - Recall that:

  Operating Cash Flow = EBIT – Taxes + Depreciation
- Net Capital Spending
  - Don’t forget salvage value (after tax, of course).
- Changes in Net Working Capital
  - Recall that when the project winds down, we enjoy a return of net working capital.

Interest Expense

- Later chapters will deal with the impact that the amount of debt that a firm has in its capital structure has on firm value.
- For now, it's enough to assume that the firm's level of debt (hence interest expense) is independent of the project at hand.

The Baldwin Company: An Example

- Costs of test marketing (already spent): $250,000.
- Current market value of proposed factory site (which we own): $150,000.
- Cost of bowling ball machine: $100,000 (depreciated according to ACRS 5-year life).
- Increase in net working capital: $10,000.
- Production (in units) by year during 5-year life of the machine: 5,000, 8,000, 12,000, 10,000, 6,000.
- Price during first year is $20; price increases 2% per year thereafter.
- Production costs during first year are $10 per unit and increase 10% per year thereafter.

The Worksheet for Cash Flows of the Baldwin Company

($ thousands) (All cash flows occur at the *end* of the year.)

	Year 0	*Year 1*	*Year 2*	*Year 3*	*Year 4*	*Year 5*
Investments:						
(1) Bowling ball machine	−100.00					21.76*
(2) Accumulated depreciation		20.00	52.00	71.20	82.72	94.24
(3) Adjusted basis of machine after depreciation (end of year)	80.00	48.00	28.80	17.28	5.76	
(4) Opportunity cost (warehouse)	−150.00					150.00
(5) Net working capital (end of year)	10.00	10.00	16.32	24.97	21.22	0
(6) Change in net working capital	−10.00		−6.32	−8.65	3.75	21.22
(7) Total cash flow of investment [(1) + (4) + (6)]	−260.00	−6.32	−8.65	3.75	192.98	

* We assume that the ending market value of the capital investment at year 5 is $30,000. Capital gain is the difference between ending market value and adjusted basis of the machine. The adjusted basis is the original purchase price of the machine less depreciation. The capital gain is $24,240 (= $30,000 – $5,760). We will assume the incremental corporate tax for Baldwin on this project is 34 percent. Capital gains are now taxed at the ordinary income rate, so the capital gains tax due is $8,240 [0.34 × ($30,000 – $5,760)]. The after-tax salvage value is $30,000 – [0.34 × ($30,000 – $5,760)] = 21,760.

The Worksheet for Cash Flows of the Baldwin Company

($ thousands) (All cash flows occur at the *end* of the year.)

	Year 0	*Year 1*	*Year 2*	*Year 3*	*Year 4*	*Year 5*
Investments:						
(1) Bowling ball machine	–100.00					21.76*
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(6) Change in net working capital	–10.00		–6.32	–8.65	3.75	21.22
(7) Total cash flow of [(1) + (4) + (6)]	–260.00	–6.32	–8.65	3.75	192.98	investment

At the end of the project, the warehouse is unencumbered, so we can sell it if we want to.

The Worksheet for Cash Flows of the Baldwin Company (continued)

($ thousands) (All cash flows occur at the *end* of the year.)

	Year 0	*Year 1*	*Year 2*	*Year 3*	*Year 4*	*Year 5*
Income:						
(8) Sales Revenues		100.00	163.00	249.72	212.20	129.90

Recall that production (in units) by year during 5-year life of the machine is given by:

(5,000, 8,000, 12,000, 10,000, 6,000).

Price during first year is $20 and increases 2% per year thereafter.

Sales revenue in year 3 = $12{,}000 \times [\$20 \times (1.02)^2] = 12{,}000 \times \$20.81 =$ $249,720.

The Worksheet for Cash Flows of the Baldwin Company (continued)

($ thousands) (All cash flows occur at the *end* of the year.)

	Year 0	*Year 1*	*Year 2*	*Year 3*	*Year 4*	*Year 5*
Income:						
(8) Sales Revenues		100.00	163.00	249.72	212.20	129.90
(9) Operating costs		50.00	88.00	145.20	133.10	87.84

Again, production (in units) by year during 5-year life of the machine is given by:

(5,000, 8,000, 12,000, 10,000, 6,000).

