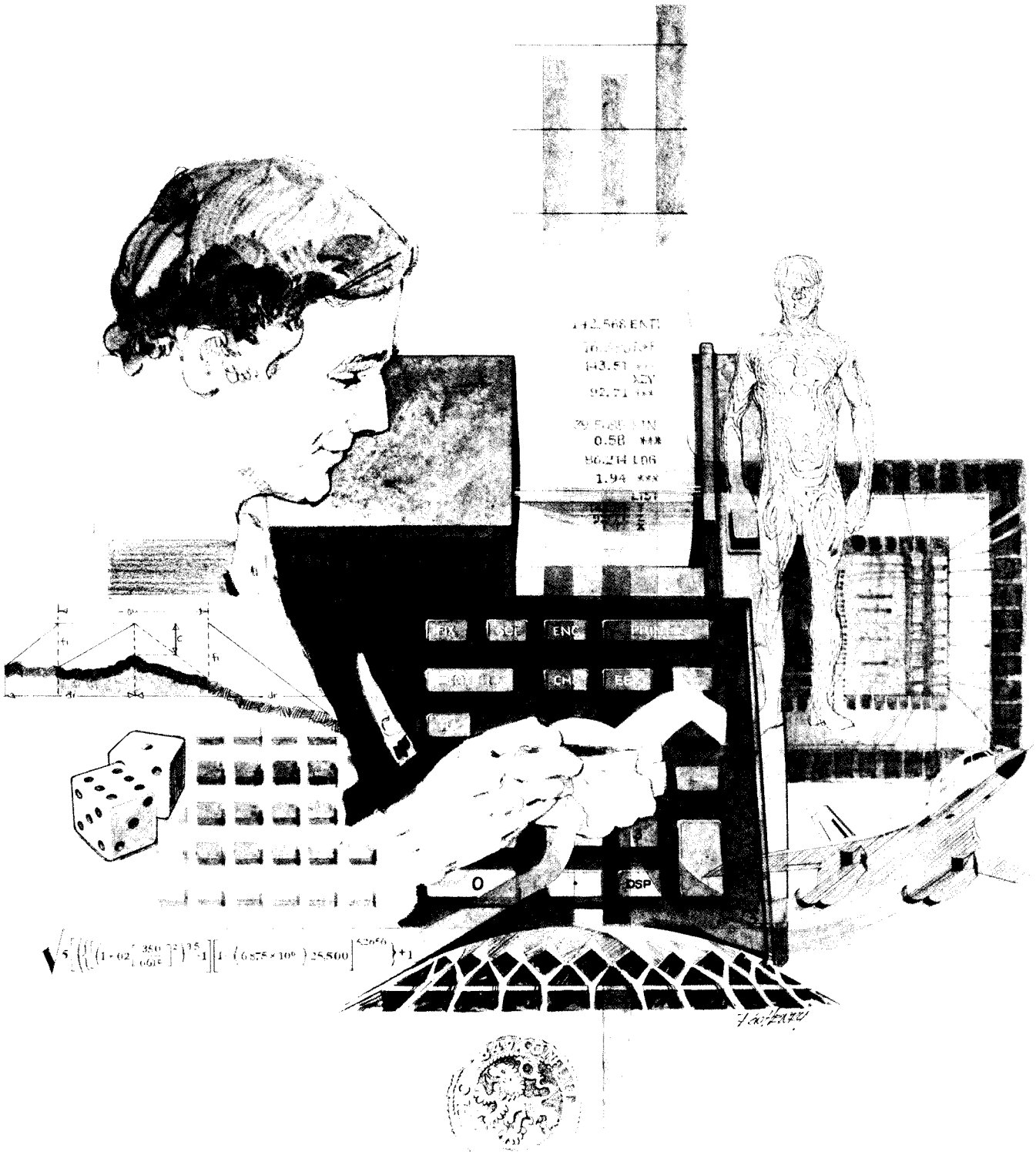
HEWLETT-PACKARD

HP-67 HP-97

Users' Library Solutions

Options/Technical Stock Analysis



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	PUT & CALL OPTION FAIR VALUES (BLACK-SCHOLES)
Contributor's Name	William B. Henderson
Address	160 Paseo de la Concha #F
City	Redondo Beach, **State** California **Zip Code** 90277

Program Description, Equations, Variables This program computes the theoretical value of a European[1] type put or call option using the valuation formulas of Black & Scholes[2,3]. The following equations are used:

$$\text{Call Option Value} = P_{stock}N(d_1) - P_{strike}N(d_2)\exp^{-Rt}$$

$$\text{Put Option Value} = P_{strike}N(-d_2)\exp^{Rt} - P_{stock}N(-d_1)$$

where:

$$d_1 = \frac{\ln(P_{stock}/P_{strike}) + (R + \frac{1}{2}V^2)t}{V\sqrt{t}}$$

$$d_2 = \frac{\ln(P_{stock}/P_{strike}) + (R - \frac{1}{2}V^2)t}{V\sqrt{t}}$$

$$N(d) = \frac{1}{\sqrt{2\pi}}\int_{-\infty}^{d} \exp^{-Z^2/2}\,dz$$

$$N(-d) = 1 - N(d)$$

The Hedge Ratio for a Call Option = $N(d_1)$

R is the appropriate interest rate expressed as a decimal.
t is the remaining time to expiration in years.
V is the variance rate of the return on the underlying security.

Operating Limits and Warnings The variance term in the equation must be the future variance of the underlying security for the option to be correctly priced. A more complete discussion of this term is available from the program author. A crude estimate of variance may be obtained from the formula:

$$V = \frac{\text{Stock High - Stock Low}}{\frac{1}{2}(\text{Stock High + Stock Low})} \quad \text{during the past year.}$$

Out-of-the-money options are extremely sensitive to this term and large errors in value may result from improper choices.

Program Description II

Sketch(es)

Sample Problem(s) A. What is the fair market price of a call option with a striking price of 65 and 91 calender days remaining to expiration? The current (risk free) interest rate for a 91-day T-Bill is 4.65%, the current stock price is $63\frac{1}{4}$ and the estimated variance is 0.125.

B. What is the fair market price of a put option with the same conditions as (A)?

C. What is the value of the call option in (A) if the variance term is actually 0.175?

D. What is the Hedge ratio of the option in (C)?

KEY IN:		DISPLAY:
65,A	---	65.00 (P_{strike})
63.25,B	---	63.25 (P_{stock})
91,C	---	0.25 (t)
.125,D	---	0.02 (V^2)
4.65,E	---	0.05 (R)

Solution(s)

SOLVE A:	fA	---	1.14	Convert to 1/16ths: fC	-- 1 2/16
SOLVE B:	fE	---	1.00	Put/Call toggle	
	fA	---	2.14	Convert to 1/16ths: fC	-- 3 1/16
SOLVE C:	.175,D	---	0.03 (V^2)		
	fE	---	0.00	Put/Call toggle	
	fA	---	1.76	Convert to 1/16ths: fC	-- 1 12/16
SOLVE D:	fB	---	0.45		

Reference(s) (1) A European option can only be exercised at maturity. This differs from an American option which can be exercised at any time through maturity.

(2) Black, Fischer and Myron Scholes; "The Pricing of Options and Corporate Liabilities". Journal of Political Economy (May/June 1973), pp 637-654.

(3) Black, Fischer; "Fact and Fantasy In the Use of Options". Financial Analysts Journal (July/August 1975), pp 36-72.

User Instructions

---FAIR OPTION VALUE---

1 → VALUE	→ HEDGE	→ 1/16ths	H↑L → V^2	PUT? 2
STRIKE	STOCK	# DAYS	VARIANCE	INT. RATE

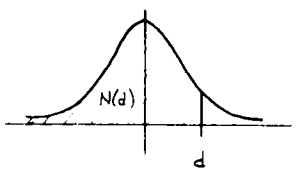
STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Key in Striking Price of Option	$	A	$
2	Key in Price of Underlying Stock	$	B	$
3	Key in # Calender Days Remaining on Option	days	C	yrs.
4	Key in Variance	V	D	V^2
	or, if variance is unknown, estimate as			
	follows:			
	Key in stock's high for year, ENT	$		
	Key in stock's low for year	$	f D	V^2
5	Key in appropriate interest rate	%	E	R
6	Select Mode:			
	0 = Call Option*		f E	
	1 = Put Option		f E	
	*Machine is in call mode when card is loaded.			
7	Solve for:			
	Option Value:		f A	$
	Hedge Ratio:		f B	
	Convert contents of X-register to 16ths:		f C	

97 Program Listing I

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	*LBLA		Striking Price
002	STOA		
003	RTN		
004	*LBLB		Stock Price
005	STOB		
006	RTN		
007	*LBLC		# Calendar Days Remaining
008	3		
009	6		
010	5		
011	÷		→ yrs. remaining
012	STOC		
013	RTN		
014	*LBLa		Stock High ↑
015	STO6		
016	R↓		Stock Low
017	STO7		
018	RCL6		→ ~ V^2
019	-		
020	RCL7		
021	RCL6		
022	+		
023	2		
024	÷		
025	÷		
026	*LBLD		Variance
027	X^2		
028	STOD		→ V^2
029	RTN		
030	*LBLE		Interest Rate (%)
031	EEX		
032	2		→ Decimal Equivalent
033	÷		
034	STOE		
035	RTN		
036	*LBLa		→ Option Value
037	RCLB		
038	RCLA		
039	÷		
040	LN		
041	RCLC		
042	RCLE		
043	x		
044	+		
045	RCLC		
046	RCLD		
047	x		
048	√X		
049	STO1		
050	÷		
051	ENT↑		
052	ENT↑		
053	RCL1		
054	2		
055	÷		
056	STO1		
057	-		
058	X≷Y		
059	RCL1		$x = d_1$
060	+		$\epsilon = d_2$
061	GSB0		← Solve $N(d_1)$ or $N(-d_1)$
062	STO9		
063	RCLB		
064	x		
065	F0?		PUT ?
066	CHS		
067	X≷Y		
068	GSB0		← Solve $N(d_2)$ or $N(-d_2)$
069	RCLA		
070	x		
071	RCLC		
072	RCLE		
073	x		
074	e^x		
075	÷		
076	F0?		
077	CHS		
078	-		PUT ?
079	RTN		
080	*LBL0		
081	STO4		
082	ABS		
083	.		
084	3		
085	3		
086	2		
087	6		
088	7		
089	x		
090	1		
091	+		
092	1/X		
093	STO5		
094	3		
095	Y^x		
096	.		
097	9		
098	3		
099	7		
100	2		
101	9		
102	8		
103	x		
104	RCL5		
105	X^2		
106	.		
107	1		
108	2		
109	0		
110	1		
111	6		
112	7		

Subroutine for evaluation of Cumulative Normal density function

$$N(d) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{d} e^{-x^2/2}\, dx$$



Ref:

Handbook of Mathematical Functions (AMS 55)

Abramowitz & Stegun

N.B.S. Publication

pp 932

$|\epsilon(d)| \leq 10^{-5}$

REGISTERS

0	1 Used	2	3	4 Used	5 Used	6 Low	7 High	8 .16	9 Hedge
S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A Strike	B Stock	C t	D V^2	E R	I Used

97 Program Listing II

STEP	KEY ENTRY	KEY CODE	COMMENTS
	113	6	
	114	×	
	115	-	
	116	RCL5	
	117	.	
	118	4	
	119	3	
	120	6	
	121	1	
	122	8	
	123	3	
	124	6	
	125	×	
	126	+	
	127	RCL4	
	128	X^2	
	129	2	
	130	÷	
	131	e^x	
	132	÷	
	133	Pi	
	134	2	
	135	×	
	136	√X	
	137	÷	
	138	RCL4	
	139	F0?	
	140	CHS	
	141	X<0?	} PUT ?
	142	GTO1	
	143	R↓	
	144	CHS	
	145	1	
	146	+	
	147	RTN	
	148	*LBL1	
	149	R↓	
	150	RTN	
	151	*LBLb	
	152	RCL9	
	153	RTN	→ Hedge Ratio
	154	*LBLc	
	155	STO1	
	156	FRC	→ Contents of
	157	.	x-register in
	158	1	Points . Ticks
	159	6	
	160	STO8	
	161	×	
	162	RND	
	163	RCL8	
	164	X=Y?	
	165	GSB2	
	166	R↓	
	167	RCL1	
	168	INT	
	169	+	
	170	RTN	
	171	*LBL2	
	172	1	
	173	ENT↑	
	174	RTN	
	175	*LBLe	
	176	F0?	
	177	GTO3	
	178	SF0	
	179	1	
	180	RTN	
	181	*LBL3	
	182	CF0	
	183	0	
	184	RTN	
	185	R/S	

PUT/CALL Toggle

190		
200		
210		
220		

LABELS

A Strike	B Stock	C # Days	D V	E R	0 Used
a Value	b → Hedge	c → Ticks	d HAL → V?	e PUT ?	1
0 N(d)	1 Used	2 Used	3 Used	4	2
5	6	7	8	9	3

FLAGS

	ON	OFF
0	☑	☐
1	☐	☑
2	☐	☑
3	☐	☑

SET STATUS

TRIG		DISP	
DEG	☑	FIX	☑
GRAD	☐	SCI	☐
RAD	☐	ENG	☐
		n	2

Program Description I

Program Title CALL OPTION EVALUATION

Contributor's Name RICHARD G. DONALD
Address 1561 BLACKHAWK DR
City SUNNYVALE **State** CA **Zip Code** 94087

Program Description, Equations, Variables THIS PROGRAM USES THE BLACK-SCHOLES FORMULA FOR THE PRICE OF CALL OPTIONS ALONG WITH PORTIONS OF THE STANDARD PAC "CALCULAS AND ROOTS OF F(X)." A SINGLE FUNCTION OF MANY VARIABLES DEFINED AS

$$f(B, R, t, P_E, P_S, V) = P_S\, g(d_1) - e^{-Rt} g(d_2)$$

WHERE

$$d_1 = \frac{\ln(P_S/P_E) + (R + V^2/2)t}{V\sqrt{t}}, \quad d_2 = \frac{\ln(P_S/P_E) + (R - V^2/2)t}{V\sqrt{t}},$$

$$g(x) = \frac{1}{2} + \frac{1}{2}\,\mathrm{erf}\left(\frac{x}{\sqrt{2}}\right)$$ WHERE THE APPROXIMATION FOR $g(x)$ IS

$$g(x) = \begin{cases} 1 - Q(x) & x \geq 0 \\ Q(x) & x < 0 \end{cases}$$

WHERE

$$Q(x) = \frac{e^{-x^2/2}}{\sqrt{2\pi}}\left\{y\left[.4362 - .12y + .9371y^2\right]\right\}$$

