CFALA REVIEW MATERIALS USING THE HP-12C CALCULATOR

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Spring 2019
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  (helpful if you put CFA Review in subject line)
Updated 1/3/2019

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HP12-C

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Note: The HP12C is not my main calculator so there may be some shortcuts or hints I am overlooking, but I think the information here will be very helpful in preparing for the exam.

Some of these slides are in the Level I lecture notes and others are new.

Part I is basic settings for the calculators, and

Part II is showing how to use the built-in functions to solve problems on the exam.

CFA Exam acceptable calculators

HP-12C, 12C Platinum, 12C Platinum 25th anniversary edition, 12C 30th anniversary edition, and HP 12C Prestige.
(The newer models can use algebra (ALG) instead of RPN.
But if you can learn RPN it is good.)
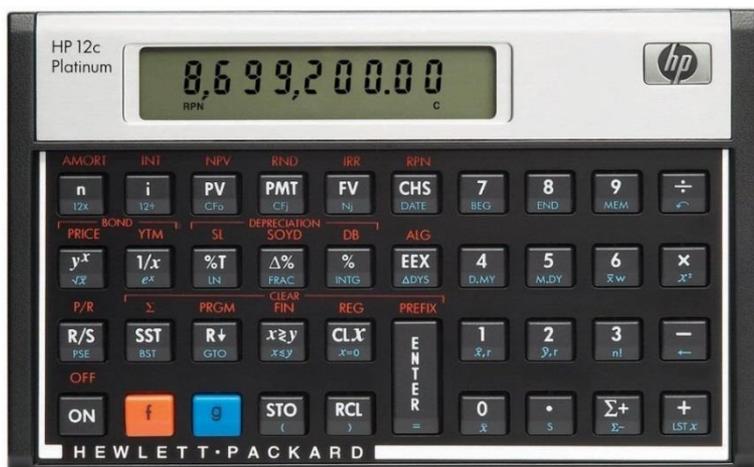
If you have the newer models you have the choice of using the Algebra format for entering data into formulas by [f] [ALG] or using the RPN format by [f] [RPN].

The older versions only use the [RPN] format.
Where appropriate, both are discussed in these notes.

Usually set P/Y = 1
& Clear memories

Have a fresh battery,
Consider taking a spare

BASIC SETUP

To set number of decimal places being shown:

- To show 2 places: Use [f] [2], "0.00"
- To show 4 places: Use [f] [4], "0.0000" etc…

To clear the memories:

- [CL*X*] clears display and X-Register
- [f] CLEAR [Σ] Clears Statistics Registers, stack registers, and display.
- [f] CLEAR [FIN] clears Financial Registers
- [f] CLEAR [REG] clears data storage, financial, stack, last X and display

[CHS] Changes the number in the display from positive to negative or from negative to positive.

ORDER OF OPERATIONS

- In the rules of algebra, calculations should be done in the following order:
  - Items in parentheses, exponents and roots, multiplication and division, and finally addition and subtraction.
  - For items in equal levels, go from left to right.
- For example, the correct order for "$2 \times 3 + 4 \times 5$" should be $2 \times 3 = 6$, "$4 \times 5 = 20$" and then "$6 + 20$" = 26.
- BUT, the ALG method in your calculator will probably chain the calculations in left to right order and do "$2 \times 3 = 6$", "$6 + 4 = 10$", "$10 \times 5 = 50$". Not the right answer.
- There are several methods discussed below to get the correct answer, relatively efficiently, with examples:
  1. Using ALG and your calculator memories, and
  2. Using ALG and parentheses, and
  3. Using RPN.

USING RPN OR ALG

- The original HP-12C used RPN. If you understand how to use it, it can be very efficient in calculations.

- The newer versions of the HP-12C offer both RPN and ALG. ALG is more like what most other calculators use.

- Example: calculate 2 + 3 x 5

- RPN: 2 [ENTER] 3 [ENTER] 5 [x] [+]
That multiplies 3 x 5 first and then adds 2 to get the correct answer 17.