Production costs during first year (per unit) are $10 and (increase 10% per year thereafter).

Production costs in year 2 = 8,000×[$10×(1.10)^1] = $88,000

The Worksheet for Cash Flows of the Baldwin Company (continued)

($ thousands) (All cash flows occur at the *end* of the year.)

	Year 0	*Year 1*	*Year 2*	*Year 3*	*Year 4*	*Year 5*
Income:						
(8) Sales Revenues		100.00	163.00	249.72	212.20	129.90
(9) Operating costs		50.00	88.00	145.20	133.10	87.84
(10) Depreciation		20.00	32.00	19.20	11.52	11.52

Depreciation is calculated using the Accelerated Cost Recovery System (shown at right)

Our cost basis is $100,000

Depreciation charge in year 4

= $100,000×(.1152) = $11,520.

Year	ACRS %
1	20.00%
2	32.00%
3	19.20%
4	11.52%
5	11.52%
6	5.76%
Total	100.00%

The Worksheet for Cash Flows of the Baldwin Company (continued)

($ thousands) (All cash flows occur at the *end* of the year.)

	Year 0	*Year 1*	*Year 2*	*Year 3*	*Year 4*	*Year 5*
Income:						
(8) Sales Revenues 129.90		100.00	163.00	249.72	212.20	
(9) Operating costs 133.10 87.84			50.00	88.00	145.20	
(10) Depreciation 11.52 11.52			20.00	32.00	19.20	
(11) Income before taxes 30.54 [(8) – (9) - (10)]		30.00	43.20	85.32	67.58	
(12) Tax at 34 percent 22.98 10.38			10.20	14.69	29.01	
(13) Net Income 20.16		19.80	28.51	56.31	44.60	

Incremental After Tax Cash Flows of the Baldwin Company

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
(1) Sales Revenues		$100.00	$163.00	$249.72	$212.20	$129.90
(2) Operating costs		-50.00	-88.00	-145.20	133.10	-87.84
(3) Taxes		-10.20	-14.69	-29.01	-22.98	-10.38
(4) OCF (1) – (2) – (3)		39.80	60.51	75.51	56.12	31.68
(5) Total CF of Investment	–260.		–6.32	–8.65	3.75	192.98
(6) IATCF [(4) + (5)]	–260.	39.80	54.19	66.86	59.87	224.66

$$NPV = -\$260 + \frac{\$39.80}{(1.10)} + \frac{\$54.19}{(1.10)^2} + \frac{\$66.86}{(1.10)^3} + \frac{\$59.87}{(1.10)^4} + \frac{\$224.66}{(1.10)^5}$$

$$NPV = \$51{,}588.05$$

Inflation and Capital Budgeting

- Inflation is an important fact of economic life and must be considered in capital budgeting.
- Consider the relationship between interest rates and inflation, often referred to as the Fisher relationship:

$$(1 + \text{Nominal Rate}) = (1 + \text{Real Rate}) \times (1 + \text{Inflation Rate})$$

- For low rates of inflation, this is often approximated as

$$\text{Real Rate} \cong \text{Nominal Rate} - \text{Inflation Rate}$$

- While the nominal rate in the U.S. has fluctuated with inflation, most of the time the real rate has exhibited far less variance than the nominal rate.

Example of Capital Budgeting under Inflation

- Sony International has an investment opportunity to produce a new stereo color TV.
- The required investment on January 1 of this year is $32 million. The firm will depreciate the investment to zero using the straight-line method. The firm is in the 34% tax bracket.
- The price of the product on January 1 will be $400 per unit. The price will stay constant in real terms.
- Labor costs will be $15 per hour on January 1. The will increase at 2% per year in real terms.
- Energy costs will be $5 per TV; they will increase 3% per year in real terms.

Example of Capital Budgeting under Inflation

	Year 1	Year 2	Year 3	Year 4
Physical Production (units)	100,000	200,000	200,000	150,000
Labor Input (hours)	2,000,000	2,000,000	2,000,000	2,000,000
Energy input, physical units	200,000	200,000	200,000	200,000

The riskless nominal discount rate is 4%.

The real discount rate for costs and revenues is 8%. Calculate the NPV.