WITH

$$y = \frac{1}{1 + .3327|x|}$$

B = OPTION PRICE (DOLLARS), R = INTEREST RATE (WHERE 5% IS ENTERED AS 0.05), t = TIME (YEARS), P_E = STRIKE PRICE (DOLLARS), P_S = CURRENT STOCK PRICE (DOLLARS), V = VOLITILITY

Operating Limits and Warnings

Program Description II

Sketch(es)

Sample Problem(s) GIVEN THE FOLLOWING STATISTICS ON HEWLETT-PACKARD STOCK ON 3/28/77:

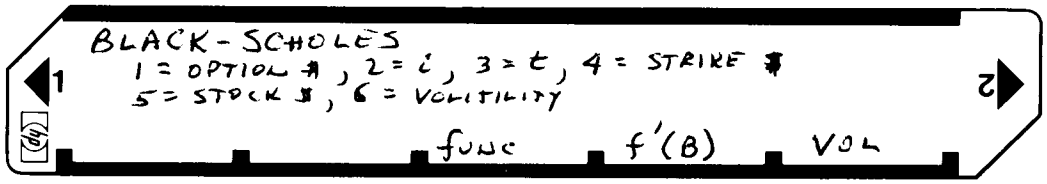
CALL OPTION EXPIRATION:	MAY	AUG
OPTION PRICE:	1 1/16	3 3/4
DAYS REMAINING:	56	146
STRIKE PRICE:	80	80
STOCK PRICE:	75 1/2	75 1/2

CALCULATE a) MARKET-ASSIGNED VOLITILITY FOR EACH SERIES
b) SLOPE OF OPTION PRICE WRT STOCK PRICE
c) SLOPE OF OPTION PRICE WRT TIME
d) AUG OPTION PRICE IF VOL WERE 0.30 (HISTORIC VOLITILITY OF HP STOCK)

Solution(s) a) KEY IN MAY PARAMETERS: 1.0625 STO 1, .05 STO 2, 56/365 STO 3, 80 STO 4, 75.5 STO 5, 0.3 (GUESS) STO 6, PRESS E, RESULT = 0.21.
KEY IN AUG PARAMETERS: 3.75 STO 1, 146 ÷ 365 STO 3, PRESS E, RESULT = 0.26
b) USING AUG PARAMETERS: 0.26 STO 6, PRESS D, RESULT = 0.44
c) USING AUG PARAMETERS: PRESS fd, RESULT = 7.65 $/YEAR
d) USING AUG PARAMETERS: 0.30 STO 6, PRESS C, RESULT = $4.47

Reference(s) FISCHER BLACK AND MYRON SCHOLES, "THE PRICING OF OPTIONS AND CORPORATE LIABILITIES," JOURNAL OF POLITICAL ECONOMY 81 (MAY/JUNE 1973)

User Instructions



STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
1	LOAD BOTH SIDES OF CARD				
2	ENTER OPTION PARAMETERS				
	a) OPTION PRICE (OMIT IF TO BE CALCULATED)	$	STO	1	B
	b) INTEREST RATE	DECIMAL	STO	2	R
	c) TIME	YEARS	STO	3	t
	d) STRIKE PRICE	$	STO	4	P_o
	e) CURRENT STOCK PRICE	$	STO	5	P_s
	f) VOLATILITY	V	STO	6	V
3	OPTIONAL: TOGGLE PAUSE MODE		fE		1.00/0.00
4	CHOOSE DESIRED MODE				
	a) FOR OPTION PRICE		C		B ($)
	b) FOR VOLITILITY		E		V
	c) FOR f'(B) WRT STOCK PRICE		D		f'(B) $/$
	d) FOR f'(B) WRT TIME		fd		f'(B) $/YEAR
5	TO REPEAT, GO TO STEP 2 AND CHANGE ANY PARAMETER				

67 Program Listing I

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	*LBL A	31 25 11	initialize
	h STF	35 33	
	RCL (i)	34 24	
	f P≒S	31 42	
	STO (i)	33 24	
	f P≒S	31 42	
	DSP 2	23 02	
	h RTN	35 22	
	*LBL e	32 25 15	PAUSE TOGGLE
010	h F0?	35 71 00	
	GTO 0	22 00	
	h SF 0	35 51 00	
	1	01	
	h RTN	35 22	
	*LBL 0	31 25 00	
	0	00	
	h CF 0	35 61 00	
	h RTN	35 22	
	*LBL a	32 25 11	STORE %Δ AND SET FLAG
020	h SF 1	35 51 01	
	STO E	33 15	
	h RTN	35 22	
	*LBL D	31 25 14	f'(x) W.R.T. STOCK PRICE
	5	05	
	GTO 2	22 02	
	*LBL d	32 25 14	f'(x) W.R.T. TIME
	3	03	
	*LBL 2	31 25 02	
	f GSB A	31 22 11	
030	*LBL B	31 25 12	CHOOSE DEFAULT %Δ OR USE 0.01%
	EEX	43	
	CHS	42	
	2	02	
	RCL E	34 15	
	h f1?	35 71 01	
	h x≒y	35 52	
	h R↓	35 53	
	f %	31 82	IF X=0 USE %Δ RATHER THAN % OF X AS ΔX
	f X=0?	31 51	
040	h LST X	35 82	
	STO C	33 13	
	2	02	f(X − ΔX/2)
	÷	81	
	−	51	
	STO A	33 11	
	STO 0	33 00	
	f GSB 1	31 22 01	
	STO D	33 14	
	RCL A	34 11	f(X + ΔX/2)
050	RCL C	34 13	
	+	61	
	STO 0	33 00	
	f GSB 1	31 22 01	
	STO B	33 12	
	RCL D	34 14	
	−	51	

STEP	KEY ENTRY	KEY CODE	COMMENTS
	RCL C	34 13	$\frac{f(x+\frac{\Delta x}{2})-f(x-\frac{\Delta x}{2})}{\Delta x}$
	÷	81	
	h RTN	35 22	
060	*LBL C	31 25 13	f(x)
	1	01	
	f GSB A	31 22 11	
	0	00	
	STO 1	33 01	
	f GSB 1	31 22 01	
	h RTN	35 22	
	*LBL E	31 25 15	USE NUMERICAL DIFFERENTIAL TO GENERATE X_i FROM INITIAL GUESS
	6	06	
	f GSB A	31 22 11	
070	f FIX	31 23	
	f GSB B	31 22 12	
	RCL B	34 12	
	GTO 0	22 00	
	*LBL 6	31 25 06	EVALUATE $f(x_i)$
	RCL 0	34 00	
	f GSB 1	31 22 01	
	STO B	33 12	
	*LBL 0	31 25 00	SECANT METHOD CALCULATES CORRECTION FOR X VALUE AND SETS VALUES FOR NEXT LOOP
	RCL A	34 11	
080	RCL 0	34 00	
	STO A	33 11	
	−	51	
	RCL D	34 14	
	RCL B	34 12	
	STO D	33 14	
	−	51	
	÷	81	
	X	71	
	STO − 0	33 51 00	SUB CORRECTION
090	RCL 0	34 00	PAUSE AND DISPLAY ROOT
	h F0?	35 71 00	
	h PSE	35 72	
	÷	81	RND (CHANGE/X_{i+1})
	f RND	31 24	
	f X≠0?	31 61	ACCURATE?
	GTO 6	22 06	
	RCL 0	34 00	IF SO, DISPLAY
	h RTN	35 22	
	*LBL 1	31 25 01	START BLACK-SCHOLES METHOD
100	STO (i)	33 24	
	RCL 6	34 06	$\frac{V^2}{2}$
	g x²	32 54	
	2	02	
	÷	81	
	STO 8	33 08	
	f GSB 2	31 22 02	d_1
	STO 7	33 07	
	RCL 8	34 08	d_2
	CHS	42	
110	f GSB 2	31 22 02	
	f GSB 3	31 22 03	
	RCL 4	34 04	

REGISTERS

0 X_i	1 B	2 R	3 t	4 P_e	5 P_s	6 V	7 TEMP	8 TEMP	9
S0	S1 B	S2 R	S3 t	S4 P_E	S5 P_S	S6 V	S7 TEMP	S8 TEMP	S9

A X_{i-1}	B $f(x_i)$	C ΔX	D $f(x_{i-1})$	E %Δ	I VARIABLE

67 Program Listing II

STEP	KEY ENTRY	KEY CODE	COMMENTS
	×	71	$e^{-Rt} P_E\, g(d_L)$
	RCL 2	34 02	
	RCL 3	34 03	
	×	71	
	g e^x	32 52	
	÷	81	
	RCL 1	34 01	
120	+	61	
	RCL 7	34 07	$P_S\, g(d_1)$
	h x≤y	35 52	
	STO 7	33 07	
	h x≤y	35 52	
	f GSB 3	31 22 03	
	RCL 5	34 05	
	×	71	
	RCL 7	34 07	
	−	51	
130	f P≤S	31 42	
	RCL(i)	34 24	
	f P≠S	31 42	
	STO(i)	33 24	
	h R↓	35 53	ANS
	h RTN	35 22	
	*LBL 2	31 25 02	
	RCL 2	34 02	$\frac{\ln(P_S/P_E)+(R+\frac{V^2}{2})t}{V\sqrt{t}}$
	+	61	
	RCL 3	34 03	
140	×	71	
	RCL 5	34 05	
	RCL 4	34 04	
	÷	81	
	f LN	31 52	
	+	61	
	RCL 6	34 06	
	÷	81	
	RCL 3	34 03	
	f √x	31 54	
150	÷	81	
	h RTN	35 22	
	*LBL 3	31 25 03	
	f P≤S	31 42	
	STO 7	33 07	
	f x<0?	31 71	
	h SF 2	35 51 02	
	h ABS	35 64	$\frac{1}{1+.3327\lvert x\rvert}$
	.	83	
	3	03	
160	3	03	
	2	02	
	7	07	
	×	71	
	1	01	
	+	61	
	h 1/x	35 62	
	STO 8	33 08	
	g x^2	32 54	

STEP	KEY ENTRY	KEY CODE	COMMENTS
	.	83	$Q(x)$
170	9	09	
	3	03	
	7	07	
	1	01	
	×	71	
	RCL 8	34 08	
	.	83	
	1	01	
	2	02	
	×	71	
180	−	51	
	.	81	
	4	04	
	3	03	
	6	06	
	2	02	
	+	61	
	RCL 8	34 08	
	×	71	
	h π	35 73	
190	2	02	
	×	71	
	f √x	31 54	
	÷	81	
	RCL 7	34 07	
	f P≤S	31 42	
	g x^2	32 54	
	2	02	
	÷	81	
	g e^x	32 52	
200	÷	81	
	h F2?	35 71 02	
	h RTN	35 22	
	CHS	42	
	1	01	
	+	61	
	h RTN	35 22	
210			
220			

LABELS

A INIT	B $X_i \to f'(X_i)$	C $X_i = f(X)$	D $f'(x)$ w/o P_S	E VOL→ROOT
a %Δ	b	c	d $f'(x)$ w/ t	e PAUSE
0 PAUSE	1 f(x)	2 $f'(x)/d$	3 Q(x)	4
5	6	7	8	9

FLAGS

0	PAUSE
1	%Δ
2	Q(x) x≥0
3	

SET STATUS

FLAGS	ON	OFF
0	☐	☑
1	☐	☑
2	☐	☑
3	☐	☑

TRIG	
DEG	☑
GRAD	☐
RAD	☐

DISP	
FIX	☑
SCI	☐
ENG	☐
n	____

Program Description I

Program Title Routines for Option Writers

Contributor's Name John R. McGinley Jr.

Address 235 East 57th St.

City New York, **State** N.Y. **Zip Code** 10022

Program Description, Equations, Variables Using the Black & Scholes Model (compliments of T.I.) the value of a given option may be calculated given stock & strike prices, an interest rate, the stock's volatility(see below), the days to expiry, and the dividends to be received in the interim. Then the hedge ratio is calculated from which the number of options per share to write is determined. Once done, the max. yield on investment, cash flow yield, and the annual rate of return on the lesser of these can be calculated. Finally the high and low break-even points for the stock are figured along with the point of maximum profit (should the option expire or be exercized there).

Equations

1) Cash flow return = Premium divided by Stock Price

2) Premium = # Options written X price per option received

$$\text{Value} = P_{stock}\,N(D_1) - P_{exer}\,N(D_2)e^{-Rt}$$

Where $$D_1 = \frac{\ln(P_{stock} \div P_{exer}) + (R + \frac{1}{2}V^2)\,\Delta t}{V\sqrt{\Delta t}}$$

$$D_2 = \frac{\ln(P_{stock} \div P_{exer}) + (R - \frac{1}{2}V^2)\,\Delta t}{V\sqrt{\Delta t}}$$

$$N(D_1) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{D_1} e^{-\frac{1}{2}t^2}\,dt$$

(continued on page 2)

Note: Based on the Black and Scholes model published in Financial Analysts Journal, July - August 1975, page 65.

Operating Limits and Warnings Option value must be calculated first, then the hedge ratio, followed by the # to write. Only then can the returns (C/F & MYOI) be figured. Latter enables the annual return to be determined. Now the high. low. max points can be calculated. The givens are all remembered until user changed.

One can go directly from getting the number to write to L-M-H without figuring the annualized return first. i.e. sequence must be E, fc, fd, fc, fb.(fa may be used any time after fd.)

3) MYOI = Premium + (Strike - Stock prices) + dividends, all divided by dividends.
4) Annualized return = (Days in year/days to expiry) X lesser of C/F or MYOI.
5) #Options to write = 1/hedge ratio.
6) Downside protection (break-even) point = Strikeprice - premium
7) Maximum profit point = Strike price
8) Upside protection point = ((Premium + strike - stock prices)/ # Options which are uncovered) + Strike price. If options are fully covered, upside protection = Strike price + premium.

*Volatility is the annual standard deviation of the return on the underlying stock. There are several ways of estimating it. One is to keep fitting various values into the equation until the actual price equals the calculated price. Another is to use this equation:

$$\text{Volatility} = \frac{\text{High} - \text{Low}}{1/2\ (\text{High} - \text{Low})}$$

where the highs and lows used are those of the stock over a period of time. Experience has shown using this method produces values which are too high. Thus use 6 months' highs and lows (those printed in the newspapers during June & July) or dispense with dividing the denominator by 2.

