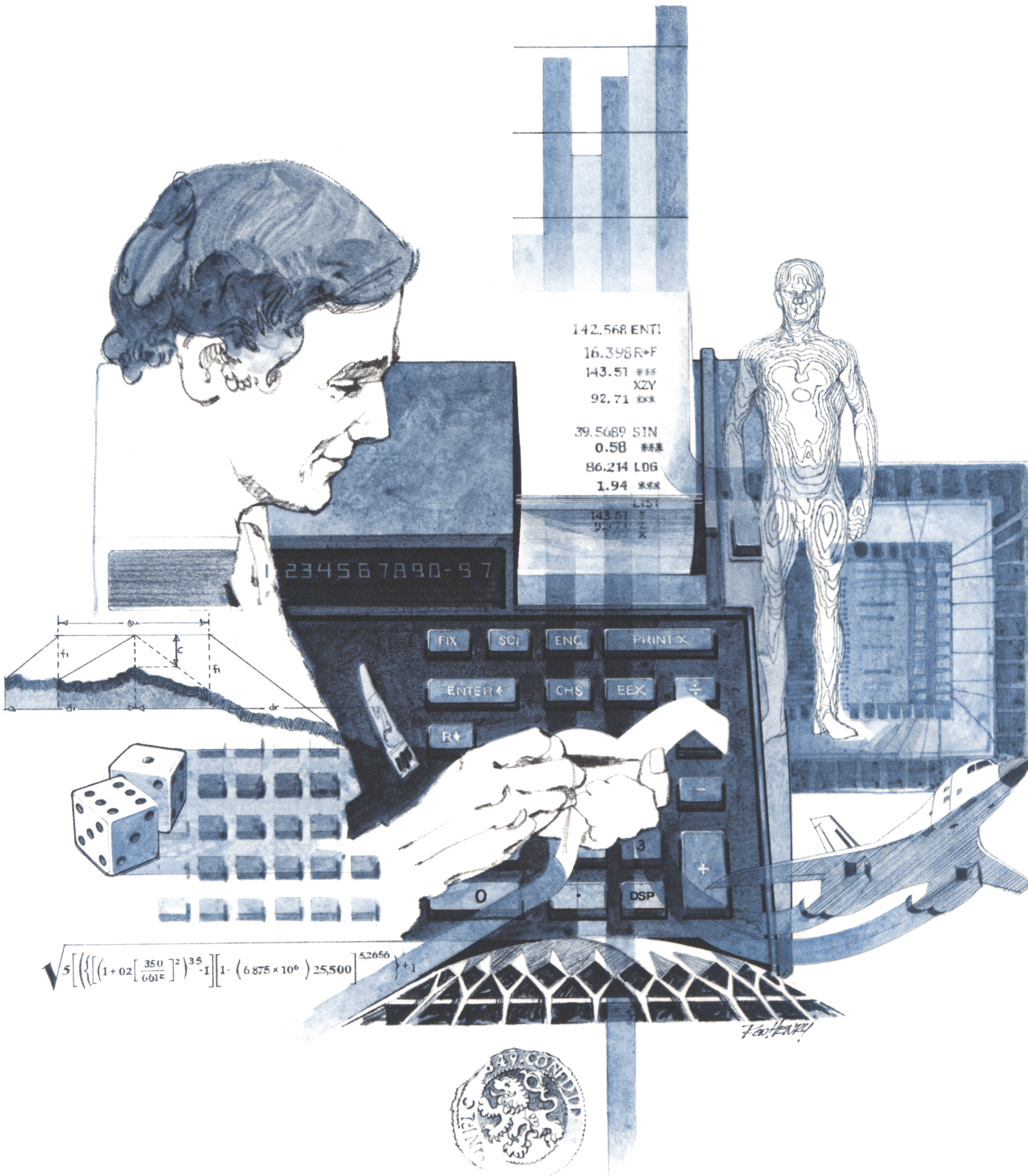
HEWLETT-PACKARD

HP-67/HP-97

Users' Library Solutions

Marketing/Sales



INTRODUCTION

In an effort to provide continued value to it's customers, Hewlett-Packard is introducing a unique service for the HP fully programmable calculator user. This service is designed to save you time and programming effort. As users are aware, Programmable Calculators are capable of delivering tremendous problem solving potential in terms of power and flexibility, but the real genie in the bottle is program solutions. HP's introduction of the first handheld programmable calculator in 1974 immediately led to a request for program **solutions** — hence the beginning of the HP-65 Users' Library. In order to save HP calculator customers time, users wrote their own programs and sent them to the Library for the benefit of other program users. In a short period of time over 5,000 programs were accepted and made available. This overwhelming response indicated the value of the program library and a Users' Library was then established for the HP-67/97 users.

To extend the value of the Users' Library, Hewlett-Packard is introducing a unique service—a service designed to save you time and money. The Users' Library has collected the best programs in the most popular categories from the HP-67/97 and HP-65 Libraries. These programs have been packaged into a series of low-cost books, resulting in substantial savings for our valued HP-67/97 users.

We feel this new software service will extend the capabilities of our programmable calculators and provide a great benefit to our HP-67/97 users.

A WORD ABOUT PROGRAM USAGE

Each program contained herein is reproduced on the standard forms used by the Users' Library. Magnetic cards are not included. The Program Description I page gives a basic description of the program. The Program Description II page provides a sample problem and the keystrokes used to solve it. The User Instructions page contains a description of the keystrokes used to solve problems in general and the options which are available to the user. The Program Listing I and Program Listing II pages list the program steps necessary to operate the calculator. The comments, listed next to the steps, describe the reason for a step or group of steps. Other pertinent information about data register contents, uses of labels and flags and the initial calculator status mode is also found on these pages. Following the directions in your HP-67 or HP-97 **Owners' Handbook and Programming Guide,** "Loading a Program" (page 134, HP-67; page 119, HP-97), key in the program from the Program Listing I and Program Listing II pages. A number at the top of the Program Listing indicates on which calculator the program was written (HP-67 or HP-97). If the calculator indicated differs from the calculator you will be using, consult Appendix E of your **Owner's Handbook** for the corresponding keycodes and keystrokes converting HP-67 to HP-97 keycodes and vice versa. No program conversion is necessary. The HP-67 and HP-97 are totally compatible, but some differences do occur in the keycodes used to represent some of the functions.

A program loaded into the HP-67 or HP-97 is not permanent—once the calculator is turned off, the program will not be retained. You can, however, permanently save any program by recording it on a blank magnetic card, several of which were provided in the Standard Pac that was shipped with your calculator. Consult your **Owner's Handbook** for full instructions. A few points to remember:

The Set Status section indicates the status of flags, angular mode, and display setting. After keying in your program, review the status section and set the conditions as indicated before using or permanently recording the program.

REMEMBER! To save the program permanently, **clip** the corners of the magnetic card once you have recorded the program. This simple step will protect the magnetic card and keep the program from being inadvertently erased.

As a part of HP's continuing effort to provide value to our customers, we hope you will enjoy our newest concept.

TABLE OF CONTENTS

Program Description I

Program Title "Forecasting Using Exponential Smoothing"

Contributor's Name Robert Olsen, Professor of Marketing

Address Dept. of Marketing, LH-626, California State University, Fullerton

City Fullerton State California Zip Code 92634

Program Description, Equations, Variables This is a singly-smoothed exponential forecasting routine which: (1) accommodates quarterly seasonal correction factors, (2) can handle some trend in the data, (3) produces smoothed estimates of current demand, D_t, (4) produces next-period smoothed demand estimates, D_{t+1}, (5) calculates a mean absolute deviation, MAD, and a tracking ratio, TR, (6) also provides a goodness-of-fit measure, V, which measures the variance between the next period's demand estimate to that period's actual demand, and (7) provides for convenient restarting when the user wants to update a data-series. While written for an HP-67, the program coding includes the option of printing all important results when an HP-97 is used.

Introductory Remarks. Exponential smoothing is a special kind of moving average. It is often used for short-term sales and inventory forecasts. Typical forecast periods are a month or quarter of a year.

Unlike a moving average, exponential smoothing does not require a great deal of historical data. This program, for example, forecasts demand by using only a smoothing constant, an "old smoothed average," and a current-period usage statistic.

Normally, exponential smoothing uses data measured in physical quantities

Operating Limits and Warnings Should not be used with data which has more than a moderate amount of up or down trend. (Use double smoothing for data with a pronounced trend.) Program has no provision for error correction. Initializing resets the seasonal correction constants to 1.0. $\hat{D}_{t+1}$ must be calculated for each time period if MAD, TR, or V are desired. At least two projections of $\hat{D}_{t+1}$ must be done before MAD or TR can be calculated.

(cases, tons, dozens, reams, etc.). It also can be used with dollar amounts but care must be taken to see that the amounts are stated in constant-dollar terms.

1. Methodology. This program is a versatile first-order smoothing routine for short-term forecasting with data having modest changes in its time-trend component. Such data will appear as a more-or-less horizontal line when plotted against time on a graph, with time being on the horizontal axis. If there is a trend in the plot this program will generate estimates which lag behind the trend line even though the formulas contain a trend correction factor. Double exponential smoothing should be used when the trend is pronounced.

Quarterly seasonal adjustments are available in this program but they are not required. This explanation begins without considering the deseasonalizing option. See Section 6 for the deseasonalizing option.

A trend-responsive first-order forecast from deseasonalized data is developed as follows.

a. Calculate a smoothed (weighted) average of: (1) actual demand/usage/sales in the current time-period, and (2) the smoothed average of demand/usage/sales in prior time periods.

$$S_t = \alpha X_t + (1 - \alpha)S_{t-1}$$

where

S_t = Current period's smoothed average
X_t = Actual current period usage
α = $0 < \alpha < +1$

b. Calculate the change, C_t, in the smoothed average S_t between this period (t) and the prior period (t-1).

$$C_t = S_t - S_{t-1}$$

c. Calculate the current smoothed rate-of-change (trend), T_t, in the smoothed average, S, between t-1 and t.

$$T_t = \alpha C_t + (1 - \alpha)T_{t-1}$$

d. Calculate the current period's expected usage, D_t. This result is an exponentially smoothed projection of what usage is expected to be in the current time period, t. It is not a forecast for period t+1.

$$D_t = S_t + ((1 - \alpha)/\alpha)T_t$$

e. Forecast the next period's expected usage.

$$\hat{D}_{t+1} = S_t + (1 / \alpha)T_t$$

f. More generally, a forecast for n time periods in the future can be obtained from the formula

$$\hat{D}_{t+n} = S_t + (1/\alpha + n - 1)T_t \qquad .$$

This formula is not included in the program but the necessary data can be gotten by inserting R/S instructions after Step 101 (S_t) and Step 112 (T_t). When Key B is pressed these values will appear after B_i but before D_t.

2. Choice of Smoothing Constant, α. α must be determined empirically. Low values of α make the trend line less responsive to new data. Responsiveness, however, means that the trend line will respond to spurious changes as well as real changes in trend. Brown and other authorities (see references below) recommend α values between 0.1 and 0.3. Trial-and-error experimentation usually is required to find a good α value for a time series. See Sections 4 and 5 for further comments.

3. Starting Data. The equations used for exponential smoothing constitute a system which has infinite regress. In theory one could go backwards in time forever because of the equation

$$S_t = \alpha X_t + (1 - \alpha)S_{t-1} \quad .$$

Where should one stop (or begin)? Somehow, then, a starting value for S_{t-1} must be found. This program assumes a default option of $S_{t-1} = X_{t-1}$ on the first iteration, following Buffa and Taubert. (This can be defeated. See Step 6 of the User Instructions.)

In addition, a starting value for T_{t-1} must be found. This program assumes a default option of $T_{t-1} = 0$. Again, this follows Buffa and Taubert. (This also can be defeated. See Step 5 of the User Instructions.)

These assumptions make it advisable not to forecast until at least four periods of current data have been entered (i.e., until Key B has been used at least four times).

4. Tracking Signals. Brown (p. 296) and Enrick (p. 17) describe the concept of a tracking signal, or tracking ratio. This measure is one way to evaluate goodness-of-fit. Conceptually, a tracking ratio is the cumulative sum of an equation's forecasting errors (either + or -) relative to the equation's cumulative mean absolute deviation.

A tracking ratio which is consistently close to 0.0 is good, while a tracking ratio which goes much above ± 3 is questionable. Exceeding 3 suggests that the process no longer is being controlled by the smoothing formula and that the researcher should develop a new formula to cope with changed conditions.

The formulas used here are from Enrick. They are simpler than Brown's and avoid several measurement problems which cannot be easily summarized in this write-up. The trade-offs are: (1) Enrick's tracking ratio is not as accurate for the first few iterations, and (2) Enrick's tracking ratio does not lend itself to statistical inference. (Brown's does.)

