

Chapter 11 Inflation and Its Impact on Project Cash Flows

Measure of Inflation

11.1

$$1.1(1+f)^9 = 2.62$$

$$f = 10.123\%$$

$$100(1+0.10123)^9 = 238.18$$

11.2

(a) Average price index:

$$150.6(1+f)^4 = 165.8$$

$$f = 2.433\%$$

(b)

$$165.8(1+0.02433)^5 = 186.98$$

11.3

$$100(1+0.05)(1+0.08) = 113.40$$

$$100(F/P, f, 2) = 113.40$$

$$f = 6.4894\%$$

11.4

Given : $f = 7\%$

$$1(1+0.07)^{-n} = 0.5$$

$$1.07^{-n} = 0.5$$

$$(-n)\log 1.07 = \log 0.5$$

$$n = -\log 0.5 / \log 1.07$$

$$= 10.24 \text{ years}$$

Comments: If you use the Rule of 72, you may find $\frac{72}{7} = 10.29$ years which is very close to the actual value.

Actual versus Constant Dollars

11.5 Given: $i = 12\%$, $\bar{f} = 5\%$, 10 annuity payments in actual dollars

$$\begin{aligned} P &= \$4,500(P/A, 12\%, 10) \\ &= \$25,426 \end{aligned}$$

Comments: Since the annuity payments are made in actual dollars, we use the market interest rate to find its equivalent lump sum amount in today's dollars.

11.6 Given: $i = 15\%$, $\bar{f} = 8\%$, maintenance costs are given in constant dollars, $i' = 6.48\%$

$$\begin{aligned} P &= \$25,000(P/F, 6.48\%, 1) + \$30,000(P/F, 6.28\%, 2) \\ &\quad + \$32,000(P/F, 6.48\%, 3) + \$35,000(P/F, 6.48\%, 4) \\ &\quad + \$40,000(P/F, 6.48\%, 5) \\ &= \$132,894 \\ A &= \$132,894(A/P, 15\%, 5) \\ &= \$39,644 \end{aligned}$$

11.7 Given: $i = 16\%$, $\bar{f} = 4\%$

n	Actual dollars	Constant Dollars
0	\$1,500	$\$1,500(P/F, 4\%, 0) = \$1,500$
4	2,500	$2,500(P/F, 4\%, 4) = 2,137$
5	3,500	$3,500(P/F, 4\%, 5) = 2,877$
7	4,500	$4,500(P/F, 4\%, 7) = 3,420$

11.8 Given: $P = \$25,000$, $i = 1\%$ per month, $\bar{f} = 0.5\%$ per month

- The 20th payment in actual dollars:

$$A_{20} = \$25,000(A/P, 1\%, 48) = \$658.35$$

- The 20th payment in constant dollars:

$$A'_{20} = \$658.35(P/F, 0.5\%, 20) = \$595.85$$

11.9

(a) Constant-dollar analysis: we need to find the inflation-free interest rate.

$$i' = \frac{i - \bar{f}}{1 + \bar{f}} = 5.607\%$$

Then, find the equivalent present worth of this geometric series at i' .

$$\begin{aligned} P &= \$7,000(P/A, 8\%, 5.607\%, 4) \\ &= \$27,428 \end{aligned}$$

(a) Actual-dollar analysis

Period	Net Cash Flow in Constant \$	Conversion factor	Net Cash Flow in Actual \$
1	\$7,000	$(1 + 0.07)^1$	\$7,490
2	7,560	$(1 + 0.07)^2$	8,655
3	8,165	$(1 + 0.07)^3$	10,002
4	8,818	$(1 + 0.07)^4$	11,559

$$\begin{aligned} P &= \$7,490(P/F, 13\%, 1) + \$8,655(P/F, 13\%, 2) \\ &\quad + \$10,002(P/F, 13\%, 3) + \$11,559(P/F, 13\%, 4) \\ &= \$27,428 \end{aligned}$$

Comments: As an alternative way of finding the equivalent cash flows in actual dollars, we may use the compound growth rate (geometric growth and inflation):

$$\begin{aligned} g &= (1 + 0.08)(1 + 0.07) - 1 \\ &= 15.56\% \\ P &= \$7,000(1.07)(P/A, 15.56\%, 13\%, 4) \\ &= \$27,428 \end{aligned}$$

11.10 Given: $i = 9\%$, $\bar{f} = 3.8\%$, we find the inflation-free interest rate as follows:

$$i' = (0.09 - 0.038) / (1 + 0.038) = 5.01\%$$

First compute the equivalent present worth of the constant dollar series at i' :

$$\begin{aligned} P &= \$1,000(P/A, 5.01\%, 4) \\ &= \$3,545.13 \end{aligned}$$

Then, we compute the equivalent annual payment in actual dollars using i :

$$\begin{aligned} A &= \$3,545.13(A/P, 9\%, 4) \\ &= \$1,094.27 \end{aligned}$$

11.11 Given: $i = 12\%$, $\bar{f} = 6\%$, bond interest rate = 9% compounded semiannually, face value = \$1,000

- The 16th interest payment in actual dollars:

$$I_{16} = \$1,000(0.045) = \$45$$

- The 16th interest payment (8th year) in constant dollars:

$$I'_{16} = \$45(P/F, 6\%, 8) = \$28.23$$

Equivalence Calculation under Inflation

11.12 Given: $i = 1\%$ per month, $\bar{f} = 0.5\%$ per month, $P = \$20,000$, $N = 60$ months

$$\begin{aligned} i' &= \frac{0.01 - 0.005}{1 + 0.005} \\ &= 0.4975\% \\ A' &= \$20,000(A/P, 0.4975\%, 60) \\ &= \$386.38 \end{aligned}$$

11.13 Given: $i' = 6\%$, $\bar{f} = 5\%$, $N = 5$ years, $A = \$1.5$ million in constant dollars

- Market interest rate:

$$i = 0.06 + 0.05 + (0.06)(0.05) = 11.3\%$$

- Actual dollar analysis:

Period	Net Cash Flow in Constant \$	Net Cash Flow in Actual \$	Equivalent Present Worth
1	\$1,500,000	\$1,575,000	\$1,415,094
2	1,500,000	1,653,750	1,334,995

3	1,500,000	1,736,438	1,259,429
4	1,500,000	1,823,259	1,188,140
5	1,500,000	1,914,422	1,120,887

$$\begin{aligned}
 P &= \$1,575,000(P/F, 11.3\%, 1) \\
 &\quad + \cdots + \$1,914,422(P/F, 11.3\%, 5) \\
 &= \$6,318,545
 \end{aligned}$$

11.14 Given: $i = 0.75\%$ per month, $\bar{f} = 0.5\%$ per month, $P = \$5,000$, $N = 24$ months, down payment = \$1,000

(a) Inflation-free interest rate:

$$i' = \frac{0.0075 - 0.005}{1 + 0.005} = 0.2488\% \text{ per month}$$

(b) Equal monthly payment in constant dollars:

$$\begin{aligned}
 A' &= \$5,000(A/P, 0.2488\%, 24) \\
 &= \$214.87
 \end{aligned}$$

11.15 Given: $i = 6\%$ compounded monthly, $\bar{f} = 5\%$ compounded annually, number of months to deposit = 240 months, number of annual withdrawals = 10, first withdrawal = 6 months after retirement

- Effective inflation rate per semiannual: Since the first withdrawal is made after 6 months from retirement, it is necessary to calculate the effective inflation rate per semiannual.

$$\bar{f} = \left(\frac{1.05}{1}\right)^{1/2} - 1 = 2.4695\% \text{ per semiannual}$$

- Annual withdrawals in actual dollars: On semiannual basis, the first withdrawal will be made after 41 semiannual periods. Then, we can calculate the equivalent amount of this first withdrawal in actual dollars as follows:

$$A_{41} = \$40,000(F/P, 2.4695\%, 41) = \$108,753$$

The second withdrawal will be made after 43 semiannual periods. The equivalent amount of this second withdrawal in actual dollars is

$$A_{43} = \$40,000(F/P, 2.4695\%, 43) = \$114,190$$

The remaining withdrawals in actual dollars are

Contemporary Engineering Economics, Fourth Edition, By Chan S. Park. ISBN 0-13-187628-7.

© 2007 Pearson Education, Inc., Upper Saddle River, NJ. All rights reserved. This material is protected by Copyright and written permission should be obtained from the publisher prior to any prohibited reproduction, storage in a retrieval system, or transmission in any form or by means, electronic, mechanical, photocopying, recording, or likewise. For information regarding permission(s), write to: Rights and Permissions Department, Pearson Education, Inc., Upper Saddle River, NJ 07458.

$$A_{45} = \$40,000(F / P, 2.4695\%, 45) = \$119,990$$

$$A_{47} = \$40,000(F / P, 2.4695\%, 47) = \$125,895$$

$$A_{49} = \$40,000(F / P, 2.4695\%, 49) = \$132,189$$

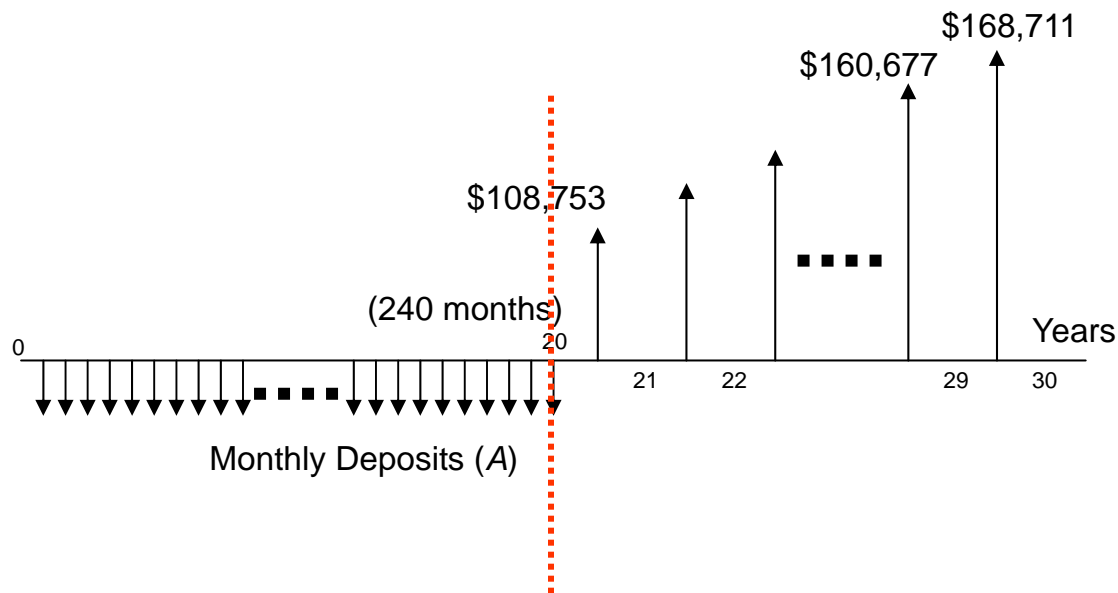
$$A_{51} = \$40,000(F / P, 2.4695\%, 51) = \$138,799$$

$$A_{53} = \$40,000(F / P, 2.4695\%, 53) = \$145,739$$

$$A_{55} = \$40,000(F / P, 2.4695\%, 55) = \$153,026$$

$$A_{57} = \$40,000(F / P, 2.4695\%, 57) = \$160,677$$

$$A_{59} = \$40,000(F / P, 2.4695\%, 59) = \$168,711$$



- Equivalence calculation: To find the required equal monthly deposit amount (A), we establish the following equivalence relationship:

$$\begin{aligned}
 A(F / A, 0.5\%, 240)(F / P, 0.5\%, 6) &= \$180,753 \\
 &+ \$114,190(P / F, 6.168\%, 1) \\
 &+ \$119,900(P / F, 6.168\%, 2) \\
 &\vdots \\
 &+ \$168,711(P / F, 6.168\%, 9) \\
 &= \$1,035,236 \\
 A &= \$1,035,236 / 476.08 \\
 &= \boxed{\$2,174.52} \text{ per month}
 \end{aligned}$$