- ALG: if you just enter 2 + 3 x 5 you will get the answer 25 as it does the calculations in order presented: "2 + 3 = 5, 5 x 5 = 25"
In order to get the correct answer you can either
1. Use memories: 2 [STO] [1], 3x5=15 [STO][2], [RCL][1] + [RCL][2] = 17, or
2. Use parentheses "2 + (3 x 5)": 2 + [g][STO] 3 [x] 5 [g][RCL] = 17
   [g][STO] is the left parenthesis "(" and [g][RCL] is the right ")".
   Note: the final right ")" is not really needed as the "=" sign assumes it, or
3. For this example, do 3 x 5 first and add 2, but that won't work for 2x3 + 4x5.

HP: Y^X FUNCTION:

- Assume you want to calculate 100 [x] 1.05^3 = 115.76.

- The HP calculator has a Y^X function, but it must be used carefully, especially in ALG mode.

- In ALG mode there are two ways of getting the correct answer:

1. Do the "1.05 [Y^X] 3" first and then multiply by 100, or

2. Do "100 [x] [( ]1.05 [Y^X] 3 [=]". The left parenthesis [( ] will allow the calculator to do the 1.05^3 before multiplying by 100. You can add [ )] after the "3" if you want.

- In RPN not really a problem: "100 [ENTER] 1.05 [ENTER] 3 [Y^X] [x]".

- Or use TVM function: 3 [N], 5 [i], 100 [PV], [FV] "= -115.76". Negative at end as you can take that amount out.

HP: Y^X FUNCTION:

- Assume you want to calculate 100 [÷] 1.05^3 = 86.38.
- Similar to previous slide
- In ALG mode there are two ways of getting the correct answer:
1. Do the "1.05 [Y^X] 3" first, then [1/x] and then multiply by 100, or
2. Do "100 [÷] [( ]1.05 [Y^X] 3 [=]". The left parenthesis [( ] will allow the calculator to do the 1.05^3 before dividing into 100.
- In RPN not really a problem: "100 [ENTER] 1.05 [ENTER] 3 [Y^X] [÷]".
- Or use TVM function: 3 [N], 5 [i], 100 [FV], [PV] "= -86.38". Negative as you want to take out 100 at the end so you have to put 86.38 in at the beginning.

USING MEMORIES

- Your calculator has 10 easily accessible memories: #0 to #9.

- You can store numbers in a memory by pressing [STO] [n] where [n] in the number of the memory where you want to store the number.

- For example: 3 [STO] [1] will store the number 3 in memory #1.

- You can recall a stored number by pressing [RCL] [n] where [n] is the number of the memory you want to recall. For example: [RCL] [1] will give the value 3 (assuming you stored it in the previous step above).

- You do not need to clear memories as when you store a number it over-writes any value that may have been there before.

ADDING, SUBTRACTING, MULTIPLYING AND DIVIDING TO MEMORIES!

- The following steps can also be done with memories, but be careful, one missed step messes up the numbers.

  - 3 [STO][1] puts 3 in Memory #1 (assume each step below is done in sequence).

  - Then if you press 4 [STO] [+] 1, the value in #1 will be 7.00, (3+4=7)

  - Then if you press 4 [STO] [−] 1, the value in #1 will be 3.00, (7 −4=3)

  - Then if you press 4 [STO] [x] 1, the value in #1 will be 12.00, (3x4=12) and

  - Then if you press 4 [STO][÷] 1, the value in #1 will be 3.00 (12 ÷ 4=3).

SPECIAL KEYS

Keys	Function	Comments
[f][4]	Set to 4 Decimal places	The number you enter will be the number of decimal places shown, 9 maximum.
[CHS]		Change number sign from + to - or back
[CLX]		Clear value in display
[g][-]	[←]	Delete last digit entered
[g][3]	[n!]	Calculates factorial: n! = n x (n-1) x … x 1
[g][7]	[BEG]	Use annuity due (beginning) mode
[g][8]	[END]	Use ordinary annuity (end) mode
[g][STO]	"("	Left parentheses
[g][RCL]	")"	Right parentheses

Calculator Hints – P/Y & BEG

Changing the number of periods per year:

- HP12C can do it, but a bunch of steps.

- I prefer to change both the number of periods and the interest rate per period.

- For example, if you have 6% per year compounded monthly for 5 years, use N = 12 × 5 = 60, and I = 6 ÷ 12 = 0.5.

Calculator Hints – BEG mode

- This is for Annuities Due where the payment is at the beginning of each period:

- To go into BEG mode [g][7],
  to go back to END mode [g][8]

Entering TVM values

How much will you have at the end of 5 years if you put 1,000 in the bank now at 8%?