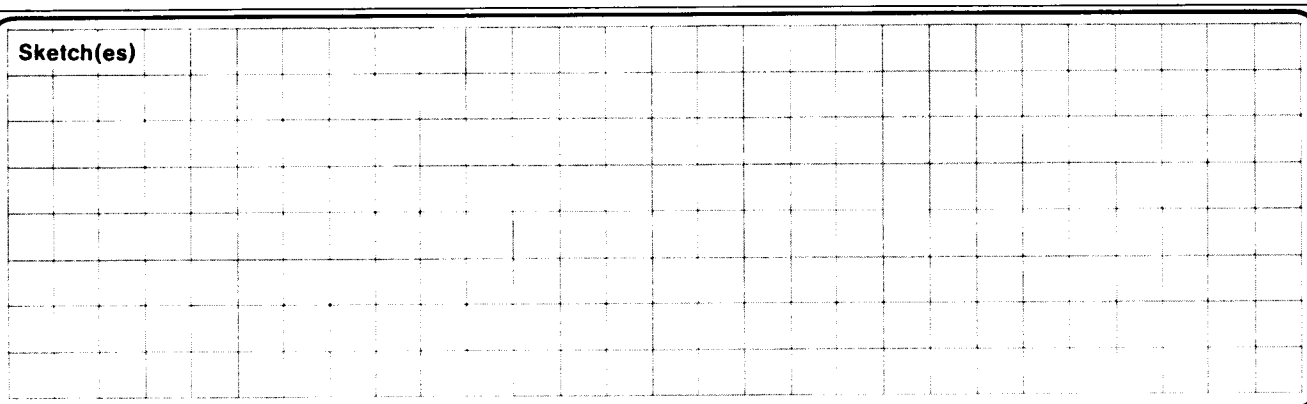
*Be careful not to confuse volatility with beta. The beta of a stock or option measures the variability with respect to the market: i.e. if the market goes up ten points, how far should the stock go? Volatility, on the other hand, measures the stock or option's variability with respect only to itself. How much does this stock tend to move around. AT & T has an approximate volatility of .11. National Semiconductor has an approximate volatility of .49! Almost 5 times as volatile. Most brokerage houses can provide you with the numbers they are using as of any given date

Purchase of a Call Option gives the buyer the right, over a specified period of time, to buy so many shares of the stock at a fixed price. Options are traded on several exchanges and move in price with the underlying stock, only with greater percent price changes because of the high leverage. There is usually a certain premium* built in to the price of the option which represents the price you pay for the right to buy at a set price. The amount of the premium is emotionally determined, but its theoretical amount can be calculated by this model. Any variations from the theoretical, then, could represent potential profit. Normally most of the premium, if any, is lost by 30 days prior to expiration of the option. Writers of options like to see high premiums when they "write". Buyers of options like to see none.

* Do not confuse the use of the word premium here with that used above. Here it describes the difference between the selling price of the option and its intrinsic value due to the price of the underlying stock. Above, it means the entire amount of money an option writer obtains for writing the contract.

Program Description II

Sketch(es)



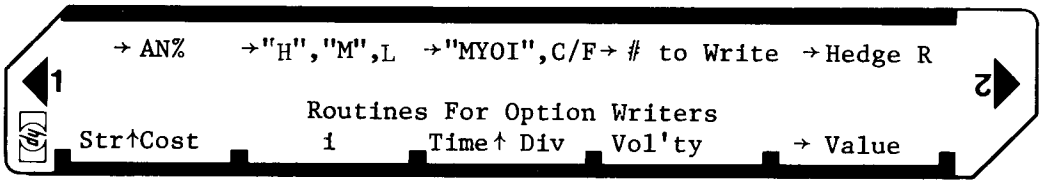
Sample Problem(s) Given the stock of XYZ Corp. at $118.25 per share, the Jan 120 option with 35 days to go, a dividend expected of $1.50, the stock's volatility at .28, and an interest rate of 6%, what is the expected value of the option now? How many options should I write against 100 shares of the stock given its hedge ratio? What are the variously figured returns which I should expect? Where do I make the most money? Where are my break-even points?

Solution(s)

	Keystrokes	Display		Keystrokes	Display
1)	120 ↑ 118.25 [A]	$120	9)	[fa]	63.47%
2)	35 ↑ 1.50 [C]	.10 yr.	10)	[fb]	"$111.05","$120".
3)	6 [B]	.06			$128.95
4)	.28 [D]	.28			
5)	[E] (In 11 seconds)	$3.60			
6)	[fe] (In 7 seconds)	.48			
7)	[fd]	200 sh.			
8)	(fc]	"8.83%", 6.09%			

Reference(s) "Fact & Fantasy in the use of options" by Fischer Black (Financial Analysts Journal, July/August 75), "The Pricing of Options and Corporate Liabilities" by Black & Scholes (Journal of Political Economy, May/June 73), "Listed Options by Bear Stearns,"A guide to AMEX options" from the American Stock Exchange. The Thompson & McKinnon Option Letter.

User Instructions



STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1.	Load both sides of the card			
2.	Enter in order, strike price	Strike	Enter	
3.	Enter in order, stock cost price	Cost	A	Strike px
4.	Enter interest rate	i	B	Decimal i
5.	Enter number of days to expiry	days	Enter	
6.	Enter dividends expected before expiry	divs	C	Decimal Yr
7.	Enter volatility	vol'ty	D	vol'ty
8.	Calculate option's theoretical value		E	$ Value
9.	Calculate hedge ratio		fe	ratio
10.	Calculate number of options to write per 100		fd	# shares
11.	Calcualte MYOI and C/F returns in percent		fc	"MYOI",C/F
12.	Calculate annualized return		fa	%
13.	Determine high & low break-even points and point of maximum profit		fb	"H","M",L
	To calculate new option values with differing givens, change only those desired, the rest are retained in memory.			

67 Program Listing I

STEP	KEY ENTRY	KEY CODE	COMMENTS
001 *	f LBL C	31 25 13	Enter time in days & dividend in $
	STO C	33 13	
	h x-y	35 52	
	3	03	
	6	06	
	5	05	
	÷	81	
	STO 3	33 03	
	h 1/x	35 62	
010	STO E	33 15	
	h LST x	35 82	
	h RTN	35 22	
*	f LBL D	31 25 14	Enter Volatility
	STO 4	33 04	
	h RTN	35 22	
*	f LBL B	31 25 12	Enter interest rate in form XX.XX
	EEX	43	
	2	02	
	÷	81	
020	STO 5	33 05	
	h RTN	35 22	
*	f LBL E	31 25 15	Calculate option value
	f GSB 5	31 22 05	
	RCL 1	34 01	
	X	71	
	STO 8	33 08	
	f GSB 4	31 22 04	
	RCL 2	34 02	
	X	71	
030	RCL 7	34 07	
	CHS	42	
	g e^x	32 52	
	X	71	
	CHS	42	
	RCL 8	34 08	
	+	61	
	STO D	33 14	
	h RTN	35 22	
*	f LBL 4	31 25 04	Display option value
040	RCL A	34 11	
	RCL 0	34 00	
	2	02	
	÷	81	
	-	51	
	GTO 1	22 01	
*	f LBL 5	31 25 05	Hedge ratio SBR
	RCL 4	34 04	
	RCL 3	34 03	
	f $\sqrt{x}$	31 54	
050	X	71	
	STO 0	33 00	
	h 1/x	35 62	
	RCL 5	34 05	
	RCL 3	34 03	
	X	71	
	STO 7	33 07	
	RCL 1	34 01	
	RCL 2	34 02	
	÷	81	
060	f Ln	31 52	
	+	61	
	X	71	
	STO A	33 11	
	RCL 0	34 00	
	2	02	
	÷	81	
	+	61	
*	f LBL 1	31 25 01	
	f x > 0	31 81	
070	GTO 2	22 02	
	CHS	42	
	h SF 0	35 51 00	
*	f LBL 2	31 25 02	
	STO 6	33 06	
	.	83	
	3	03	
	3	03	
	2	02	
	7	07	
080	X	71	
	1	01	
	+	61	
	h 1/x	35 62	
	STO 9	33 09	
	.	83	
	1	01	
	2	02	
	CHS	42	
	X	71	
090	RCL 9	34 09	
	g x^2	32 54	
	.	83	
	9	09	
	3	03	
	7	07	
	1	01	
	X	71	
	.	83	
	4	04	
100	3	03	
	6	06	
	2	02	
	+	61	
	+	61	
	RCL 9	34 09	
	X	71	
	STO B	33 12	
	RCL 6	34 06	
	g x^2	32 54	
110	2	02	
	÷	81	
	CHS	42	

REGISTERS

0 $v\sqrt{dt}$/RNGE	1 Stock Px	2 Strike Px	3 Decimal time	4 Volatility	5 Interest Rate	6 Used/# Optn	7 rt/prem	8 Used/MYOI	9 Used/c/f
S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A 99	B Ln(Ps/Pe)	C Dividend	D Option price	E 1/Time	I

67 Program Listing II

STEP	KEY ENTRY	KEY CODE	COMMENTS
	g e^x	32 52	
	2	02	
	h π	35 73	
	X	71	
	f $\sqrt{x}$	31 54	
	÷	81	
	RCL B	34 12	
120	X	71	
	h F? 0	35 71 00	
	GTO 3	22 03	
	CHS	42	
	1	01	
	+	61	
*	f LBL 3	31 25 03	
	h CF 0	35 61 00	
	h RTN	35 22	
*	g LBL e	32 25 15	Hedge Ratio Routine
130	f GSB 5	31 22 05	
	STO 0	33 00	
	h RTN	35 22	
*	g LBL d	32 25 14	Determine # to write in round lots
	EEX	43	
	2	02	
	RCL 0	34 00	
	h 1/x	35 62	
	DSP 0	23 00	
	f RND	31 24	
140	STO 6	33 06	
	X	71	
	h RTN	35 22	
*	g LBL c	32 25 13	Calculate MYOI and cash flow % return
	DSP 2	23 02	
	RCL D	34 14	
	RCL 6	34 06	
	X	71	
	STO 7	33 07	
	RCL 2	34 02	
150	RCL C	34 13	
	+	61	
	+	61	
	RCL 1	34 01	
	-	51	
	h LST x	35 82	
	÷	81	
	EEX	43	
	2	02	
	X	71	
160	STO 8	33 08	
	f -x-	31 84	
	RCL 7	34 07	
	RCL 1	34 01	
	÷	81	
	EEX	43	
	2	02	
	X	71	
	STO 9	33 09	

STEP	KEY ENTRY	KEY CODE	COMMENTS
	h RTN	35 22	
170 *	g LBL a	32 25 11	Calculate Annual % return
	RCL 8	34 08	
	RCL 9	34 09	
	g x>y	32 81	
	h x-y	35 52	
	RCL E	34 15	
	X	71	
	h RTN	35 22	
*	f LBL A	31 25 11	Enter strike price & stock cost
	STO 1	33 01	
180	h R↓	35 53	
	STO 2	33 02	
	DSP 2	23 02	
	1	01	
	2	02	
	CHS	42	
	h ST I	35 33	
*	h R↓	35 53	Calculate high & low break-even points. Also max. profit point.
	h RTN	35 22	
	g LBL b	32 25 12	
190	RCL 7	34 07	
	RCL 2	34 02	
	RCL 1	34 01	
	-	51	
	+	61	
	RCL 6	34 06	
	1	01	
	-	51	
	f x = 0	31 51	
	GTO 6	22 06	
200	÷	81	
	f LBL 7	31 25 07	
	RCL 2	34 02	
	+	61	
	f -x-	31 84	
	RCL 2	34 02	
	f -x-	31 84	
	RCL 1	34 01	
	RCL 7	34 07	
	-	51	
210	f -x-	31 84	
	h RTN	35 22	
	f LBL 6	31 25 06	
	RCL 7	34 07	
	GTO (i)	22 24	
220			

LABELS

A Str-Stk Price	B i	C Time-Div	D Vol'ty	E Opt Value
a Ann'l %	b L-M-H	c MYOI-C/F	d # Write	e Hedge R.
0	1 Used	2 Used	3 Used	4 Used
5 Used	6	7	8	9

FLAGS

0 Used	1	2	3

SET STATUS

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

Program Description I

Program Title Empirical CBOE Call Pricing

Contributor's Name Hewlett-Packard

Address 1000 Circle Blvd.

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

Program Description, Equations, Variables The input variables are the 52 week HIGH and LOW prices of the stock, the dividend yield (Y) in percent, the time (T) on the option in months, the current stock price (Ps), the exercise price of the option (Pe), and the call loan rate on money lent brokers (I).

Combining the high and low prices to form a standard measure of price volatility

$$V = \frac{HIGH - LOW}{\frac{(HIGH + LOW)}{2}}$$

Clasing fit the following curves to the CBOE data he studied:

for $Ps \geq P_E$ ("in the money")

$$Ps\left\{\left(\left(\frac{Ps}{P_E} - 1\right)\left(1 - \frac{T}{45}\right) + T\left[.01 + \frac{v}{180} - \frac{11\text{-}Y\text{-}I}{1200}\right]\right\}$$

for $Ps < P_E$ ("out of the money")

$$Ps\left\{.4\left(\frac{Ps}{P_E} - 1\right) + T^{1/2}\left[.0267 + \frac{v}{30} - \frac{11\text{-}Y\text{-}I}{400}\right]\right\}$$

These expressions yield the call premium in dollars. If the underlying stock is ex-dividend for the option period, the premium is reduced by [(months to maturity ÷12) x (Annual yield in %)] per cent.

Operating Limits and Warnings The formulas are empirical fits. The premiums derived are only estimates. The formulas are not applicable to over-the-counter options since the underlying stocks on the CBOE are uniformly high-volume, large-number-of-shares-outstanding stocks. Dividends are also handled differently on the two markets. Do not neglect to account for dividends, if applicable, per the last lines of the "program description" section above.

Program Description II

Sketch(es)

Sample Problem(s) A certain CBOE Stock yields 6% in dividends, its 52 week range is 25 to 48, last price 40 1/2. The call loan rate for brokers from N.Y. banks is 8%.

a. What is the estimated premium for 3 month calls with $45 strike price?

b. For 2 months at $35?