In this program all the calculations are done with deseasonalized data. Here are the formulas.

$$\text{CFE} = \sum_{1}^{N} (X_t - \hat{D}_t)$$

$$\text{CAD} = \sum_{1}^{N} |(X_t - \hat{D}_t)|$$

$$\text{MAD} = \text{CAD}/B_{n-1}$$

$$\text{TR} = \text{CFE}/\text{MAD}$$

where

CFE	=	Cumulative Forecast Error (can be + or -)
CAD	=	Cumulative Absolute Deviation
MAD	=	Mean Absolute Deviation
TR	=	Tracking Ratio
B_n	=	Number of times a smoothed forecast $\hat{D}_{t+1}$ has been calculated (done by pressing Key C after Key B after <u>each</u> entry of data by Key B)

Notice the "hat" superscript over the D_t values in the formulas. The hat emphasizes that the comparisons are being made between observed demand in period t and the forecasted demand projection made earlier in period t-1. Also notice that the formula for CFE is written so that an overforecast of demand results in a negative value for CFE. Conversely, an underforecast results in a positive value. This sign convention carries through to the tracking ratio results as well.

5. <u>Variance Measure</u>. This program also calculates a variance, V, as follows.

$$V = \frac{\sum e_i^2}{n} = \frac{\sum\left(\hat{D}_t - X_t\right)^2}{B_n}$$

This variance is provided to give another measure of variability. It is useful for measuring variance as statisticians define it, but it is not a particularly good way to assess goodness-of-fit. Oftentimes the variance*when α is set very high, such as in the range of 0.7 to 0.9. Such an α implies that the smoothing process is not working very well and that some other smoothing procedure should be tried. Restated, a high value of α implies that practically no smoothing is being done and that another approach should be tried. *will be minimized

6. <u>Deseasonalization of Data</u>. The following examples show how seasonalized and deseasonalized data are distinguished in this write-up.

$X_{t(S)}$	=	Actual usage, inclusive of a seasonal component
$X_{t(D)}$	=	Actual usage, deseasonalized
$D_{t(D)}$	=	Deseasonalized expected usage

Assuming that quarterly deseasonalizing constants, SV_i (i = 1, 2, 3, 4) are available, those constants can be entered into this program so that the deseasonalization will be done automatically. One program which will produce the correct seasonal constants is "Seasonal Variation Factors," in the Hewelett-Packard Marketing/Sales Solutions Manual.

This program assumes that the seasonal factors will be used multiplicatively to eliminate seasonality. That is,

$$X_{t(S)} \cdot SV_i = X_{t(D)} \quad .$$

A multiplicative constant of 0.909 (0.909 = 1.00/110%) thus would be used to deseasonalize an observation for a quarter which normally had a usage rate which was 10% greater than the annual average.

This process operates in the reverse when re-seasonalizing data. To obtain

$\hat{D}_{t+1(S)}$, for example, the following is done. $\hat{D}_{t+1(D)} \div SV_i = \hat{D}_{t+1(S)}$

7. Counters for Time. Two counters keep track of time. B_i records the number of times a smoothed demand estimate is calculated. It does that by counting the number of times Key B is pressed. Counter Q_i is used with the de-seasonalizing adjustment option. Q_i keeps track of the fiscal quarter or calendar quarter associated with a given X_t. Since Q_i is entered by means of Key A for time period t-1, Q_i should always be for time period t-1.

Examples: (refer to the numbering convention in the next paragraph) - Suppose that X_{t-1} (Key A's input) is for the 4th calendar quarter of the preceding year. Then Q_i should be entered as 4. Now suppose that X_{t-1} is for the 2nd quarter of the current year. Then Q_i should be entered as 2.

Following is the numbering convention.

B_i	=	1	1st quarter of the year
		2	2nd quarter of the year
		3	3rd quarter of the year
		4	4th quarter of the year

Finally, Key f b assumes that the seasonal constants always will be entered in this order: SV_1, SV_2, SV_3, and SV_4 (see the User Instructions). The order of entry via Key f b has no relationship to the Q_i figure entered in the start-up process.

8. Coding. The basic coding is relatively straightforward. The one thing to remember is that all values are time-dated. The coding in f LBL 0 may therefore seem confusing, for it uses D_{t+1} values calculated in prior time periods as the basis for its calculations. Just keep in mind that those values were calculated one iteration earlier.

Some users are likely to want to modify the instructions used here for the program stops (h PAUSE, f -x-, R/S) to better fit their needs. That can be done, but be sure not to alter any h RTN instructions without carefully considering the consequences. Changes in some of them could cause the program to "run through" a label and desynchronize the time-counters B_i and Q_i. Also, 97 users may want to add print-outs of the input data: only results are printed in this program.

9. Limitations. The chief limitation of this program is the limitation of the methodology itself. First-order exponential smoothing is not appropriate for data with a pronounced upward or downward trend. A lesser shortcoming is the need to let the start-up assumptions work themselves out of the equation system.

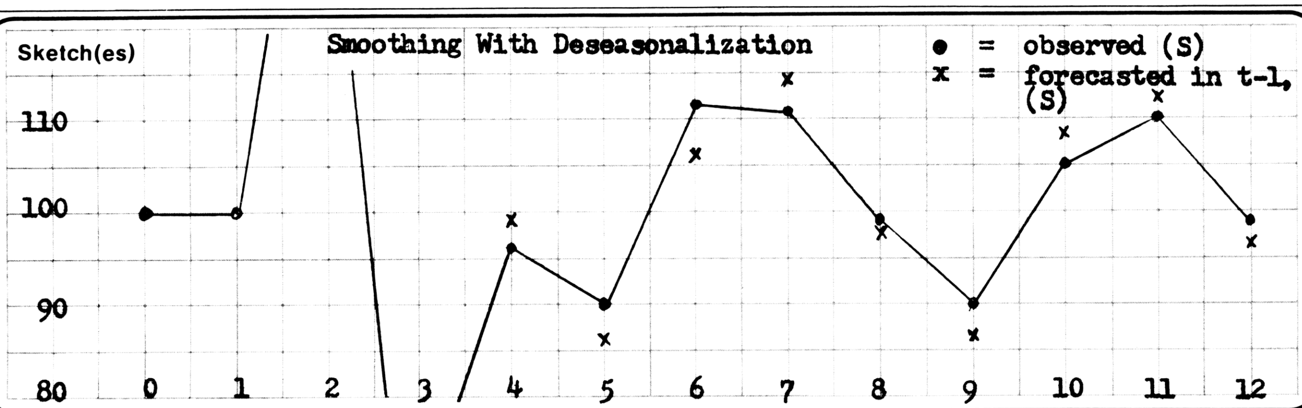
References. Robert Goodell Brown, Smoothing, Forecasting, and Prediction of Discrete Time Series (Englewood Cliffs, N.J.: Prentice-Hall, 1963). An excellent general introduction to the subject.

Elwood S. Buffa and William H. Taubert, Production-Inventory Systems: Planning and Control, Rev. ed.(Homewood, Illinois: Richard D. Irwin, 1972), pp. 44-45. Has the formulas used for Keys B and C.

Norbert Lloyd Enrick, Market and Sales Forecasting (San Francisco, Calif.: Chandler Publishing Co., 1969), p. 17. Has the formulas for Key D.

Program Description II

Sketch(es)



Sample Problem(s) Refer to the data on page 7 for the case where deseasonalization is to be done. Proceed as follows.

		Inputs	Keys	Outputs	
1. Initialize			f A	1.00	
2. Enter seasonal factors	SV_1	1.15	↑		
	SV_2	0.94	↑		
	SV_3	0.89	↑		
	SV_4	1.02	f B	1.02	SV_4
3. Enter start-up data	α	.2	↑		
	Q_0	4	↑		
	X_0	100	A	102.00	$X_{0(D)}$
4. Enter current usage, find D_1	X_1	100	B	1.00	B_1
				106.80	$D_{1(D)}$
			R/S	92.77	$D_{1(S)}$
5. Find forecasted usage, $\hat{D}_2$			C	107.20	$\hat{D}_{2(D)}$
[redacted]				114.04	$\hat{D}_{2(S)}$
6. Enter current usage, find D_2	X_2	150	B	2.00	B_2
				119.37	$D_{2(D)}$
			R/S	126.99	$D_{2(S)}$
7. Find forecasted usage, $\hat{D}_3$			C	121.24	$\hat{D}_{3(D)}$
				136.22	$\hat{D}_{3(S)}$
8. Find MAD, TR			D	33.80	MAD
				1.00	TR

[redacted]

9. Find Σe_i^2, B_2, V	E	1142.44	Σe_i^2
		2.00	B_2
		571.22	V

See page 7 for additional example results.

Test Data When Deseasonalization Not Done, Alpha = 0.2

Time Period (Iteration)	Actual X_t	Smoothed D_t	Forecast D_{t+1}	MAD	TR	V
0	100					
1	100	100	100	-	-	-0-
2	150	118	120	50	1.00	1,250
3	70	102	102	50	0.00	1,667
4	180	130	133	59	1.31	2,771
5	98	121	122	53	0.80	2,465
6	104	116	117	46	0.53	2,109
7	105	112	113	41	0.32	1,827
8	99	108	108	37	-0.03	1,623
9	101	105	105	33	-0.24	1,448
10	102	104	104	30	-0.37	1,304
11	99	102	101	27	-0.57	1,188
12	98	100	99	25	-0.76	1,090

Test Data When Deseasonalization Done, Alpha = 0.2*

Time Period (Iteration)	Actual X_t	Smoothed $D_{t(S)}$	Forecast $D_{t+1}(S)$	MAD	TR	V
0	100					
1	100	93	114	-	-	-0-
2	150	127	136	34	1.00	571
3	70	112	98	46	-0.54	1,539
4	96	97	86	31	-0.85	1,155
5	90	87	106	25	-0.87	929
6	112	108	114	21	-0.78	779
7	111	113	98	18	-1.07	669
8	99	99	87	15	-1.20	585
9	90	88	108	14	-1.11	521
10	105	107	113	13	-1.44	470
11	110	112	97	12	-1.76	428
12	99	98	87	11	-1.73	392

* $SV_1 = 1.15$, $SV_2 = 0.94$, $SV_3 = 0.89$, $SV_4 = 1.02$

User Instructions

SINGLE EXPONENTIAL SMOOTHING W/ TREND & SEASONAL ADJUSTMENTS

1 | Initial. | $SV_i\uparrow$ | Print? | 2

$\alpha\uparrow Q_i\uparrow X_{t-1}$ | $X_t \longrightarrow D_t$ | $\rightarrow \hat{D}_{t+1}$ | $\rightarrow$ MAD, TR | $\rightarrow \Sigma e_i^2$, V

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Load both sides of program card			
2	Initialize		f A	1.00
3	(Optional) Enter seasonal coefficients (default	SV_1	$\uparrow$	
	assumption is no seasonal variation)	SV_2	$\uparrow$	
		SV_3	$\uparrow$	
		SV_4	f B	SV_4
4	Choose print mode (toggle)		f C	Pi / 0.00
	(Pi = print all results / 0.00 = print some)			
	Pi and zero appear alternately			
5	(Optional) Store T_{t-1}, if known (default = 0)	T_{t-1}	STO 4	
6	Input α, Q_i for T_{t-1}, X_{t-1} (or S_{t-1}, if	α	$\uparrow$	
	known)	Q_i	$\uparrow$	
		X_{t-1}	A	X_{t-1}(D)
7	Find expected current usage. Key in X_t	X_t	B	B_i
				D_t(D)
	(Optional) Find seasonalized D_t		R/S	D_t(S)
8	(Optional) Find $\hat{D}_{t+1}$ and set up calculations		C	$\hat{D}_{t+1}$(D)
	needed for MAD, TR, & V			$\hat{D}_{t+1}$(S)
9	Find MAD, TR. (Can be done if Key C has been pressed		D	MAD
	each time data has been entered by Key B. Error mes-			TR
	sage is given if B_i = 0 or 1.)			
10	Find Σe_i^2, V (Can be done if Key C has been pressed		E	Σe_i^2
	each time data has been entered by Key B. Error mes-			B_i
	sage is given if B_i = 0.)			V
11	Continue entering data by Key B (Step 6), re-			
	peating steps 8 - 10 as desired.			
12	Record data for future use		f W/DATA	
13	To restart with data recorded on data card			
	a. Load both sides of program card			
	b. Load both sides of data card			
	c. Begin at Step 7			

Program Listing I

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	*g LBLf a	32 25 11	Initialize
	f CL REG	31 43	
	f P≷S	31 42	
	f CL REG	31 43	
	1	01	
	STO 1	33 01	Assume no seasonal-
	STO 2	33 02	ity. Store 1 in all
	STO 3	33 03	SV registers.
	STO 4	33 04	
010	f P≷S	31 42	
	1	01	SV_i = 1 prompt
	h RTN	35 22	
	*g LBLf b	32 25 12	Enter SV's
	f P≷S	31 42	
	STO 4	33 04	SV_4
	h R↓	35 53	
	STO 3	33 03	SV_3
	h R↓	35 53	
	STO 2	33 02	SV_2
020	h R↓	35 53	
	STO 1	33 01	SV_1
	RCL 4	34 04	Prompt - SV's used
	f P≷S	31 42	
	h RTN	35 22	
	*g LBLf c	32 25 13	Print? Yes, all.
	h SF 1	35 51 01	
	h Pi	35 73	Mnemonic for print
	h RTN	35 22	
	*g LBLf c	32 25 13	Print? Not all re-
030	h CF 1	35 61 01	sults.
	0	00	
	h RTN	35 22	
	*f LBL A	31 25 11	Enter start-up data
	STO C	33 13	X_{t-1}
	h R↓	35 53	
	STO 8	33 08	Q_i for X_{t-1}
	h R↓	35 53	
	STO A	33 11	
	CHS	42	
040	1	01	
	+	61	
	STO B	33 12	$1-\alpha$
	RCL 8	34 08	Deseasonalize X_{t-1}
	1	01	
	0	00	
	+	61	
	h ST I	35 33	
	RCL (i)	34 24	SV_i
	RCL C	34 13	X_{t-1}
050	X	71	$X_{t-1}(D)$
	STO D	33 14	Proxy for S_{t-1}
	STO 1	33 01	
	h RTN	35 22	
	*f LBL B	31 25 12	Enter X_t
	STO 0	33 00	
	1	01	