11.16 Given : $i = 2\%$ per quarter, $\bar{f} = 6\%$ per year

(a)

- Actual dollar analysis:

$$\begin{aligned} A(F / A, 2\%, 160) &= \$600,000(F / P, 6\%, 40) \\ &= \$6,171,431 \\ A &= \$5,420.69 \end{aligned}$$

- Constant dollar analysis: Given: $i = 2\%$ per quarter and $\bar{f} = 6\%$ per year, we need to find the inflation free interest rate (i') per quarter. In doing so, we first compute the equivalent inflation rate per quarter.

$$\begin{aligned} (1 + \bar{f})^4 - 1 &= 6\% \\ \bar{f} &= 1.4674\% \text{ per quarter} \\ i' &= \frac{i - \bar{f}}{1 + \bar{f}} = \frac{0.02 - 0.014674}{1 + 0.014674} = 0.525\% \end{aligned}$$

Now, we can establish the following equivalence relationship:

$$\begin{aligned} A'(F / A, 0.525\%, 160) &= \$600,000 \\ A' &= \$2,402.41 \end{aligned}$$

(b)

- Effective annual interest rate:

$$i_a = (1 + 0.08 / 4)^4 - 1 = 8.243\%$$

- Equivalent value of \$600,000 in actual dollars at the end of 63rd birthday:

$$\$600,000(F / P, 6\%, 40) = \$6,171,431$$

- Conversion of a gradient series to an equivalent uniform series:

$$\begin{aligned} A &= G(A / G, 8.243\%, 40) \\ &= \$1,000(10.3746) \\ &= \$10,374 \end{aligned}$$

- Amount of the first deposit (A_1):

$$\begin{aligned} (A_1 + \$10,374)(F / A, 8.243\%, 40) &= \$6,171,431 \\ 276.21A_1 &= 3,306,026 \\ A_1 &= \$11,969 \end{aligned}$$

11.17 Given: $i = 8\%$ per year, $\bar{f} = 6\%$ per year

(a) Freshman-year expense in actual dollars:

$$\$40,000(F/P, 6\%, 10) = \$71,634$$

(b) Equivalent single-sum amount at $n = 0$

$$i' = \frac{i - \bar{f}}{1 + \bar{f}} = \frac{0.08 - 0.06}{1 + .06} \\ = 0.01887$$

$$P = [\$40,000(P/A, 1.887\%, 3) + \$40,000](P/F, 1.887\%, 10) \\ = \$129,077$$

(c) Required annual deposit in actual dollars:

$$A = \$129,077(A/P, 8\%, 10) = \$19,236$$

Effects of Inflation on Project Cash Flows

11.18 Consider the following project's after-tax cash flow and the expected annual general inflation rate during the project period:

End of year	Cash flow in actual dollars	Expected general inflation rate
0	-\$45,000	
1	26,000	6.5%
2	26,000	7.7%
3	26,000	8.1%

(a) The average annual general inflation rate:

$$(1 + 0.065)(1 + 0.077)(1 + 0.081) = 1.2399 \\ (1 + \bar{f})^3 = 1.2399 \\ \bar{f} = 7.4312\%$$

(b) Constant dollars:

n	Actual dollars	Constant dollars
-----	----------------	------------------

0	-\$45,000	-\$45,000
1	26,000	$26,000(0.9390) = 24,414$
2	26,000	$26,000(0.8718) = 22,667$
3	26,000	$26,000(0.8065) = 20,969$

Conversion factors:

$$(P/F, 6.5\%, 1) = 0.9390$$

$$(P/F, 7.7\%, 1)(P/F, 6.5\%, 1) = 0.8718$$

$$(P/F, 8.1\%, 1)(P/F, 7.7\%, 1)(P/F, 6.5\%, 1) = 0.8065$$

(c) The project is still profitable under inflationary economy.

$$\begin{aligned}
 P &= -\$45,000 + \$24,414(P/F, 5\%, 1) \\
 &\quad + \$22,667(P/F, 5\%, 2) + \$20,969(P/F, 5\%, 3) \\
 &= \$16,925 > 0
 \end{aligned}$$

11.19 (a) and (b)

	0	1	2
Income Statement			
Revenue		\$114,000	\$114,000
Expenses:			
O&M		\$ 56,490	\$ 59,315
Depreciation		\$ 11,000	\$ 8,800
Interest		\$ 5,000	\$ 2,619
Taxable Income		\$ 41,510	\$ 43,266
Income Taxes		\$ 16,604	\$ 17,306
Net Income		\$ 24,906	\$ 25,960
Cash Flow Statement			
Cash from operation			
Net Income		\$ 24,906	\$ 25,960
Depreciation		\$ 11,000	\$ 8,800
Investment / Salvage	\$ (55,000)		\$ 29,768
Working capital	\$ (12,000)	\$ (600)	\$ 12,600
Gains Tax			\$ 2,173
Loan repayment	\$ 50,000	\$ (23,810)	\$ (26,190)
Net Cash Flow (actual)	(\$17,000)	\$11,496	\$53,110
Net Cash Flow (constant)	(\$17,000)	\$10,949	\$48,172
		PW (18%) = \$ 30,885	
		IRR (%) = 103.59%	

11.20 (a) and (b)