Find the FV if N = 5, I = 8, PV = 1,000

- enter the value and then hit the key:

- 5 [N], 8 [I], 1000 [PV]

To get the answer:

- [FV] *"-1,469.33" note, if you enter PV as positive, FV will be negative and vice vesa.*

- 5 [N], 8 [I], 1000[CHS] [PV], [FV] *"1,469.33"*

Entering TVM values

Note: if solving for number of periods or the interest rate, one or more of the value(s) (PV, PMT, FV) should be entered as negative.

- Put 100 in the bank, grows to 200 in 8 years, calculate implied interest rate:

- 8[N], 100[CHS][PV], 200[FV], [I/Y] *"I/Y = 9.05"*

If you put 100 in the bank and add 20 at the end of each year for 8 years and it grows to 400, calculate the implied interest rate:

- 8 [N], 100[CHS][PV], 20[CHS][PMT], 400[FV], [I/Y] *"I/Y = 8.10"*

- *Or* 8 [N], 100 [PV], 20 [PMT], 400 [CHS] [FV], [I/Y] *"I/Y = 8.10"*

- *Note: PV and PMT should have the same sign, FV the opposite.*

PV or FV of Uneven Cash Flows

- To find the PV (or FV) of uneven cash flows, find the PV (or FV) of each cash flow and add them together.

- Or use your calculator functions and save a lot of time!

- Example: Find PV of receiving $100 at the end of year 1, $200 at the end of year 2, $400 at the end of year 3 and $600 at the end of year 4, using 10%, and then add all those up:

$$100/1.1 + 200/1.1^2 + 400/1.1^3 + 600/1.1^4 = ???$$

PV OF UNEVEN CASHFLOWS

$$CF_0 = 0, CF_1 = 100, CF_2 = 200$$
$$CF_3 = 400, CF_4 = 600, I = 10\%$$

HP12C		
Key Strokes	*Explanation*	*Display*
[f] [REG]	clear memory registers	0.0000
0 [g] [Cfo]	Initial Outflow = 0	0.0000
100 [g] [CFj]	Enter CF1	100.0000
200 [g] [CFj]	Enter CF2	200.0000
400 [g] [CFj]	Enter CF3	400.0000
600 [g] [CFj]	Enter CF4	600.0000
10 [i]	Enters I%	10.0000
[f] [NPV]	Calculate NPV	966.5323
	(PV in this case)	

To get FV, *(display = 966.53234)*
[FV] *(Display = 1,415.10)*

NPV, IRR example

- Assume a project costs $1,000. It will generate cash flows of $100, $200, $400, $600 for the next 4 years[1]. The discount rate is 10%. Calculate NPV and IRR.

- $CF_0 = -1000$, $CF_1 = 100$, $CF_2 = 200$, $CF_3 = 400$, $CF_4 = 600$, $I = 10\%$

- $NPV = -33.47$

- $IRR = 8.79\%$, note $NPV < 0$, $IRR < $ discount rate.

- *Calculator steps on next slide.*

[1] *Like the previous example, except for initial cost.*

NPV & IRR of Uneven Cash flows

$CF_0 = -1000, CF_1 = 100, CF_2 = 200$
$CF_3 = 400, CF_4 = 600, I = 10\%$

HP12C		
Key Strokes	*Explanation*	*Display*
[f] [REG]	clear memory registers	0.0000
1000 [CHS] [g] [Cfo]	Initial Outflow = -1000	-1000.0000
100 [g] [CFj]	Enter CF1	100.0000
200 [g] [CFj]	Enter CF2	200.0000
400 [g] [CFj]	Enter CF3	400.0000
600 [g] [CFj]	Enter CF4	600.0000
10 [i]	Enters I%	10.0000
[f] [NPV]	Calculate NPV	-33.4677
[f] [IRR]	Calculate IRR	8.7871

Note: NPV is negative so you would expect IRR to be less than the interest rate used to calculate NPV.