STEP	KEY ENTRY	KEY CODE	COMMENTS
	STO + 8	33 61 08	Q_i
	5	05	Is Q_i = 5?
	RCL 8	34 08	
060	g x = y?	32 51	
Yes	f GSB 6	31 22 06	Reset. Step 204.
No	RCL 8	34 08	
	1	01	Get SV_i
	0	00	
	+	61	
	h ST I	35 33	
	RCL (i)	34 24	SV_i
	RCL 0	34 00	← $X_t(S)$
	X	71	$X_t(D)$
070	STO E	33 15	
	1	01	Increment B_i
	STO + 9	33 61 09	
	RCL 9	34 09	B_i
	h F? 1	35 71 01	
Yes	f -x-	31 84	
No	h PAUSE	35 72	
	*f LBL 0	31 25 00	Fit, MAD, Tracking
	1	01	
	g x = y?	32 51	First iteration?
080 Yes	GTO 1	22 01	Bypass to Step 093
No	RCL E	34 15	$X_t(D)$
	f P≷S	31 42	
	RCL 9	34 09	Prior period estimate of $\hat{D}_{t+1}(D)$
	-	51	
	STO + 5	33 61 05	CFE
	STO 8	33 08	
	h ABS	35 64	
	STO + 6	33 61 06	CAD
	RCL 8	34 08	e_i
090	g x^2	32 54	
	f P≷S	31 42	
	STO + 3	33 61 03	Σe_i^2
	*f LBL 1	31 25 01	Calculate $S_t(D)$
	RCL B	34 12	
	RCL 1	34 01	$S_{t-1}(D)$
	X	71	
	RCL A	34 11	
	RCL E	34 15	$X_t(D)$
	X	71	
100	+	61	
	STO 2	33 02	$S_t(D)$
	*f LBL 2	31 25 02	Calculate $C_t(D)$
	RCL 1	34 01	
	-	51	C_t
	*f LBL 3	31 25 03	Calculate $T_t(D)$
	RCL A	34 11	
	X	71	
	RCL 4	34 04	
	RCL B	34 12	
110	X	71	
	+	61	
	STO 5	33 05	$T_t(D)$

REGISTERS

0 $X_t(S)$	1 S_{t-1}	2 S_t	3 Σe_i^2	4 T_{t-1}	5 T_t	6 D_{t-1}	7 D_t	8 Q_i	9 B_i
S0 -	S1 SV_1	S2 SV_2	S3 SV_3	S4 SV_4	S5 CFE	S6 CAD	S7 -	S8 Temp e_i	S9 $\hat{D}_{t+1}$

A α	B $1-\alpha$	C $X_{t-1}(S)$	D $X_{t-1}(D)$	E $X_t(D)$	I Rel. address

Program Listing II

STEP	KEY ENTRY	KEY CODE	COMMENTS
	*f LBL 4	31 25 04	Calculate $D_{t(D)}$
	RCL B	34 12	
	RCL A	34 11	
	÷	81	
	RCL 5	34 05	
	X	71	
	RCL 2	34 02	
120	+	61	
	STO 7	33 07	$D_{t(D)}$
	*f LBL 8	31 25 08	Move results from
	RCL 2	34 02	t registers to t-1
	STO 1	33 01	registers
	RCL 5	34 05	
	STO 4	33 04	
	RCL 7	34 07	
	STO 6	33 06	
	RCL E	34 15	
130	STO D	33 14	
	RCL 7	34 07	$D_{t(D)}$
	h F? 1	35 71 01	
Yes	f -x-	31 84	
No	R/S	84	
	*f LBL 9	31 25 09	Calculate $D_{t(S)}$
	1	01	
	0	00	
	RCL 8	34 08	Q_i
	+	61	
140	h ST I	35 33	
	RCL 7	34 07	
	RCL (i)	34 24	
	÷	81	$D_{t(S)}$
	h F? 1	35 71 01	
	f -x-	31 84	
	h RTN	35 22	
	*f LBL C	31 25 13	Calculate D_{t+1}
	RCL 2	34 02	
	RCL 5	34 05	
150	RCL A	34 11	
	÷	81	
	+	61	$D_{t+1(D)}$
	h F? 1	35 71 01	
Yes	f -x-	31 84	
No	h PAUSE	35 72	
	f P≷S	31 42	
	STO 9	33 09	
	f P≷S	31 42	
	1	01	Q_i more than 4?
160	5	05	
	RCL 8	34 08	Q_i
	1	01	
	1	01	
	+	61	
	g x = y?	32 51	
Yes	f GSB 7	31 22 07	Step 177
No	h ST I	35 33	
	RCL (i)	34 24	SV_i

STEP	KEY ENTRY	KEY CODE	COMMENTS
	f P≷S	31 42	
170	RCL 9	34 09	$D_{t+1(D)}$
	f P≷S	31 42	
	h x≷y	35 52	
	÷	81	$D_{t+1(S)}$
	h F? 1	35 71 01	
Yes	f -x-	31 84	
No	h RTN	35 22	
	*f LBL 7	31 25 07	Reset Q_i
	1	01	
	1	01	
180	h RTN	35 22	
	*f LBL D	31 25 14	MAD & Tracking Rat-
	f P≷S	31 42	io
	RCL 5	34 05	CFE
	RCL 6	34 06	CAD
	f P≷S	31 42	
	RCL 9	34 09	B_i
	1	01	
	-	51	
	÷	81	MAD
190	f -x-	31 84	
	÷	81	TR
	h F? 1	35 71 01	
Yes	f -x-	31 84	
No	h RTN	35 22	
	*f LBL E	31 25 15	Fit
	RCL 3	34 03	Σe_i^2
	f -x-	31 84	
	RCL 9	34 09	B_i
	h PAUSE	35 72	
200	÷	81	V
	h F? 1	35 71 01	
Yes	f -x-	31 84	
No	h RTN	35 22	
	*f LBL 6	31 25 06	Reset Q_i to 1
	1	01	
	STO 8	33 08	
	h RTN		

LABELS

A	B	C	D	E
$\alpha \uparrow Q_i \uparrow X_{t-1}$	X_t	D_{t+1}	MAD, TR	Σe_i^2

a	b	c	d	e
Initial.	SV_i	-	-	-

0	1	2	3	4
Σe_i^2	S_t	C_t	T_t	D_t

5	6	7	8	9
CFE, CAD	Reset Q_i	Reset Add	t → t-1	$D_{t(S)}$

FLAGS

Flag	
0	-
1	Print?
2	-
3	-

SET STATUS

FLAGS	ON	OFF	TRIG		DISP	
0	☐	☒	DEG	☒	FIX	☒
1	☐	☒	GRAD	☐	SCI	☐
2	☐	☒	RAD	☐	ENG	☐
3	☐	☒			n 2	

Program Description I

Program Title Financial Trend Analysis

Contributor's Name Robert Walker

Address 23413 Broadwell Ave.

City Torrance, **State** Calif. **Zip Code** 90502

Program Description, Equations, Variables Many types of financial data follow a continuous compounded growth pattern which can be depicted by an exponential function ($Y=ae^{bx}$). This program fits these data points to an exponential curve and calculates the regression coefficients and the coefficient of determination. In addition, the program outputs the compounded annual growth trend $100(1-e^{b})$ and the geometric mean of the data. ($GM =_e (\Sigma \ln Y/N)$).

Stability is a number which measures the degree of consistency about a given reference. This program calculates the stability about the mean (standard deviation of the data), $\sigma = \left[(\ln Y-\overline{\ln Y})/N\right]^{\frac{1}{2}}$; and the stability about the trend line (standard error of the estimate), $\sigma_e = \sigma(1-r^2)^{\frac{1}{2}}$.

Projections for the independent variable can also be made.

Operating Limits and Warnings Since the program uses logrithms to manipulate the data, negative values will cause an error message to be displayed.

Program Description II

Sketch(es)

Sample Problem(s) Listed are the company's reported earnings per share (EPS) for the years 1966-1975. Calculate the coefficients of the least square trend line for the data, the coefficient of determination, the annualized rate of EPS growth, the geometric mean EPS for the period, the stability of the percentage fluctuations about the mean, and the stability of the percentage fluctuation about the trend line.

Year	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
EPS	$0.68	$0.73	$0.75	$0.82	$0.73	$1.03	$1.47	$1.89	$1.65	$2.08

What is the trend line estimated EPS for 1976?

Solution(s)

f A → 1.00

.68 A .73 A .75 A .82 A .73 A 1.03 A 1.47 A 1.89 A 1.65 A 2.08 A → 11.00

B a → 0.51

B b → 0.14

B r^2 → 0.88

D → 14.60 Annualized Trend (%) ; D → 1.08 Geometric mean of EPS

E → 0.44 Stability about the mean ; E → 0.16 Stability about trend line 11 C → 2.29 estimated 1976 EPS

Reference(s)

Francis, Jack Clark, Investments - Analysis and Management. McGraw-Hill: New York, 1976.

Whitbeck and Kisor, "A New Tool in Investment Decision Making," Financial Analysts Journal, Vol 19, No. 3 (May-June 1963), pp. 55-62.

User Instructions

Financial Trend Analysis
INIT $\Sigma x \uparrow y(-)$
$\Sigma X \uparrow Y(+)$ | $\rightarrow a, \rightarrow b \rightarrow r^2$ | $x \rightarrow \hat{y}$ | $\rightarrow$trend$\rightarrow$G.M. | $\rightarrow \sigma \rightarrow \sigma_E$

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
1	Load side 1 and side 2				
2	Initialize		f	a	1.00
3	Enter data				
	input x value*	Xi	Enter	↑	
	input y value	Yi	A		i+1
4	Optional: delete an incorrect data pair				
	input x value	Xi	Enter	↑	
	input y value	Yi	f	B	i+1
5	Compute and Output a,b and r^2		B		
6	Optional: Make projections based on a				
	known x value	X	C		$\hat{Y}$
7	Compute and output the trend	D			Trend(%)
8	Compute and output the geometric mean	D			G.M.
9	Compute and output the stability about				
	the mean		E		σ
10	Compute and output the stability about				
	the trend line		E		σ_E
	*Note: This step may be skipped if time				
	increments are equal (X value equals the				
	display counter (i+1))				

67 Program Listing I

STEP	KEY ENTRY	KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS
001	L BL a	32 25 11		057	RCL 1	34 01	
002	CL Reg	31 43		058	$\div$	81	
003	1	01		059	−	51	
004	STO 1	33 01		060	$\div$	81	
005	RTN	35 22		061	STO 7	33 07	
006	LBL A	31 25 11		062	RCL 4	34 04	
007	LN	31 52		063	RCL 7	34 07	
008	STO 7	33 07		064	RCL 2	34 02	
009	STO + 4	33 61 04		065	x	71	
010	X^2	32 54		066	−	51	
011	STO + 5	33 61 05		067	RCL 1	34 01	
012	$x \rightleftarrows y$	35 52		068	$\div$	81	
013	STO + 2	33 61 02		069	e^x	32 52	
014	X^2	32 54		070	STO 8	33 08	
015	STO + 3	33 61 03		071	RTN	25 22	
016	LST X	35 82		072	LBL B	31 25 12	
017	RCL 7	34 07		073	RCL 7	34 07	
018	X	71		074	RTN	35 22	
019	STO + 6	33 61 06		075	LBL B	31 25 12	
020	RCL 1	34 01		076	RCL 7	34 07	
021	1	01		077	RCL 9	34 09	
022	+	61		078	x	71	
023	STO 1	33 01		079	RCL 5	34 05	
024	RTN	35 22		080	RCL 4	34 04	
025	LBL b	32 25 12		081	x^2	32 54	
026	LN	31 52		082	RCL 1	34 01	
027	STO 7	33 07		083	$\div$	81	
028	STO − 4	33 51 04		084	−	51	
029	X^2	32 54		085	$\div$	81	
030	STO − 5	33 51 05		086	STO 0	33 00	
031	$x \rightleftarrows y$	35 52		087	RTN	35 22	
032	STO − 2	33 51 02		088	LBL C	31 25 13	
033	X^2	32 54		089	Enter	41	
034	STO − 3	33 51 03		090	RCL 7	34 07	
035	LST X	35 82		091	x	71	
036	RCL 7	34 07		092	e^x	32 52	
037	X	71		093	RCL 8	34 08	
038	STO − 6	33 51 06		094	x	71	
039	1	01		095	RTN	35 22	
040	STO − 1	33 51 01		096	LBL D	31 25 14	
041	RCL 1	34 01		097	RCL 7	34 07	
042	RTN	35 22		098	e^x	32 52	
043	LBL B	31 25 12		099	1	01	
044	1	01		100	−	51	
045	STO − 1	33 51 01		101	EEX	43	
046	RCL 6	34 06		102	2	02	
047	RCL 2	34 02		103	x	71	
048	RCL 4	34 04		104	RTN	35 22	
049	x	71		105	LBL D	31 25 14	
050	RCL 1	34 01		106	RCL 4	34 04	
051	$\div$	81		107	Enter	41	
052	−	51		108	RCL 1	34 01	
053	STO 9	33 09		109	$\div$	81	
054	RCL 3	34 03		110	e^x	32 52	
055	RCL 2	34 02		111	RTN	35 22	
056	x^2	32 54		112	LBL E	31 25 15	

