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NEW RADAR FOR THE F-13 - A DISCOUNTED CASH FLOW ANALYSIS.(U)
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DEFENSE SYSTEMS MANAGEMENT SCHOOL

PROGRAM MANAGEMENT COURSE

INDIVIDUAL STUDY PROGRAM

(6) NEW RADAR FOR THE F-13 — A DISCOUNTED CASH FLOW ANALYSIS.

(9) STUDY PROJECT REPORT., PMC 76-1

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LTCOL USAF

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SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

STUDY TITLE:

New Radar for the F-13 - A Discounted Cash Flow Analysis

STUDY PROJECT GOALS: To demonstrate the application of economic analysis to government acquisition alternatives and discounted cash flow techniques to the determination of optimal production methods, through the use of a case study to be used as a teaching device in a corporate and/or government finance course.

STUDY REPORT ABSTRACT:

The case study is presented in four parts:

Part A is the application of economic analysis in determining the optimal acquisition strategy for a new radar to be installed in an existing fighter aircraft. Alternatives include modification of an existing radar and development of a new state of the art radar.

Part B is the introduction of a discrete probability distribution of the previous analysis. Cash flows are now based on expected value.

Part C is the use of discounted cash flow techniques in determining the optimal among three possible alternative production methods for the above radar. The alternatives include subcontracting, modification of an existing production line, and procurement of a new, fully automated production line.

Part D is the introduction of a variation in volume and its impact on the previous decision.

Included with the case is a section of instructor's notes and suggested student analysis.

KEY WORDS: Economic Analysis, Discounted Cash Flow.

RESOURCES MANAGEMENT
MATERIEL ACQUISITION
FINANCIAL MANAGEMENT
LIFE CYCLE COST
DISCOUNTING
DECISION THEORY
ECONOMIC ANALYSIS
BUDGETS

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NEW RADAR FOR THE F-13

A DISCOUNTED CASH FLOW ANALYSIS

Study Project Report

Individual Study Program

Defense Systems Management School

Program Management Course

Class 76-1

by
Porter W. Venn
LTCOL USAF

May 1976

Study Project Advisor
Dr. Benjamin C. Rush

EXECUTIVE SUMMARY

This report is a case study on the application of economic analysis and discounted cash flow techniques as an input to the decision making process regarding the acquisition of major weapon systems.

The case contains four separate parts, which include:

A. Application of economic analysis in the selection of the best of two alternative acquisition strategies for the installation of a new radar on a fighter aircraft already in the operational inventory - modification of an existing radar presently being installed on another aircraft or development of an advanced state of the art radar.

B. Introduction of uncertainty and its impact on the acquisition decision. Several of the applicable cash flows are converted from a point estimate to a discrete probability distribution and the expected value of cash flows must be determined.

C. Application of discounted cash flow analysis to three alternative production methods envisioned by a prospective manufacturer of the radar. The alternatives include subcontracting, modification of an existing production line, and purchase of a fully automated production line.

D. Introduction of increased volume and its impact on the selection of the best production methodology.

The case is designed for use as a teaching device in a corporate and/or government finance course. It includes instructor's notes and suggested student analysis.

TABLE OF CONTENTS

NEW RADAR FOR THE F-13

A DISCOUNTED CASH FLOW ANALYSIS

A.
ECONOMIC ANALYSIS

You are a systems engineer in the F-13 Chicken Hawk program office. You are involved in the preparation of a systems specification involving the incorporation of all-weather radar capability into the Chicken Hawk.

The present Chicken Hawk, which has been in the operational inventory for 5 years, is a twin engine, mach 2.5, air superiority fighter, with a limited capability conical scan radar. It is armed with the AIM-27 Zinger missle, with infra-red homing and 5 mile range capability. Initial acquisition cost for the aircraft was $5 million and it has an estimated remaining service life of 15 years. It is equipped with an inertial navigation system and a 4000 word memory computer for displaying fire control solutions on the heads-up display. There are presently 800 Chicken Hawks in the operational inventory.

The systems specification that you are writing will require significant aircraft modification and will include a pulse doppler radar, display, 32,000 word memory computer, and lookdown capability. The modification will utilize components from the present inertial navigation system and heads-up display. The aircraft will be armed with the new AIM-41 Zonker missle with Shootdown radar homing and 40 mile range capability.