Viewing and/or Correcting Cash Flow inputs for NPV and IRR

After entering the Cash Flows for an NPV or IRR calculation, you can see the values by using the [RCL] key. For example,

[RCL] 0	Shows CF_0
[RCL] 1	Shows CF_1
[RCL] 2	Shows CF_2
[RCL] 3	Shows CF_3
Etc…	

You can correct an CF input using the [STO] key. For example, assume you had entered 10 for CF_1 but should have been 100,

[RCL] 1	10
100 [STO] 1	100
[RCL] 1	100
You can repeat for any other incorrect cash flows.	

Cash Flows

- Note: on the exam they may try a trick:

- Assume the cash flows are
  CF_0 = -1000, CF_1 = 100, CF_2 = 200, CF_3 = 0, CF_4 = 400, CF_5 = 500.

- You MUST enter CF_3 as 0 or the remaining cash flows will be for the wrong periods and you will get the wrong answer!

- Note, they could make a cashflow after time 0 to be negative, so be careful.

Practice Problem

Year	S&P
2007	13.5%
2008	-1.2%
2009	-35.6%
2010	32.4%
2011	16.5%
2012	3.8%
R_f	3.0%

Calculate the following:
1. Mean
2. Standard Deviation
3. Coefficient of Variation
4. Sharpe Ratio

Similar to example in D.Cary lecture notes.

Calculating the Mean and Standard deviation

HP-12C:	On Screen	
[f][Σ] *or [f][REG]*	0.0000	Clears Memories
13.5 [Σ+]	1.0000	Enters 1st value
1.2 [CHS] [Σ+]	2.0000	Enters 2nd value (Neg)
35.6 [CHS] [Σ+]	3.0000	Enters 3rd value (Neg)
32.4 [Σ+]	4.0000	Enters 4th value
16.5 [Σ+]	5.0000	Enters 5th value
3.8 [Σ+]	6.0000	Enters 6th value
[g][0] "$\bar{x}$"	4.9000	Mean
[g] [.] "s"	22.9932	Standard Deviation

I don't think you can view your entered values when calculating statistics on the HP-12C. If your answer is different than choices, redo.

Practice Problem continued…

Mean = r = 4.90%
StDev = s = 22.99%

3. Coefficient of Variation = s / r
   CV = 22.99% / 4.90%
       = 4.69

4. Sharpe $= (r - r_f) / s$
   $= (4.90\% - 3.0\%) / 22.99\%$
   $= 0.083$

If asked for the Mean Absolute Deviation: No shortcut!

Year	S&P	|S&P - Mean|
2007	13.50%	8.60%
2008	-1.20%	6.10%
2009	-35.60%	40.50%
2010	32.40%	27.50%
2011	16.50%	11.60%
2012	3.80%	1.10%
sum	29.40%	95.4%
Mean	4.90%	÷ 6
median	8.65%	
MAD		15.90%

Using **ALG**: Geometric and Harmonic Mean

Using the Statistics Function for the calculation is after these slides.

- Data: 3, 3, 4, 6, 22

Geometric Mean (ALG)	
KEYS	DISPLAY
3 [×]	3.0000
3 [×]	9.0000
4 [×]	36.0000
6 [×]	216.000
22 [=]	4,752.0000
[y^x] 5 [1/x] [=]	**5.4372**

Harmonic Mean (ALG)	
KEYS	DISPLAY
3 [1/x] [+]	0.3333
3 [1/x] [+]	0.6667
4 [1/x] [+]	0.9167
6 [1/x] [+]	1.0833
22 [1/x] [=]	1.1288
[÷] 5 [=]	0.2258
[1/x]	**4.4295**

From D.Cary's notes, SS 2, STATISTICAL CONCEPTS AND MARKET RETURNS.

Using **RPN**: Geometric and Harmonic Mean

Using the Statistics Function for the calculation is after these slides.

- Data: 3, 3, 4, 6, 22

Geometric Mean (RPN)	
KEYS	DISPLAY
3 [ENTER]	3.0000
3 [×]	9.0000
4 [×]	36.0000
6 [×]	216.000
22 [×]	4,752.0000
5 [1/x] [yˣ]	**5.4372**

From D.Cary's notes, SS 2.

Harmonic Mean (RPN)	
KEYS	DISPLAY
3 [1/x] [ENTER]	0.3333
3 [1/x] [+]	0.6667
4 [1/x] [+]	0.9167
6 [1/x] [+]	1.0833
22 [1/x] [+]	1.1288
5 [÷]	0.2258
[1/x]	**4.4295**

- The next two slides show how to use the built-in statistic functions to do Geometric and Harmonic Average calculations.

