HOW TO USE YOUR TI BA II PLUS CALCULATOR

This document is designed to provide you with (1) the basics of how your TI BA II Plus financial calculator operates, and (2) the typical keystrokes that will be required on the CFA® examination. A similar guide as published by Texas Instruments is available for download from www.ti.com/calc/baiiplus. In this tutorial, the following keystroke and data entry conventions will be used.

[•] Denotes keystroke
{•} Denotes data input

A.   Setting Up Your TI-BA II Plus

The following is a list of the basic preliminary set up features of your TI BA II Plus. You should understand these keystrokes <u>before</u> you begin work on statistical or TVM functions.

Please note that your calculator's sign convention requires that one of the TVM inputs ([PV], [FV], or [PMT]) be a negative number. Intuitively, this negative value represents the cash outflow that will occur in a TVM problem.

1. To set the number of decimal places that show on your calculator:

$[2^{nd}] \rightarrow [\text{FORMAT}] \rightarrow \{\text{Desired \# of decimal places}\} \rightarrow [\text{ENTER}] \rightarrow [\text{CE/C}]$

For the exam, I would make sure that the number of decimal places is set to 5.

2. To set the number of payments per year (P/Y):

$[2^{nd}] \rightarrow [\text{P/Y}] \rightarrow \{\text{Desired \# of payments per year}\} \rightarrow [\text{ENTER}] \rightarrow [\text{CE/C}]$

P/Y should be set to 1 for all computations on the Schweser Notes and on the exam.

3. To switch between annuity-due [BGN] and ordinary annuity modes:

$[2^{nd}] \rightarrow [\text{BGN}] \rightarrow [2^{ND}] \rightarrow [\text{SET}] \rightarrow [\text{CE/C}]$

4. To clear the time value of money memory registers:

$[2^{nd}] \rightarrow [\text{CLR TVM}]$

This function clears all entries into the time value of money functions (N, I/Y, PMT, PV, FV). This function is important because each TVM function button represents a

memory register. If you do not clear your memory, you many have erroneous data left over when you perform new TVM computations.

5. **The reset button [2nd] [RESET].**

The reset button serves to reset all calculator presets [P/Y], [FORMAT] to their factory default values. If you feel that you've accidentally altered your calculator's presets in a way that could be detrimental, simply press [2nd]→[RESET]→[ENTER] to reinstate the factory defaults. Be sure to reset P/Y to 1 and the number of decimals to the preferred levels.

6. **Clearing your work from the statistical data entry registers:**

To clear the (X, Y) coordinate pairs from the [2nd]→[DATA] memory registers, press:

[2nd]→[DATA]→[2nd]→[CLR WORK]→[CE/C]

7. **Additional memory registers:**

You may wish to store the results of certain computations and recall them later. To do this, press [2nd]→[MEM]. To enter data into register M (0),

{desired number}→[ENTER]→[CE/C]

To enter another number into M (1), [↓]→{desired number}→[ENTER]→[CE/C]

B. **How to Handle Multiple Payment Periods Per Year:**

When a present value or future value problem calls for a number of payments per year that is different from 1, use the following rules. These rules only work if P/Y is set to 1.

1. **For semi-annual computations:**

PMT = (annual PMT) / 2
I/Y = (annual I/Y) / 2
N = (number of years) × 2

2. **For quarterly computations:**

PMT = (annual PMT) / 4
I/Y = (annual I/Y) / 4
N = (number of years) × 4

3. **For monthly computations:**

PMT = (annual PMT) / 12
I/Y = (annual I/Y) / 12
N = (number of years) × 12

C.   Time Value of Money (TVM) Computations

1. Basic Present Value Computations

If a single cash flow is to occur at some future time period, we must consider the opportunity cost of funds to find the present value of that cash flow. Hence, our goal here is to discount future cash flows to the present using the appropriate discount rate. For example, suppose you will receive $100 one year from today and that the appropriate discount rate is 8%. The value of that cash flow today is:

{1}→[N]
{100}→[FV]
{0}→[PMT]
{8}→[I/Y]
[CPT]→[PV] = -92.59

Example: Suppose you will receive $1,000 ten years from today and that the appropriate annualized discount rate is 10%. Compute the present value of this cash flow assuming semi-annual compounding

{10×2}→[N]
{10/2}→[I/Y]
{0}→[PMT]
{1,000}→[FV]
[CPT]→[PV] = -376.89

The result is a negative number due to your calculator's sign convention. Intuitively, to receive $1000 ten years from now at 10% semi-annually, this would cost you $376.89.

2. Basic Future Value

Here, we want to compute how much a given amount today will be worth a certain number of periods from today, given an expected interest rate or compounding rate.

Example: Suppose that you have $1,000 today and can invest this amount at 14% over the next 5 years with quarterly compounding. Compute the value of the investment after 5 years.

{−1000}→[PV]
{5×4}→[N]
{14/4}→[I/Y]
{0}→[PMT]
[CPT]→[FV] = $1,989.79

3. Ordinary Annuities

In an ordinary annuity, a constant cash flow is either paid or received at the end of a particular payment period over the life of an investment or liability. Here, we begin use of the [PMT] key.