REGISTERS

0	1	2	3	4	5	6	7	8	9
r^2	i+1, i	ΣXi	ΣXi^2	$\Sigma LN(y)$	$\Sigma LN(y)^2$	$\Sigma XLN(y)$	LN(y),b	a	Used
S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I
σ					

67 Program Listing II

STEP	KEY ENTRY	KEY CODE	COMMENTS
113	RCL 5	34 05	
114	Enter	41	
115	RCL 4	34 04	
116	x^2	32 54	
117	Enter	41	
118	RCL 1	34 01	
119	÷	81	
120	−	51	
121	Enter	41	
122	RCL 1	34 01	
123	Enter	41	
124	1	01	
125	−	51	
126	÷	81	
127	$\sqrt{x}$	31 54	
128	STO A	33 11	
129	RTN	35 22	
130	LBL E	31 25 15	
131	1	01	
132	Enter	41	
133	RCL 0	00	
134	−	51	
135	$\sqrt{x}$	31 54	
136	RCL A	34 11	
137	x	71	
138	RTN	35 22	

LABELS

A $\Sigma x\uparrow y(+)$	B $\rightarrow a, \rightarrow b \rightarrow r^2$	C $x \rightarrow \hat{y}$	D $\rightarrow$trend$\rightarrow$GM	E $\rightarrow\sigma\rightarrow\sigma_E$
a INIT	b $\Sigma x\uparrow y(-)$	c	d	e
0	1	2	3	4
5	6	7	8	9

FLAGS

0

1

2

3

SET STATUS

FLAGS	ON	OFF
0	☐	☒
1	☐	☒
2	☐	☒
3	☐	☒

TRIG	
DEG	☒
GRAD	☐
RAD	☐

DISP	
FIX	☒
SCI	☐
ENG	☐
n	2

Program Description I

Program Title SEASONAL VARIATION FACTORS

Contributor's Name Hewlett Packard

Address 1000 N.E. Circle Boulevard

City Corvallis **State** Oregon **Zip Code** 97330

Program Description, Equations, Variables, etc.

This program utilizes the four quarter moving average, two item averaging technique to develop seasonal variation factors. The technique should be applied whenever the historical data appears to have a short term cycle, i.e. less than a year. If forecasting with exponential smoothing is to be done on a basis other than quarterly it is suggested that the historical data may be grouped into quarterly figures, the quarterly seasonal variations developed, and graphed over time. The quarterly seasonal variation figures should be plotted in the center of the quarter. Seasonal variation factors for other time periods, i.e. monthly, semi-annually, etc., may then be extrapolated from the plotted graph. These extrapolations should be determined at the center of the time period involved. When graphing, the user is reminded that seasonal variation at December 31 must equal seasonal variation at January 1.

Operating Limits and Warnings

1) D has not been used as a subroutine. Depression of this key will cause indeterminant errors. Program should be restarted.

2) E is a subroutine used in data manipulation and should not be depressed. Depression of this key will cause erroneous results. Program should be restarted.

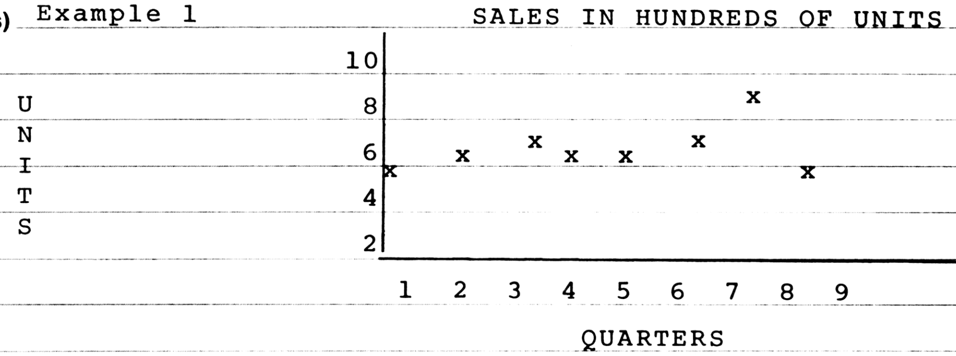
3) A minimum of two years data is required.

Program Description II

Sketch(es)

Sample Problem(s) Example 1

SALES IN HUNDREDS OF UNITS



Find the seasonal variation factors for the sales data plotted above

Solution(s)

Keystrokes	Display
5 [↑] 6[↑] 7[↑] 6[A] R/S	4.00
6 [B] 7 [R/S] 9 [R/S] 5 [R/S]	8.00
C	0.89 (SV_1)
R/S	1.02 (SV_2)
R/S	1.15 (SV_3)
R/S	0.94 (SV_4)

Reference(s)

This program is a translation of the HP-65 User's Library Program # 03973A submitted by Jim Caldwell.

User Instructions

inlt qts add. qts factors

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
1	Enter program				0.00
2	Key in Q_1	Data Q_1	Enter		Q_1
3	Key in Q_2	Data Q_2	Enter		Q_2
4	Key in Q_3	Data Q_3	Enter		Q_3
5	Key in Q_4	Data Q_4	A		4
6	Key in Q_5	Data Q_5	B		
7	Key in Q_6	Data Q_6	R/S		
8	Key in Q_7	Data Q_7	R/S		
9	Key in Q_8	Data Q_8	R/S		
10	Repeat steps 6 thru 9 for all values of Q_1				
	Note: Erroneous depression of R/S FOR 5th Q in year is indicated by flashing zeros. No harm has been done. Re-enter Z and depress B.				
11	Calculate SV1		C		SV1
12	Calculate SV2		R/S		SV2
13	Calculate SV3		R/S		SV3
14	Calculate SV4		R/S		SV4

97 Program Listing I

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	*LBLA	21 11	
002	CLRG	16-53	
003	STO4	35 04	
004	R↓	-31	
005	STO3	35 03	store initial
006	R↓	-31	quarters
007	STO2	35 02	
008	R↓	-31	
009	STO1	35 01	
010	4	04	# of data pts
011	STO5	35 05	
012	R/S	51	
013	*LBLB	21 12	
014	GSBE	23 15	
015	ST+8	35-55 08	1st quarter accum
016	RCL5	36 05	
017	R/S	51	
018	GSBE	23 15	
019	ST+9	35-55 09	2nd quarter accum
020	RCL5	36 05	
021	R/S	51	
022	GSBE	23 15	
023	ST+6	35-55 06	3rd quarter accum
024	RCL5	36 05	
025	R/S	51	
026	GSBE	23 15	
027	ST+7	35-55 07	4th quarter accum
028	RCL5	36 05	
029	RTN	24	
030	0	00	
031	÷	-24	warning
032	*LBLC	21 13	
033	RCL6	36 06	
034	RCL7	36 07	
035	RCL8	36 08	calculate grand
036	RCL9	36 09	average
037	+	-55	
038	+	-55	
039	+	-55	
040	4	04	
041	X⇄Y	-41	
042	÷	-24	
043	STO1	35 01	
044	RCL6	36 06	
045	RCL1	36 01	qtr 1
046	×	-35	
047	R/S	51	
048	RCL7	36 07	
049	RCL1	36 01	
050	×	-35	qtr 2
051	R/S	51	
052	RCL8	36 08	
053	RCL1	36 01	
054	×	-35	qtr 3
055	R/S	51	
056	RCL9	36 09	
057	RCL1	36 01	qtr 4
058	×	-35	
059	RTN	24	
060	*LBLE	21 15	
061	RCL1	36 01	
062	RCL2	36 02	
063	STO1	35 01	
064	RCL3	36 03	
065	STO2	35 02	
066	+	-55	moving average
067	RCL4	36 04	for last qtr
068	STO3	35 03	entered
069	+	-55	
070	ENT↑	-21	
071	R↑	16-31	
072	STO4	35 04	
073	+	-55	
074	+	-55	
075	+	-55	
076	RCL2	36 02	
077	X⇄Y	-41	
078	÷	-24	
079	1	01	
080	ST+5	35-55 05	
081	R↓	-31	
082	RTN	24	
083	R/S	51	
090			
100			
110			

SET STATUS

FLAGS	ON	OFF
0	☐	☑
1	☐	☑
2	☐	☑
3	☐	☑

TRIG	
DEG	☐
GRAD	☐
RAD	☐

DISP	
FIX	☒
SCI	☐
ENG	☐
n	2

REGISTERS

0	1	2	3	4	5	6	7	8	9
	1st quarter	2nd quarter	3rd quarter	4th quarter	# of qts	acc 1	acc 2	acc 3	acc 4

S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I

Program Description I

Program Title PRICE ELASTICITY OF DEMAND

Contributor's Name Hewlett Packard

Address 1000 N.E. Circle Boulevard

City Corvallis **State** Oregon **Zip Code** 97330

Program Description, Equations, Variables

Mathematical model: $Ed = \left[\dfrac{\Delta Q}{Q_i + Q_{i+1}/2} \Big/ \dfrac{\Delta P}{P_i + P_{i+1}/2}\right]$

Where:

Ed = Demand elasticity

(That is elasticity of quantity sold with respect to a change in price.)

Q_{i+1} = Quantity sold after price change

Q_i = Quantity sold before price change

P_{i+1} = New price

P_i = Old price

[for i= 1,2,3,. . . .n]

$\Delta Q = [Q_{i+1} - Q_i]$

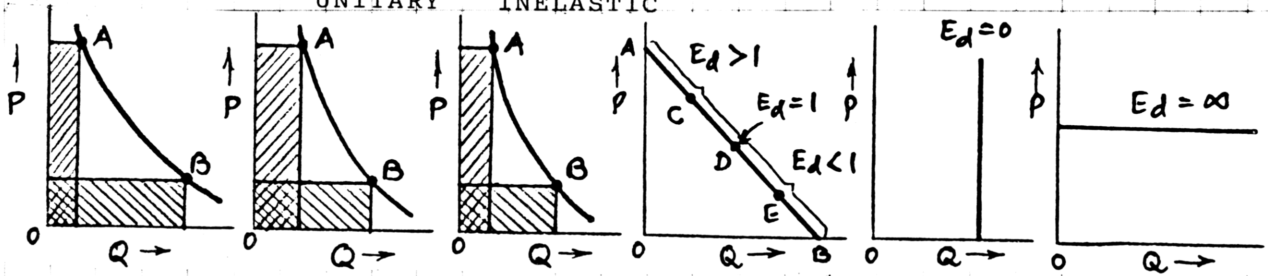
$\Delta P = [P_{i+1} - P_i]$

Operating Limits and Warnings

$$\frac{\Delta P}{(P_i + P_{i+1})/2} \neq 0$$

Program Description II

Sketch(es) ELASTIC UNITARY INELASTIC



ELASTICITY OF DEMAND SHOWS HOW TOTAL REVENUE MOVES

ELASTICITY AT A POINT

PERFECT INELASTICITY

INFINITE ELASTICITY

Sample Problem(s) Sales volume of certain product varied with the different price changes per unit as follows:

n	Quantity sold Q	Price/Unit P
1	0	6
2	10	4
3	20	2
4	30	0*

Compute price elasticity of demand.

*just hypothetical price for simplicity of explanation.

Solution(s)

6 [E↑] 0 [A]	0.00
4 [E↑]10 [B]	5.00
2 [E↑]20 [B]	1.00
0 [E↑]30 [B]	0.20

Reference(s) Paul A. Samuelson, "Economics" Mc Grawhill. 1975; 9th edition.

This program is a modification of the User's Library Program #05168A submitted by Ashok H. Doshi

User Instructions

1					2
1st P↑Q	subsequent P↑Q→Ed				

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
1	Enter program				
2	Key in 1st price of series	$		E↑	$
	Key in 1st quantity of series	units		A	units
3	Key in subsequent price			E↑	
	Key in subsequent quantity			B	Ed
	continue step 3 for all price quantity				
	pairs				
	For a new case go to step 2.				