Solution(s)

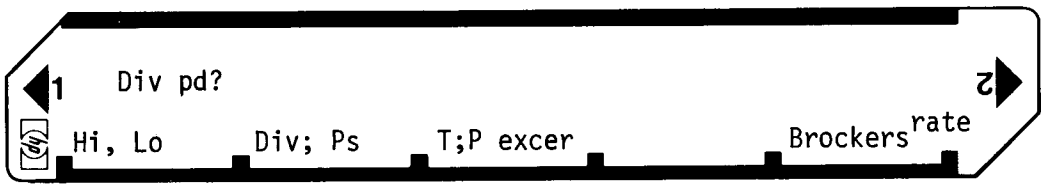
a) 8 [E] 48 ↑ 25 [A] 40.5 ↑ 6 [B] 3 ↑ 45 [C] ans 2.25

b) 2 ↑ 35 [C] ans 7.38

c) f [B] 6 ↑ 50 [C] ans 2.30

Reference(s) This program is a modification of the 65 user contributed program #3942A written by Paul W. Snow. The 65 program was based on. Clasing, H.K. Jr. The Dow Jones - Irwin Guide to Put and Call Options, Homeword, Ill, Dow Jones - Irwin, 1975 chapter 3.

User Instructions



STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Enter program			
2	Key in brockers rate	%	E	
3	a. 52 wk HIGH price	$	↑	
	b. 52 wk LOW price	$	A	
4	a. Current stock price	$	↑	
	b. Stock dividend yield	%	B	
5	If a dividend is to be paid during span of option press f[B]*	no input	f B	
6	a. Time to expiration (months)	months	↑	
	b. Strike price	$	C	Premium
	Evaluating an additional option on the same stock requires only step 5 (if applicable) and step 6			
*	After pressing [C] the dividend to be paid flag is cleared. If two or more stocks in a row have dividends paid during the option period, f[B] must be pressed each time.			

97 Program Listing I

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	*LBL6		Dividends paid flag (test cleared)
002	SF2		
003	RTN		
004	*LBLA		
005	STO6		LOW
006	X≠Y		
007	STO1		HIGH
008	RTN		
009	*LBLB		
010	X≠Y		Y
011	STO3		
012	R↓		I
013	RCL4		
014	+		11-(Y+I)
015	1		
016	1		
017	X≠Y		
018	-		
019	4		
020	0		$\frac{11-Y-I}{400}$
021	0		
022	÷		
023	STO2		
024	RCL1		
025	RCL6		HIGH-LOW
026	-		
027	LSTX		
028	RCL1		
029	+		
030	2		$V=\frac{HI-LO}{(\frac{HI+LO}{2})}$
031	÷		
032	÷		
033	1		
034	8		
035	0		
036	÷		
037	STO1		$\frac{V}{180}$
038	RCL3		
039	RTN		
040	*LBLC		
041	RCL3		STRIKE PRICE
042	X≠Y		STOCK PRICE
043	÷		P_S/P_E
044	1		
045	-		$(P_S/P_E) - 1$
046	STO7		
047	R↓		
048	STO5		TIME
049	RCL7		$(P_S/P_E) - 1 \geq 0 \rightarrow$
050	0		$P_S \geq P_E \rightarrow$ other eqn
051	X≤Y?		
052	GTO6		
053	RCL7		
054	.		
055	4		
056	x		$.4\ (\frac{P_S}{P_E} - 1)$
057	.		
058	0		
059	2		
060	6		
061	7		
062	RCL1		V/180
063	6		
064	x		V/30
065	+		$(.0267 + V/30$
066	RCL2		
067	-		$\frac{-11-Y-I}{400}$
068	RCL5		
069	√X		T 1/2(above)
070	x		$.4\ (P_S/P_E-1)+T^{1/2}(1)$
071	+		
072	RCL3		
073	x		
074	F2?		
075	GSB1		Dividends?
076	RTN		
077	*LBL0		
078	RCL7		$T/45$
079	1		
080	RCL5		
081	4		
082	5		
083	÷		$1 - T/45$
084	-		$(P_S/P_E-1)(1-T/45)$
085	x		
086	.		
087	0		.01 + V/180
088	1		
089	RCL1		
090	+		
091	RCL2		
092	3		$[.01 + \frac{V}{180} - \frac{11-Y-I}{1200}]$
093	÷		
094	-		
095	RCL5		T [·]
096	x		
097	+		
098	RCL3		$P_S\{(\cdot)(\cdot)+[\cdot]\}$
099	x		
100	F2?		
101	GSB1		Dividends?
102	RTN		
103	*LBLE		
104	STO4		I
105	RTN		
110			

REGISTERS

0	1	2	3	4	5	6	7	8	9
	$\frac{V}{180}$	$\frac{11-Y-I}{400}$	Ps	I	T	Used	$\frac{Ps-1}{P_E}$		
S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I
111,Lo,Y,Ps	P_E,T,Go				

97 Program Listing II

STEP	KEY ENTRY	KEY CODE	COMMENTS
	106	*LBL1	
	107	RCL5	
	108	1	Reduce Premium
	109	2	by T/12 xI%
	110	÷	
	111	RCL4	
	112	x	
	113	%	
	114	-	
	115	RTN	
	116	R/S	
130			
140			
150			
160			
170			
180			
190			
200			
210			
220			

LABELS					FLAGS	SET STATUS		
A Used	B Used	C Used	D	E Used	0	FLAGS	TRIG	DISP
a	b Used	c	d	e	1	ON OFF		
0 Used	1 Dividend Reduction	2	3	4	2 Dividends	0 ☐ ☐	DEG ☐	FIX ☐
5	6	7	8	9	3	1 ☐ ☐	GRAD ☐	SCI ☐
						2 ☐ ☐	RAD ☐	ENG ☐
						3 ☐ ☐		n____

Program Description I

Program Title WARRANT & OPTION HEDGING

Contributor's Name HEWLETT PACKARD

Address 19310 PRUNERIDGE AVE

City CUPERTINO **State** CA **Zip Code** 95014

Program Description, Equations, Variables

$$\text{CROSS RETURN} = \frac{\frac{\text{CONVERSION PRICE}}{\text{conversion rate}} + \text{warrant price x number sold} - \text{stock price}}{\text{warrant price x number sold} + .5 \text{ x stock price} + \text{interest}}$$

$$\text{lower break-even point} = \max\{0, \text{stock price} - \text{warrant price x number sold}\}$$

$$\text{upper break-even point} = \frac{\text{stock price} - \text{number warrants sold x [warrant price + conversion price]}}{1 - \text{conversion rate x number of warrants sold}}$$

$$\text{Cross Return} = \frac{\text{warrant price} - \text{Max}\{0, \text{hypothetical price/conversion rate} - \text{stock price}\} + \text{hypothetical stock price} - \text{stock price}}{\text{warrant price x number sold} + .5 \text{ x stock price} + \text{interest}}$$

Operating Limits and Warnings

1. The dividends shoud be the expected amount to be received over a year, since the time of payment is not used the calculated rate of return is the apparent rate rather than the true rate (a very small difference here).
2. The program assumes purchases on 50$ margin at 10% interest.
3. The program assumes equity of 100% of the price on $5 whichever is greater on the short sales.
4. program I calculates the rate of return for the most favorable situation (i.e. stock closes at conversion price on the expiration date); program II should be used then.

Program Description II

Sketch(es)

Sample Problem(s)

XYZ corporation stock is trading at $9 3/4 and a warrant, convertible 1 for 1 at $34, is selling for $1.75 expiring in 547 days. For various investment strategies[1] what is the maximum return (in percent) lower break even point and upper break even point. Further more, what are the possible returns if we assume various stock closing prices on the expiration date (eg $5, $10 and $20 closing prices).

Solution(s)

Input		Output
547 E↑ .5	[A]	.50
1[1] E↑ 34 E↑ 1.75 E↑ 9.75	[B]	133.28% [R/S] 8.00 [R/S] Error[2] [CLX]
5	[D]	-15.18%
10	[D]	16.93
20	[D]	70.41
	[C][3]	100.95 [R/S] 6.25 [R/S] 61.75
5	[D]	-2.21
etc.		

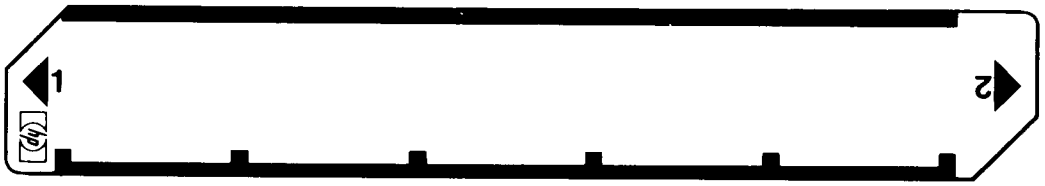
Reference(s)

[1] One, two, ... warrants sold short for each purchase of stock

[2] Infinity: To clear press CLX and continue.

[3] Each additional press of C produces an additional warrant sold [1]. For example the first C you get 2 warrants, second C pressed three etc.

User Instructions



STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Days left until warrants expire	Days	↑	Days
2	Dividends earned over period	Div.	A	Div.
3	Conversion rate	C. rate	Enter↑	C. rate
	Conversion price	C. price	Enter↑	C. price
	Current warrant price	W. price	Enter↑	W. price
	Current stock price	S. price	B	annual return
			R/S	lower
	negative or error infinity		R/S	break even
	If error appears, press clx			upper break even
4	Repeat for i + 1 warrant sold for each share of stock purchased		C	
			R/S	lower break even
			R/S	upper break even
5	Hypothetical wxpiration price		D	annual return
	Note:			
	Step 4 may be repeated as often as required or			
	Step 4 followed by Step 5 may be repeated as often as required			

97 Program Listing I

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	*LBL A	21 11	Dividend → R_3
002	STO 3	35 03	
003	X≷Y	-41	
004	STO 0	35 00	Days → R_0
005	X≷Y	-41	
006	RTN	24	
007	*LBL B	21 12	
008	STO 5	35 05	Stock price → R_5
009	R↓	-31	
010	STO 4	35 04	Warr. price → R_4
011	R↓	-31	
012	STO 6	35 06	Conversion price → R_6
013	R↓	-31	
014	STO 2	35 02	Conversion rate → R_2
015	0	00	
016	STO I	35 46	
017	*LBL C	21 13	
018	DSZ I	16 25 46	
019	RCL I	36 46	
020	CHS	-22	
021	RCL 4	36 04	
022	×	-35	
023	RCL 6	36 06	B x WP
024	RCL 2	36 02	
025	÷	-24	
026	+	-55	CP/CR + B x WP
027	RCL 5	36 05	
028	-	-45	CP/CR + B x WP - SP
029	STO 1	35 01	
030	5	05	
031	RCL 4	36 04	
032	X≷Y?	16-35	
033	R↓	-31	
034	RCL I	36 46	
035	CHS	-22	
036	×	-35	
037	.	-62	
038	5	05	
039	RCL 5	36 05	
040	×	-35	.5 x SP
041	+	-55	
042	1	01	
043	3	03	
044	7	07	
045	EEX	-23	
046	6	06	≈.10/365 x .5
047	CHS	-22	
048	RCL 0	36 00	
049	RCL 5	36 05	
050	×	-35	
051	×	-35	.10/365 x .5 x L
052	+	-55	x SP
053	STO 7	35 07	Equity → R_7
054	RCL 1	36 01	
055	X≷Y	-41	
056	÷	-24	R/E
057	1	01	
058	+	-55	
059	LN	32	
060	3	03	
061	6	06	
062	5	05	
063	×	-35	
064	RCL 0	36 00	
065	÷	-24	
066	e^x	33	
067	1	01	
068	-	-45	
069	RCL 3	36 03	D
070	RCL 7	36 07	
071	÷	-24	D/E
072	+	-55	
073	EEX	-23	Annual rate of return
074	2	02	
075	×	-35	
076	R/S	51	
077	×	-35	
078	RCL 5	36 05	
079	RCL 4	36 04	SP - B x WP
080	RCL I	36 46	Lower breakeven point
081	CHS	-22	
082	×	-35	
083	-	-45	
084	R/S	51	
085	RCL 5	36 05	
086	RCL I	36 46	
087	CHS	-22	
088	RCL 4	36 04	SP - B(WP + CP)
089	RCL 6	36 06	
090	+	-55	
091	×	-35	
092	-	-45	
093	1	01	
094	RCL I	36 46	
095	CHS	-22	
096	RCL 2	36 02	Upper breakeven point
097	×	-35	
098	-	-45	
099	÷	-24	
100	R/S	51	
101	*LBL D	21 14	HSP - CP/CR
102	STO 8	35 08	
103	RCL 6	36 06	
104	RCL 2	36 02	
105	÷	-24	
106	-	-45	
107	RCL 7	36 07	
108	ENT↑	-21	
109	ENT↑	-21	M = Max(0, HSP - CP/CR)
110	R↓	-31	
111	R↓	-31	
112	R↓	-31	

REGISTERS

0	1	2	3	4	5	6	7	8	9
Days	Return	Conv rate	Div.	Warr. pr.	Stock pr.	Conv. pr.	Equity	HSP	
S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I
					#warr. sold

97 Program Listing II

STEP	KEY ENTRY	KEY CODE	COMMENTS
113	0	00	
114	X>Y?	16-34	
115	X≷Y	-41	
116	R↑	16-31	
117	STO7	35 07	
118	R↓	-31	
119	R↓	-31	
120	RCL4	36 04	
121	X≷Y	-41	B x (WP - M)
122	-	-45	
123	RCLI	36 46	
124	CHS	-22	HSP - SP
125	×	-35	
126	RCL8	36 08	
127	RCL5	36 05	
128	-	-45	
129	+	-55	
130	RCL7	36 07	
131	÷	-24	
132	1	01	
133	+	-55	
134	LN	32	
135	3	03	
136	6	06	
137	5	05	
138	×	-35	
139	RCL0	36 00	
140	÷	-24	
141	e^x	33	D/E
142	1	01	
143	-	-45	Total annual rate or return
144	RCL3	36 03	
145	RCL7	36 07	
146	÷	-24	
147	+	-55	
148	EEX	-23	
149	2	02	
150	×	-35	
151	R/S	51	

STEP	KEY ENTRY	KEY CODE	COMMENTS
160			
170			
180			
190			
200			
210			
220			

LABELS

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

FLAGS

0
1
2
3

SET STATUS

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

Program Description 1

Program Title Bull Spread Option Strategy

Contributor's Name Hewlett-Packard
Address 1000 Circle Blvd.
City Corvallis **State** Oregon **Zip Code** 97330

Program Description, Equations, Variables

$$\text{Upside Breakeven} = \frac{R\,(C_S+E_S) - (C_L+E_L)}{R-1}$$

$$\text{Downside Breakeven} = RC_S - C_L$$

Where:

R = The ratio of the calls with higher exercise price sold short to the calls with lower exercise price purchased.