Example: You would like to buy a 9%, semi-annual, 8-year corporate bond with a par value of $1,000 (par value represents the terminal value of the bond). Compute the value of this bond today if the appropriate discount rate is 8%. Here, the 9% is the coupon rate of the bond and represents the annual cash flow associated with the bond. Hence, the annual PMT = (0.09) × ($1,000) = $90.

The value of the bond today is:

{8 × 2}→[N]
{$90/2}→[PMT]
{8/2}→[I/Y]
{$1,000}→[FV]
[CPT]→[PV] = -$1,058.26

Example: You will receive $100 per month for the next three years and you have nothing today. The appropriate annual interest rate is 12%. Compute your accumulated funds at the end of three years.

{3×12}→[N]
{0}→[PV]
{100}→[PMT]
{12/12}→[I/Y]
[CPT]→[FV] = -$4,307.69

4. Annuity Due

In an annuity due, you receive each constant annuity cash flow at the beginning of each period. You must set your calculator to BGN mode by pressing [2nd]→[BGN]→[2nd]→[SET]. BGN will appear in the calculator's LCD screen.

Example: You will receive $100 per month for the next three years and you have nothing today. The appropriate annual interest rate is 12%. Compute your accumulated funds at the end of three years:

$\{3 \times 12\} \rightarrow [N]$
$\{0\} \rightarrow [PV]$
$\{100\} \rightarrow [PMT]$
$\{12/12\} \rightarrow [I/Y]$
$[CPT] \rightarrow [FV] = -\$4,350.76$

Notice that the future value is larger in this case because you receive each cash flow at the beginning of the period, so each cash flow is exposed to one additional compounding period.

5. Continuous Compounding and Discounting

If the number of compounding periods is said to be continuous, what this means is that the time between compounding periods is infinitesimally small. To discount and compound, you need the magic number $e = 2.718281$.

The formula for continuous compounding of a single cash flow is:

$$FV = PV \times (e^{rt})$$

The formula for continuous discounting is:

$$PV = FV \times (e^{-rt})$$

where:
r = the annualized interest rate
t = the number of years

Example: You have $100 today and have been offered a 6-month continuously compounded investment return of 10%. How much will the investment be worth?

Step 1: Compute $r \times t =$

$0.1 \times 0.5 = 0.05$

Note that you always use the decimal representative of both the interest rate and time when performing these computations

Step 2: Compute $e^{r \times t}$

$\{0.05\} \rightarrow [2^{nd}] \rightarrow [e^x] = 1.05127$

Step 3:   Find the future value

$$\$100 \times 1.05127 = \$105.13$$

Example: You will receive $1,000 eighteen months from today and would like to compute the present value of this amount at 8% with continuous compounding.

Step 1:   Compute $-r \times t$

$$-0.08 \times 1.5 = -0.12$$

Step 2:   Compute e^{-rt}

$$\{-0.12\} \rightarrow [2^{nd}] \rightarrow [e^x] = 0.88692$$

Step 3:   Find the present value

$$\$1,000 \times 0.88692 = 886.92$$

6. Internal Rate of Return (IRR) and Net Present Value (NPV)

Just in case there is a question on the examination that asks for an IRR calculation, the keystrokes are as indicated in the following example.

To use the IRR and NPV functions in your TI-BA II Plus, you must first familiarize yourself with the up and down arrows ($\uparrow\downarrow$) at the top of the keyboard. These keys will help you navigate your way through the data entry process. After entering the initial cash flow, you will need to key [$\downarrow$] *once*. After each subsequent cash flow, (until the final cash flow) you will need to key [$\downarrow$] *twice*, once to enter the cash flow and once to scroll through the display that shows the frequency of the cash flow. After entering the final cash flow, key [$\downarrow$] *once* only.

Example: Project X has the following expected after-tax net cash flows. The firm's cost of capital is 10%.

<div align="center">

Expected Net After-Tax Cash Flows – Project X

Year	Cash Flow
0 (initial outlay)	-$2,000
1	1,000
2	800
3	600
4	200

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The **IRR** for Project X is:

    [CF] [2ⁿᵈ] [CLR WORK]
    2,000 [+/-] [ENTER] [↓]
        1,000 [ENTER] [↓][↓]
         800 [ENTER] [↓][↓]
         600 [ENTER] [↓][↓]
         200 [ENTER] [↓]
    [IRR] [CPT] gives the result, 14.48884.

A note on Net Present Value (NPV): For NPV calculations on the examination, we recommend computing the present value of each individual cash flow and adding them together. No need to memorize more calculator functions - you've got enough to memorize for the exam! However, for the curious, the keystrokes to calculate NPV are as follows:

The **NPV** of Project X is:

    [CF] [2ⁿᵈ] [CLR WORK]
    2,000 [+/-] [ENTER] [↓]
        1,000 [ENTER] [↓][↓]
         800 [ENTER] [↓][↓]
         600 [ENTER] [↓][↓]
         200 [ENTER] [↓]
    [NPV] {10} [ENTER] [↓]
    [CPT] gives the result, $157.63951.