- I'm not sure they are any easier, but thought I would include them so you can compare.

Using the Statistics Function to Calculate Geometric Mean

Note: converting the numbers to logs, calculating the average, then using e^x is mathematically the same as multiplying the numbers and taking the root.

- Data: 3, 3, 4, 6, 22
- This works for both ALG and RPN!

Keys	Display	Keys	Display	Comments
[f] [Σ]	0.0000			Clears Memories
3 [g][LN]	1.0986	[Σ+]	1.000	Converts to Log, Enters first value
3 [g][LN]	1.0986	[Σ+]	2.000	Converts to Log, Enters second value
4 [g][LN]	1.3863	[Σ+]	3.000	Converts to Log, Enters third value
6 [g][LN]	1.7918	[Σ+]	4.000	Converts to Log, Enters fourth value
22[g][LN]	3.0910	[Σ+]	5.000	Converts to Log, Enters fifth value
[g] [x̄]	1.6933			Gets average of natural logs
[g] [e^x]	5.4372			***Converts the average of the logs to the answer!***

Probably just as easy to multiply and take the root!

Using the Statistics Function to Calculate Harmonic Mean

- Data: 3, 3, 4, 6, 22
- This works for both ALG and RPN!

Keys	Display	Keys	Display	Comments
[f] [Σ]	0.0000			Clears Memories
3 [1/x]	0.3333	[Σ+]	1.000	Converts to reciprocal, Enters first value
3 [1/x]	0.3333	[Σ+]	2.000	Converts to reciprocal, Enters second value
4 [1/x]	0.2500	[Σ+]	3.000	Converts to reciprocal, Enters third value
6 [1/x]	0.1667	[Σ+]	4.000	Converts to reciprocal, Enters fourth value
22 [1/x]	0.0455	[Σ+]	5.000	Converts to reciprocal, Enters fifth value
[g] [x̄]	0.2258			Gets average of reciprocals
[1/x]	4.4295			***The reciprocal of the average reciprocal. The Answer!***

CALCULATING MEANS AND COVARIANCES OF TWO ASSET PORTFOLIO

	1	2
w	75%	25%
r	20%	12%
var	625	196
Covar	120	

Example from D.Cary's Level I CFALA review lecture notes, SS 2, Reading 8:

- The question is to find the expected return "r_p" and the variance "s_p^2" (and standard deviation) of this portfolio.

- Before doing the calculations, look at the numbers carefully.

  - A weight of 75% will be entered as 0.75

  - A return of 20% can be entered as 20 and the answer will be in "%" value or as 0.20 and the answer will be in decimal value "0.00".

  - Note if they give you Variance or Standard Deviation. For part of the equations used you might need variance and other parts might need standard deviation.

  - Also note if they give you covariance or correlation of the two assets. Remember that covariance = correlation x s_1 x s_2.

  - The following pages use "s_{12}" to denote covariance.

USING ALG: CALCULATING MEANS AND COVARIANCES OF TWO ASSET PORTFOLIO

	1	2
w	75%	25%
r	20%	12%
var	625	196
Covar	120	

1. USING MEMORIES:

- $r_p = r_1 \times w_1 + r_2 \times w_2$
  1: $0.75 \times 20 =$ '15' [STO] [1] *"stores first step in #1"*
  2: $0.25 \times 12 =$ '3' [STO] [2] *"stores second step in #2"*
  3: [RCL] [1] + [RCL][2] = '18' *"adds #1 and #2 to get answer"*

- $s_p^2 = w_1^2 \times s_1^2 + w_2^2 \times s_2^2 + 2 \times w_1 \times w_2 \times s_{12}$
  1: $0.75[x^2] \times 625 =$ '351.56' [STO][1]   *"x^2 is [g][x]"*
  2: $0.25[x^2] \times 196 =$ '12.25' [STO][2]
  3: $2 \times 0.75 \times 0.25 \times 120 =$ '45.00' [STO] [3]
  4: [RCL] [1] + [RCL][2] + [RCL][3] = '408.81' *"the variance"*
  5: $[\sqrt{x}] =$ '20.22' "the standard deviation = 20.22%"   "$[\sqrt{x}]$ is [g][y^x]"

- Remember if they give you the standard deviations, you have to square them to get the variance for the first two parts of the equation just like you squared the weights. If they give you correlation you have to multiply by the standard deviations to get covariance for the third part.