Example of Capital Budgeting under Inflation

The depreciation tax shield is a risk-free nominal cash flow, and is therefore discounted at the nominal riskless rate.

Cost of investment today = $32,000,000

Project life = 4 years

Annual depreciation expense:

$$\$8{,}000{,}000 = \frac{\$32{,}000{,}000}{4 \text{ years}}$$

Depreciation tax shield = $8,000,000 × .34 = $2,720,000

CF0	0		
CF1	2,720,000	I	4
F1	4	NPV	9,873,315

Year 1 After-tax Real Risky Cash Flows

- Risky Real Cash Flows
  - Price: \$400 per unit with zero real price increase
  - Labor: \$15 per hour with 2% real wage increase
  - Energy: \$5 per unit with 3% real energy cost increase
- Year 1 After-tax Real Risky Cash Flows:

After-tax revenues =

$$\$400 \times 100{,}000 \times (1 - .34) = \$26{,}400{,}000$$

After-tax labor costs =

$$\$15 \times 2{,}000{,}000 \times 1.02 \times (1 - .34) = \$20{,}196{,}000$$

After-tax energy costs =

$$\$5 \times 2{,}00{,}000 \times 1.03 \times (1 - .34) = \$679{,}800$$

After-tax net operating CF =

Year 2 After-tax Real Risky Cash Flows

- Risky Real Cash Flows
  - Price: \$400 per unit with zero real price increase
  - Labor: \$15 per hour with 2% real wage increase
  - Energy: \$5 per unit with 3% real energy cost increase
- Year 1 After-tax Real Risky Cash Flows:

After-tax revenues =

$$\$400 \times 100{,}000 \times (1 - .34) = \$26{,}400{,}000$$

After-tax labor costs =

$$\$15 \times 2{,}000{,}000 \times (1.02)^2 \times (1 - .34) = \$20{,}599{,}920$$

After-tax energy costs =

$$\$5 \times 2{,}00{,}000 \times (1.03)^2 \times (1 - .34) = \$700{,}194$$

Year 3 After-tax Real Risky Cash Flows

- Risky Real Cash Flows
  - Price: \$400 per unit with zero real price increase
  - Labor: \$15 per hour with 2% real wage increase
  - Energy: \$5 per unit with 3% real energy cost increase
- Year 1 After-tax Real Risky Cash Flows:

After-tax revenues =

$$\$400 \times 100{,}000 \times (1 - .34) = \$26{,}400{,}000$$

After-tax labor costs =

$$\$15 \times 2{,}000{,}000 \times (1.02)^3 \times (1 - .34) = \$21{,}011.92$$

After-tax energy costs =

$$\$5 \times 2{,}00{,}000 \times (1.03)^3 \times (1 - .34) = \$721{,}199.82$$

After-tax net operating CF =

Year 4 After-tax Real Risky Cash Flows

- Risky Real Cash Flows
  - Price: $400 per unit with zero real price increase
  - Labor: $15 per hour with 2% real wage increase
  - Energy: $5 per unit with 3% real energy cost increase
- Year 1 After-tax Real Risky Cash Flows:

After-tax revenues =

$$\$400 \times 100{,}000 \times (1 - .34) = \$26{,}400{,}000$$

After-tax labor costs =

$$\$15 \times 2{,}000{,}000 \times (1.02)^4 \times (1 - .34) = \$21{,}432.16$$

After-tax energy costs =

$$\$5 \times 2{,}00{,}000 \times (1.03)^4 \times (1 - .34) = \$742{,}835.82$$

After-tax net operating CF =

Example of Capital Budgeting under Inflation

The project *NPV* can now be computed as the sum of the *PV* of the cost, the *PV* of the risky cash flows discounted at the risky rate and the *PV* of the risk-free cash flows discounted at the risk-free discount rate.

$NPV = –\$32,000,000 + \$69,590,868 + \$9,873,315 = \$47,464,183$

The Boeing 777: A Real-World Example

- In late 1990, the Boeing Company announced its intention to build the Boeing 777, a commercial airplane that could carry up to 390 passengers and fly 7,600 miles.
- Analysts expected the up-front investment and R&D costs would be as much as $8 billion.
- Delivery of the planes was expected to begin in 1995 and continue for at least 35 years.