C_S = Market Price of Calls Sold Short
E_S = Exercise Price of Calls Sold Short
C_L = Market Price of Calls Bought Long
E_L = Exercise Price of Calls Bought Long

Operating Limits and Warnings

On matched hedges, upside breakeven is infinite.

HP-65 will blink 0.00 Hit [CLX] to stop blinking.

Program Description II

Sketch(es)

NONE

Sample Problem(s) I. Matched:

Buy 5 Oct. ITT 25's @ 6

Sell 5 Oct. ITT 30's @ 2 7/8

Calculate Upside and Downside Breakeven's and how much % the stock moves.

II. Unmatched:

Buy 7 Oct. ITT 25's @ 6

Sell 10 Oct. ITT 30's @ 2 7/8

Calculate Upside and Downside Breakeven's and what % the stock moves

In both cases stock is now selling at 28 3/4.

Solution(s) I. 5[A] 2.875[A] 30[A] 5[B] 6[B] 25[B] 28.75 [C]

DBE= [D] = 28.13 % change to reach downside = [D] = - 2.17%

UBE= [E] = α [CLX] % change to reach upside = [E] = -100.00%

II. 10[A] 2.875 [A] 30[A] 7 [B] 6 [B] 25 [B] 28.75 [C]

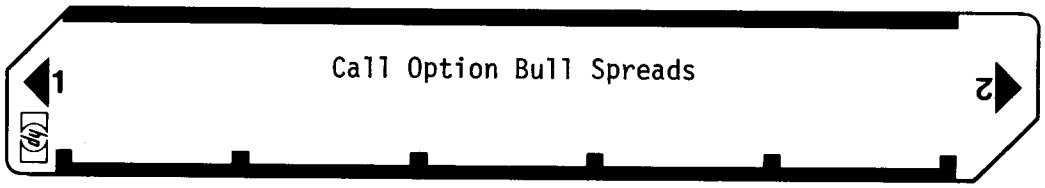
DBE= [D] = 26.89 % change to reach downside = [D] = - 6.46%

UBE= [E] = 37.25 % change to reach upside = [E] = 29.57%

If II had followed I directly, input only 10[A] 7[B] [D] [D] [E] [E].

Reference(s) This program is a one for one translation of the 65 User's Library program #3769 by Morris A. Nunes, based on an article by D. Turov called "Limitless Option" in Barrons, '75 p 9.

User Instructions



STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Input # of Options Sold Short	x	A	x.xxx
2	Input Price of Options Sold Short	y.yyy	A	y.yy
3	Input Exercise Price of Options Sold Short	z	A	z.zz
4	Input # of Options Bought Long	x	B	x.xx
5	Input Price of Options Bought Long	y.yyy	B	y.yy
6	Input Exercise Price of Options Bought	z	B	z.zz
7	Input Current Underlying Stock Price	z	C	z.zz
8	Find Downside Breakeven Stock Price		D	y.yy
9	Find % Change from Current to DBE.		D	z.zz
10	Find Upside Breakeven Stock Price		E	y.yy
11	Find % Change from Current to UBE		E	z.zz
	To repeat go to step 1 or those input steps (#'s 1-7) where input data is different. There is no need to enter new input data if it is the same for that step as in the previous problem.			

97 Program Listing I

STEP	KEY ENTRY	KEY CODE	COMMENTS
01		*LBLA	Enter # Options Shorted
02		STO1	
03		RTN	
004		*LBLA	Enter Price of Options Shorted
005		STO2	
006		RTN	
007		*LBLA	Enter Exercise Price of Options Shorted
008		STO3	
009		RTN	
010		*LBLB	Enter # Options Bought Long
011		STO4	
012		RTN	
013		*LBLB	Enter Price of Options Bought Long
014		STO5	
015		RTN	
016		*LBLB	Enter Exercise Price of Options Bought Long
017		STO6	
018		RTN	
019		*LBLC	Enter Current Underlying Stock Price
020		STO7	
021		RTN	
022		*LBLD	Calculate Downside Breakeven Price using the formula: $DBE = RC_S - C_L$ ↓
023		RCL6	
024		RCL5	
025		+	
026		RCL1	
027		RCL4	
028		÷	
029		RCL2	
030		x	
031		-	
032		RTN	
033		*LBLD	Calculate Percentage Change in underlying Stock to go from current price to Downside Breakeven Price
034		RCL7	
035		÷	
036		1	
037		-	
038		EEX	
039		2	
040		x	
041		RTN	
042		*LBLE	Calculate Upside Breakeven Price using the formula: $UBE = \frac{R(C_S - E_S) - (C_L + E_L)}{R-1}$ ↓
043		RCL1	
044		RCL4	
045		÷	
046		STO8	
047		RCL2	
048		RCL3	
049		+	
050		x	
051		RCL5	
052		RCL6	
053		+	
054		-	
055		RCL8	
056		1	
057		-	↓
058		÷	
059		RTN	
060		*LBLE	Calculate Percentage Change in underlying Stock to go from Current Price to Upside Breakeven Price
061		RCL7	
062		÷	
063		1	
064		-	
065		EEX	
066		2	
067		x	
068		RTN	
069		R/S	

080 090 100 110

REGISTERS

0	1 # Short	2 Price Short	3 Exercise Price Short	4 # Long	5 Price Long	6 Exercise Price Long	7 Current Stock Price	8 Ratio	9
S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I

97 Program Listing II

STEP	KEY ENTRY	KEY CODE	COMMENTS
120			
130			
140			
150			
160			

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

LABELS					FLAGS
A Shorts	B Longs	C Current	D Downside BE	E Upside BE	0
a	b	c	d	e	1
0	1	2	3	4	2
5	6	7	8	9	3

SET STATUS

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

Program Description I

Program Title Butterfly Options

Contributor's Name Hewlett-Packard
Address 1000 Circle Blvd.
City Corvallis **State** Oregon **Zip Code** 97330

Program Description, Equations, Variables A butterfly option is actually the combination of one bull spread and one bear spread i.e. the purchase of one high, one low and the sale of two middle option on the same underlying stock. If the stock closes between the high and low strike prices (including consideration of commissions and premiums) the investor will generally profit with maximum profit occuring in the middle strike price. Program assumes a standard option commission of $25 per option per transaction.

Calculation formulas are shown on the program listing using the following variables.

E_L = Lowest Exercise Price	P_L = Price of Low Strike Option
E_M = Middle Exercise Price	P_M = Price of Middle Strike Option
E_H = High Exercise Price	P_H = Price of High Strike Option

BE_H = Upside Breakeven Price

Operating Limits and Warnings Always hit E as the first step. Maximum "Profit" may be negative indicating merely the minimum loss. Similarly, if premiums work out right, maximum "Loss" may be positive, equally minimum profit (and meaning no cash is needed as an investment).

Program Description II

Sketch(es)

NONE

Sample Problem(s) Given XYZ stock with the following options available and due simultaneously:

Strike price 40 selling at 13 1/4
Strike price 50 selling at 7
Strike price 60 selling at 1 5/8

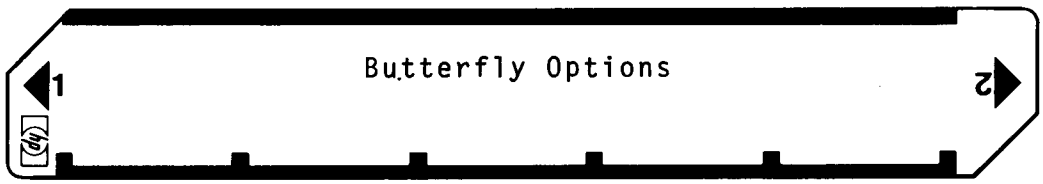
Calculate maximum profit, maximum loss (investment), upside breakeven price, downside breakeven price if a butterfly is developed and commissions are assumed at $25 per option per transaction.

Solution(s) E; 40A 13.25 R/S 50 R/S 7 R/S 60 R/S 1.625 R/S yields 787.50 = max profit; B yields -262.50 = max loss (equals investment); C yields 57.38 = upside breakeven price; D yields 42.13 = downside breakeven price;

E initializes for new case. All 6 variables must be entered for each case.

Reference(s) A one for one translation of the 65 User's Library program 3768 by Morris A. Nunes.

User Instructions



STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Initial program		E	0.00
2	Enter Exercise Price of Lowest Strike Option	X.XXX	A	X.XX
3	Enter Market Price of Lowest Strike Option	X.XXX	R/S	X.XX
4	Enter Exercise Price of Middle Strike Option	X.XXX	R/S	X.XX
5	Enter Market Price of Middle Strike Option	X.XXX	R/S	X.XX
6	Enter Exercise Price of Highest Strike Option	X.XXX	R/S	X.XX
7	Enter Exercise Price of Highest Strike Option & Calculate Maximum Profit	X.XXX	R/S	y.yy
8	Calculate Maximum Loss		D	Z.ZZ
9	Calculate Breakeven High Stock Price		C	a.aa
10	Calculate Breakeven Low Stock Price		D	b.bb
11	Go to new case - initial		E	0.00

FLAGS
0
1
2
3

SET STATUS

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

97 Program Listing I

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	*LBL A		Enter Low Excercise
002	STO 4		
003	R/S		
004	STO 1		Enter Low Price
005	R/S		
006	STO 5		Enter Mid Exercise
007	R/S		
008	STO 2		Enter Mid Price
009	R/S		
010	STO 6		Enter High Exercise
011	R/S		
012	STO 3		Enter High Price
013	RCL 5		$(E_M - E_L - P_L + 2P_M - P_H)(100)$ Calculate Maximum Profit
014	RCL 4		
015	-		
016	RCL 1		
017	-		
018	RCL 2		
019	2		
020	x		
021	+		
022	RCL 3		
023	-		
024	RCL 7		
025	x		
026	RCL 7		
027	-		
028	2		
029	5		
030	-		
031	RTN		
032	*LBL B		$P_L - ((E_H - E_M) - P_M)(2) + (E_H - E_L) - P_H = X;$ $100X - 175$ Calculate Maximum Loss
033	RCL 6		
034	RCL 4		
035	-		
036	RCL 1		
037	-		
038	RCL 6		
039	RCL 5		
040	-		
041	RCL 2		
042	X⇄Y		
043	-		
044	2		
045	x		
046	+		
047	RCL 3		
048	-		
049	RCL 7		
050	x		
051	1		
052	7		
053	5		
054	-		
055	RTN		
056	*LBL C		
057	RCL 5		$2(E_H + P_M) - E_L - P_L - P_H - 1.75$ Calculate BE High
058	2		
059	x		
060	RCL 2		
061	2		
062	x		
063	+		
064	RCL 4		
065	-		
066	RCL 1		
067	-		
068	RCL 3		
069	-		
070	1		
071	.		
072	7		
073	5		
074	-		
075	RTN		
076	*LBL D		$2E_M - BE_{High} + .5$ Calculate BE Low
077	RCL 5		
078	2		
079	x		
080	X⇄Y		
081	-		
082	.		
083	5		
084	-		
085	RTN		
086	*LBL E		Initial:
087	CLRG		Clear Registers
088	1		Generate 100 Store IN 7
089	0		
090	0		
091	STO 7		
092	0		Clear Stack
093	ENT↑		
094	ENT↑		
095	ENT↑		
096	ENT↑		
097	RTN		
098	R/S		

100

110

REGISTERS

0	1 Low Exer	2 Low Price	3 Mid Exer	4 Mid Price	5 High Exer	6 High Price	7 100	8	9
S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I

Program Description I

Program Title 67 - STOCK PRICE 30-WEEK MOVING AVERAGE WITH DATA STORAGE

Contributor's Name Delmer D. Hinrichs

Address 2116 S. E. 377th Ave.

City Washougal **State** Washington **Zip Code** 98671

Program Description, Equations, Variables This program allows both the data and the program for a 30-unit moving average to be stored on one card. This is especially convenient for calculating and periodic updating of 30-week moving averages of stock prices. After loading the data and program from a card, the previous average may be displayed, and only the new data entered. The updated average is displayed after each data entry. When all available data have been entered, the updated data may be recorded on the card.

Data may be entered as 5-digit integers, as 3-digit integers plus quarter points, or as 2-digit integers plus eighth points. For example, using eighth points, for 25 1/8 enter 25.1; for 56 7/8 enter 56.7; for 38½ enter 38.4; for 17 enter 17; etc. All data to be averaged together must be entered in the same mode (integer, quarters, eighths).

The 30 data units are stored in 15 registers, two per register, as 5-digit integers. Data for quarter points or eighth points are also stored as 5-digit integers, but with the decimal point shifted. The decimal point is shifted back again before displaying the average. The data are not moved from register to register for each new entry, but only the oldest datum is replaced by the new datum, and the index is incremented. The "I" register contains both the index, and the sum of all the data stored as a decimal fraction.

There is no output of an average until 30 units have been entered.

Entries are checked for format and size errors. Negative Nos. or zero are illegal.

Do not clip side 1 of the card, to allow updating of the stored data.

Operating Limits and Warnings Put data on side 1 and program on side 2 of card.

Clear registers and flags before starting a new series of data entries.

Press "Reset" only once after loading data and program.

After an erroneous entry ("Error" display) press "CLx", but do not Reset.

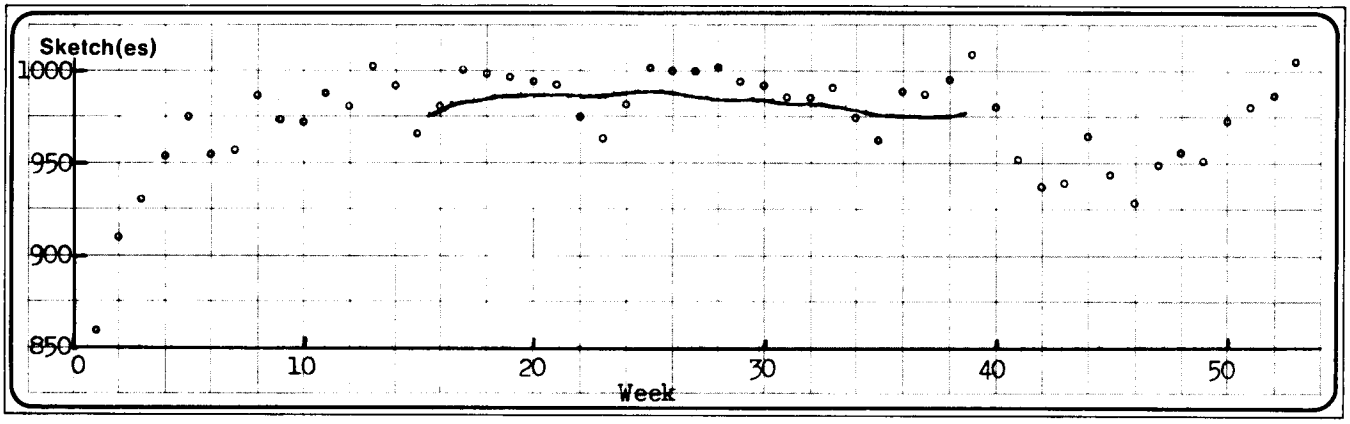
All data entries for a series must be in the same mode.