After doing extensive analysis and tradeoffs between all conceiveable options, you have managed to narrow the field to two possible alternative acquisition strategies:

Alternative 1: Buy an existing radar presently being supplied for another fighter on a firm fixed price contract by Little Dandy All-Purpose Radar Supply Corp. This radar can meet the requirements, but will require extensive modification to increase power and antenna size. A development effort will be required. The aircraft nose must be modified to incorporate the larger antenna and extensive rewiring and component relocation will be required. The radar will include a simple raster-scan display. Anticipated procurement is 1000 units (800 aircraft + 25% spares). Estimated costs are:

Item	Years	Cost (Mill.)
Development Effort.	1	$ 20.
Radar (1000 units @ $200,000)	2&3	200.
Radar modification (1000 units @ 200,000) .	2&3	200.
Aircraft modification (800 units @ $100,000)	2&3	80.
Total		$500.

It is estimated that radar acquisition, modification, and installation costs will be incurred fairly evenly over years 2&3.

Alternative 2: Buy an advanced state-of-the-art radar presently in the conceptual development stage. This radar will also meet the requirements, but will incorporate new technology, including mirco-miniaturized, large scale integrated circuitry, parametric amplifiers, an improved traveling wave tube, and a stroke-written display. The aircraft will not require structural modification but will still require rewiring and component relocation. A three year engineering development effort will also be required. Biggie Consolidated Aircraft Incorporated and two competitors have facilities that could handle a production effort of this nature. Estimated costs are:

Item	Years	Cost (Mill.)
Engineering Development.	1-3	$300.
Radar (1000 units @ $260,000).	4-5	260.
Aircraft rewire (800 units @ $50,000). . . .	4-5	40.
Total		$600.

It is anticipated that all costs will be incurred fairly evenly over the applicable years.

It is Friday morning. You have completed your analysis and are ready to present the results to the Chicken Hawk program manager. You are pleased with the outcome of your efforts and are convinced that the depth of your analysis will persuade your PM to go with Alternative 1, since Alternative 2 costs 20% more and has greater technical risk.

Your secretary informs you that one Doctor Benardo Tush is on the phone from the Pentagon. After 2 minutes on the phone with Doctor Tush, you have lost a great deal of your confidence. He informs you that in addition to his position in the OSD Comptroller office, he is a member of the Cost Analysis Improvement Group (CAIG) which will certainly review the cost implications of your acquisition plan, the rough details of which he is already aware. He stated that he is confident that you are a highly capable young systems analyst and will therefore be well prepared to present the economic analysis that you have prepared (in accordance with DODI 7041.3) to the CAIG at the appropriate time. He also informs you that the CAIG will be highly interested in your in-depth analysis of life cycle costs. You assure Doctor Tush that you have all of these aspects under control.

Now that this winner from OSD has ruined your whole day, you have to decide what to do next. After some soul searching, you inform your PM that your analysis will take a few more days. During that time you gather the following data regarding the life cycle cost implications of the previous alternatives:

Alternative 1:

Item	Years	Cost (Mill.)
Peculiar Support Equipment (1 Unit/20. . . . aircraft = 40 @ $500,000)	3	$20.
Initial training, data, etc.	3	30.
Operation & Support costs (MTBF=100 hours) .	4-15	20.

Alternative 2:

Item	Years	Cost (Mill.)
Peculiar Support Equipment (Uses multi-purpose test equipment.		0
Initial training, data, etc	5	$40.
Operation & Support Costs (MTBF= 200 hours)	6-15	10.

A. What is the appropriate discount rate to use in performing the economic analysis?

B. Based on the results of your economic analysis, what is the optimal alternative?

(Assume that cash flows occur at the end of the applicable years. Also assume that the benefits from the 2 year earlier delivery of Alternative 1 are just offset by the increased capability of Alternative 2).

B.

UNCERTAINITY

Several days have gone by. Your analysis now includes life cycle cost implications, you have performed an economic analysis in accordance with DODI 7041.3, and you are once again prepared to brief the Chicken Hawk program manager, now that you are a little older and hopefully a little wiser.

Your secretary informs you that one Doctor Donte Herzog is on the phone from the Pentagon. Doctor Herzog informs you that he works in the office of OSD Program Analysis and Evaluation (PA&E) and in addition is a member of the Cost Analysis Improvement Group (CAIG). His associate Doctor Tush has informed him of the high quality of your work and he is therefore confident (99%) that you have had the foresight to consider uncertainity in the performance of your analysis. As the conversation ends, he informs you as to how delighted he will be to explore your analysis of uncertainity when you make your presentation to the CAIG. Now that you have received this second piece of bad news from OSD, you make another value judgement. You inform your PM that your analysis will take a few more days and after some effort are able to persuade him that you are still engaged in a serious endeavor. During that time you gather estimates as to uncertainity from the best authorities to whom you can obtain immediate access. (In the Avionics Lab. and the Logistics Planning Division.) They are unable to provide any further information beyond the point estimates presented in Part A, except in the following areas:

	Cost (Mill.)	Probability
Engineering Development (Alternative 2)	$300.	30%
	350.	30%
	400.	20%
	425.	20%
		100%
Operation & Support Costs (Alternative 1)	$15.	10%
	20.	40%
	25.	30%
	30.	20%
		100%
Operation & Support Costs (Alternative 2)	$ 5.	10%
	8.	20%
	10.	40%
	15.	20%
	20.	10%
		100%

A. How does this additional information affect your decision from Part A?

B. What is your next step? (multiple choice)

1. Present results to PM.
2. Ask OSD for futher guidance.
3. Have phone disconnected.
4. Panic
5. Transfer
6. Retire
7. Other

C.