	1	2
w	75%	25%
r	20%	12%
var	625	196
Covar	120	

2. USING PARENTHESES:

- $r_p = r_1 \times w_1 + r_2 \times w_2$
  $0.75 \times 20 + (0.25 \times 12) = \text{“18”}$
  "the parentheses are [g][STO] & [g][RCL]"
  "they are NOT needed for the first calculation since it is multiplication"
  "you do not really need the last parenthesis, the "=" will be enough"

- $s_p^2 = w_1^2 \times s_1^2 + w_2^2 \times s_2^2 + 2 \times w_1 \times w_2 \times s_{12}$
  Note: I recommend using memories for the variance calculation as there are several steps and it could be easy to hit a wrong button. But if using the parentheses here are the steps:
  $0.75[x^2] \times 625 + (0.25[x^2] \times 196) + (2 \times 0.75 \times 0.25 \times 120) = \text{‘408.81’}$
  "the variance"   "x^2 is [g][x]"
  $[\sqrt{x}] = 20.22$ "the standard deviation is 20.22%" "$[\sqrt{x}]$ is [g][y^x]"

- See previous bottom note if given standard deviations and/or correlations.

USING RPN: CALCULATING MEANS AND COVARIANCES OF TWO ASSET PORTFOLIO

	1	2
w	75%	25%
r	20%	12%
var	625	196
Covar	120	

3. USING RPN:

- $r_p = r_1 \times w_1 + r_2 \times w_2$
  0.75[ENTER] 20 [x] 0.25 [ENTER] 12 [x] [+] "18"
  "You have to be careful to enter everything correctly"

- $s_p{}^2 = w_1{}^2 \times s_1{}^2 + w_2{}^2 \times s_2{}^2 + 2 \times w_1 \times w_2 \times s_{12}$
  Note: I recommend using memories for the variance calculation as there are several steps and it could be easy to hit a wrong button.
  1: 0.75[x^2] [ENTER] 625 [×] '351.56' [STO][1]   *"x^2 is [g][x]"*
  2: 0.25[x^2] [ENTER] 196 [×] '12.25' [STO][2]
  3: 2 [ENTER] 0.75 [×] 0.25 [×] 120 [×] '45.00' [STO][3]
  4: [RCL] [1] [ENTER] [RCL][2] + [RCL][3] + '408.81' *"the variance"*
  5: [$\sqrt{x}$] = '20.22' "the standard deviation = 20.22%"   "[$\sqrt{x}$] is [g][y^x]"

- See previous bottom note if given standard deviations and/or correlations.

Tree Diagram

- Assume there is a 60% probability that interest rates will decrease and if they do, there is a 25% chance that EPS = $2.60 and a 75% chance that EPS = $2.45.

- Also, there is a 40% probability that interest rates will be stable and if so, there is a 60% probability that EPS = $2.20 and a 40% probability that EPS = $2.00

- *Note: Actual calculator steps included following the next slide.*

Figure 8-2

60% probability of lower interest

25% → EPS = $2.60

75% → EPS = $2.45

Expected Value if rates decrease:
$$0.25 \times 2.60 \\ + 0.75 \times 2.45 \\ = \$2.4875$$