Be sure to press "f P⇄S" before loading data onto a card. Ignore "Crd" after data load.

Max. size of whole No. is 5 digits for Integer; 3 digits for Quarter; 2 digits for Eighth.

Program Description 11

Sketch(es)



Sample Problem(s) Calculate a 30-Week Moving Average of 1976 DJIA Data:

Week	DJIA	Week	DJIA	Week	DJIA	Week	DJIA	Week	DJIA	Week	DJIA	Week	DJIA
1	859	9	973	17	1001	25	1002	33	990	41	952	49	951
2	911	10	973	18	997	26	1000	34	974	42	937	50	973
3	930	11	988	19	996	27	1000	35	964	43	939	51	979
4	954	12	980	20	993	28	1003	36	989	44	965	52	986
5	975	13	1003	21	991	29	993	37	988	45	943	53	1005
6	955	14	992	22	975	30	991	38	995	46	928		
7	958	15	968	23	964	31	985	39	1009	47	949		
8	988	16	980	24	979	32	986	40	980	48	957		

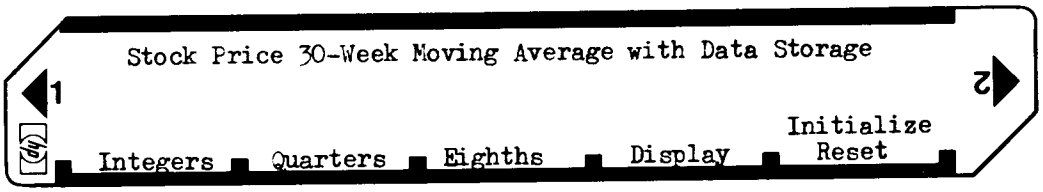
A moving average is correctly plotted in the center of the span of the averaged data. With a 30-unit span, as with this program, the first average must then be plotted between the 15th and the 16th data points, as shown below. Thus the output always lags 15 weeks behind the current data, so the 15 most recent weeks have no average to plot.

For this example, the HP-67 was set to "DSP 0", so that the output shown below was rounded to the nearest integer.

Week Solution(s)	DJIA	Avg	Week	DJIA	Avg	Week	DJIA	Avg	Week	DJIA	Avg	Week	DJIA	Avg
1	859		12	980		22	975		32	986		43	939	
2	911	--	13	1003	--	23	964	987	33	990	979	44	965	--
3	930	--	14	992	--	24	979	987	34	974	977	45	943	--
4	954	--	15	968	--	25	1002	988	35	964	976	46	928	--
5	975	--	16	980	976	26	1000	989	36	989	975	47	949	--
6	955	--	17	1001	980	27	1000	987	37	988	975	48	957	--
7	958	--	18	997	982	28	1003	986	38	995	975	49	951	--
8	988	--	19	996	984	29	993	984	39	1009	976	50	973	--
9	973	--	20	993	985	30	991	983	40	980	--	51	979	--
10	973	--	21	991	985	31	985	982	41	952	--	52	986	--
11	988	--	22	975	986	32	986	980	42	937	--	53	1005	--

Reference(s) HP-65 Users' Library Program No. 03133

User Instructions



STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	a) If new series (no data on card) clear Regist.		f CL REG	--
	b) If data from card, enter data (side 1 of card)			Crd
2	Enter program, side 2 of card			0.00
3	Prepare for data entry:			
	a) If new series, Initialize:		f e	0.00
	b) If data from card, Reset:		E	0.00
4	If desired, display previous average:		D	Avg.
5	Enter data: a) Integers:	Entry	A	Avg.
	or: b) Quarters:	Entry	B	Avg.
	or: c) Eighths:	Entry	C	Avg.
6	Repeat Step 5 as desired			
7	To store updated data on card:		f P⇄S	--
			f W/DATA	Crd
	Enter card, side 1			Crd
	(Ignore second "Crd" display)			
*	* * * * * * * * * * * * * *	* * *	* * * *	* * *
	Notes:			
	1) In Step 5, all entries must be in the same mode (Integers, Quarters, or Eighths). Quarters or Eighths are entered as: (whole number).(No. of quarters or eighths) i.e., 25 3/8 is entered as: "25.3, C"			
	2) In Step 5, no average is displayed until 30 entries have been made. Until then, "0.00" is displayed.			
	3) If an illegal entry is made, there will be an display. Then press "CLx", go to Step 5, and reenter the number correctly.	"Error"		

67 Program Listing I

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	f LBL B	31 25 12	Enter 1/4 Points
	h SF 0	35 51 00	
	GTO 0	22 00	
	f LBL C	31 25 13	Enter 1/8 Points
	h SF 1	35 51 01	
	f LBL 0	31 25 00	
	f INT	31 83	
	h LST x	35 82	
	g FRAC	32 83	
010	h F? 0	35 71 00	1/4 Points Entered?
	RCL 4	34 04	Yes
	h F? 1	35 71 01	1/8 Points Entered?
	RCL 8	34 08	Yes
	X	71	
	+	61	Convert to Decimal
	h F? 0	35 71 00	
	RCL 2	34 02	
	h F? 1	35 71 01	
	RCL 3	34 03	
020	÷	81	Convert to Integer
	f LBL A	31 25 11	Enter Integers
	f LN	31 52	
	h LST x	35 82	
	f INT	31 83	
	h LST x	35 82	Error Checking:
	g x≠y	32 61	Entry ≤ Zero?
	g SIN^{-1}	32 62	Entry Non-Integer?
	RCL 5	34 05	Entry Oversize?
	g x≤y	32 71	
030	g SIN^{-1}	32 62	
	h R↓	35 53	
	RCL (i)	34 24	
	g FRAC	32 83	
	h LST x	35 82	
	f INT	31 83	
	RCL 5	34 05	Update Data
	÷	81	
	h R↑	35 54	
	+	61	
040	STO (i)	33 24	
	CLx	44	
	RCL 1	34 01	
	h R↑	35 54	
	RCL 5	34 05	
	÷	81	
	h R↑	35 54	
	−	51	
	f DSZ	31 33	Update Sum and
	RCL 3	34 03	Increment Index
050	X	71	
	h RC I	35 34	
	+	61	
	g x≤y	32 71	
	f GSB 1	31 22 01	
	h ST I	35 33	
	f LBL D	31 25 14	Display Average
	RCL (i)	34 24	
	g FRAC	32 83	
	f x=0	31 51	30 Entries Yet?
060	h RTN	35 22	No, Display Zero
	1	01	Yes, Continue
	h RC I	35 34	
	g FRAC	32 83	
	RCL 7	34 07	
	÷	81	
	h F? 0	35 71 00	1/4 Points Entered?
	RCL 2	34 02	Yes
	h F? 1	35 71 01	1/8 Points Entered?
	RCL 3	34 03	Yes
070	X	71	
	h RTN	35 22	Display Average
	g LBL f e	32 25 15	Initialize, New Data
	h SF 2	35 51 02	
	f LBL E	31 25 15	Reset, Save Old Data
	f P⇄S	31 42	
	EEX	43	
	1	01	
	STO 1	33 01	
	h F? 2	35 71 02	Set for New Data?
080	h ST I	35 33	Yes
	EEX	43	
	2	02	
	CHS	42	
	STO 2	33 02	
	EEX	43	
	3	03	
	CHS	42	
	STO 3	33 03	
	2	02	
090	.	83	
	5	05	
	STO 4	33 04	
	EEX	43	
	5	05	
	STO 5	33 05	
	3	03	
	EEX	43	
	7	07	
	CHS	42	
100	STO 7	33 07	
	1	01	
	.	83	
	2	02	
	5	05	
	STO 8	33 08	
	CLx	44	
	h RTN	35 22	Stop & Display Zero
	f LBL 1	31 25 01	Subroutine to Reset
	1	01	Data Index
110	5	05	
	+	61	
	h RTN	35 22	

REGISTERS

0	1	2	3	4	5	6	7	8	9
	10	0.01	0.001	2.5	100000		3 x 10^{-7}	1.25	
S0 Data	S1 Data	S2 Data	S3 Data	S4 Data	S5 Data	S6 Data	S7 Data	S8 Data	S9 Data

A	B	C	D	E	I
Data	Data	Data	Data	Data	Index, Sum

67 Program Listing II

STEP	KEY ENTRY	KEY CODE	COMMENTS
120			
130			
140			
150			
160			

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

LABELS

A Integers	B Quarters	C Eighths	D Display	E Reset
a	b	c	d	e Initialize
0 Skip	1 Subroutine	2	3	4
5	6	7	8	9

FLAGS

0 Quarters
1 Eighths
2 Set "I"
3

SET STATUS

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

Program Description I

Program Title Exponential Smoothing

Contributor's Name Ted Bright
Address 40 Woodland Road
City Fairfax **State** California **Zip Code** 94930

Program Description, Equations, Variables

Projections from time-series data are computed using a weighted moving average, eliminating the need to retain past observations.

First, a smoothed moving average, $S_{t+i}(x)$ is calculated from the current series value, X_{t+i}, and the prior average, $S_{t+i-1}(x)$, according to the formula:

$$S_{t+i}(x) = \alpha X_{t+i} + (1-\alpha c)\, S_{t+i-1}(x), \text{ (recalled by keying c)}$$

where α is the smoothing constant, determined in the program as a function of the number of observations to be smoothed, n, by the relationship $\alpha = \frac{2}{n+1}$

The change in average, C_{t+i}, is simply:

$$C_{t+i} = S_{t+i}(x) - S_{t+i-1}(x) \quad \text{(recalled by keying fC)}$$

From this is found a new trend, T_{t+i}, thru the equasion:

$$T_{t+i} = \alpha C_{t+i} + (1-\alpha)\, T_{t+i-1} \quad \text{(recalled by keying D)}$$

Finally, expected demand, D_{t+i+1}, is defined as:

$$D_{t+i+1} = S_{t+i}(x) + \frac{1-\alpha}{\alpha} T_{t+i} \quad \text{(displayed after each iteration)}$$

With the entry of a new x value, a prediction error can be expressed as:

$$e_{t+i} = D_{t+i} - X_{t+i} \quad \text{(recalled by keying E)}$$

The user may wish to increase the sensitivity of the program to anticipated trends with an increase in the value of α observing that $0 < \alpha < 1$.

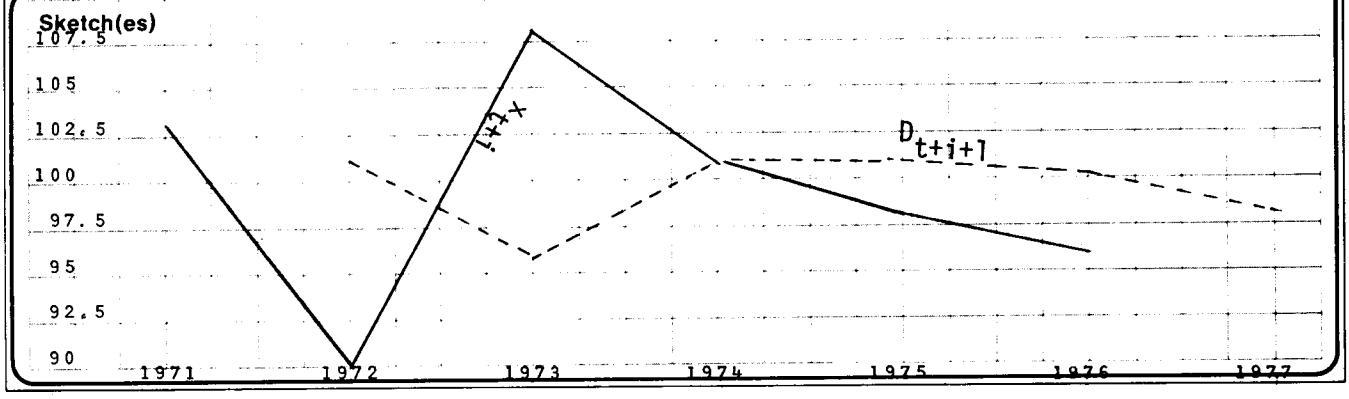
The initial trend is assumed to be 0 unless a value is entered.

OPERATING LIMITS AND WARNINGS

There being no prior value of D, e on the first iteration will be meaningless.

Program Description 11

Sketch(es)



Sample Problem(s)

The chart below shows six (n=6) values, x_{t+i}, for 1971 thru 1976. The program, using an initial estimate for the smoothed average, $S_{t+i-1}(x)$, of 100, will produce the remaining data, including a projected quantity, D_{t+i+1}, for 1977.

Initialize using the keystrokes 6[↑], 100[A].

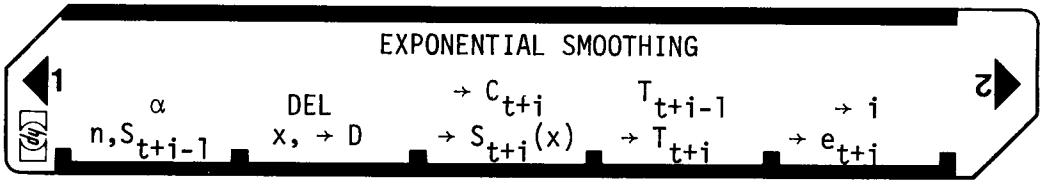
Then enter the value of x_{t+i} for 1971 (103), press [B], and observe that the output displayed agrees with the first solution under D_{t+i+1}. Press [C], f[C], [D], and [E], likewise noting the results in their respective columns. Enter the X_{t+i} values for each succeeding year followed by the keystrokes above each column.