CHOOSING PRODUCTION METHODOLOGY

You are a production engineer in the employ of the Biggie Consolidated Aircraft Corporation. Management believes that it is highly probable that Biggie will be awarded the Chicken Hawk radar contract presently going through the government source selection process. Management also fervently believes that Biggie's long established reputation for technical excellence, for meeting cost and schedule targets, and for displaying dynamic management practices will be just adequate to overcome an obvious disadvantage - government representatives have to buy their own lunch in the company automat.

You have been assigned the task of developing a production plan for the Chicken Hawk radar. Biggie will have to provide the radars at a production rate of 500/year (contract completion in two years), but with follow-on sales for the Chicken Hawk, other military programs, and foreign military sales, it is anticipated that there will be a market for at least 5000-8000 radars over a ten year span. Management has asked you to consider three alternatives in your analysis:

Alternative 1: Subcontract - All production will be subcontracted to three vendors, with Biggie performing acceptance, inspection, and component integration tasks. Anticipated cash flows are as follows:

Item	Years	Cost (Mill.)
Sales (500 @ $250,000)	1-10	($125.)
Subcontracts (500 @ $150,000)	1-10	75.
Acceptance, Inspection, and Integration	1-10	42.
Specialized facility for radar component integration	0	25.

Depreciation - straight line, no salvage. Tax rate - 40%.

Alternative 2 - Modify existing production line

Biggie is presently phasing out a radar used in commercial applications, which will free up a production line for use on the Chicken Hawk radar production. However, the production line would require significant redesign to accommodate the new program, primarily on the drive mechanisms, access trays, and overhead racks. The labor would involve hand soldering, hand electronic component insertion, and manual test and checkout equipment. In addition, an updated production system must be designed, including work flow production drawings. Anticipated cash flows are as follows:

Item	Years	Cost (Mill.)
Sales (500 @ $250,000)	1-10	($125.)
Production Labor (500 @ $125,000)	1-10	62.5
Materials (500 @ $25,000)	1-10	12.5
Overhead (production line)	1-10	20.0
Modifications to production line	0	35.0
Salvage value	10	(5.0)

Depreciation - straight line. Tax rate - 40%.

Alternative 3 - Fully automated production line

Biggie can also invest in new technology (for a significantly greater investment cost). This production line, which would be purchased as an entire unit, would incorporate the latest electronic equipment production technology, including automatic component insertion, automatic lead trimming, flow soldering, and computerized checkout equipment with tape print out indicating fault isolation. Fabrication of some mechanical components would be accomplished with automatic assembly equipment using pneumatic driven attachment mechanisms. Anticipated cash flows are as follows:

Item	Years	Cost (Mill.)
Sales (500 @ $250,000)	1-10	($125.)
Production Labor (500 @ $60,000)	1-10	30.
Materials (500 @ $20,000)	1-10	10.
Overhead (production line)	1-10	25.
Initial investment	0	132.
Salvage	10	(10.)

Depreciation - straight line. Tax rate - 40%.

Biggie's weighted average cost of capital (WACC) is 20%, which they also use as their hurdle rate for capital investment decisions. Assume that cash flows occur at the end of the applicable years.

A. Assuming that you use discounted present value as your decision criterion, which alternative would you choose?

B. What is the internal rate of return (IRR) for alternative 1?

D.

IMPACT OF INCREASED VOLUME

You have briefed corporate management on your analysis and have received 5 "At-a-boy's." The nexy day, Biggie is informed by its Washington representative that the State Department has just received a request from the Sheik of Araby to purchase 1000 units of the new radar over the next ten (100/year) through foreign military sales channels. The radar will be used on the Sheik's fleet of brand new, Mach 4, F-29 Miracle fighters, presently standing five minute alert to guard against the ever-present danger of a surprise saturation bombing attack on the Oofi oasis by a certain unfriendly country, whose nearest border is 3000 miles away. You are asked to revise your analysis based on the possibility of the increased sales of 100 units/year for ten years. Alternative 3 is the only alternative that can handle the increased volume. Revised cash flows for alternative 3 are as follows:

Item	Years	Cost (Mill.)
Sales (600 @ $250,000).	1-10	($150.)
Production Labor (600 @ $60,000).	1-10	36.
Materials (600 @ $20,000)	1-10	12.
Overhead (production line).	1-10	28.
Initial investment (minor modification. . . required to handle increased volume). . .	0	140.
Salvage	10	(10.)