97 Program Listing I

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	*LBLA	21 11	
002	STO4	35 04	
003	X⇄Y	-41	store initial
004	STO2	35 02	P+Q
005	X⇄Y	-41	
006	RTN	24	
007	*LBLB	21 12	
008	RCL2	36 02	
009	STO1	35 01	
010	RCL4	36 04	replace i data
011	STO3	35 03	i+2 daa
012	R↑	16-31	
013	STO2	35 02	
014	R↑	16-31	
015	STO4	35 04	
016	4	04	
017	STOI	35 46	set for reg
018	*LBL1	21 01	recall calculate
019	GSB2	23 02	Ed
020	DSZI	16 25 46	
021	GTO1	22 01	
022	÷	-24	
023	CHS	-22	
024	RTN	24	
025	*LBL2	21 02	
026	RCLi	36 45	
027	ENT↑	-21	
028	DSZI	16 25 46	subroutine 4 for
029	RCLi	36 45	$\frac{x_2-x_1}{y_2+y_1}$
030	-	-45	
031	X⇄Y	-41	
032	LSTX	16-63	
033	+	-55	
034	÷	-24	
035	RTN	24	
036	R/S	51	

SET STATUS

FLAGS: 0 OFF, 1 OFF, 2 OFF, 3 OFF
TRIG: DEG ☐ GRAD ☐ RAD ☐
DISP: FIX ☑ SCI ☐ ENG ☐ n 2

REGISTERS

0	1	2	3	4	5	6	7	8	9
	Pi	Pi+i	Qi	Qi+i					

S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I
					Used

Program Description I

Program Title Experience (Learning) Curve for Manufacturing Cost

Contributor's Name Hewlett Packard

Address 1000 N.E. Circle Boulevard

City Corvallis **State** Oregon **Zip Code** 97330

Program Description, Equations, Variables Many production process costs vary with output in close relation to the learning curve:

$$C_n = C_1 n^{\log r/\log 2}$$

where C_1 is the cost of the first unit produced

C_n is the cost of the n^{th} unit produced

n is the number of units produced

r is a special constant arrived by through empirical analysis

This program solves for any of the above variables and also solves for average cost over a range from i to j using the formula:

$$\overline{C}_n = \frac{C_1}{j-1} \quad \frac{j^{B+1} - i^{B+1}}{B+1}$$

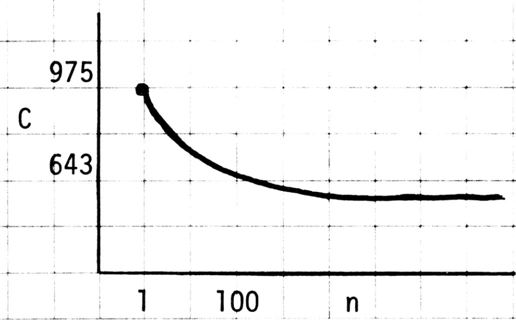
where $B = \log r/\log 2$

Operating Limits and Warnings The theory applies to a single product, or closely related series of similar products.

The average cost is only approximate since the function is continuous although the data is discrete the greater n, the less the error.

Program Description II

Sketch(es)



Sample Problem(s) A computer manufacturer begins a pilot run on a component. Cost accounting informs him that the first unit off of the line cost $975 and the 100th unit a week later cost $643.

What cost can the manufacturer expect for the 10,000th unit off the line. What is the average cost of the 10,000 units.

Solution(s)

975	[A]	0.00	
643	[C]	0.00	
100	[D]	0.00	
	[B]	.94	(learning factor r)
	[B]	0.00	
10,000	[D]	0.00	
	[C]	424.05	10,000th unit cost
	[E]	620.34	average for 10,000 units

Reference(s) Publications of the Boston Consulting Group on Experience Curve Theory.

These programs are a modification of the User's Library Programs #'s 02319A & 00985A submitted by Harry G. Heard and George E. Comstock.

User Instructions

Learning Curve Pricing				
C_1	r	C_n	N	

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
1	Enter program				
2	Input three of the following:				
	·cost of first unit		A		
	·learning exponent		B		
	·cost of the n-th unit		C		
	·Number of units		D		
3	Compute the remaining variable				
	·cost of first unit	C_1 ($)	A		C_1 ($)
	·learning exponent	r	B		r
	·cost of n-th unit	C_n ($)	C		C_n ($)
	·number of units	N	D		N
4	Compute average cost on N units	$\bar{C}$	E		$\bar{C}$ ($)
	Notes:				
a.	Variables may be entered in any order.				
b.	The value of N is rounded to the				
	nearest whole number of units				

97 Program Listing I

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	*LBLA	21 11	
002	STO1	35 01	
003	0	00	
004	X≠Y?	16-32	
005	GSBe	23 16 15	
006	GSB1	23 01	
007	RCL4	36 04	
008	X⇄Y	-41	
009	Yˣ	31	
010	RCL3	36 03	$\frac{C_n}{N^k}$
011	X⇄Y	-41	
012	÷	-24	
013	RTN	24	
014	*LBLB	21 12	
015	STO2	35 02	
016	0	00	
017	X≠Y?	16-32	
018	GSBe	23 16 15	
019	RCL4	36 04	
020	LOG	16 32	
021	2	02	
022	LOG	16 32	$r=\log^{-1}\left\{\frac{\log (C_n/C_1)}{\log n/\log 2}\right\}$
023	÷	-24	
024	RCL3	36 03	
025	RCL1	36 01	
026	÷	-24	
027	LOG	16 32	
028	X⇄Y	-41	
029	÷	-24	
030	10ˣ	16 33	
031	RTN	24	
032	*LBLC	21 13	
033	STO3	35 03	
034	0	00	
035	X≠Y?	16-32	
036	GSBe	23 16 15	
037	GSB1	23 01	
038	RCL4	36 04	
039	X⇄Y	-41	
040	Yˣ	31	
041	RCL1	36 01	$C_n=C_1N^k$
042	×	-35	
043	RTN	24	
044	*LBLD	21 14	
045	STO4	35 04	
046	0	00	
047	X≠Y?	16-32	
048	GSBe	23 16 15	
049	GSB1	23 01	
050	RCL3	36 03	
051	RCL1	36 01	
052	÷	-24	
053	LOG	16 32	$\log^{-1}\left\{\frac{\log C_n/C.}{k}\right\}$
054	X⇄Y	-41	
055	÷	-24	
056	10ˣ	16 33	
057	0	00	
058	.	-62	
059	5	05	
060	+	-55	
061	INT	16 34	
062	RTN	24	
063	*LBL1	21 01	
064	RCL2	36 02	
065	LOG	16 32	
066	2	02	K=log r/log 2
067	LOG	16 32	
068	÷	-24	
069	RTN	24	
070	*LBLe	21 16 15	
071	0	00	
072	R/S	51	
073	*LBLE	21 15	$\bar{C}_n=\frac{C_1}{j-1}\left\{\frac{j^{k+1}-i^{k+1}}{k+1}\right\}$
074	STO5	35 05	
075	GSB1	23 01	
076	1	01	
077	+	-55	
078	STO7	35 07	
079	Yˣ	31	
080	STO9	35 09	
081	R↓	-31	
082	STO8	35 08	
083	RCL7	36 07	
084	Yˣ	31	
085	CHS	-22	
086	RCL9	36 09	
087	+	-55	
088	RCL7	36 07	
089	÷	-24	
090	RCL1	36 01	
091	×	-35	
092	RCL5	36 05	
093	RCL8	36 08	
094	-	-45	
095	÷	-24	
096	R/S	51	
100			
110			

REGISTERS

0	1	2	3	4	5	6	7	8	9
	C_1	r	C_n	N			1+k	i	j^{1+k}

S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I

Program Description I

Program Title **BREAK-EVEN ANALYSIS**

Contributor's Name HEWLETT-PACKARD COMPANY

Address Corvallis Division
1000 N.E. Circle Boulevard

City Corvallis, OR 97330 **ate** **Zip Code**

Program Descript

Break-even analysis is basically a technique for analyzing the relationships among fixed costs, variable costs, and income. Until the break-even point is reached, at the intersection of the total income and total cost lines, the producer operates at a loss. After the break-even point, each unit produced and sold makes a profit. Break-even analysis may be represented as follows:

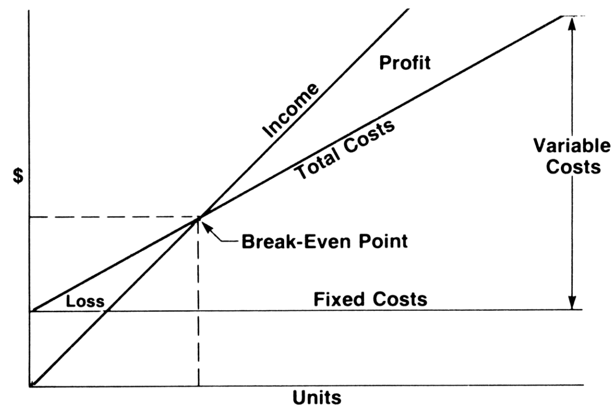


Figure 8

Given four of the following variables: fixed costs (F), sales price per unit (P), variable costs per unit (V), number of units sold (U), and gross profit (GP), this program evaluates the remaining variable. To calculate the break-even values, simply let the gross profit equal zero.

The degree of operating leverage (OL) at a point is defined as the ratio of the percentage change in net operating income to the percentage change in units sold. The greatest degree of operating leverage is found near the break-even point, where a small change in sales may produce a very large increase in profits. This happens because the profits are close to zero near the break-even point. Likewise, firms with a small degree of operating leverage are operating farther from the break-even point, and they are relatively insensitive to changes in sales volume.

The necessary inputs to calculate the degree of operating leverage are fixed costs (F), sales price per unit (P), variable costs per unit (V), and number of units (U).

For subsequent calculations, it is necessary only to input *new* data.

Program Description II

Break Even Analysis

$$GP = U(P - V) - F$$

$$OL = \frac{U(P - V)}{U(P - V) - F}$$

Sample Problem(s)

Example 1:

The Cooper Company sells finance textbooks at $13 apiece. Given costs and revenues below, how many textbooks must be sold to break even?

Fixed Costs	
Typesetting	$ 4,000
Graphics production	5,000
Printing and binding	3,000
Total fixed costs	$12,000
Variable costs per copy	
Distribution	$1.00
Commissions	3.75
Royalties	2.00
Total variable costs per copy	$6.75
Sales price per copy	$13.00

Solution(s)

Keystrokes:	**Outputs:**
12000 A 13 B 6.75 C	
0 E D ⟶	1920.00 (number of units)

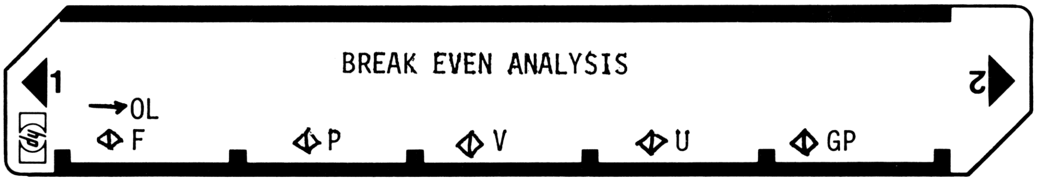
Example 2:

Having just completed the above problem, what is the Copper Company's degree of operating leverage at 2000 units? At 5000 units?

Keystrokes:	**Outputs:**
2000 D f A ⟶	25.00 (this is close to the break-even point)
5000 D f A ⟶	1.62 (the company is farther from the break-even point and less sensitive to changes in sales volume)

Reference(s)

User Instructions



STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Load side 1			
2	Key in four of the following in			
	any order:			
	• Fixed costs	F	A	F
	• Sales price per unit	P	B	P
	• Variable costs per unit	V	C	V
	• Number of units	U	D	U
	• Gross profit	GP	E	GP
3	Calculate the remaining			
	variable.		A	F
			B	P
			C	V
			D	U
			E	GP
4	To calculate the degree of			
	operating leverage		f A	OL

97 Program Listing I

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	*LBLA	21 11	
002	STOA	35 11	F R_A
003	F3?	16 23 03	Digit entered?
004	RTN	24	
005	RCLB	36 12	
006	RCLC	36 13	Calculate F and
007	-	-45	store in R_A.
008	RCLD	36 14	
009	x	-35	
010	RCLE	36 15	
011	-	-45	
012	STOA	35 11	
013	RTN	24	
014	*LBLB	21 12	
015	STOB	35 12	P R_B
016	F3?	16 23 03	
017	RTN	24	Digit entered?
018	RCLA	36 11	
019	RCLE	36 15	
020	+	-55	Calculate P & store
021	RCLD	36 14	in R_B.
022	÷	-24	
023	RCLC	36 13	
024	+	-55	
025	STOB	35 12	
026	RTN	24	
027	*LBLC	21 13	
028	STOC	35 13	V R_C
029	F3?	16 23 03	Digit entered?
030	RTN	24	
031	RCLB	36 12	Calculate V & store
032	RCLA	36 11	in R_C.
033	RCLE	36 15	
034	+	-55	
035	RCLD	36 14	
036	÷	-24	
037	-	-45	
038	STOC	35 13	
039	RTN	24	
040	*LBLD	21 14	
041	STOD	35 14	U R_D
042	F3?	16 23 03	Digit entered?
043	RTN	24	
044	RCLA	36 11	
045	RCLE	36 15	
046	+	-55	Calculate U & store
047	RCLB	36 12	in R_D.
048	RCLC	36 13	
049	-	-45	
050	÷	-24	
051	STOD	35 14	
052	PTN	24	GP R_E
053	*LBLE	21 15	
054	STOE	35 15	Digit entered?
055	F3?	16 23 03	
056	RTN	24	

STEP	KEY ENTRY	KEY CODE	COMMENTS
057	RCLB	36 12	Calculate GP & store
058	RCLC	36 13	in R_E.
059	-	-45	
060	RCLD	36 14	
061	x	-35	
062	RCLA	36 11	
063	-	-45	
064	STOE	35 15	
065	RTN	24	
066	*LBLa	21 16 11	
067	RCLB	36 12	
068	RCLC	36 13	Calculate OL
069	-	-45	
070	RCLD	36 14	
071	x	-35	
072	STOI	35 46	
073	RCLI	36 46	
074	RCLA	36 11	
075	-	-45	
076	÷	-24	
077	RTN	24	
080			
090			
100			

FLAGS

0	
1	
2	
3	Digit?