Keystrokes			B	C	fc	D	E
			Expected Demand	Smoothed Average	Change in Smoothed Average	Trend	Error
	i	x_{t+i}	D_{t+i+1}	$S_{t+i}(x)$	C_{t+i}	T_{t+i}	e_{t+i}
	0			100		0	
1971	1	103	101.47	100.86	.86	.24	-
1972	2	90	95.98	97.76	-3.10	-.71	11.47
1973	3	108	101.50	100.68	2.93	.33	-12.02
1974	4	101	101.42	100.77	.09	.26	.50
1975	5	98	99.88	99.98	-.79	-.04	3.42
1976	6	96	97.96	98.84	-1.14	-.35	3.88

Reference(s)

Charles T. Clarke and Lawrence L. Schkade, Statistical Methods for Business Decisions (Cincinnati, Ohio: South-Western Publishing Co. 1969), pp 702-711.

User Instructions



STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1.	Enter program			
2.	Enter number of values to be smoothed (not required if α option selected in step 4)	n	↑	n
3.	Enter initial estimate of smoothed average	$S_{t+i-1}(x)$	A	α
4.	Optional: Select smoothing constant	$0<\alpha<1$	f a	α
5.	Optional: Select initial trend	T_{t+i-1}	f d	T_{t+i-1}
6.	Enter first value for smoothing repeat step 6 for each succeeding value	X_{t+i}	B	D_{t+i+1}
7.	Recover (once per i) from erroneous X_{t+i} (Return to step 6 and continue with correct value)		f b	D_{t+i}
8.	Recall smoothed average		C	$S_{t+i}(x)$
9.	Recall change in average		f C	C_{t+i}
10.	Recall trend		D	T_{t+i}
11.	Recall forecast error		E	e_{t+i}
12.	Recall number of values smoothed		f e	i
	(For a new series go to step 2)			

97 Program Listing II

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	*LBLA	21 11	Initialization routine
002	CLRG	16-53	
003	STO3	35 03	$S_{t+1-1}(x)$
004	CLX	-51	
005	1	01	
006	+	-55	
007	2	02	α computed
008	X≷Y	-41	
009	÷	-24	
010	*LBL0	21 00	
011	STO0	35 00	α
012	1	01	
013	STO1	35 01	$1-\alpha$ computed
014	RCL0	36 00	
015	ST-1	35-45 01	$1-\alpha$
016	RTN	24	α displayed
017	*LBLa	21 16 11	α option routine
018	GTO0	22 00	
019	*LBLB	21 12	D_{t+1+1} routine
020	STO7	35 07	X_{t+i}
021	RCL2	36 02	D_{t+1}
022	STO8	35 08	D_{t+i}
023	RCL3	36 03	$S_{t+1-1}(x)$ copied for error recovery routine
024	STO9	35 09	$S_{t+i-1}(x)$
025	RCL5	36 05	T_{t+i-1}
026	STOA	35 11	T_{t+i-1}
027	ISZI	16 26 46	i indexed
028	RCL2	36 02	D_{t+i}
029	RCL7	36 07	X_{t+i} e_{t+i} computed
030	-	-45	
031	STO6	35 06	e_{t+i}
032	RCL7	36 07	X_{t+i}
033	RCL0	36 00	α
034	x	-35	
035	RCL1	36 01	$1-\alpha$
036	RCL3	36 03	$S_{t+i-1}(x)$ $S_{t+i}(x)$ computed
037	x	-35	
038	+	-55	
039	STO3	35 03	$S_{t+i}(x)$
040	RCL9	36 09	$S_{t+i-1}(x)$
041	-	-45	C_{t+i} computed
042	STO4	35 04	C_{t+i}
043	RCL0	36 00	α
044	x	-35	
045	RCL1	36 01	$1-\alpha$
046	RCL5	36 05	T_{t+i-1} T_{t+i} computed
047	x	-35	
048	+	-55	
049	STO5	35 05	T_{t+1}
050	RCL1	36 01	$1-\alpha$
051	RCL0	36 00	α
052	÷	-24	
053	x	-35	
054	RCL3	36 03	$S_{t+1}(x)$ D_{t+i+1} computed
055	+	-55	
056	STO2	35 02	D_{t+i+1}
057	RTN	24	D_{t+i+i} displayed
058	*LBLb	21 16 12	error recovery routine
059	DSZI	16 25 46	decriment I
060	RCLA	36 11	T_{t+i-1}
061	STO5	35 05	T_{t+i-1}
062	RCL9	36 09	$S_{t+1-1}(x)$
063	STO3	35 03	$S_{t+i-1}(x)$
064	RCL8	36 08	D_{t+1}
065	STO2	35 02	D_{t+1}
066	RTN	24	D_{t+i} displayed
067	*LBLC	21 13	$S_{t+i}(x)$ display routine
068	RCL3	36 03	$S_{t+i}(x)$
069	RTN	24	
070	*LBLc	21 16 13	e_{t+i} display routine
071	RCL4	36 04	C_{t+i}
072	RTN	24	
073	*LBLD	21 14	T_{t+i} display routine
074	RCL5	36 05	T_{t+i}
075	RTN	24	
076	*LBLd	21 16 14	T_{t+i} entry routine
077	STO5	35 05	T_{t+i}
078	RTN	24	
079	*LBLE	21 15	e_{t+i} display routine
080	RCL6	36 06	e_{t+i}
081	RTN	24	
082	*LBLe	21 16 15	i display routine
083	RCLI	36 46	i
084	RTN	24	
085	R/S	51	

090

100

110

SET STATUS

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

REGISTERS

0 α smoothing constant	1 $1-\alpha$	2 D_{t+i+1} expected demand	3 $S_{t+i}(x)$ smoothed moving avg.	4 C_{t+i} change in average	5 T_{t+i} trend	6 e_{t+i} error in forecast	7 X_{t+i} Value in series at t+i	8 D_{t+i} saved for error recovery	9 $S_{t+1-1}(x)$ saved for error recovery
S0 T_{t+1-1} saved for error recovery	S1	S2	S3	S4	S5	S6	S7	S8	S9
A	B	C	D	E	I i time period				

Program Description I

Program Title MULTIPLE LINEAR REGRESSION

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

Program Description, Equations, Variables

This program performs a least squares multiple linear regression for a series of data points x, y, z. Linear regression is a statistical method for finding a straight line that best fits a set of data points. The equation of this straight line expresses the linear relationship between independent (x and y) and dependent (z) variables and is of the from:

$$z = a + bx + cy$$

Independent variables are input by pressing B. If one or more of the data points was entered incorrectly, simply re-enter the incorrect value(s) and press f A. Then continue as before. The three coefficients (a, b, c) are calculated by pressing C.

In addition, the program also calculates the coefficient of determination r^2 (D). This is an indication of the "goodness of fit" for the calculated straight line, and is a number between 0 and 1. Values closer to 1 indicate "better" fits than values closer to 0.

Having determined the equation (the C key), the user can then project estimates of z for given x, y values (E). The sums (Σx_i; Σy_i; Σz_i), the sums of squares (Σx_i^2; Σy_i^2; Σz_i^2), and the sums of cross products ($\Sigma x_i y_i$; $\Sigma x_i z_i$; $\Sigma y_i z_i$) are stored in registers 7–9, 4–6, and 1–3 respectively.

An option is available (f E) to automatically print/pause the calculated values. Pressing f E sets and clears the print option. Successive use of f E will alternately display 1.00 and 0.00, indicating that the print/pause mode is on or off respectively.

Operating Limits and Warnings

Program Description 11

Sketch(es)

Sample Problem(s)

18. Multiple Linear Regression

$$z = a + bx + cy$$

$$\Sigma z_i = an + b\Sigma x_i + c\Sigma y_i \qquad i = 1, 2, \ldots, n$$

$$\Sigma x_i z_i = a\Sigma x_i + b\Sigma x_i^2 + c\Sigma x_i y_i$$

$$\Sigma y_i z_i = a\Sigma y_i + b\Sigma x_i y_i + c\Sigma y_i^2$$

$$c = \frac{A - B}{\left[n\Sigma x_i^2 - (\Sigma x_i)^2\right]\left[n\Sigma y_i^2 - (\Sigma y_i)^2\right] - \left[n\Sigma x_i y_i - (\Sigma x_i)(\Sigma y_i)\right]^2}$$

where:

$$A = \left[n\Sigma x_i^2 - (\Sigma x_i)^2\right]\left[n\Sigma y_i z_i - (\Sigma y_i)(\Sigma z_i)\right]$$

$$B = \left[n\Sigma x_i y_i - (\Sigma x_i)(\Sigma y_i)\right]\left[n\Sigma x_i z_i - (\Sigma x_i)(\Sigma z_i)\right]$$

$$b = \frac{\left[n\Sigma x_i z_i - (\Sigma x_i)(\Sigma z_i)\right] - c\left[n\Sigma x_i y_i - (\Sigma x_i)(\Sigma y_i)\right]}{n\Sigma x_i^2 - (\Sigma x_i)^2}$$

Solution(s)

$$a = \frac{1}{n}(\Sigma z_i - c\,\Sigma y_i - b\,\Sigma x_i)$$

$$R^2 = \frac{a\,\Sigma z_i + b\,\Sigma x_i z_i + c\,\Sigma y_i z_i - \frac{1}{n}(\Sigma z_i)^2}{(\Sigma z_i^2) - \frac{(\Sigma z_i)^2}{n}}$$

Reference(s)

Program Description II

Sketch(es)

Sample Problem(s)

Example 1:

A commercial land appraiser has examined 5 vacant lots in the downtown section of a local community, all of which have different depths, frontages, and values as shown below. Based on this data, what is the relationship between depth, frontage, and lot value? What is the coefficient of determination? What predicted value would a lot have with a 50 foot depth and 70 foot frontage? With a 75 foot depth and 80 foot frontage?

Lot Depth (feet)	Lot Frontage (feet)	Lot Value
70	70.8	$101,000
90	60.0	82,190
85	90.0	170,000
40	70.0	100,000
100	60.0	90,000

Solution(s)

Keystrokes: **Outputs:**

A 70 ENTER↑ 70.8 ENTER↑ 101000 B
90 ENTER↑ 60 ENTER↑ 82190 B
85 ENTER↑ 90 ENTER↑ 170000 B
40 ENTER↑ 70 ENTER↑ 100000 B
100 ENTER↑ 60 ENTER↑ 90000 B → 5.00 (number of entries)
C → −118499.03 (a)
R/S → 314.71 (b)
R/S → 2892.02 (c)

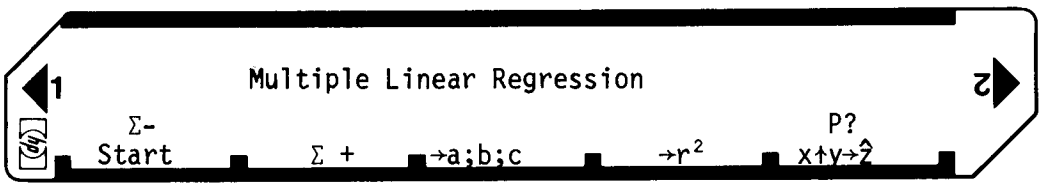
Hence, $z = -118499.03 + 314.71x + 2892.02y$

D → 0.98 (r^2)
50 ENTER↑ 70 E → 99678.08 (value of 50 × 70 foot lot)
75 ENTER↑ 80 E → 136466.08 (value of 75 × 80 foot lot)

Notice that if your lot has a depth of 50 feet and a frontage of 10 feet a negative $ value results (−73843.26). You may have difficulty selling this property!

Reference(s)

User Instructions



STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Load side 1 and side 2			
2	Optional: Select print/pause mode		f E	1.00 or 0.00
3	Initialize (START)		A	0.00
4	Key in x and y, and corresponding z value			
		x	ENTER↑	
		y	ENTER↑	
		z	B	# entries
5	Repeat step 4 for all x, y, z data pairs.			
6	If a data pair was input incorrectly, re-enter incorrect x, y, z values			
		x	ENTER↑	
		y	ENTER↑	
		z	f A	# entries − 1
7	Calculate coefficients:		C	a
			R/S	b
			R/S	c
	If the print/pause mode is on (1.00), b and c are automatically calculated.			
8	Optional: Calculate the coefficient of determination: r^2		D	r^2
9	Optional: Key in x and y values and calculate the estimated z value. (This may be repeated as often as desired.)			
		x	ENTER↑	
		y	E	$\hat{z}$
10	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	
003	CF1	16 22 01	Initialize
004	0	00	
005	RTN	24	
006	*LBLB	21 12	----------
007	STOC	35 13	
008	R↓	-31	
009	STOB	35 12	
010	R↓	-31	Input x_i,y_i,z_i
011	STOA	35 11	
012	F0?	16 23 00	
013	GSB6	23 06	
014	7	07	
015	STOI	35 46	
016	R↓	-31	
017	GSB1	23 01	Compute Σx_i,Σy_i,Σz_i
018	8	08	Σx_i^2,Σy_i^2,Σz_i^2
019	STOI	35 46	$\Sigma x_i y_i$,$\Sigma y_i z_i$,$\Sigma z_i x_i$
020	RCLB	36 12	
021	F0?	16 23 00	
022	GSB6	23 06	
023	GSB1	23 01	
024	9	09	
025	STOI	35 46	
026	RCLC	36 13	
027	F0?	16 23 00	
028	GSB6	23 06	
029	GSB1	23 01	
030	RCLA	36 11	
031	RCLB	36 12	
032	×	-35	
033	GSB2	23 02	
034	ST+1	35-55 01	
035	RCLA	36 11	
036	RCLC	36 13	
037	×	-35	
038	GSB2	23 02	
039	ST+2	35-55 02	
040	RCLB	36 12	
041	RCLC	36 13	
042	×	-35	
043	GSB2	23 02	
044	ST+3	35-55 03	
045	1	01	
046	GSB2	23 02	
047	ST+0	35-55 00	
048	RCL0	36 00	
049	F0?	16 23 00	
050	GSB6	23 06	
051	RTN	24	----------
052	*LBL1	21 01	Subroutine for
053	GSB2	23 02	Σx_i,...
054	ST+i	35-55 45	Σx_i^2,...
055	RCLI	36 46	
056	3	03	
057	-	-45	
058	STOI	35 46	
059	R↓	-31	
060	X²	53	
061	GSB2	23 02	
062	ST+i	35-55 45	----------
063	RTN	24	
064	*LBLC	21 13	
065	RCL0	36 00	
066	RCL4	36 04	Calculate a,b,c
067	×	-35	
068	RCL7	36 07	
069	X²	53	
070	-	-45	
071	STOD	35 14	
072	RCL0	36 00	
073	RCL3	36 03	
074	×	-35	
075	RCL8	36 08	
076	RCL9	36 09	
077	×	-35	
078	-	-45	
079	×	-35	
080	STOC	35 13	
081	RCL0	36 00	
082	RCL1	36 01	
083	×	-35	
084	RCL7	36 07	
085	RCL8	36 08	
086	×	-35	
087	-	-45	
088	STOA	35 11	
089	RCL0	36 00	
090	RCL2	36 02	
091	×	-35	
092	RCL7	36 07	
093	RCL9	36 09	
094	×	-35	
095	-	-45	
096	STOB	35 12	
097	×	-35	
098	RCLC	36 13	
099	X≷Y	-41	
100	-	-45	
101	RCLD	36 14	
102	RCL0	36 00	
103	RCL5	36 05	
104	×	-35	
105	RCL8	36 08	
106	X²	53	
107	-	-45	
108	×	-35	
109	RCLA	36 11	
110	X²	53	
111	-	-45	
112	÷	-24	