Table 7.5 Incremental Cash Flows: Boeing 777

Year	Units	Sales Revenue	Operating Costs	Dep.	Taxes	ΔNWC	Capital Spending	Investment	Net Cash Flow
1991			$865.00	$40.00	$(307.70)		$400.00	$400.00	$(957.30)
1992			1,340.00	96.00	(488.24)		600.00	600.00	(1,451.76)
1993			1,240.00	116.40	(461.18)		300.00	300.00	(1,078.82)
1994			840.00	124.76	(328.02)		200.00	200.00	(711.98)
1995	14	$1,847.55	1,976.69	112.28	(82.08)	181.06	1.85	182.91	(229.97)
1996	145	19,418.96	17,865.45	101.06	493.83	1,722.00	19.42	1,741.42	681.74
1997	140	19,244.23	16,550.04	90.95	885.10	(17.12)	19.42	2.30	1,806.79

Net Cash Flow can be determined in three steps:

Taxes ($19,244.23 – $16,550.04 – $90.95)×0.34 = $885.10

Investment –$17.12 + $19.42 = $2.30

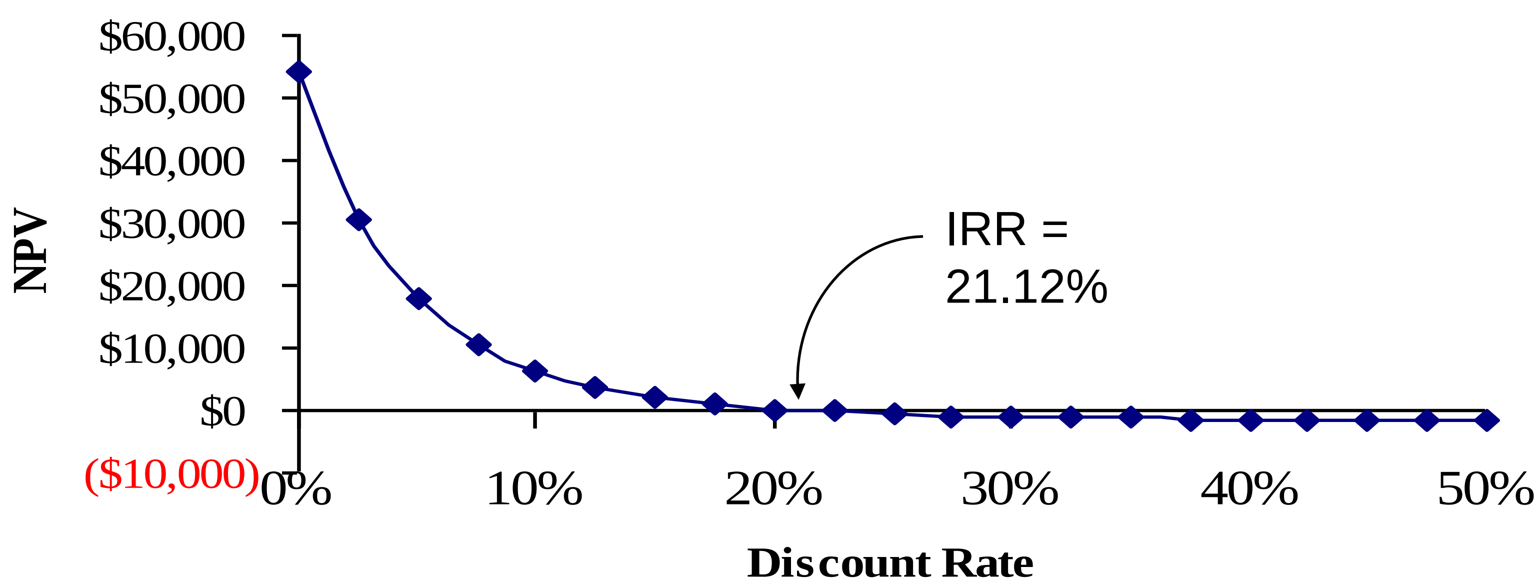
NCF $19,244.23 – $16,550.04 – $885.10 – $2.30 = $1,806.79