40% probability of stable interest

60% → EPS = $2.20

40% → EPS = $2.00

Expected Value if stable rates:
$$0.6 \times 2.20 \\ + 0.4 \times 2.00 \\ = \$2.12$$
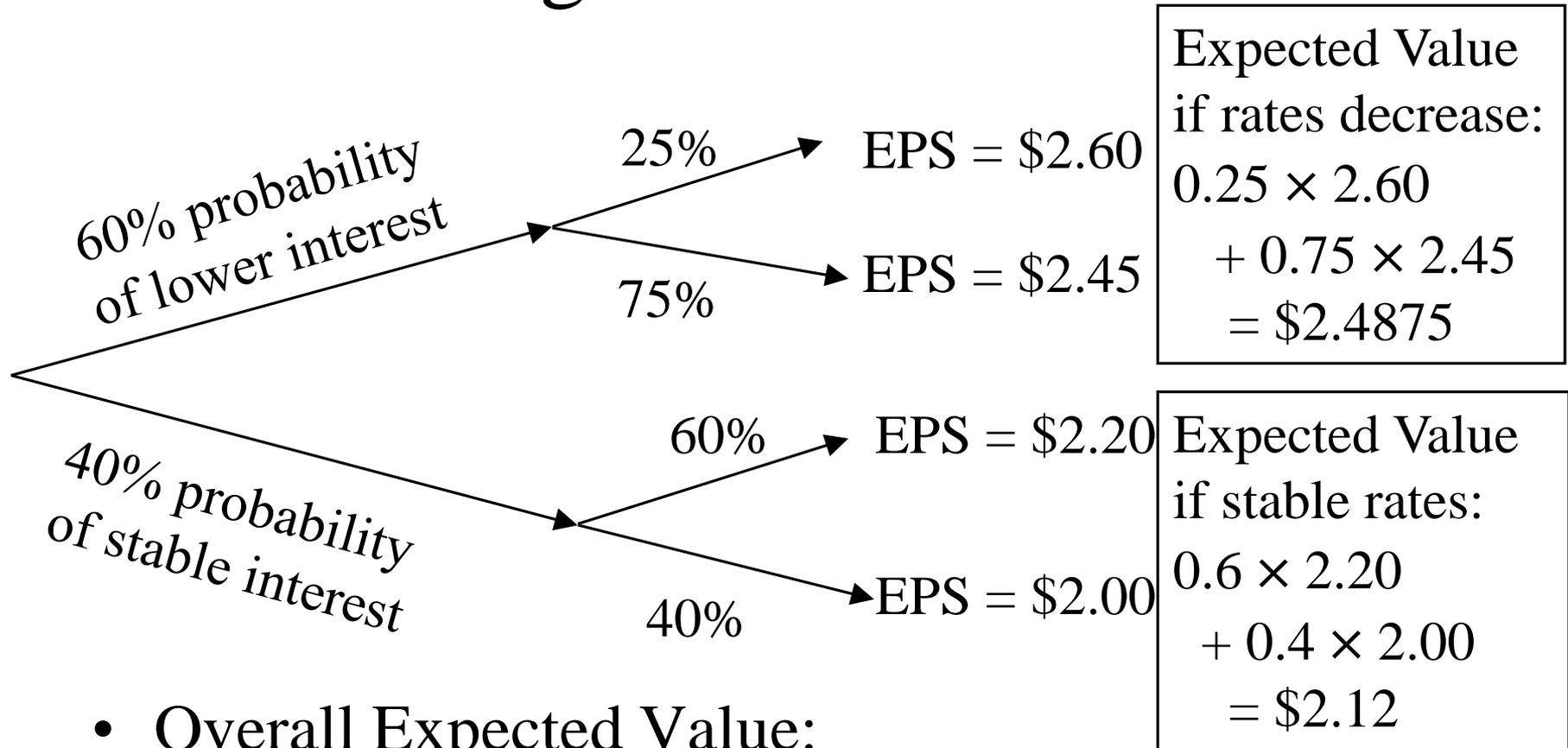
- Overall Expected Value:
$$0.6 \times (0.25 \times 2.60 + 0.75 \times 2.45) \\ + 0.4 \times (0.6 \times 2.20 + 0.4 \times 2.00) = \$2.34$$

- Note: $0.6 \times 2.4875 + 0.4 \times 2.12 = \$2.34$

DECISION TREES (ALG MODE)

Keys (Using Memories)	Display	Comments
0.60 [x] 0.25 [x] 2.60 [=] [STO][1]	0.3900	Top Branch
0.60 [x] 0.75 [x] 2.45 [=] [STO][2]	1.1025	2nd Branch
0.40 [x] 0.60 [x] 2.20 [=] [STO][3]	0.5280	3rd Branch
0.40 [x] 0.40 [x] 2.00 [=] [STO][4]	0.3200	Bottom Branch
[RCL][1] [+] [RCL][2] [+] [RCL][3] [+] [RCL][4] [=]	**2.3405**	**Answer**

- *Note: Quick check for reasonableness, values between 2.60 and 2.00, answer is about in the middle, that is reasonable!*
- *Note 2: There is a weighted average statistical mode for the calculator , "[g][6]" but I think using the memories, as above or next slide, is actually faster for this type of problem and probably less chance of making an error.*