(a) Project Cash Flows with Inflation

	0	1	2	3	4	5	6
Income Statement							
Revenue		\$152,250	\$159,863	\$167,856	\$176,248	\$185,061	\$194,314
Expenses:							
O&M		\$ 86,100	\$ 90,405	\$ 94,925	\$ 99,672	\$ 104,655	\$ 109,888
Depreciation		\$ 24,000	\$ 38,400	\$ 23,040	\$ 13,824	\$ 13,824	\$ 6,912
Interest		\$ 10,800	\$ 10,800				
Taxable Income		\$31,350	\$20,258	\$49,891	\$62,752	\$66,582	\$77,514
Income Taxes (40%)		\$12,540	\$8,103	\$19,956	\$25,101	\$26,633	\$31,006
Net Income		\$18,810	\$12,155	\$29,935	\$37,651	\$39,949	\$46,508
Cash Flow Statement							
Cash from operation							
Net Income		\$18,810	\$12,155	\$29,935	\$37,651	\$39,949	\$46,508
Depreciation		\$24,000	\$38,400	\$23,040	\$13,824	\$13,824	\$6,912
Cash from investing activities:							
Investment / Salvage	\$ (120,000)						\$ 20,101
Gains Tax							\$ (8,041)
Working Capital							
Cash from financing activities:							
Loan repayment	\$ 120,000		\$ (120,000)				
Net Cash Flow (actual \$)	\$0	\$42,810	(\$69,445)	\$52,975	\$51,475	\$53,773	\$65,481
PW (18%) =		\$92,959					

(b) Income Statement (without inflation)

	0	1	2	3	4	5	6
Income Statement							
Revenue		\$145,000	\$145,000	\$145,000	\$145,000	\$145,000	\$145,000
Expenses:							
O&M		82,000	82,000	82,000	82,000	82,000	82,000
Depreciation		24,000	38,400	23,040	13,824	13,824	6,912
Interest		10,800	10,800				
Taxable Income		\$28,200	\$13,800	\$39,960	\$49,176	\$49,176	\$56,088
Income Taxes		\$11,280	\$5,520	\$15,984	\$19,670	\$19,670	\$22,435
Net Income		\$16,920	\$8,280	\$23,976	\$29,506	\$29,506	\$33,653
Cash Flow Statement							
Cash from operation							
Net Income		\$16,920	\$8,280	\$23,976	\$29,506	\$29,506	\$33,653
Depreciation		\$24,000	\$38,400	\$23,040	\$13,824	\$13,824	\$6,912
Investment / Salvage	(120,000)						\$15,000
Gains Tax							(6,000)
Working Capital							
Loan repayment	120,000		(120,000)				
Net Cash Flow (constant \$)	\$0	\$40,920	(\$73,320)	\$47,016	\$43,330	\$43,330	\$49,565
PW (12.38%) =		\$87,429					

(c) Present value gain (or loss) due to inflation:

$$i' = \frac{0.18 - 0.05}{1 + 0.05} = 12.38\%$$

$$PW(12.38\%)_{\text{no inflation}} = \$87,429$$

$$PW(18\%)_{\text{with inflation}} = \$92,958$$

$$\text{present value gain} = \$92,958 - \$87,429$$

$$= \$5,529$$

(d) Present value gain due to borrowing:

	Net Financing Cost		Net
n	Principal	Interest (A/T)	Loan Flow
0	+\$120,000		+\$120,000
1		-(1-0.4)(10,800)	-\$6,480
2	-\$120,000	-(1-0.4)(10,800)	-\$126,480

$$PW(18\%)_{\text{Loan}} = +\$120,000 - \$6,480(P/F, 18\%, 1)$$

$$- \$126,480(P/F, 18\%, 2)$$

$$= \boxed{\$23,673}$$

Comments: The present value gain is possible here due to the fact that the firm was able to finance the project at a lower interest rate than its MARR. In practice, the lenders would raise their lending rates under inflationary economy, so that it is not likely to realize a significant gain.

11.21: (a) and (b) Net gains due to financing - \$906

(a) Project Cash Flows with Inflation

	0	1	2	3	4	5
Income Statement						
Revenue		\$15,750	\$18,743	\$16,207	\$17,017	\$17,868
Expenses:						
Depreciation		\$4,000	\$6,400	\$3,840	\$2,304	\$1,152
Interest		\$2,000	\$1,396	\$731		
Taxable Income		\$9,750	\$10,947	\$11,636	\$14,713	\$16,716
Income Taxes		\$3,900	\$4,379	\$4,654	\$5,885	\$6,686
Net Income		\$5,850	\$6,568	\$6,982	\$8,828	\$10,030
Cash Flow Statement						
Cash from operation						
Net Income		\$5,850	\$6,568	\$6,982	\$8,828	\$10,030
Depreciation		\$4,000	\$6,400	\$3,840	\$2,304	\$1,152
Investment / Salvage	(\$20,000)					\$2,553
Gains Tax						(\$100)
Loan repayment	\$20,000	(\$6,042)	(\$6,647)	(\$7,311)		
Net Cash Flow (actual)	\$0	\$3,808	\$6,321	\$3,511	\$11,132	\$13,635

PW (20%) = \$20,443

(b) Income Statement (without inflation)

	0	1	2	3	4	5
Income Statement						
Revenue		\$15,000	\$17,000	\$14,000	\$14,000	\$14,000
Expenses:						
Depreciation		4,000	6,400	3,840	2,304	1,152
Interest		2,000	1,396	731		
Taxable Income		\$9,000	\$9,204	\$9,429	\$11,696	\$12,848
Income Taxes		\$3,600	\$3,682	\$3,772	\$4,678	\$5,139
Net Income		\$5,400	\$5,523	\$5,657	\$7,018	\$7,709
Cash Flow Statement						
Cash from operation						
Net Income		\$5,400	\$5,523	\$5,657	\$7,018	\$7,709
Depreciation		\$4,000	\$6,400	\$3,840	\$2,304	\$1,152
Investment / Salvage	(20,000)					\$2,000
Gains Tax						122
Loan repayment	20,000	(6,042)	(6,647)	(7,311)		
Net Cash Flow (actual)	\$0	\$3,358	\$5,276	\$2,186	\$9,322	\$10,982

PW (14.29%) = \$19,537

11.22 (a), (b), and (c)

		0	1	2	3
Income Statement	inflation				
Revenue (Savings)	5%		\$84,000	\$88,200	\$92,610
Expenses:					
O&M					
Depreciation			\$ 21,435	\$ 36,735	\$ 13,118
Interest					
Taxable Income			\$62,565	\$51,465	\$79,493
Income Taxes (40%)			\$25,026	\$20,586	\$31,797
Net Income			\$37,539	\$30,879	\$47,696
Cash Flow Statement					
Cash from operation					
Net Income			\$37,539	\$30,879	\$47,696
Depreciation			\$21,435	\$36,735	\$13,118
Cash from investing activities:					
Investment / Salvage		\$ (150,000)			\$ 80,000
Gains Tax					\$ (515)
Working capital	8%	\$ (10,000)	\$ (800)	\$ (864)	\$ 11,664
Cash from financing activities:					
Loan repayment					
Net Cash Flow (actual)		(\$160,000)	\$58,174	\$66,750	\$151,962
Net Cash Flow (constant)		(160,000)	54,881	59,407	127,590
		PW (20%) =	\$ 22,773		
		PW (13.21%) =	\$ 22,765		
		Yes, the project is acceptable.			