Depreciation - Straight line. Tax rate - 40%.

A. What impact do the anticipated foreign military sales have on your previous decision as to the best alternative?

B. Biggie has just been informed that the Chicken Hawk radar contract has been awarded to the Little Dandy All-Purpose Radar Supply Corp. A prime criterion in the source selection was a new provision in the Armed Services Procurement Regulation (ASPR) entitled: "Give the little guy a break."

Corporate management has taken back your 5 "At-a-boy's." What would you recommend as the next step in your decision process?

INSTRUCTOR'S NOTES

Substantive Issues Raised:

The case presents the application of the traditional capital budgeting, discounted cash flow techniques in the determination of the optimal acquisition strategy for radar modification to an existing aircraft weapons system. The discount rate used is 10%, as specified by DODI 7041.3. The case proceeds to an analysis of uncertainty in the costs of the new radar development and follow on operation and support costs. The scene then switches to a potential contractor who must determine the optimal production methodology for the anticipated radar program. Once again, discounted cash flow techniques are utilized, this time with the introduction of depreciation and tax effects. Finally, the impact of volume variation on the selection of the optimal alternative is determined.

The case is broken into four parts, which can be assigned separately. However, Part B requires reference to Part A, and Part D requires reference to Part C.

The problem description and substantive issues of each part are:

Part A. Application of economic analysis (discounted cash flows) as a decision criterion in choosing between two acquisition alternatives. Alternative 1 is the modification of an existing radar presently being supplied for another aircraft. Alternative 2 is a development effort and procurement of a new radar. R&D and procurement costs are considered first, with subsequent introduction of life cycle costs. Undiscounted costs favor alternative 1, but when Operation & Support costs are introduced and all costs are discounted, alternative 2 becomes the least cost alternative. Other issues for discussion include:

1. Justification for a discount rate of 10% (specified by DODI 7041.3) and support for alternative rates. Based on a hypothetical cost of capital to the federal government.

2. The impact of the two year spread in development between alternatives 1 and 2, and the impact of increased capability of alternative 2. Factors external to straight numerical analysis.

3. Questions external to the economic analysis itself, such as the validity of presented costs and relationships. Other assumptions that could be made, differing from those presented in the case.

Part B. Application of uncertainity to the analysis from Part A. The development costs for alternative 2 and the O&S costs for both alternatives are switched from point estimates to discrete probability distributions, requiring the student to determine expected values for the three costs. The heavy loading of probability on the high cost side for development of alternative 2 causes the optimal alternative to switch to alternative 1. Other issues for discussion include:

1. Uncertainties other than those presented in the case.

2. Application of continuous probability distributions to various costs, which was considered to be outside the scope of the learning goals of this case.

Part C. Application of discounted cash flow techniques in the determination of an optimal production methodology by a selection among three alternatives. Alternative 1 is to subcontract the fabrication work, with the company retaining integration tasks. Alternative 2 involves the modification of an existing production line and utilization of manual assembly techniques. Alternative 3 involves the acquisition of a fully automated

production line. The impact of tax shield from depreciation is introduced. Alternative 1 results in a negative cash flow on a discounted basis and alternative 2 is superior to alternative 3 when discounted cash flows are the prime decision criterion. As an additional exercise, the student is asked to compute the internal rate of return (I.R.R.) for alternative 1. Other issues for discussion include:

1. The proper "rate" - Cost of capital rate, hurdle rate, I.R.R. of other alternatives, or other?

2. The impact of depreciation methods other than straight line, which were not included in this case.

3. Determination of I.R.R. when cash flows are not even over the applicable years. Looking up values in discount tables on an iterative basis.

4. Factors external to cash flow analysis, such as impact of increased automation on labor, material, and overhead costs.

Part D. Impact of increased volume. Alternative 3 from part C is impacted by increased volume. It is assumed that alternatives 1 and 2 are not amenable to increased volume. This impact causes the optimal alternative to switch from #2 to #3. Other issues for discussion include:

1. Impact of limited capacity. The company might choose both alernatives 2 and 3, with sufficient capacity, thereby increasing volume, if relevant net cash flows remained positive.

2. Impact of increased volume on a low fixed investment - high variable cost production methodology as opposed to the impact on a high fixed cost - low variable cost production methodology.