REGISTERS

0	1	2	3	4	5	6	7	8	9
n	$\Sigma x_i y_i$	$\Sigma x_i z_i$	$\Sigma y_i z_i$	Σx_i^2	Σy_i^2	Σz_i^2	Σx_i	Σy_i	Σz_i
S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I
Used	Used	Used	Used	Used	Used

97 Program Listing II

STEP	KEY ENTRY	KEY CODE	COMMENTS
113	STOC	35 13	
114	RCLB	36 12	
115	RCLA	36 11	
116	RCLC	36 13	
117	x	-35	
118	-	-45	
119	RCLD	36 14	
120	÷	-24	
121	STOB	35 12	
122	RCL9	36 09	
123	RCLC	36 13	
124	RCL8	36 08	
125	x	-35	
126	-	-45	
127	RCLB	36 12	
128	RCL7	36 07	
129	x	-35	
130	-	-45	
131	RCL0	36 00	
132	÷	-24	
133	STOA	35 11	a
134	GSB7	23 07	
135	RCLB	36 12	b
136	GSB9	23 09	
137	RCLC	36 13	c
138	GTO9	22 09	----------
139	*LBLD	21 14	
140	RCLA	36 11	
141	RCL9	36 09	
142	x	-35	Calculate r^2
143	RCLB	36 12	
144	RCL2	36 02	
145	x	-35	
146	+	-55	
147	RCLC	36 13	
148	RCL3	36 03	
149	x	-35	
150	+	-55	
151	RCL9	36 09	
152	X^2	53	
153	RCL0	36 00	
154	÷	-24	
155	-	-45	
156	RCL6	36 06	
157	RCL9	36 09	
158	X^2	53	
159	RCL0	36 00	
160	÷	-24	
161	-	-45	
162	÷	-24	
163	GTO7	22 07	----------
164	*LBLE	21 15	
165	X≷Y	-41	Calculate $\hat{z}$ for
166	F0?	16 23 00	given x,y.
167	GSB8	23 08	
168	X≷Y	-41	

STEP	KEY ENTRY	KEY CODE	COMMENTS
169	F0?	16 23 00	
170	GSB6	23 06	
171	RCLC	36 13	
172	x	-35	
173	X≷Y	-41	
174	RCLB	36 12	
175	x	-35	
176	+	-55	
177	RCLA	36 11	
178	+	-55	----------
179	GTO9	22 09	Correction of
180	*LBLa	21 16 11	input values.
181	SF1	16 21 01	
182	GSBB	23 12	
183	CF1	16 22 01	
184	RTN	24	
185	*LBLe	21 16 15	Print instructions
186	F0?	16 23 00	
187	GTO5	22 05	
188	SF0	16 21 00	
189	1	01	
190	RTN	24	
191	*LBL5	21 05	
192	0	00	
193	CF0	16 22 00	
194	RTN	24	
195	*LBL7	21 07	
196	F0?	16 23 00	
197	SPC	16-11	
198	*LBL9	21 09	
199	F0?	16 23 00	
200	GTO6	22 06	
201	R/S	51	
202	RTN	24	
203	*LBL6	21 06	
204	PRTX	-14	
205	RTN	24	----------
206	*LBL2	21 02	Change sign for
207	F1?	16 23 01	correction.
208	CHS	-22	
209	RTN	24	
210	*LBL8	21 08	
211	SPC	16-11	
212	GTO9	22 09	
213	R/S	51	
220			

LABELS

A Start	B Σ+	C a;b;c	D r^2	E $\hat{z}$	0 Print
a Σ-	b	c	d	e Print?	1 Correction
0	1 Used	2 Used	3	4	2
5 Used	6 Used	7 Used	8 Used	9 Used	3

FLAGS

FLAGS	ON	OFF
0	☐	☒
1	☐	☒
2	☐	☒
3	☐	☒

SET STATUS

TRIG	DISP
DEG ☒	FIX ☒
GRAD ☐	SCI ☐
RAD ☐	ENG ☐
	n 2

Program Description I

Program Title Curve Fitting, Selecting Best Function

Contributor's Name C.D. Bopp
Address 306 Virginia Road
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Program Description, Equations, Variables This program compares the coefficients of determination for the four functions described in the HP67/97 Standard Pac Program 03. The function having the largest coefficient of determination is indicated by displaying a code number, as explained in the User Instructions.

Operating Limits and Warnings The calculating time is roughly about one minute. Negative coordinates are not admissable. To enter another set of points, turn calculator off and on.

Program Description II

Sketch(es)

Sample Problem(s) Given the points (x,y) 1,2; 2,3; 3,4; find (a) which of above-mentioned four correlations gives the highest coefficient of determination (COD), (b) compute the value of the COD, (c) with x equal to 4 project the value for y, and (d) compute the COD and project y for two of the other three correlations.

Solution(s) Part (a): 2 (↑) 1 (A) 3 (↑) 2 (A) 4 (↑) 3 (A) (B)→ 1, indicating that the linear fit is best (using the coding numbers as described in the User Instructions).

Part (b):(RCL) (C)→ 1.000, the COD.

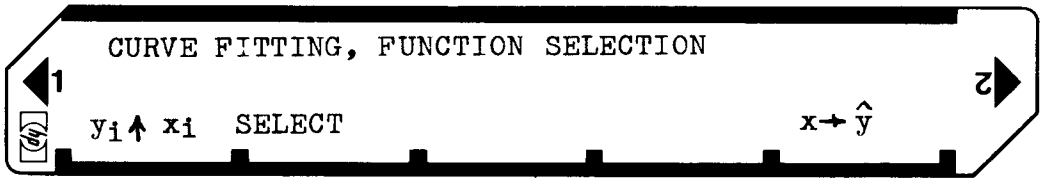
Part (c): 4 (E)→ 5.000, the projected y.

Part (d): (SF)(1) (GTO) (A) (GTO) (2) (R/S) (RCL) (C)→ 0.990, the COD for the exponential fit. 4 (E) → 5.77, the projected y.

(GTO) (A) (GTO) (3) (R/S) (RCL) (C)→ 0.978, the COD for the logarithmic fit. 4 (E) → 4.40, the projected y.

Reference(s)

User Instructions



STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Load side 1 and side 2.			
2	Input y value.	y_i	ENTER	
3	Input x value.	x_i	A	
4	Repeat steps 2 and 3 for all data pairs.			
5	Compute of the functions listed below		B	N, a, b
	the one with the largest coefficient of		RCL C	r^2
	determination r^2. This function is			
	indicated by a number 1, 2, 3, or 4			
	according to the following coding:			
	1 Linear regression $y = a + bx$			
	2 Exponential Curve $y = ae^{bx}$			
	3 Logarithmic Curve $y = a + b\ln x$			
	4 Power Curve $y = ax^b$			
	The quantities that are printed are the			
	code number (N) designating the function			
	and the parameters a and b of this function. The parameter			
	a is stored in register A. The parameter b is stored in register B. The			
	coefficient of determination r^2 is stored in register C.			
6	Optional: Make projection based on a	x	E	$\hat{y}$
	known x value.			
7	Optional: Find the coefficient of		SF 1	
	determination (COD) and the parameters		GTO A	
	a and b for any of the other functions		GTO N	
	(than that selected).		R/S	N
			RCL C	r^2
		x	E	y

97 Program Listing I

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	*LBLA	21 11	
	Σ	56	
	LSTX	16 63	
	STOA	35 11	
	LN	32	
	STOB	35 12	
	X≠Y	-41	
	STOC	35 13	
	LN	32	
010	STOD	35 14	
	RCLB	36 12	
	P≠S	16-51	
	Σ	56	
	RCLD	36 14	
	RCLA	36 11	
	×	-35	
	ST+3	35-55 03	
	RCLB	36 12	
	RCLC	36 13	
020	×	-35	
	ST+2	35-55 02	
	P≠S	16-51	
	RTN	24	
	*LBLB	21 12	
	0	00	
	STOC	35 13	
	GSB1	23 01	
	GSB2	23 02	
	GSB3	23 03	
030	GSB4	23 04	
	RCLD	36 14	
	STOI	35 46	
	GSBi	23 45	
	RCLD	36 14	
	PRTX	-14	
	RCLA	36 11	
	PRTX	-14	
	RCLB	36 12	
	PRTX	-14	
040	R/S	51	
	*LBL1	21 01	
	1	01	
	8	08	
	GSB0	23 00	
	STO3	35 03	
	1	01	
	4	04	
	GSB0	23 00	
	STO2	35 02	
050	1	01	
	6	06	
	GSB0	23 00	
	STO1	35 01	
	1	01	
	5	05	
	GSB0	23 00	

STEP	KEY ENTRY	KEY CODE	COMMENTS
	STO0	35 00	
	1	01	
	7	07	
060	GSB0	23 00	
	STOE	35 15	
	GSBC	23 13	
	1	01	
	F2?	16 23 02	
	STOD	35 14	
	RTN	24	
	*LBL2	21 02	
	SF0	16 21 00	
	RCL6	36 06	
070	STO1	35 01	
	RCL7	36 07	
	STOE	35 15	
	1	01	
	3	03	
	GSB0	23 00	
	STO3	35 03	
	1	01	
	4	04	
	GSB0	23 00	
080	STO2	35 02	
	1	01	
	5	05	
	GSB0	23 00	
	STO0	35 00	
	GSBC	23 13	
	CF0	16 22 00	
	2	02	
	F2?	16 23 02	
	STOD	35 14	
090	RTN	24	
	*LBL3	21 03	
	RCL4	36 04	
	STO2	35 02	
	RCL5	36 05	
	STO0	35 00	
	1	01	
	2	02	
	GSB0	23 00	
	STO3	35 03	
100	1	01	
	6	06	
	GSB0	23 00	
	STO1	35 01	
	1	01	
	7	07	
	GSB0	23 00	
	STOE	35 15	
	GSBC	23 13	
	3	03	
110	F2?	16 23 02	
	STOD	35 14	
	RTN	24	

REGISTERS

0 used	1 used	2 used	3 used	4 $\Sigma \ln x$	5 $\Sigma(\ln x)^2$	6 $\Sigma \ln y$	7 $\Sigma(\ln y)^2$	8 $\Sigma \ln x \ln y$	9 n
S0	S1	S2 $\Sigma y \ln x$	S3 $\Sigma x \ln y$	S4 Σx	S5 Σx^2	S6 Σy	S7 Σy^2	S8 Σxy	S9 n
A a	B b	C r^2	D used	E used	I used				

97 Program Listing II

STEP	KEY ENTRY	KEY CODE	COMMENTS
	*LBL4	21 04	
	SF0	16 21 00	
	RCL8	36 08	
	STO3	35 03	
	RCL4	36 04	
	STO2	35 02	
	RCL6	36 06	
120	STO1	35 01	
	RCL5	36 05	
	STO0	35 00	
	RCL7	36 07	
	STOE	35 15	
	GSBC	23 13	
	CF0	16 22 00	
	4	04	
	F2?	16 23 02	
	STOD	35 14	
130	RTN	24	
	*LBLC	21 13	
	3	03	
	GSB0	23 00	
	2	02	
	GSB0	23 00	
	1	01	
	GSB0	23 00	
	x	-35	
	RCL9	36 09	
140	÷	-24	
	-	-45	
	STOB	35 12	
	0	00	
	GSB0	23 00	
	2	02	
	GSB0	23 00	
	x^2	53	
	RCL9	36 09	
	÷	-24	
150	-	-45	
	÷	-24	
	RCLB	36 12	
	x≒y	-41	
	STOB	35 12	
	x≒y	-41	
	x	-35	
	2	02	
	4	04	
	GSB0	23 00	
160	1	01	
	GSB0	23 00	
	x^2	53	
	RCL9	36 09	
	÷	-24	
	-	-45	
	÷	-24	
	F1?	16 23 01	
	STOC	35 13	

STEP	KEY ENTRY	KEY CODE	COMMENTS
	RCLC	36 13	
170	x>y?	16-34	
	GTO6	22 06	
	x≒y	-41	
	STOC	35 13	
	SF2	16 21 02	
	LBL6	21 06	
	1	01	
	GSB0	23 00	
	2	02	
	GSB0	23 00	
180	RCLB	36 12	
	x	-35	
	-	-45	
	RCL9	36 09	
	÷	-24	
	F0?	16 23 00	
	e^x	33	
	STOA	35 11	
	RTN	24	
	*LBL0	21 00	
190	STOI	35 46	
	R↓	-31	
	RCLi	36 45	
	RTN	24	
	*LBLE	21 15	
	RCLD	36 14	
	STOI	35 46	
	R↓	-31	
	GTOi	22 45	
	*LBL1	21 01	
200	RCLB	36 12	
	x	-35	
	RCLA	36 11	
	+	-55	
	RTN	24	
	*LBL2	21 02	
	RCLB	36 12	
	x	-35	
	e^x	33	
	RCLA	36 11	
210	x	-35	
	RTN	24	
	*LBL3	21 03	
	LN	32	
	RCLB	36 12	
	x	-35	
	RCLA	36 11	
	+	-55	
	RTN	24	
	*LBL4	21 04	
220	RCLB	36 12	
	y^x	31	
	RCLA	36 11	
	x	-35	
	RTN	24	

LABELS

A y↑x	B →D, A, B	C used	D	E x→ŷ
a	b	c	d	e
0 used	1 used	2 used	3 used	4 used
5	6 used	7	8	9

FLAGS

0	used
1	used
2	used
3	

SET STATUS

FLAGS	ON	OFF
0	☐	☒
1	☐	☒
2	☐	☒
3	☐	☒

TRIG	
DEG	☒
GRAD	☐
RAD	☐

DISP	
FIX	☒
SCI	☐
ENG	☐
n	2

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