Rate of Return Analysis under Inflation

11.23

(a) Project's IRR with no inflation									
	0	1	2	3	4	5	6	7	8
Income Statement									
Revenue		\$20,000	\$20,000	\$20,000	\$20,000	\$20,000	\$20,000	\$20,000	\$20,000
Expenses:									
O&M		\$ 8,000	\$ 8,000	\$ 8,000	\$ 8,000	\$ 8,000	\$ 8,000	\$ 8,000	\$ 8,000
Depreciation		\$ 7,145	\$ 12,245	\$ 8,745	\$ 6,245	\$ 4,465	\$ 4,460	\$ 4,465	\$ 2,230
Taxable Income		\$4,855	(\$245)	\$3,255	\$5,755	\$7,535	\$7,540	\$7,535	\$9,770
Income Taxes		1,699	(86)	1,139	2,014	2,637	2,639	2,637	3,420
Net Income		\$3,156	(\$159)	\$2,116	\$3,741	\$4,898	\$4,901	\$4,898	\$6,351
Cash Flow Statement									
Cash from operation									
Net Income		\$ 3,156	\$ (159)	\$ 2,116	\$ 3,741	\$ 4,898	\$ 4,901	\$ 4,898	\$ 6,351
Depreciation		\$ 7,145	\$ 12,245	\$ 8,745	\$ 6,245	\$ 4,465	\$ 4,460	\$ 4,465	\$ 2,230
Investment / Salvage	\$ (50,000)								\$ 5,000
Gains Tax									\$ (1,750)
Working capital	\$ (10,000)								\$ 10,000
Net Cash Flow	(\$60,000)	\$10,301	\$12,086	\$10,861	\$9,986	\$9,363	\$9,361	\$9,363	\$21,831
	PW (12.38%)	(4,763)		IRR (%)	10.18%				

(b) Project's IRR with inflation

Project Cash Flows with Inflation

	0	1	2	3	4	5	6	7	8
Income Statement									
Revenue		\$21,600	\$23,328	\$25,194	\$27,210	\$29,387	\$31,737	\$34,276	\$37,019
Expenses:									
O&M		\$ 8,480	\$ 8,989	\$ 9,528	\$ 10,100	\$ 10,706	\$ 11,348	\$ 12,029	\$ 12,751
Depreciation		\$ 7,145	\$ 12,245	\$ 8,745	\$ 6,245	\$ 4,465	\$ 4,460	\$ 4,465	\$ 2,230
Taxable Income		\$5,975	\$2,094	\$6,921	\$10,865	\$14,216	\$15,929	\$17,782	\$22,038
Income Taxes		2,091	733	2,422	3,803	4,976	5,575	6,224	7,713
Net Income		\$3,884	\$1,361	\$4,499	\$7,062	\$9,240	\$10,354	\$11,559	\$14,325
Cash Flow Statement									
Cash from operation									
Net Income		3,884	1,361	4,499	7,062	9,240	10,354	11,559	14,325
Depreciation		7,145	12,245	8,745	6,245	4,465	4,460	4,465	2,230
Investment / Salvage	\$ (50,000)								\$ 7,387
Gains Tax									\$ (2,585)
Working capital	\$ (10,000)	\$ (800)	\$ (864)	\$ (933)	\$ (1,008)	\$ (1,088)	\$ (1,175)	\$ (1,269)	\$ 17,138
Loan repayment									
Net Cash Flow (actual dollars)	(\$60,000)	\$10,229	\$12,742	\$12,311	\$12,299	\$12,617	\$13,639	\$14,754	\$38,495
Net Cash Flow (constant dollar)	(\$60,000)	\$9,741	\$11,558	\$10,635	\$10,119	\$9,885	\$10,178	\$10,485	\$26,054
PW (18%)		(2,904)		IRR' (%) =	11.11%				

11.24: Assumption – the rental expenses are fixed at \$9,600 per year

Income Statement	0	1	2	3	4	5	6
Income Statement							
Revenue		\$30,000	\$35,000	\$55,000	\$70,000	\$70,000	\$60,000
Expenses:							
Rental		\$9,600	\$9,600	\$9,600	\$9,600	\$9,600	\$9,600
O&M		\$15,000	\$21,000	\$25,000	\$30,000	\$30,000	\$30,000
Depreciation		\$11,000	\$17,600	\$10,560	\$6,336	\$6,336	\$1,584
Taxable Income		(\$5,600)	(\$13,200)	\$9,840	\$24,064	\$24,064	\$18,816
Income Taxes		(\$1,680)	(\$3,960)	\$2,952	\$7,219	\$7,219	\$5,645
Net Income		(\$3,920)	(\$9,240)	\$6,888	\$16,845	\$16,845	\$13,171
Cash Flow Statement							
Cash from operation							
Net Income		(\$3,920)	(\$9,240)	\$6,888	\$16,845	\$16,845	\$13,171
Depreciation		\$11,000	\$17,600	\$10,560	\$6,336	\$6,336	\$1,584
Investment / Salvage	(\$55,000)						\$13,401
Gains Tax							(\$3,545)
Working capital							
Net Cash Flow (Actual Dollar)	(\$55,000)	\$7,080	\$8,360	\$17,448	\$23,181	\$23,181	\$24,611
Net Cash Flow (Constant Dollar)	(\$55,000)	\$6,743	\$7,583	\$15,072	\$19,071	\$18,163	\$18,365
PW (10%) =		15,573		IRR (%)	:	11.74%	

11.25

(a) Real after-tax yield on bond investment:

- Nontaxable municipal bond:

$$i'_{\text{municipal}} = \frac{0.09 - 0.03}{1 + 0.03} = 5.825\%$$

- Taxable corporate bond:

$$i'_{\text{municipal}} = \frac{0.12(1 - 0.3) - 0.03}{1 + 0.03} = 5.245\%$$

The municipal bond provides a better return on investment.