STUDENT ANALYSIS

Part A:

Alternative 1:	Cost	Years	Factor	Disc. Cost
Development	$ 20	1	.909	$ 18.18
Radar, radar mod., A/C mods. (1/2)	240	2-3	1.577	378.48
P.S.E., training, data, etc.	50	3	.751	37.55
O&S costs	20	4-15	5.119	102.38
Total				$536.59 (mil.)

(Students were given the assumption that production costs were incurred evenly over years 2 & 3, so they are split between years 2 & 3).

Alternative 2:	Cost	Years	Factor	Disc. Cost
Development (1/3)	$100	1-3	2.487	$248.70
Radar & A.C. rewire (1/2)	150	4-5	1.304	195.60
Training, etc.	40	5	.621	24.84
O&S Costs	10	6-15	3.815	38.15
Total				$507.29 (mil.)

This is the optimal alternative on a discounted cash flow basis.
(Same note as under alternative 1)

Part B:

Alternative 1: Expected value, O & S costs:

Cost	p(cost)	Cost weight
$15	.1	$1.5
20	.4	8.0
25	.3	7.5
30	.2	6.0
Expected value	1.0	23.0

	Cost	Years	Factor	Disc. Costs
O & S Costs	$23	4-15	5.119	$117.74
Other costs (no change)	-	-	-	434.21
Total				$551.95

Alternative 2: Expected value, development costs:

Cost	p(Cost)	Cost Weight
$300	.3	$ 90.
350	.3	105.
400	.2	80.
425	.2	85.
Expected Value	1.0	$360.

Expected value, O & S costs:

Cost	p(Cost)	Cost Weight
$ 5	.1	$ .5
8	.2	1.6
10	.4	4.0
15	.2	3.0
20	.1	2.0
Expected Value	1.0	$11.1

	Cost	Years	Factor	Disc. Cost
Development (1/3)	$120	1-3	2.487	$298.44
O & S Costs	11.1	6-15	3.815	42.35
Other costs (no change)	-	-	-	220.44
Total				$561.23

The optimal alternative switches to #1.

Part C:

Alternative 1:	Rev (Cost)	Years	Factor	Disc. rev (Cost)
Facility	($25.00)	0	1.0	($25.00)
Gross (Sales less cost)	8.0	1-10	4.192	33.54
Tax (40%)	(3.2)	1-10	4.192	(13.41)
Depreciation - Tax Shield (.4 x (25/10))	1.0	1-10	4.192	4.19
Total				(.68)

Negative cash flow!

Alternative 2:	Rev(Cost)	Years	Factor	Disc.rev(Cost)
Modifications	(35.0)	0	1.0	($ 35.00)
Gross (Sales less cost)	30.0	1-10	4.192	125.76
tax (40%)	(12.0)	1-10	4.192	(50.30)
Depreciation-Tax shield (.4 x (35-5)/10)	1.2	1-10	4.192	5.03
Salvage	5.0	10	.162	.81
Total				$46.30

Alternative 3:	Rev(Cost)	Years	Factor	Disc.rev(Cost)
Investment	($132.00)	0	1.0	($132.00)
Gross (Sales less cost)	60.00	1-10	4.192	251.52
Tax (40%)	(24.00)	1-10	4.192	(100.61)
Depreciation - Tax shield (.4 x (132-10)/10)	4.88	1-10	4.192	20.46
Salvage	10.00	10	.162	1.62
Total				$40.99

Optimal alternative on discounted cash flow basis is #2.

Determination of I.R.R. (Alternative 1):

Yearly cash flows:		
	Gross	$8.0
	Tax shield	1.0
	Tax	(3.2)
	Total	$5.8

Investment (year 0) = 25.0 ÷ 5.8 = 4.31.

Present value of annuity table, 10 years, at 4.31:
Rate ≃ 19%

Part D:

Alternative 3: (No change in 1 or 2)

	Rev(Cost)	Years	Factor	Disc.rev(Cost)
Investment	($140.0)	0	1.0	($140.00)
Gross (sales less cost)	74.0	1-10	4.192	310.21
Tax (40%)	(29.6)	1-10	4.192	(124.08)
Depreciation - Tax shield (.4 x (140-10)/10)	5.2	1-10	4.192	21.80
Salvage	10.0	10	.162	1.62
Total				$69.55

Optimal alternative switches to #3.