7. **The natural log function (Primarily for CFA® Levels 2 and 3)**

The natural log function is intimately related to e^x. In Level 1, you will use this function to calculate a continuously compounded return given a specific holding period return. The natural log function (LN) is also used when working Black-Scholes and Merton Model problems.

Example: The value of the stock is $45 (S) today and the exercise price of a call option that trades on that stock is $50 (X). Calculate the natural log of (S/X).

Step 1:   Compute S/X

           $45/50 = 0.90$

Step 2:   Compute ln(S/X)

           $\{0.90\} \rightarrow [LN] = -0.10536$

As a check of the relationship between [LN] and [e^x], press {-1.0536}→[2nd]→[e^x]. The result is 0.90.

More precisely, $e^{\ln(x)} = x$, and, $\ln(e^x) = x$

D. **Your TI-BA II Plus Statistical Functions (use at your own risk).**

Understanding the previous sections of this document is critical to your success on the exam. What follows are some cool short cuts you can take to calculate the mean and variance of a small data set. Please beware, that in many cases, doing these computations by brute force is sometimes quicker. If you feel you'll have a hard time memorizing these keystrokes for the exam, don't sweat it – focus on the actual formulas and basic calculations. In other words, don't get fancy – it could backfire!

As with the IRR and NPV calculations, to use the data functions in your TI-BA II Plus, you must first familiarize yourself with the up and down arrows (↑↓) at the top of the keyboard. These keys will help you navigate your way through the data entry process.

To enter a data series into your BAII Plus, press [2nd] →[DATA]. Notice that you can enter both X and Y coordinates (you can actually perform a simple linear regression on your calculator!). If you just have one data series (X), you will simply press the down arrow through the prompts for Y data values. Notice that X and Y both begin at X (01) and Y (01) respectively, and that [X (01), Y (01)] represents one X, Y coordinate pair.

Example: You have been given the following observations that measure the speed of randomly selected vehicles as they pass a particular checkpoint.

30, 42, 32, 35, 28

Compute the mean ($\overline{X}$), population variance, and sample variance for this data set.

Step 1: Enter the data: [2nd]→[DATA]

X (01) {30}→[ENTER]→[↓]→[↓]
X (02) {42}→[ENTER]→[↓]→[↓]
X (03) {32}→[ENTER]→[↓]→[↓]
X (04) {35}→[ENTER]→[↓]→[↓]
X (05) {28}→[ENTER]→

Step 2: Calculate the statistics: [2nd]→ [STAT]→ [↓]→[↓]

$\overline{X}$ = 33.4
[↓] = Sx = sample standard deviation = 5.459
[↓] = σ_x = population standard deviation = 4.883

Notice that you're simply entering through the Y (i) data entry fields – a "1" is placed in the Y data value as you down-arrow through this value.

Also, remember that the population variance differs from the sample variance in that the sum of the squared deviations from the mean are divided by n and n – 1 respectively. In addition, the standard deviation is the square root of the variance.

Example: You have calculated the following returns for an individual stock and the stock market over the past four months.

	R_i (Y)	R_m (X)
Month 1	12%	15%
Month 2	8%	4%
Month 3	9%	12%
Month 4	10%	14%

Calculate the stock's mean return, the market's mean return, and the correlation between the stock's returns and market returns.

Step 1:   Enter the data: $[2^{nd}]\rightarrow[DATA]$ – make sure to $[2^{nd}]\rightarrow[CLR\ WORK]$ first!!
X (01): {15}→[ENTER]→[↓]
Y (01) {12}→[ENTER]→[↓]
X (02) {4}→[ENTER]→[↓]
Y (02) {8}→[ENTER]→[↓]
X (03) {12}→[ENTER]→[↓]
Y (03) {9}→[ENTER]→[↓]
X (04) {14}→[ENTER]→[↓]
Y (04) {10}→[ENTER]→[↓]

Step 2:   Calculate the statistics: $[2^{nd}]\rightarrow[STAT]\rightarrow[↓]\rightarrow$

Mean of X	[↓] = X = 11.25
Sample standard deviation $_X$	[↓] = S_X = 4.992
Population standard deviation $_X$	[↓] = σ_x = 4.323
Mean of Y	[↓] = Y = 9.75
Sample standard deviation $_Y$	[↓] = S_Y = 1.708
Population standard deviation $_Y$	[↓] = σ_Y = 1.479
Intercept term	[↓] = a = 6.55
Slope coefficient	[↓] = b = 0.284
Correlation X, Y	[↓] = r = 0.831

Given this data, we can say that our estimate of the beta of the stock is 0.28, the correlation of stock i's returns relative to the market is 83.1%, and the R^2 of the regression is $(0.831)^2 = 0.691$ or 69.1% (i.e., 69.1 percent of the variation in stock i's returns is explained by the variability in market returns).