DECISION TREES (RPN MODE)

Keys (Using Memories)	Display	Comments
0.60 [ENTER] 0.25 [x] 2.60 [x] [STO][1]	0.3900	Top Branch
0.60 [ENTER] 0.75 [x] 2.45 [x] [STO][2]	1.1025	2nd Branch
0.40 [ENTER] 0.60 [x] 2.20 [x] [STO][3]	0.5280	3rd Branch
0.40 [ENTER] 0.40 [x] 2.00 [x] [STO][4]	0.3200	Bottom Branch
[RCL][1] [ENTER] [RCL][2] [+] [RCL][3] [+] [RCL][4] [+]	**2.3405**	**Answer**

- *Note: Quick check for reasonableness, values between 2.60 and 2.00, answer is about in the middle, that is reasonable!*
- *Note 2: There is a weighted average statistical mode for the calculator , "[g][6]" but I think using the memories, as above, is actually faster for this type of problem and probably less chance of making an error.*

FACTORIAL, COMBINATIONS, AND PERMUTATIONS

- N Factorial is when you multiply

  N x (N-1) x (N-2) x … x 2 x 1 = N!

- There is a built in function in your calculator to do this:

  [g][3] = [n!], To get 5!: 5 [g][3] "120"

- This can be useful for combination calculations:

  To select a subset of 3 items out of 5:
  $_5C_3$ = 5! / ((5-3!)(3!)) = 10
  Using RPN:
  5[g][3][ENTER] 2[g][3][÷] 3[g][3] [÷] gives the answer of 10

  note, CFA reading sloppy, says 5! / (5-3)!(3!). Wrong under rules of algebra.

- Or 5[g][3][ENTER] 2[g][3] [ENTER] 3[g][3] [x] [÷] "10"

FACTORIAL, COMBINATIONS, AND PERMUTATIONS

- Using ALG:
  5[g][3] [÷] 2[g][3] [÷] 3[g][3] [=] gives the answer of 10

- Or with ALG mode you could use parentheses:

- 5[g][3] [÷] [g] [( ] 2[g][3] [x] 3[g][3] [g][ )] [=] gives the answer of 10

- Note that if you don't use parentheses you must divide by both the 2nd and 3rd terms,

- but with the parentheses, the calculator multiplies the 2nd and 3rd terms together and then divides that answer into the first term, giving the correct answer.

FACTORIAL, COMBINATIONS, AND PERMUTATIONS

- This can also be useful for permutation calculations:

To select and rank a subset of 3 items out of 5:
$_5P_3 = 5! / (5-3!) = 60$

Using RPN:
 5[g][3][ENTER] 2[g][3][÷] gives the answer of 60

Using ALG:
 5[g][3] [÷] 2[g][3] gives the answer of 60

$$p(x) = \left[\frac{n!}{(n-x)! \times x!} \right] p^x (1-p)^{n-x}$$

- Calculate the probability of getting 3 heads when tossing a fair coin 5 times: $[5!/(2! \times 3!)] \times 0.5^3 \times 0.5^2$
- HP: RPN mode:
  5 [g][3] [ENTER] 2 [g][3] [÷] 3 [g][3] [÷] *"calculates 1st part"*
     0.5 [ENTER] 3 [yˣ] [x] 0.5 [ENTER] 3 [yˣ] [x] "The answer"
- HP: ALG mode:
   5 [g][3] [÷] 2 [g][3] [÷] 3 [g][3] *"calculates 1st part"*
     [x] [(] 0.5 [yˣ] 3 [x] [(] 0.5 [yˣ] 2 [=] "The answer"
   Have to add "(" before each of the parts using [yˣ].
- Or just calculate each of the three parts and store in memories 1, 2, and 3, and then multiply the memories!

SOME ADDITIONAL CALCULATIONS COVERED IN THE LECTURE NOTES:

- Possible slide #s references below might be off by 1 or 2 slides due to possible editing of lecture notes in the future. So please check.

SS 2

- Two Stage DDM #100 (topic covered in SS 14)

- Mean Absolute Deviation (MAD) #132

- Covariance and Joint Probability #184

SS 3

- Macaulay's Duration #132 (topic covered in SS 16)