Table A

PRESENT VALUE OF $1

Years Hence	1%	2%	4%	6%	8%	10%	12%	14%	15%	16%	18%	20%	22%	24%	25%	26%	28%	30%	35%	40%	45%	50%
1	0.990	0.980	0.962	0.943	0.926	0.909	0.893	0.877	0.870	0.862	0.847	0.833	0.820	0.806	0.800	0.794	0.781	0.769	0.741	0.714	0.690	0.667
2	0.980	0.961	0.925	0.890	0.857	0.826	0.797	0.769	0.756	0.743	0.718	0.694	0.672	0.650	0.640	0.630	0.610	0.592	0.549	0.510	0.476	0.444
3	0.971	0.942	0.889	0.840	0.794	0.751	0.712	0.675	0.658	0.641	0.609	0.579	0.551	0.524	0.512	0.500	0.477	0.455	0.406	0.364	0.328	0.296
4	0.961	0.924	0.855	0.792	0.735	0.683	0.636	0.592	0.572	0.552	0.516	0.482	0.451	0.423	0.410	0.397	0.373	0.350	0.301	0.260	0.226	0.198
5	0.951	0.906	0.822	0.747	0.681	0.621	0.567	0.519	0.497	0.476	0.437	0.402	0.370	0.341	0.328	0.315	0.291	0.269	0.223	0.186	0.156	0.132
6	0.942	0.888	0.790	0.705	0.630	0.564	0.507	0.456	0.432	0.410	0.370	0.335	0.303	0.275	0.262	0.250	0.227	0.207	0.165	0.133	0.108	0.088
7	0.933	0.871	0.760	0.665	0.583	0.513	0.452	0.400	0.376	0.354	0.314	0.279	0.249	0.222	0.210	0.198	0.178	0.159	0.122	0.095	0.074	0.059
8	0.923	0.853	0.731	0.627	0.540	0.467	0.404	0.351	0.327	0.305	0.266	0.233	0.204	0.179	0.168	0.157	0.139	0.123	0.091	0.068	0.051	0.039
9	0.914	0.837	0.703	0.592	0.500	0.424	0.361	0.308	0.284	0.263	0.225	0.194	0.167	0.144	0.134	0.125	0.108	0.094	0.067	0.048	0.035	0.026
10	0.905	0.820	0.676	0.558	0.463	0.386	0.322	0.270	0.247	0.227	0.191	0.162	0.137	0.116	0.107	0.099	0.085	0.073	0.050	0.035	0.024	0.017
11	0.896	0.804	0.650	0.527	0.429	0.350	0.287	0.237	0.215	0.195	0.162	0.135	0.112	0.094	0.086	0.079	0.066	0.056	0.037	0.025	0.017	0.012
12	0.887	0.788	0.625	0.497	0.397	0.319	0.257	0.208	0.187	0.168	0.137	0.112	0.092	0.076	0.069	0.062	0.052	0.043	0.027	0.018	0.012	0.008
13	0.879	0.773	0.601	0.469	0.368	0.290	0.229	0.182	0.163	0.145	0.116	0.093	0.075	0.061	0.055	0.050	0.040	0.033	0.020	0.013	0.009	0.005
14	0.870	0.758	0.577	0.442	0.340	0.263	0.205	0.160	0.141	0.125	0.099	0.078	0.062	0.049	0.044	0.039	0.032	0.025	0.015	0.009	0.006	0.003
15	0.861	0.743	0.555	0.417	0.315	0.239	0.183	0.140	0.123	0.108	0.084	0.065	0.051	0.040	0.035	0.031	0.025	0.020	0.011	0.006	0.004	0.002
16	0.853	0.728	0.534	0.394	0.292	0.218	0.163	0.123	0.107	0.093	0.071	0.054	0.042	0.032	0.028	0.025	0.019	0.015	0.008	0.005	0.003	0.002
17	0.844	0.714	0.513	0.371	0.270	0.198	0.146	0.108	0.093	0.080	0.060	0.045	0.034	0.026	0.023	0.020	0.015	0.012	0.006	0.003	0.002	0.001
18	0.836	0.700	0.494	0.350	0.250	0.180	0.130	0.095	0.081	0.069	0.051	0.038	0.028	0.021	0.018	0.015	0.012	0.009	0.005	0.002	0.001	0.001
19	0.828	0.686	0.475	0.331	0.232	0.164	0.116	0.083	0.070	0.060	0.043	0.031	0.023	0.017	0.014	0.012	0.009	0.007	0.003	0.002	0.001	
20	0.820	0.673	0.456	0.312	0.215	0.149	0.104	0.073	0.061	0.051	0.037	0.026	0.019	0.014	0.012	0.010	0.007	0.005	0.002	0.001	0.001	
21	0.811	0.660	0.439	0.294	0.199	0.135	0.093	0.064	0.053	0.044	0.031	0.022	0.015	0.011	0.009	0.008	0.006	0.004	0.002	0.001		
22	0.803	0.647	0.422	0.278	0.184	0.123	0.083	0.056	0.046	0.038	0.026	0.018	0.013	0.009	0.007	0.006	0.004	0.003	0.001	0.001		
23	0.795	0.634	0.406	0.262	0.170	0.112	0.074	0.049	0.040	0.033	0.022	0.015	0.010	0.007	0.006	0.005	0.003	0.002	0.001			
24	0.788	0.622	0.390	0.247	0.158	0.102	0.066	0.043	0.035	0.028	0.019	0.013	0.008	0.006	0.005	0.004	0.003	0.002	0.001			
25	0.780	0.610	0.375	0.233	0.146	0.092	0.059	0.038	0.030	0.024	0.016	0.010	0.007	0.005	0.004	0.003	0.002	0.001	0.001			
26	0.772	0.598	0.361	0.220	0.135	0.084	0.053	0.033	0.026	0.021	0.014	0.009	0.006	0.004	0.003	0.002	0.002	0.001				
27	0.764	0.586	0.347	0.207	0.125	0.076	0.047	0.029	0.023	0.018	0.011	0.007	0.005	0.003	0.002	0.002	0.001	0.001				
28	0.757	0.574	0.333	0.196	0.116	0.069	0.042	0.026	0.020	0.016	0.010	0.006	0.004	0.002	0.002	0.002	0.001	0.001				
29	0.749	0.563	0.321	0.185	0.107	0.063	0.037	0.022	0.017	0.014	0.008	0.005	0.003	0.002	0.002	0.001	0.001	0.001				
30	0.742	0.552	0.308	0.174	0.099	0.057	0.033	0.020	0.015	0.012	0.007	0.004	0.003	0.002	0.001	0.001	0.001					
40	0.672	0.453	0.208	0.097	0.046	0.022	0.011	0.005	0.004	0.003	0.001	0.001										
50	0.608	0.372	0.141	0.054	0.021	0.009	0.003	0.001	0.001	0.001												