(b) Given $i = 6\%$, and $\bar{f} = 3\%$

$$i'_{\text{savings}} = 2.91\%$$

Since $i'_{\text{municipal}} > 2.91\%$ and $i'_{\text{corporate}} > 2.91\%$, both bond investments are better than the savings account. Now to compare two mutually exclusive bond investment alternatives, we need to perform an incremental analysis.

We cannot find the rate of return on incremental investment, as returns from municipal bond dominate those from corporate bond in every year. Municipal bond is a clear choice for any value of MARR.

n	After- tax Cash Flow		
	Municipal	Corporate	Incremental
0	-\$10,000	-\$10,000	\$0
1	\$900	\$840	-\$60
2	\$900	\$840	-\$60
3	\$900	\$840	-\$60
4	\$900	\$840	-\$60
5	\$900	\$840	-\$60

11.26 (a), (b), and (c)

Engine A

	0	1	2	3	4	5
Income Statement						
Revenue						
Expenses:						
O&M		\$135,000	\$145,800	\$157,464	\$170,061	\$183,666
Depreciation		12,000	12,000	12,000	12,000	12,000
Taxable Income		(\$147,000)	(\$157,800)	(\$169,464)	(\$182,061)	(\$195,666)
Income Taxes		(58,800)	(63,120)	(67,786)	(72,824)	(78,266)
Net Income		(\$88,200)	(\$94,680)	(\$101,678)	(\$109,237)	(\$117,400)
Cash Flow Statement						
Cash from operation						
Net Income		(88,200)	(94,680)	(101,678)	(109,237)	(117,400)
Depreciation		12,000	12,000	12,000	12,000	12,000
Investment / Salvage	(100,000)					40,000
Gains Tax						
Net Cash Flow	(\$100,000)	(\$76,200)	(\$82,680)	(\$89,678)	(\$97,237)	(\$65,400)
	PW (20%)=	(\$345,989)	AE (20%)=	(\$115,692)	FW (20%)=	(\$860,932)

Engine B

	0	1	2	3	4	5
Income Statement						
Revenue						
Expenses:						
O&M		\$86,400	\$93,312	\$100,777	\$108,839	\$117,546
Depreciation		\$ 24,000	\$ 24,000	\$ 24,000	\$ 24,000	\$ 24,000
Taxable Income		(\$110,400)	(\$117,312)	(\$124,777)	(\$132,839)	(\$141,546)
Income Taxes		\$ (44,160)	\$ (46,925)	\$ (49,911)	\$ (53,136)	\$ (56,618)
Net Income		(\$66,240)	(\$70,387)	(\$74,866)	(\$79,703)	(\$84,928)
Cash Flow Statement						
Cash from operation						
Net Income		\$ (66,240)	\$ (70,387)	\$ (74,866)	\$ (79,703)	\$ (84,928)
Depreciation		\$ 24,000	\$ 24,000	\$ 24,000	\$ 24,000	\$ 24,000
Investment / Salvage	\$ (200,000)					\$ 80,000
Gains Tax						
Net Cash Flow	(\$200,000)	(\$42,240)	(\$46,387)	(\$50,866)	(\$55,703)	\$19,072
	PW (20%)=	(\$316,048)	AE (20%)=	(\$105,680)	FW (20%)=	(\$786,429)

11.27 (a) & (b) Actual and constant dollar analysis:

	0	1	2
Income Statement			
Revenue		\$126,000	\$132,300
Expenses:			
O&M		62,400	64,896
Depreciation		12,000	9,600
Taxable Income		\$51,600	\$57,804
Income Taxes (30%)		\$15,480	\$17,341
Net Income		\$36,120	\$40,463
Cash Flow Statement			
Cash from operation:			
Net Income		36,120	40,463
Depreciation		12,000	9,600
Investment / Salvage	(60,000)		40,000
Working capital	(5,000)	(200)	5,200
Gains Tax			(480)
Net Cash Flow (actual)	(\$65,000)	\$47,920	\$94,783
Net Cash Flow (constant)	(\$65,000)	\$44,370	\$81,261

(c) Given $\bar{f} = 8\%$, $i = 15\%$

$$i' = \frac{0.15 - 0.08}{1 + 0.08} = 6.48\% \quad (\text{Inflation-free MARR})$$

Since $\text{IRR}' (51.04\%) > 6.48\%$, the project is a profitable one.

11.28 (a) & (b) Project cash flows in actual and constant dollars:

	0	1	2	3	4	5	6
Income Statement							
Revenue		\$84,800	\$89,888	\$95,281	\$100,998	\$107,058	\$113,482
Expenses:							
O&M							
Depreciation		20,000	32,000	19,200	11,520	11,520	5,760
Interest							
Taxable Income		\$64,800	\$57,888	\$76,081	\$89,478	\$95,538	\$107,722
Income Taxes (40%)		\$25,920	\$23,155	\$30,432	\$35,791	\$38,215	\$43,089
Net Income		\$38,880	\$34,733	\$45,649	\$53,687	\$57,323	\$64,633
Cash Flow Statement							
Cash from operation							
Net Income		38,880	34,733	45,649	53,687	57,323	64,633
Depreciation		20,000	32,000	19,200	11,520	11,520	5,760
Investment / Salvage	(100,000)						42,556
Gains Tax							(17,022)
Working capital							
Loan repayment							
Net Cash Flow (actual \$)	(\$100,000)	\$58,880	\$66,733	\$64,849	\$65,207	\$68,843	\$95,927
Net Cash Flow (constant \$)	(\$100,000)	\$55,547	\$59,392	\$54,448	\$51,650	\$51,443	\$67,625
	PW (18%) =	\$136,553					
	IRR' (%) =	51.53%					