Year	NCF	Year	NCF	Year	NCF
1991	$ (957.30)	2002	$ 1,717.26	2013	$ 2,213.18
1992	$ (1,451.76)	2003	$ 1,590.01	2014	$ 2,104.73
1993	$ (1,078.82)	2004	$ 1,798.97	2015	$ 2,285.77
1994	$ (711.98)	2005	$ 616.79	2016	$ 2,353.81
1995	$ (229.97)	2006	$ 1,484.73	2017	$ 2,423.89
1996	$ 681.74	2007	$ 2,173.59	2018	$ 2,496.05
1997	$ 1,806.79	2008	$ 1,641.97	2019	$ 2,568.60
1998	$ 1,914.06	2009	$ 677.92	2020	$ 2,641.01
1999	$ 1,676.05	2010	$ 1,886.96	2021	$ 2,717.53
2000	$ 1,640.25	2011	$ 2,331.33	2022	$ 2,798.77
2001	$ 1,716.80	2012	$ 2,576.47	2023	$ 2,882.44
				2024	$ 2,964.45

The Boeing 777: A Real-World Example

- Prior to 1990, Boeing had invested several hundred million dollars in research and development.
- Since these cash outflows were incurred prior to the decision to build the plane, they are *sunk costs*.
- The relevant costs were the at the time the decision was made were the forecasted Net Cash Flows

NPV Profile of the Boeing 777 Project



- This graph shows NPV as a function of the discount rate.
- Boeing should accept this project at discount rates less than 21 percent and reject the project at higher discount rates.

Boeing 777

- As it turned out, sales failed to meet expectations.
- In fairness to the financial analysts at Boeing, there is an important distinction between a good *decision* and a good *outcome*.

Investments of Unequal Lives: The Equivalent Annual Cost Method

- There are times when application of the NPV rule can lead to the wrong decision. Consider a factory which must have an air cleaner. The equipment is mandated by law, so there is no "doing without".
- There are two choices:
  - The "Cadillac cleaner" costs $4,000 today, has annual operating costs of $100 and lasts for 10 years.
  - The "Cheapskate cleaner" costs $1,000 today, has annual operating costs of $500 and lasts for 5 years.
- Which one should we choose?

Investments of Unequal Lives: The Equivalent Annual Cost Method

- This overlooks the fact that the Cadillac cleaner lasts twice as long.
- When we incorporate *that*, the Cadillac cleaner is actually cheaper.

Investments of Unequal Lives: The Equivalent Annual Cost Method

The Cadillac cleaner time line of cash flows:

-$4,000 –100 -100 -100 -100 -100 -100 -100 -100 -100 -100

0 1 2 3 4 5 6 7 8 9 10

The Cheapskate cleaner time line of cash flows *over ten years:*

-$1,000 –500 -500 -500 -500 -1,500 -500 -500 -500 -500 -500

0 1 2 3 4 5 6 7 8 9 10

Investments of Unequal Lives

- Replacement Chain
  - Repeat the projects forever, find the *PV* of that perpetuity.
  - Assumption: Both projects can and will be repeated.
- Matching Cycle
  - Repeat projects until they begin and end at the same time—like we just did with the air cleaners.
  - Compute *NPV* for the "repeated projects".
- The Equivalent Annual Cost Method

Investments of Unequal Lives: EAC

The Equivalent Annual Cost Method

- Applicable to a much more robust set of circumstances than replacement chain or matching cycle.
- The Equivalent Annual Cost is the value of the level payment annuity that has the same *PV* as our original set of cash flows.
- $NPV = EAC \times A_r^T$
- Where A_r^T is the present value of $1 per period for T periods when the discount rate is r.
  - For example, the EAC for the Cadillac air cleaner is $750.98

Example of Replacement Projects

Consider a Belgian Dentist's office; he needs an autoclave to sterilize his instruments. He has an old one that is in use, but the maintenance costs are rising and so is considering replacing this indispensable piece of equipment.