Table B

PRESENT VALUE OF $1 RECEIVED ANNUALLY FOR *N* YEARS

Years (N)	1%	2%	4%	6%	8%	10%	12%	14%	15%	16%	18%	20%	22%	24%	25%	26%	28%	30%	35%	40%	45%	50%
1	0.990	0.980	0.962	0.943	0.926	0.909	0.893	0.877	0.870	0.862	0.847	0.833	0.820	0.806	0.800	0.794	0.781	0.769	0.741	0.714	0.690	0.667
2	1.970	1.942	1.886	1.833	1.783	1.736	1.690	1.647	1.626	1.605	1.566	1.528	1.492	1.457	1.440	1.424	1.392	1.361	1.289	1.224	1.165	1.111
3	2.951	2.884	2.775	2.673	2.577	2.487	2.402	2.322	2.283	2.246	2.174	2.106	2.042	1.981	1.952	1.923	1.868	1.816	1.696	1.589	1.493	1.407
4	3.902	3.808	3.630	3.465	3.312	3.170	3.037	2.914	2.855	2.798	2.690	2.589	2.494	2.404	2.362	2.320	2.241	2.166	1.997	1.849	1.720	1.605
5	4.853	4.713	4.452	4.212	3.993	3.791	3.605	3.433	3.352	3.274	3.127	2.991	2.864	2.745	2.689	2.635	2.532	2.436	2.220	2.035	1.876	1.737
6	5.795	5.601	5.242	4.917	4.623	4.355	4.111	3.889	3.784	3.685	3.498	3.326	3.167	3.020	2.951	2.885	2.759	2.643	2.385	2.168	1.983	1.824
7	6.728	6.472	6.002	5.582	5.206	4.868	4.564	4.288	4.160	4.039	3.812	3.605	3.416	3.242	3.161	3.083	2.937	2.802	2.508	2.263	2.057	1.883
8	7.652	7.325	6.733	6.210	5.747	5.335	4.968	4.639	4.487	4.344	4.078	3.837	3.619	3.421	3.329	3.241	3.076	2.925	2.598	2.331	2.108	1.922
9	8.566	8.162	7.435	6.802	6.247	5.759	5.328	4.946	4.772	4.607	4.303	4.031	3.786	3.566	3.463	3.366	3.184	3.019	2.665	2.379	2.144	1.948
10	9.471	8.983	8.111	7.360	6.710	6.145	5.650	5.216	5.019	4.833	4.494	4.192	3.923	3.682	3.571	3.465	3.269	3.092	2.715	2.414	2.168	1.965
11	10.368	9.787	8.760	7.887	7.139	6.495	5.937	5.453	5.234	5.029	4.656	4.327	4.035	3.776	3.656	3.544	3.335	3.147	2.757	2.438	2.185	1.977
12	11.255	10.575	9.385	8.384	7.536	6.814	6.194	5.660	5.421	5.197	4.793	4.439	4.127	3.851	3.725	3.606	3.387	3.190	2.779	2.456	2.196	1.985
13	12.134	11.343	9.986	8.853	7.904	7.103	6.424	5.842	5.583	5.342	4.910	4.533	4.203	3.912	3.780	3.656	3.427	3.223	2.799	2.469	2.204	1.990
14	13.004	12.106	10.563	9.295	8.244	7.367	6.628	6.002	5.724	5.468	5.008	4.611	4.265	3.962	3.824	3.695	3.459	3.249	2.814	2.477	2.210	1.993
15	13.865	12.849	11.118	9.712	8.559	7.606	6.811	6.142	5.847	5.575	5.092	4.675	4.315	4.001	3.859	3.726	3.483	3.268	2.825	2.484	2.214	1.995
16	14.718	13.578	11.652	10.106	8.851	7.824	6.974	6.265	5.954	5.669	5.162	4.730	4.357	4.033	3.887	3.751	3.503	3.283	2.834	2.489	2.216	1.997