SET STATUS

FLAGS	ON	OFF	TRIG		DISP	
0	☐	☒	DEG	☒	FIX	☒
1	☐	☒	GRAD	☐	SCI	☐
2	☐	☒	RAD	☐	ENG	☐
3	☐	☒			n	2

LABELS

A F	B P	C V	D U	E GP
a	b	c	d	e
0	1	2	3	4
5	6	7	8	9

REGISTERS

0	1	2	3	4	5	6	7	8	9
S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A F	B P	C V	D U	E GP	I P(U-V)

Program Description I

Program Title INCOME STATEMENT (P & L) ANALYSIS

Contributor's Name Hewlett Packard

Address 1000 N.E. Circle Boulevard

City Corvallis **State** Oregon **Zip Code** 97330

Program Description, Equations, Variables Using the standard product income formula

Net Income = (1-Tax) (Net sale price - Mfg. - Op Ex)

Although freely capable of calculating in dollars or percents, the dynamic simulator operates only with net income return (%) and percent operating expense. Both percentage figures are based on net sales price.

net sale = list (1-discount (%)*)

operating expense (%) = operating expense ÷ net sale price

The program can also be used to simulate a company wide income statement by replacing list with gross sales, and manufacturing cost with cost of goods sold.

Operating Limits and Warnings *discount is a percentage of list

The program assumes a tax rate of 48%. Since the rate varies from company to company, the .52. (1-.48) in the program must be replaced by one minus your applicable tax rate (steps: 44-5, 64-5, 112-3, 190-1)

Program Description II

Sketch(es)

Sample Problem(s) What is the net return on an item that is sold for 11.98, discounted through the distribution at an average of 35%, and has a manufacturing cost of $2.50. Your standard company operating expense is 32% of net shipping (sale) price.

b) if manufacturing is increased to $3.25, what is the effect on the return.

c) what is the total net dollar cash flow if 10,000 units are sold. (assuming the 3.25 manufacturing cost)

d) how high could the overhead (operating expense) go before the product begins to lose money.

e) how sensitive is the profit to the selling price (for each dollar below $12.00)

f) print out an income statement for the final selling price of 10.49, 35% discount, $3.00 manufacturing cost and 32% operating expense.

Reference(s)

Program Description II

Sketch(es)

Solution

a) 11.98 [A] 35 [B] 2.5 [C] 32 [D] [E]....18.67

b) 3.25 [C] [E]........13.67

C) F [E] 10000 [X].....10634.83

d) O [E] [D] 58.26

e) 32 [D]* [E]** 12 [E↑] 1.00 [f] [A]...35 discount

3.25 manufacturing cost
32 operating expense (%)
12.00 list price
13.69%return (at $12 list)
11.00 list
11.72%return
10.00 list
9.36%return
9.00 list
6.47%return
8.00
2.86%return
seven dollars would yield
a negative return

f) 10.49 [A] 35 [B] 3 [C] 32 [D] [E]** [F] [B]..10.49 list ($)

-3.67 discount ($)
6.82 net sale ($)
-3.00 manufacturing ($)
3.82 gross (contribution) margin ($)
-2.19 applied operating expense (overhead) ($)
1.64 net profit before tax($)
- .79 tax ($)

Program Description II

Sketch(es)

Sample Problem(s) .85 net after tax profit.

Solution(s) con't

**It is always necessary to complete a solution before using a shift ([f]) option.

*Change operating expense from the previous answer of 58.26% back to 32%.

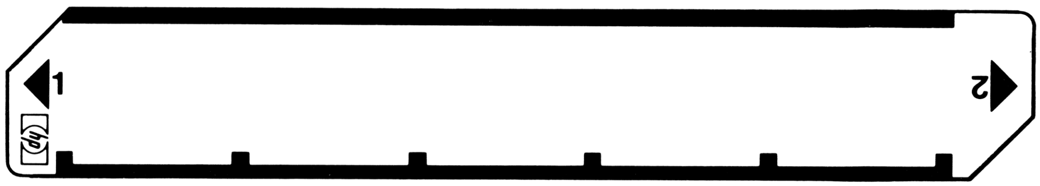
Reference(s)

User Instructions

1	Price Sen List ↑ Decr	Income Statement	Net Sale ($)	Op Exp ($)	Net Prft ($)	2
	List ($)	Disc (%)	Mfg. ($)	Op Exp(%)	Net Prft (%)	

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
1	Load program				
2	Key in values for four of the following				
	5 variables				
	•list	$		A	
	•discount	%		B	
	•manufacturing cost	$		C	
	•operating expense	%		D	
	•net profit after tax	%		E	
3	Solve for the fifth variable			A-E	
4	Change any variable by keying in a new				
	value			A-E	
5	Press any of the 4 remaining variables				
	to see the effect of step 4.				
6	Press any of the following 3 keys *				
	•net sales ($)	$	f	c	
	•operating expense ($)	$	f	d	
	•net profit ($)	$	f	e	
7	To preview the list price sensitivity				
	of the net profit*				
	a) beginning price	$		↑	
	b) decrement	$	f	a	
	preview of constants				
	disc				
	Manufacturing cost				$
	operating expense				%
	Beginning price				$
	resulting net profit				%
	Beginning price minus decrement				$
	resulting net profit				
	Beginning price minus (2 times decr)				
	resulting net profit				
	This proceedure continues until a price				
	is reached below which the profit				
	would be zero.				
8	To preview the income statement *		f	b	
	List price				$
	-Discount				$
	Net Sale				$

User Instructions



STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
	-Manufacturing			$
	Gross (contribution) margin			$
	-Operating Expenses			$
	Profit before taxes			$
	-Taxes			$
	Net profit after taxes			$
	*If any variable has been changed			
	(or all variables have just been			
	entered) it is necessary to activate			
	a solution (steps 3 or 5) before using			
	any of the shift options f(a) through			
	f(e)			

97 Program Listing I

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	*LBLA	21 11	
002	STOA	35 11	store list price
003	F3?	16 23 03	for use of flag
004	RTN	24	see std pac lo5-
005	RCLC	36 13	02
006	GSB2	23 02	
007	÷	-24	
008	STO9	35 09	
009	1	01	$\frac{MFG}{LBL2}$/lbl4
010	GSB4	23 04	
011	÷	-24	
012	STOA	35 11	
013	RTN	24	
014	*LBLB	21 12	
015	STOB	35 12	store % disc
016	F3?	16 23 03	
017	RTN	24	
018	RCLC	36 13	
019	GSB2	23 02	
020	÷	-24	100
021	STO9	35 09	list-(MFg/Lbl2)x
022	CHS	-22	list
023	RCLA	36 11	
024	+	-55	
025	RCLA	36 11	
026	÷	-24	
027	EEX	-23	
028	2	02	
029	x	-35	
030	STOB	35 12	
031	RTN	24	
032	*LBLC	21 13	
033	STOC	35 13	store mfg
034	F3?	16 23 03	
035	RTN	24	
036	GSB1	23 01	
037	GSB2	23 02	Lbl1xlbl2
038	x	-35	
039	STOC	35 13	
040	RTN	24	
041	*LBL2	21 02	100-((Net profit%/1-tax)+OpExp%) / 100
042	RCLE	36 15	
043	.	-62	
044	5	05	
045	2	02	
046	÷	-24	
047	RCLD	36 14	
048	+	-55	
049	CHS	-22	
050	EEX	-23	
051	2	02	
052	+	-55	
053	EEX	-23	
054	2	02	
055	÷	-24	
056	RTN	24	
057	*LBLD	21 14	
058	STOD	35 14	store % Op Exp
059	F3?	16 23 03	
060	RTN	24	
061	GSB3	23 03	
062	RCLE	36 15	
063	.	-62	
064	5	05	lbl3-Net Profit
065	2	02	.52
066	÷	-24	
067	-	-45	
068	STOD	35 14	
069	RTN	24	
070	*LBLa	21 16 11	
071	STO6	35 06	
072	R↓	-31	
073	STOA	35 11	
074	SPC	16-11	
075	SPC	16-11	
076	RCLB	36 12	print % disc mfg
077	PRTX	-14	% Op Exp
078	RCLC	36 13	
079	PRTX	-14	
080	RCLD	36 14	
081	PRTX	-14	
082	SPC	16-11	
083	*LBL5	21 05	
084	CF3	16 22 03	
085	GSBE	23 15	calculate net profit
086	0	00	end on net profit
087	X>Y?	16-34	less than zero
088	R/S	51	print list
089	RCLA	36 11	
090	PRTX	-14	print net profit
091	RCLE	36 15	
092	PRTX	-14	
093	SPC	16-11	
094	RCLA	36 11	
095	RCL6	36 06	decrement list
096	-	-45	
097	STOA	35 11	
098	GTO5	22 05	
099	1	01	superfluous junk
100	4	04	
101	CHS	-22	
102	STOI	35 46	
103	GTOi	22 45	
104	*LBLE	21 15	
105	STOE	35 15	store net profit
106	F3?	16 23 03	
107	RTN	24	
110			

REGISTERS

0	1	2	3	4	5	6 Decr	7 Net Prft ($)	8 Op Exp ($)	9 Net Sale ($)
S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A List	B % Disc	C Mfg ($)	D % Op Exp	E % Net Prft	I

97 Program Listing II

STEP	KEY ENTRY	KEY CODE	COMMENTS
108	GSB3	23 03	
109	RCLD	36 14	
110	-	-45	
111	.	-62	.52(lbl3-% oper Exp)
112	5	05	
113	2	02	
114	x	-35	
115	STOE	35 15	
116	RTN	24	
117	*LBL3	21 03	
118	RCLC	36 13	
119	GSB1	23 01	
120	÷	-24	[1-(Mfg/(list(1-%
121	CHS	-22	disc)/100)))]x100
122	1	01	
123	+	-55	
124	EEX	-23	
125	2	02	
126	x	-35	
127	RTN	24	Rcl list
128	*LBL1	21 01	
129	RCLA	36 11	
130	*LBL4	21 04	
131	RCLB	36 12	$1-\frac{\%Disc}{100}$
132	EEX	-23	
133	2	02	
134	÷	-24	
135	CHS	-22	
136	1	01	
137	+	-55	
138	x	-35	
139	STO9	35 09	
140	RTN	24	
141	*LBLd	21 16 14	
142	GSBe	23 16 15	
143	RCL9	36 09	
144	RCLD	36 14	
145	x	-35	
146	EEX	-23	Net salex$\frac{\%Op\ Exp}{100}$
147	2	02	
148	÷	-24	
149	STO8	35 08	
150	RTN	24	
151	*LBLe	21 16 15	
152	RCL9	36 09	
153	RCLE	36 15	
154	EEX	-23	Net Sale x$\frac{\%net\ prft}{100}$
155	2	02	
156	÷	-24	
157	x	-35	
158	STO7	35 07	
159	RTN	24	
160	*LBLc	21 16 13	
161	RCL9	36 09	Net sale
162	RTN	24	

STEP	KEY ENTRY	KEY CODE	COMMENTS
163	*LBLb	21 16 12	
164	RCLA	36 11	
165	PRTX	-14	
166	RCL9	36 09	
167	-	-45	
168	LSTX	16-63	
169	X⇄Y	-41	
170	CHS	-22	
171	PRTX	-14	List -discount net
172	X⇄Y	-41	sale
173	PRTX	-14	
174	SPC	16-11	
175	RCLC	36 13	
176	CHS	-22	
177	PRTX	-14	-Mfg contribution
178	+	-55	margin
179	PRTX	-14	
180	SPC	16-11	
181	GSBd	23 16 14	
182	CHS	-22	
183	PRTX	-14	
184	X⇄Y	-41	-Op Exp profit
185	R↓	-31	before tax
186	+	-55	
187	PRTX	-14	
188	SPC	16-11	
189	.	-62	
190	5	05	
191	2	02	
192	X⇄Y	-41	-tax profit after
193	x	-35	tax
194	LSTX	16-63	
195	-	-45	
196	PRTX	-14	
197	LSTX	16-63	
198	+	-55	
199	PRTX	-14	
200	R/S	51	

LABELS

A used	B used	C used	D used	E used
a used	b used	c used	d used	e used
0	1 used	2 used	3 used	4 used
5 used	6	7	8	9

FLAGS

0	used
1	
2	
3	used

SET STATUS

FLAGS	ON	OFF
0	☐	☒
1	☐	☒
2	☐	☒
3	☐	☐

TRIG	
DEG	☐
GRAD	☐
RAD	☐

DISP	
FIX	☐
SCI	☐
ENG	☐
n ____	

Program Description I

Program Title INTERNAL RATE OF RETURN

Contributor's Name HEWLETT-PACKARD COMPANY
Address Corvallis Division
1000 N.E. Circle Boulevard
City Corvallis, OR 97330 State Zip Code

Program Descript

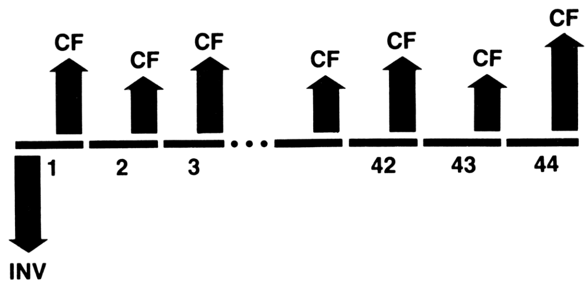


Figure 1

Note:

The above diagram is representative of diagrams which will be used in this pac. The horizontal line represents the time period(s) involved, while the arrows represent the cash flows.