<u>New Autoclave</u>

- Cost = $3,000 today,
- Maintenance cost = $20 per year
- Resale value after 6 years = $1,200
- *NPV* of new autoclave (at *r* = 10%) is $2,409.74

$$-\$2{,}409.74 = -\$3{,}000 - \sum_{t=1}^{6} \frac{\$20}{(1.10)^t} + \frac{\$1{,}200}{(1.10)^6}$$

EAC of new autoclave = -$553.29

$$-\$2{,}409.74 = \sum_{t=1}^{6} \frac{-\$553.29}{(1.10)^t}$$

Example of Replacement Projects

- Existing Autoclave

Year	0	1	2	3	4	5
Maintenance	0	200	275	325	450	500
Resale	900	850	775	700	600	500
Total Annual Cost		*340*	*435*	*478*	*620*	*660*

Total Cost for year 1 = (900 × 1.10 – 850) + 200 = $340
Total Cost for year 2 = (850 × 1.10 – 775) + 275 = $435
Total Cost for year 3 = (775 × 1.10 – 700) + 325 = $478
Total Cost for year 4 = (700 × 1.10 – 600) + 450 = $620
Total Cost for year 5 = (600 × 1.10 – 500) + 500 = $660

Note that the total cost of keeping an autoclave for the first year includes the $200 maintenance cost as well as the opportunity cost of the foregone future value of the $900 we didn't get from selling it in year 0 less the $850 we have if we still own it at year 1.

Example of Replacement Projects

- New Autoclave
  - *EAC* of new autoclave = -$553.29
- Existing Autoclave

Year	**0**	**1**	**2**	**3**	**4**	**5**
Maintenance 0	200	275	325	450	500	
Resale	900	850	775	700	600	500
Total Annual Cost		*340*	*435*	*478*	*620*	*660*

•We should keep the old autoclave until it's cheaper to buy a new one.

•Replace the autoclave after year 3: at that point the new one will cost $553.29 for the next year's autoclaving and the old one will cost $620 for one more year.

Dorm Beds Example

- Consider a project to supply the University of Missouri with 10,000 dormitory beds annually for each of the next 3 years.
- Your firm has half of the woodworking equipment to get the project started; it was bought years ago for $200,000: is fully depreciated and has a market value of $60,000. The remaining $60,000 worth of equipment will have to be purchased.
- The engineering department estimates you will need an initial net working capital investment of $10,000.

Dorm Beds Example

- The project will last for 3 years. Annual fixed costs will be $25,000 and variable costs should be $90 per bed.
- The initial fixed investment will be depreciated straight line to zero over 3 years. It also estimates a (pre-tax) salvage value of $10,000 (for all of the equipment).
- The marketing department estimates that the selling price will be $200 per bed.
- You require an 8% return and face a marginal tax rate of 34%.

Dorm Beds Example OCF_0

What is the OCF in year zero for this project?

Cost of New Equipment	\$60,000
Net Working Capital Investment	\$10,000
Opportunity Cost of Old Equipment	\$39,600 =

\$60,000 × (1-.34)

\$109,600

Dorm Beds Example $OCF_{1,2}$

What is the *OCF* in years 1 and 2 for this project?

Revenue	10,000× \$200 =	\$2,000,000
Variable cost	10,000 × \$90 =	\$900,000
Fixed cost		\$25,000
Depreciation	\$60,000 ÷ 3 =	\$20,000
EBIT		\$1,055,000
Tax (34%)		\$358,700
Net Income		\$696,300

OCF =\$696,300 + \$20,000 \$716,300

OCF = \$2,000,000 – 925,000 – 358,700 = \$716,300

(\$2,000,000 – 925,000)×(1 – .34)+20,000×.34 = \$716,300

Dorm Beds Example OCF_3

Revenue	$10{,}000 \times \$200$ =	$2,000,000
Variable cost	$10{,}000 \times \$90$ =	$900,000
Fixed cost		$25,000
Depreciation	$\$60{,}000 \div 3$ =	$20,000
EBIT	$10{,}000 \times \$200$ =	<u>$1,055,000</u>
Tax		<u>$358,700</u>
	NI	$696,300
	$OCF = NI + D$	$716,300

We get our $10,000 NWC back and sell the equipment.

The after-tax salvage value is $6,600 = $10,000 × (1-.34)

Thus, OCF_3 = $716,300 + $10,000 + $6,600 = $732,900