17	15.562	14.292	12.166	10.477	9.122	8.022	7.120	6.373	6.047	5.749	5.222	4.775	4.391	4.059	3.910	3.771	3.518	3.295	2.840	2.492	2.218	1.998
18	16.398	14.992	12.659	10.828	9.372	8.201	7.250	6.467	6.128	5.818	5.273	4.812	4.419	4.080	3.928	3.786	3.529	3.304	2.844	2.493	2.219	1.999
19	17.226	15.678	13.134	11.158	9.604	8.365	7.366	6.550	6.198	5.877	5.316	4.844	4.442	4.097	3.942	3.799	3.539	3.311	2.848	2.496	2.220	1.999
20	18.046	16.351	13.590	11.470	9.818	8.514	7.469	6.623	6.259	5.929	5.353	4.870	4.460	4.110	3.954	3.808	3.546	3.316	2.850	2.497	2.221	1.999
21	18.857	17.011	14.029	11.764	10.017	8.649	7.562	6.687	6.312	5.973	5.384	4.891	4.476	4.121	3.963	3.816	3.551	3.320	2.852	2.498	2.221	2.000
22	19.660	17.658	14.451	12.042	10.201	8.772	7.645	6.743	6.359	6.011	5.410	4.909	4.488	4.130	3.970	3.822	3.556	3.323	2.853	2.498	2.222	2.000
23	20.456	18.292	14.857	12.303	10.371	8.883	7.718	6.792	6.399	6.044	5.432	4.925	4.499	4.137	3.976	3.827	3.559	3.325	2.854	2.499	2.222	2.000
24	21.243	18.914	15.247	12.550	10.529	8.985	7.784	6.835	6.434	6.073	5.451	4.937	4.507	4.143	3.981	3.831	3.562	3.327	2.855	2.499	2.222	2.000
25	22.023	19.523	15.622	12.783	10.675	9.077	7.843	6.873	6.464	6.097	5.467	4.948	4.514	4.147	3.985	3.833	3.564	3.329	2.856	2.499	2.222	2.000
26	22.795	20.121	15.983	13.003	10.810	9.161	7.896	6.906	6.491	6.118	5.480	4.956	4.520	4.151	3.988	3.837	3.566	3.331	2.856	2.500	2.222	2.000
27	23.560	20.707	16.330	13.211	10.935	9.237	7.943	6.935	6.514	6.136	5.492	4.964	4.524	4.154	3.990	3.839	3.567	3.331	2.856	2.500	2.222	2.000
28	24.316	21.281	16.663	13.406	11.051	9.307	7.984	6.961	6.534	6.152	5.502	4.970	4.528	4.157	3.992	3.840	3.568	3.331	2.857	2.500	2.222	2.000
29	25.066	21.844	16.984	13.591	11.158	9.370	8.022	6.983	6.551	6.166	5.510	4.975	4.531	4.159	3.994	3.841	3.569	3.332	2.857	2.500	2.222	2.000
30	25.808	22.396	17.292	13.765	11.258	9.427	8.055	7.003	6.566	6.177	5.517	4.979	4.534	4.160	3.995	3.842	3.569	3.332	2.857	2.500	2.222	2.000
40	32.835	27.355	19.793	15.046	11.925	9.779	8.244	7.105	6.642	6.236	5.548	4.997	4.544	4.166	3.999	3.846	3.571	3.333	2.857	2.500	2.222	2.000
50	39.196	31.424	21.482	15.762	12.234	9.915	8.304	7.133	6.661	6.246	5.554	4.999	4.545	4.167	4.000	3.846	3.571	3.333	2.857	2.500	2.222	2.000

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