The interest rate that equates the present value of all future cash flows with the original investment is known as the internal rate of return (IRR, also called discounted rate of return or yield). Given a non-zero initial investment and up to 44 **positive** cash flows, this program calculates the periodic IRR. If there are negative as well as positive cash flows, the program accepts up to 22 cash flows.

If more than 44 positive cash flows are entered, all cash flows over 44 will be ignored. There will be no indication, however, that more than 44 cash flows have been entered. Likewise, if more than 22 positive and negative cash flows are entered, erroneous results will occur.

Operating Limits a

Zero should be entered for periods with no cash flow.

When more than 22 cash flows are involved (all of which must be positive), the user is asked to enter the largest cash flow in step 3 because of the storage techniques being used. This value is then used to scale all other cash flows, and depending on these values, accuracy may be reduced. Consequently, the resulting periodic rate of return should be considered accurate to within ±.01% (.0001 decimal). This largest cash flow must be entered again in sequence in step 4. If a cash flow larger than the value entered for CF MAX is keyed in at step 4, erroneous results may occur.

The answer produced is the *periodic rate of return*. If the cash flow periods are

Program Description I

Program Title

Contributor's Name

Address

City **State** **Zip Code**

Program Description, Equations, Variables

other than annual (monthly, quarterly) the answer should be multiplied by the number of periods per year to determine the annual internal rate of return.

In many instances another program may be more suitable for calculating IRR. If all cash flows are equal and equally spaced, or if all cash flows except the last are equal and equally spaced, DIRECT REDUCTION LOANS (BD-04) is a better choice. If the cash flows occur in groups of uneven amounts, IRR-GROUPS (BD-02) may be more suitable.

This program was designed for optimum operation when the interest rate being solved for is between 0 and 100%. The program will often solve for interest rates outside this range, but occasionally may halt prematurely with ERROR in the display. This is an error condition generated by an intermediate calculation, and indicates that the program cannot solve that particular problem.

The calculated answer may be verified by using DISCOUNTED CASH FLOW ANALYSIS—NET PRESENT VALUE (BD-03), to calculate the net present value. The NPV should be close to 0.

Note:

When the sign of the cash flows is reversed more than once, more than one interest rate is considered correct in the mathematical sense. While this program may find one of the answers, it has no way of finding or indicating other possibilities.

Operating Limits and Warnings

Program Description II

Sketch(es)

Sample Problem(s)

PRINCIPAL EQUATIONS

Unless otherwise stated, all interest rates (i, APR, IRR, NOM, EFF, CR, YLD, etc.) are expressed in decimal form in the equations which follow. Only symbols not defined in the program descriptions are defined here.

Program Number

1. Internal Rate of Return

   Solve for IRR in:

$$INV = \sum_{j=1}^{n} \frac{CF_j}{(1 + IRR)^j}$$

   where:

   n = number of cash flows
   CF_j = j^{th} cash flow

Solution(s)

Reference(s)

Program Description II

Sketch(es)

Sample Problem(s)

Solution(s)

Reference(s)

Example 1:

Income property requiring a $250,000 equity investment and to be sold in ten years is expected to generate the ''after tax'' cash flows shown below. What is the expected yield or IRR?

End of Year	Cash Flow	End of Year	Cash Flow
1	$46,423	6	$ 23,199
2	40,710	7	21,612
3	36,638	8	20,037
4	34,097	9	18,460
5	32,485	10	311,406 (property sold)

Keystokes: / **Outputs:**

250000 A 46423 C 40710 C
36638 C 34097 C 32485 C
23199 C 21612 C 20037 C
18460 C 311406 C D ⟶ 13.98 (annual IRR is 13.98%)

Example 2:

Property requiring a $30,000 investment will be sold at the end of 2 years. If the investment results in the monthly net cash flows shown below, what is the IRR?

End of Month	Cash Flow	End of Month	Cash Flow
1	$ 16	13	$ 201
2	50	14	195
3	175	15	178
4	181	16	197
5	143	17	210
6	147	18	220
7	151	19	206
8	176	20	194
9	184	21	187
10	193	22	190
11	157	23	201
12	190	24	35,000 (property sold)

Keystrokes:	Outputs:
30000 A 35000 B	
16 C 50 C 175 C 181 C	
143 C 147 C 151 C 176 C	
184 C 193 C 157 C 190 C ⟶	12.00 (12 cash flows input)
201 C 195 C 178 C 197 C	
210 C 220 C 206 C 194 C	
187 C 190 C 201 C 35000 C ⟶	24.00 (all cash flows input)
D ⟶	1.15 (monthly IRR)
12 × ⟶	13.79 (an annual IRR of 13.79%)

User Instructions

INTERNAL RATE OF RETURN

INV | CF MAX | CF | -IRR

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Load side 1 and side 2.			
2	Input initial investment.	INV	A	INV
3	If there are > 22 cash flows, key			
	in the largest cash flow.	CF MAX	B	CF MAX
4	Beginning with the first period,			
	key in all cash flows in sequence,			
	pressing C after each value.	CF	C	# of CFs
5	Calculate the periodic internal			
	rate of return		D	IRR (%)

97 Program Listing I

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	*LBLA	21 11	Clear registers
002	CLRG	16-53	
003	P⇄S	16-51	
004	CLRG	16-53	
005	STOE	35 15	INV → R_E
006	CF0	16 22 00	Clear flags
007	CF1	16 22 01	
008	RTN	24	
009	*LBLB	21 12	Input largest cash flow if $\#CF_s>22$
010	2	02	
011	×	-35	
012	STO0	35 00	
013	RCLE	36 15	
014	X⇄Y	-41	
015	÷	-24	
016	STOE	35 15	INV/2CMAX→R_E
017	LSTX	16-63	
018	SF0	16 21 00	Flag 0 indicates >22 cash flows
019	2	02	
020	÷	-24	
021	RTN	24	
022	*LBLC	21 13	
023	ISZI	16 26 46	
024	F0?	16 23 00	If F0, pack data in registers
025	GSBc	23 16 13	
026	ST+i	35-55 45	
027	X⇄Y	-41	
028	RCLI	36 46	Dispaly # of cash flows (add if >22CF)
029	F1?	16 23 01	
030	+	-55	
031	RTN	24	
032	*LBLc	21 16 13	
033	2	02	
034	3	03	
035	RCLI	36 46	
036	X≠Y?	16-32	23rd cash flow?
037	GTO0	22 00	
038	1	01	
039	STOI	35 46	Reset I
040	+	-55	
041	CLX	-51	Drop stack and clear x
042	EEX	-23	
043	5	05	
044	ST÷0	35-24 00	2CMAX/10^5→R_0
045	SF1	16 21 01	
046	*LBL0	21 00	
047	R↓	-31	
048	1	01	
049	-	-45	
050	X⇄Y	-41	Scale cash flow
051	RCL0	36 00	
052	÷	-24	If CF_j,j>22, drop fractional part of CF_j
053	F1?	16 23 01	
054	INT	16 34	
055	RTN	24	
056	*LBLa	21 16 11	
057	RCLI	36 46	LBL fa sets up I for count down and keeps track of original # of cash flows by storing N.N.
058	1	01	
059	0	00	
060	1	01	
061	×	-35	
062	STOI	35 46	
063	RTN	24	
064	*LBLe	21 16 15	
065	F0?	16 23 00	
066	GTO0	22 00	Unpack double stored cash flows
067	INT	16 34	
068	EEX	-23	
069	5	05	
070	÷	-24	
071	RTN	24	
072	*LBL0	21 00	
073	FRC	16 44	
074	RTN	24	
075	*LBLD	21 14	Set-up I N N
076	GSBa	23 16 11	
077	RCLI	36 46	
078	EEX	-23	
079	2	02	
080	÷	-24	
081	STOI	35 46	N.N→ I
082	1	01	
083	.	-62	
084	0	00	
085	1	01	1 + i_0→R_D
086	STOD	35 14	
087	*LBL4	21 04	
088	CF0	16 22 00	
089	0	00	
090	STO0	35 00	
091	*LBL5	21 05	
092	RCLI	36 46	
093	INT	16 34	
094	F1?	16 23 01	Get j
095	GSBd	23 16 14	
096	RCLi	36 45	
097	F1?	16 23 01	
098	GSBe	23 16 15	Unpack CF_j
099	ST+0	35-55 00	
100	×	-35	
101	+	-55	f(i) in R_0
102	RCLD	36 14	
103	ST÷0	35-24 00	
104	÷	-24	
105	DSZI	16 25 46	
106	GTO5	22 05	
107	F1?	16 23 01	
108	GTO0	22 00	
109	*LBL6	21 06	
110	RCL0	36 00	
111	RCLE	36 15	
112	-	-45	

REGISTERS

0	1	2	3	4	5	6	7	8	9
Used	Used	Used	Used	Used	Used	Used	Used	Used	Used

S0	S1	S2	S3	S4	S5	S6	S7	S8	S9
Used	Used	Used	Used	Used	Used	Used	Used	Used	Used

A	B	C	D	E	I
Used	Used	Used	1 + i_0	Used	Used

97 Program Listing II

STEP	KEY ENTRY	KEY CODE	COMMENTS
113	X⇄Y	-41	
114	÷	-24	
115	RCLD	36 14	
116	×	-35	$\frac{f}{f'}$, (1 + i)
117	RCLD	36 14	
118	X⇄Y	-41	
119	+	-55	(1 + i) next
120	STOD	35 14	
121	LSTX	16-63	
122	ABS	16 31	
123	EEX	-23	
124	CHS	-22	f (i)/f′(i)
125	5	05	
126	X>Y?	16-34	
127	GTO7	22 07	←DONE!
128	GSBa	23 16 11	
129	GTO4	22 04	
130	*LBL0	21 00	
131	F0?	16 23 00	
132	GTO6	22 06	
133	SF0	16 21 00	
134	GSBb	23 16 12	
135	GTO5	22 05	
136	*LBLb	21 16 12	
137	2	02	Loop back for
138	2	02	lower 22 CF_s
139	RCLI	36 46	
140	+	-55	Reset I to lower
141	STOI	35 46	22 CF_s
142	CLX	-51	
143	+	-55	
144	RTN	24	
145	*LBLd	21 16 14	
146	2	02	Add 22 if flag 0
147	2	02	clear
148	F0?	16 23 00	
149	CLX	-51	
150	+	-55	
151	RTN	24	
152	*LBL7	21 07	Reset R_I for another
153	RCLD	36 14	
154	1	01	pressing of [D]
155	-	-45	
156	STOD	35 14	
157	EEX	-23	R_I must contain
158	2	02	integer here
159	×	-35	
160	RCLI	36 46	
161	LSTX	16-63	
162	×	-35	
163	STOI	35 46	
164	X⇄Y	-41	
165	RTN	24	
166	R/S	51	

STEP	KEY ENTRY	KEY CODE	COMMENTS
170			
180			
190			
200			
210			
220			

LABELS

A INV	B CF MAX	C CF	D →IRR	E
a USED	b USED	c USED	d USED	e USED
0 USED	1	2	3	4 USED
5 USED	6 USED	7 USED	8	9

FLAGS

0	>22 CF_s
1	USED
2	
3	

SET STATUS

FLAGS	ON	OFF
0	☐	☒
1	☐	☒
2	☐	☒
3	☐	☒

TRIG	
DEG	☒
GRAD	☐
RAD	☐

DISP	
FIX	☒
SCI	☐
ENG	☐
n	2

Program Description I

Program Title SALES FORCE REQUIREMENTS

Contributor's Name Hewlett Packard

Address 1000 N.E. Circle Boulevard

City Corvallis **State** Oregon **Zip Code** 97330

Program Description, Equations, Variables The calculation of required salesman to cover η territories utilizes the model:

1.

$$N = \frac{\sum_{i=1}^{\eta} C_i F_i}{P}$$

2. Where:

n = Desirable number of salesmen

C_i = Number of customers in class size i

F_i = The desirable number of annual calls to make to customers in size class i.

P = The annual average numbers of calls to be made by a salesman.

η = The number of customer size classes

Operating Limits and Warnings

The optimality of the overall solution depends upon managements accuracy in estimating call frequencies for different size accounts.

Program Description II

Sketch(es)

Sample Problem(s)

Territories i	C_i Number of customers	F_i Call frequencies in territories i
1	3	1000
2	7	2500
3	10	3000

Given the above data and the information that the number of calls made by each salesman averages 2000 per year; find how many salesmen would be required to reach the workload?