(c) The effects of project financing under inflation: $A = \$100,000(A/P, 12\%, 6) = \$24,323$

	0	1	2	3	4	5	6
Income Statement							
Revenue		\$84,800	\$89,888	\$95,281	\$100,998	\$107,058	\$113,482
Expenses:							
O&M							
Depreciation		20,000	32,000	19,200	11,520	11,520	5,760
Interest		12,000	10,521	8,865	7,010	4,933	2,606
Taxable Income		\$52,800	\$47,367	\$67,216	\$82,468	\$90,605	\$105,116
Income Taxes (40%)		21,120	18,947	26,886	32,987	36,242	42,046
Net Income		\$31,680	\$28,420	\$40,330	\$49,481	\$54,363	\$63,070
Cash Flow Statement							
Cash from operation							
Net Income		31,680	28,420	40,330	49,481	54,363	63,070
Depreciation		20,000	32,000	19,200	11,520	11,520	5,760
Investment / Salvage	(100,000)						42,556
Gains Tax							(17,022)
Working capital							
Loan repayment	100,000	(12,323)	(13,801)	(15,457)	(17,312)	(19,390)	(21,717)
Net Cash Flow (actual \$)	\$0	\$39,357	\$46,619	\$44,072	\$43,688	\$46,493	\$72,646
Net Cash Flow (constant \$)	\$0	\$37,130	\$41,491	\$37,004	\$34,605	\$34,743	\$51,213
	PW (18%) =	\$163,425					

- (d) The present value loss due to inflation: present value loss = \$136,553 - \$140,656 = (\$4,093)

	0	1	2	3	4	5	6
Income Statement							
Revenue		\$80,000	\$80,000	\$80,000	\$80,000	\$80,000	\$80,000
Expenses:							
O&M							
Depreciation		20,000	32,000	19,200	11,520	11,520	5,760
Interest							
Taxable Income		\$60,000	\$48,000	\$60,800	\$68,480	\$68,480	\$74,240
Income Taxes		24,000	19,200	24,320	27,392	27,392	29,696
Net Income		\$36,000	\$28,800	\$36,480	\$41,088	\$41,088	\$44,544
Cash Flow Statement							
Cash from operation							
Net Income		36,000	28,800	36,480	41,088	41,088	44,544
Depreciation		20,000	32,000	19,200	11,520	11,520	5,760
Investment / Salvage	(100,000)						30,000
Gains Tax							(12,000)
Working capital							
Loan repayment							
Net Cash Flow (actual \$)	(\$100,000)	\$56,000	\$60,800	\$55,680	\$52,608	\$52,608	\$68,304
	PW (11.32%) =	\$140,656					

- (e) Required additional before-tax annual revenue in actual dollars (equal amount) to make-up the inflation loss.

$$\frac{\$4,093(A / P, 18\%, 6)}{1 - 0.40} = \$1,952$$

Short Case Studies

ST 11.1 (a) & (b) The project cash flows and IRR with no inflation:

Income Statement	0	1	2	3	4	5	6	7	8	9	10
Revenue		\$80,000	\$80,000	\$80,000	\$80,000	\$80,000	\$80,000	\$80,000	\$80,000	\$80,000	\$80,000
Expenses:											
O&M		\$3,000	\$3,000	\$3,000	\$3,000	\$3,000	\$3,000	\$3,000	\$3,000	\$3,000	\$3,000
Labor		\$15,000	\$15,000	\$15,000	\$15,000	\$15,000	\$15,000	\$15,000	\$15,000	\$15,000	\$15,000
Material		\$9,000	\$9,000	\$9,000	\$9,000	\$9,000	\$9,000	\$9,000	\$9,000	\$9,000	\$9,000
Energy		\$4,500	\$4,500	\$4,500	\$4,500	\$4,500	\$4,500	\$4,500	\$4,500	\$4,500	\$4,500
Depreciation :											
Building											
Milling machine		\$15,719	\$26,939	\$19,239	\$13,739	\$9,823	\$9,812	\$9,823	\$4,906	\$0	\$0
Jigs & dies		\$3,333	\$4,445	\$1,481	\$741	\$0	\$3,333	\$4,445	\$1,481	\$741	\$0
Taxable Income		\$29,448	\$17,116	\$27,780	\$34,020	\$38,677	\$35,355	\$34,232	\$42,113	\$47,759	\$48,500
Income Taxes		\$10,307	\$5,991	\$9,723	\$11,907	\$13,537	\$12,374	\$11,981	\$14,740	\$16,716	\$16,975
Net Income		\$19,141	\$11,125	\$18,057	\$22,113	\$25,140	\$22,981	\$22,251	\$27,373	\$31,043	\$31,525
Cash Flow Statement											
Cash from operation											
Net Income		\$19,141	\$11,125	\$18,057	\$22,113	\$25,140	\$22,981	\$22,251	\$27,373	\$31,043	\$31,525
Depreciation											
Building											
Milling machine		\$15,719	\$26,939	\$19,239	\$13,739	\$9,823	\$9,812	\$9,823	\$4,906	\$0	\$0
Jigs & dies		\$3,333	\$4,445	\$1,481	\$741	\$0	\$3,333	\$4,445	\$1,481	\$741	\$0
Investment / Salvage											
Building											
Milling machine	(\$110,000)										\$10,000
Jigs & dies	(\$10,000)					\$300					
(Replacement)						(\$10,000)					\$300
Gains Taxes:											
Building											
Milling machine											(\$3,500)
Jigs & dies						(\$105)					(\$105)
Net Cash Flow	(\$120,000)	\$38,193	\$42,509	\$38,777	\$36,593	\$25,158	\$36,126	\$36,519	\$33,760	\$31,784	\$38,220

$$\text{PW (11.32\%)} = \$90,992 \quad \text{IRR (\%)} = 28.40\%$$

(c), (d) & (e): The economic loss (or gain) in present worth due to inflation = \$108,404 - \$90,988 = \$17,416.