Solution(s)

2000	[A]	2000.00	[P]			
3	[B]	1.00	[entry #]	[E]	20.00	[Σ C_i]
1000	[C]	1.00	[ ]	[E]	6500.00	[Σ F_i]
	[D]	3000.00	[$C_i F_i$]	[E]	25.00	[N]
7	[B]	2.00				
2500	[C]	2.00				
	[D]	17500.00	[$C_i F_i$]			
10	[B]	3.00				
3000	[C]	3.00				
	[D]	30000.00	[$C_i F_i$]			

Reference(s) S.E. Heymann, "Determining the Optimum Size of the Sales Force," in Marketing Research in Action (New York: The Conference Board Report, Studies in Business Policy, No. 84, 1957), pp.82-84.

This program is a translation of the HP-65 Users' Library Program #05176A submitted by Ashok H. Doshi.

User Instructions

Sales Force Structure (Territorial)

P	C_i	F_i	$\Sigma C_i F_i$	N

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
1	Enter program.				
2	Input annual average # of calls made by a				
	salesman	P	A		P
3	Input # of customers in class size i (C_i)	C_i	B		# of entries i
4	Input # of annual calls to make to customers				
	in class size i_i (F_i)	F_i	C		i
5	Compute $\Sigma\ C_i\ F_i$		D		$\Sigma\ C_i F_i$
	Repeat 4-6 for i=1, 2,3, ...n				
6	Compute total # of customers		E		$\Sigma\ C_i$
7	Compute total # of annual calls to make to				
	customers		E		$\Sigma\ F_i$
8	Compute # of salesmen required		E		N.00
9	For a new case go to step - 2				

97 Program Listing I

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	*LBLA	21 11	
002	CLRG	16-53	clear register
003	STO1	35 01	
004	RTN	24	store P
005	*LBLB	21 12	
006	STO2	35 02	
007	ST+3	35-55 03	
008	1	01	
009	ST+4	35-55 04	
010	RCL4	36 04	
011	X⇄Y	-41	
012	R↓	-31	
013	RTN	24	input C_i to compute
014	*LBL0	21 00	ΣC_i and to compute
015	RCL3	36 03	$\bar{C}_i$
016	RCL4	36 04	
017	÷	-24	
018	RTN	24	
019	*LBLC	21 13	
020	STO5	35 05	
021	ST+6	35-55 06	
022	1	01	
023	ST+7	35-55 07	
024	RCL7	36 07	input F_i to compute
025	X⇄Y	-41	ΣF_i and to compute
026	R↓	-31	$\bar{F}_i$
027	RTN	24	
028	*LBL1	21 01	
029	RCL6	36 06	
030	RCL7	36 07	
031	÷	-24	
032	RTN	24	
033	*LBLD	21 14	
034	RCL2	36 02	
035	RCL5	36 05	
036	×	-35	compute $\Sigma C_i F_i$
037	ST+8	35-55 08	
038	RTN	24	
039	*LBLE	21 15	
040	RCL3	36 03	compute ΣC_i
041	R/S	51	
042	*LBLE	21 15	
043	RCL6	36 06	compute ΣF_i
044	R/S	51	
045	*LBLE	21 15	
046	RCL8	36 08	compute N
047	RCL1	36 01	
048	÷	-24	
049	INT	16 34	
050	RTN	24	
051	R/S	51	

060 070 080 090 100 110

SET STATUS

FLAGS	ON	OFF	TRIG		DISP	
0	☐	☒	DEG	☐	FIX	☒
1	☐	☒	GRAD	☐	SCI	☐
2	☐	☒	RAD	☐	ENG	☐
3	☐	☒			n	2

REGISTERS

0	1	2	3	4	5	6	7	8	9
	P	C_i	ΣC_i	F_i	Σ	ΣF_i		$\Sigma C_i F_i$	
S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I

Program Description I

Program Title COST AND PRICE COMPUTATIONS

Contributor's Name Hewlett Packard

Address 1000 N.E. Circle Boulevard

City Corvallis **State** Oregon **Zip Code** 97330

Program Description, Equations, Variables Sales work often involves calculating the unknown amongst the interrelated terms margin, markup, selling price, and cost. Margin is defined as 100 x (selling price-cost)/ selling price. Markup is 100 x (selling price - cost)/cost.

There are numerous equations which evolve from the interrelation of these terms. This program solves for any of the four variables when two of the other variables are known.

In addition, with discount synonymous with margin, list with selling price and net with cost, this program calculates any unknown among list, net and up to three consecutive discounts rates.

Operating Limits and Warnings

Program Description II

Sketch(es)

Sample Problem(s)

a) If the margin is 20% and cost is $160, what is the selling price?

b) If the margin is 30% what markup would this be?

c) If list price is $3.28, net is $1.45 and two of the discounts are 48% and 5%, what is the third discount rate?

d) If list price is 6.20 and there are two discount rates, 50% and 2% what is the net?

e) The discounts 20%, 5%, and .5% are equivelant to what single discount rate.

Solution(s)

a) 20 [C], 160 [B] [A] 200

b) 30 [C] [D] 42.86%

c) 3.28 [f] [A] 1.45 [f] [B] 48 [f] [C] 5 [f] [D] [f] [E] 10.51%

d) 6.20 [f] [A] 50 [f] [C] 2 [f] [D] 0 [f] [E] [f] [B] 3.04%

e) 1 [f] [A] 20 [f] [C] 5 [f] [D] .5 [f] [E] [f] [B] 1 [X⪌Y] [-] .... .24 or 24%

Reference(s) These programs are a modification of the Users' Library Program # 2305A submitted by Miguel Tarrab and # 4571 submitted by R.W. Edelen.

User Instructions

List	Net	Disc 1	Disc 2	Disc 3
Selling	Cost	Margin	Markup	

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
1	Enter program card				
2	Input the known values				
	• selling price	$		A	
	• cost	$		B	
	• margin	%		C	
	• markup	%		D	
3	Calculate the unknown				
	• selling price			A	$
	• cost			B	$
	• margin			C	%
	• markup			D	%
	OR				
2	Input the known values				
	• list price	$	f	A	
	• net	$	f	B	
	• discount 1	%	f	C	
	• discount 2	%	f	D	
	• discount 3	%	f	E	
3	Calculate the unknown				
	• list price		f	A	$
	• net		f	B	$
	• discount 1		f	C	%
	• discount 2		f	D	%
	• discount 3		f	E	%
	If you wish to solve discount problems with less than three discounts, use 0 for the remaining discounts				

97 Program Listing I

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	*LBLa	21 16 11	
002	STO1	35 01	store list price
003	F3?	16 23 03	
004	RTN	24	
005	RCL5	36 05	
006	RCL4	36 04	
007	RCL3	36 03	
008	RCL2	36 02	
009	x	-35	calculate list
010	x	-35	
011	÷	-24	
012	RND	16 24	
013	STO1	35 01	
014	RTN	24	
015	*LBLb	21 16 12	
016	STO5	35 05	store net
017	F3?	16 23 03	
018	RTN	24	
019	RCL4	36 04	
020	RCL3	36 03	
021	RCL2	36 02	
022	RCL1	36 01	
023	x	-35	
024	x	-35	calculated net
025	x	-35	
026	RND	16 24	
027	STO5	35 05	
028	RTN	24	
029	*LBLc	21 16 13	
030	EEX	-23	
031	2	02	change to decimal
032	÷	-24	store D_1
033	1	01	
034	X⇄Y	-41	
035	-	-45	
036	STO2	35 02	
037	F3?	16 23 03	
038	RTN	24	
039	RCL5	36 05	
040	RCL4	36 04	
041	RCL3	36 03	
042	RCL1	36 01	
043	GSB1	23 01	calculate D_1
044	STO2	35 02	
045	EEX	-23	
046	2	02	
047	x	-35	
048	RTN	24	
049	*LBLd	21 16 14	
050	EEX	-23	
051	2	02	
052	÷	-24	
053	1	01	
054	X⇄Y	-41	
055	-	-45	
056	STO3	35 03	
057	F3?	16 23 03	
058	RTN	24	calculate D_2 F3 is used to differentiate between entering a value and solving for a value see standard pac p.L0502
059	RCL5	36 05	
060	RCL4	36 04	
061	RCL2	36 02	
062	RCL1	36 01	
063	GSB1	23 01	
064	STO3	35 03	
065	EEX	-23	
066	2	02	calculate D_2
067	x	-35	
068	RTN	24	
069	*LBLe	21 16 15	
070	EEX	-23	
071	2	02	
072	÷	-24	
073	1	01	
074	X⇄Y	-41	
075	-	-45	
076	STO4	35 04	
077	F3?	16 23 03	store D_3
078	RTN	24	calculate D_3
079	RCL5	36 05	
080	RCL3	36 03	note
081	RCL2	36 02	F1 is used to decide which of two equations to use to solve for selling or cost
082	RCL1	36 01	
083	GSB1	23 01	
084	STO4	35 04	
085	EEX	-23	
086	2	02	1 using margin
087	x	-35	2 using markup
088	RTN	24	
089	*LBL1	21 01	
090	x	-35	
091	x	-35	
092	÷	-24	
093	1	01	
094	X⇄Y	-41	
095	-	-45	
096	RTN	24	
097	*LBLA	21 11	
098	STOA	35 11	
099	SF2	16 21 02	calculate or store
100	F3?	16 23 03	selling price
101	RTN	24	
102	RCLB	36 12	
103	RCLC	36 13	
104	F1?	16 23 01	selling = C(1+markup) or selling=C/(1-margin)
105	CHS	-22	
106	1	01	
107	+	-55	
108	F1?	16 23 01	
109	1/X	52	
110	x	-35	
111	STOA	35 11	

REGISTERS

0	1	2	3	4	5	6	7	8	9
	list	D_1	D_2	D_3	net				

S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I
selling	cost	markup or margin			

97 Program Listing II

STEP	KEY ENTRY	KEY CODE	COMMENTS
112	RTN	24	
113	*LBLB	21 12	
114	STOB	35 12	
115	SF2	16 21 02	
116	F3?	16 23 03	
117	RTN	24	
118	RCLA	36 11	
119	RCLC	36 13	
120	F1?	16 23 01	cost =S/(1+markup)
121	CHS	-22	cost =S(1-margin)
122	1	01	
123	+	-55	
124	F1?	16 23 01	
125	1/X	52	
126	1/X	52	
127	x	-35	
128	STOB	35 12	
129	RTN	24	
130	*LBLC	21 13	
131	F3?	16 23 03	margin = markup/(1+markup) Flag 2 is used in the markup and margin routines to differentiate between the two methods of solving for markup or margin. 1. Use selling and cost 2. Use rate and value
132	GTO2	22 02	
133	RCLC	36 13	
134	F2?	16 23 02	
135	GTO4	22 04	
136	ENT↑	-21	
137	ENT↑	-21	
138	1	01	
139	+	-55	
140	1/X	52	
141	x	-35	
142	STOC	35 13	
143	SF1	16 21 01	
144	EEX	-23	
145	2	02	
146	x	-35	
147	RTN	24	
148	*LBL2	21 02	
149	1	01	
150	%	55	
151	STOC	35 13	store margin and
152	SF1	16 21 01	adjust flags
153	CF2	16 22 02	
154	RTN	24	
155	*LBLD	21 14	
156	F3?	16 23 03	
157	GTO3	22 03	
158	F2?	16 23 02	
159	GTO5	22 05	
160	RCLC	36 13	
161	ENT↑	-21	
162	ENT↑	-21	markup = margin/
163	CHS	-22	(1-margin)
164	1	01	
165	+	-55	
166	1/X	52	
167	x	-35	

STEP	KEY ENTRY	KEY CODE	COMMENTS
168	STOC	35 13	
169	CF1	16 22 01	
170	EEX	-23	
171	2	02	
172	x	-35	
173	RTN	24	
174	*LBL3	21 03	
175	CF1	16 22 01	
176	CF2	16 22 02	
177	1	01	
178	%	55	store markup &
179	STOC	35 13	adjust flags
180	RTN	24	
181	*LBL4	21 04	
182	RCLA	36 11	
183	RCLB	36 12	
184	%CH	16 55	margin = selling -
185	CHS	-22	cost/selling
186	SF1	16 21 01	
187	1	01	
188	%	55	
189	STOC	35 13	
190	X⇄Y	-41	
191	RTN	24	
192	*LBL5	21 05	
193	RCLB	36 12	
194	RCLA	36 11	
195	%CH	16 55	
196	CF1	16 22 01	
197	1	01	
198	%	55	markup = selling -
199	STOC	35 13	cost/cost
200	X⇄Y	-41	
201	RTN	24	
202	R/S	51	
210			
220			

LABELS

A selling	B cost	C margin	D markup	E
a list	b net	c D_1	d D_2	e D_3
0	1	2	3	4
5	6	7	8	9

FLAGS

0	
1	
2	
3	used

SET STATUS

FLAGS	ON	OFF	TRIG		DISP	
0	☐	☐	DEG	☐	FIX	☐
1	☐	☐	GRAD	☐	SCI	☐
2	☐	☐	RAD	☐	ENG	☐
3	☐	☐			n ____	

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