Income Statement	0	1	2	3	4	5	6	7	8	9	10
Revenue		\$85,600	\$91,592	\$98,003	\$104,864	\$112,204	\$120,058	\$128,463	\$137,455	\$147,077	\$157,372
Expenses:											
O&M		3,090	3,183	3,278	3,377	3,478	3,582	3,690	3,800	3,914	4,032
Labor		15,750	16,538	17,364	18,233	19,144	20,101	21,107	22,162	23,270	24,433
Material		9,360	9,734	10,124	10,529	10,950	11,388	11,843	12,317	12,810	13,322
Energy		4,635	4,774	4,917	5,065	5,217	5,373	5,534	5,700	5,871	6,048
Depreciation :											
Building											
Milling machine		15,719	26,939	19,239	13,739	9,823	9,812	9,823	4,906	0	0
Jigs & dies		3,333	4,445	1,481	741	0	3,333	4,445	1,481	741	0
Taxable Income		\$33,713	\$25,979	\$41,599	\$53,181	\$63,592	\$66,468	\$72,021	\$87,088	\$100,470	\$109,537
Income Taxes		11,800	9,093	14,560	18,613	22,257	23,264	25,207	30,481	35,165	38,338
Net Income		\$21,913	\$16,887	\$27,040	\$34,568	\$41,335	\$43,204	\$46,814	\$56,607	\$65,306	\$71,199
Cash Flow Statement											
Cash from operation											
Net Income		21,913	16,887	27,040	34,568	41,335	43,204	46,814	56,607	65,306	71,199
Depreciation											
Building											
Milling machine		15,719	26,939	19,239	13,739	9,823	9,812	9,823	4,906	0	0
Jigs & dies		3,333	4,445	1,481	741	0	3,333	4,445	1,481	741	0
Investment / Salvage											
Building											
Milling machine	(110,000)										10,000
Jigs & dies	(10,000)					300					
(Replacement)						(10,000)					300
Gains Taxes:											
Building											
Milling machine											(3,500)
Jigs & dies						(105)					(105)
Net Cash Flow (actual \$)	(\$120,000)	\$40,965	\$48,271	\$47,760	\$49,048	\$41,353	\$56,349	\$61,082	\$62,994	\$66,047	\$77,894
Net Cash Flow (constant \$)	(\$120,000)	\$38,647	\$42,960	\$40,100	\$38,850	\$30,899	\$39,724	\$40,620	\$39,523	\$39,093	\$43,496
	PW (18%)	\$108,407		IRR (%) =	30.53%						

ST11.2 (a) & (b): Assumption: The building will be placed in service in the month of January.

Income Statement	2006	2007	2008	2009	2010	2011	2012	2013	2014
	-2	-1	0	1	2	3	4	5	6
Revenues:									
Sales unit				\$2,000	\$2,000	\$2,000	\$2,000	\$2,000	\$2,000
Unit price				\$95,000	\$99,750	\$104,738	\$109,974	\$115,473	\$121,247
Sales volume				\$190,000,000	\$199,500,000	\$209,476,000	\$219,948,000	\$230,946,000	\$242,494,000
Expenses:									
Fixed costs				\$5,000,000	\$5,250,000	\$5,512,500	\$5,788,125	\$6,077,531	\$6,381,408
Variable costs				\$114,000,000	\$119,700,000	\$125,685,600	\$131,968,800	\$138,567,600	\$145,496,400
Depreciation :									
Building				\$128,205	\$128,205	\$128,205	\$128,205	\$128,205	\$128,205
Equipment				\$1,214,650	\$2,081,650	\$1,486,650	\$1,061,650	\$759,050	\$379,100
Amortization				\$250,000	\$250,000	\$250,000	\$250,000	\$250,000	\$250,000
Taxable Income				\$69,407,145	\$72,090,145	\$76,413,045	\$80,751,220	\$85,163,614	\$89,858,887
Income Taxes				\$27,762,858	\$28,836,058	\$30,565,218	\$32,300,488	\$34,065,446	\$35,943,555
Net Income				\$41,644,287	\$43,254,087	\$45,847,827	\$48,450,732	\$51,098,168	\$53,915,332
Cash Flow Statement									
Operating Activities:									
Net Income				\$41,644,287	\$43,254,087	\$45,847,827	\$48,450,732	\$51,098,168	\$53,915,332
Depreciation				\$1,342,855	\$2,209,855	\$1,614,855	\$1,189,855	\$887,255	\$507,305
Amortization				\$250,000	\$250,000	\$250,000	\$250,000	\$250,000	\$250,000
Investment activities									
Opportunity cost*	(\$600,000)								
Land	(\$1,500,000)								\$2,000,000
Building		(\$1,000,000)	(\$4,000,000)						\$3,000,000
Equipment			(\$8,500,000)						\$1,500,000
Gains Taxes									
Land									(\$200,000)
Building									\$492,308
Equipment									\$6,900
Working capital			(\$1,000,000)	(\$1,425,000)	(\$1,496,400)	(\$1,570,800)	(\$1,649,700)	(\$1,732,200)	\$8,874,100
Net Cash Flow (actual)	(\$2,100,000)	(\$1,000,000)	(\$13,500,000)	\$41,812,142	\$44,217,542	\$46,141,882	\$48,240,887	\$50,503,223	\$70,345,945
Net Cash Flow (constant)	(\$2,100,000)	(\$952,381)	(\$12,244,898)	\$36,118,900	\$36,377,881	\$36,153,372	\$35,998,093	\$35,891,698	\$47,612,905
IRR' =		137.08%		PW (20%) =	\$98,366,458				

*Note: If the firm decides not to invest in the project, the firm could write off the R&D expenditure. This results in an opportunity cost in the amount of $(0.40)(\$1,500,000) = \$600,000$. This should be considered as an investment required undertaking the project.