Step #0 BEFORE you start this Project … might be a good idea to read/do the following

This Project is not difficult, requires little originality but is tedious and requires you to follow these lengthy step-by-step instructions. So, before your start, it helps to read the following before organizing and implementing your calculations/plots in your **Excel** and compiling the required results in your **PDF Deliverables** file:

1. **About observing academic conduct.** Read *Page 2 and 11*. It affects how you do this project and whether you will be accorded credit for your work or even failing the course.

2. **About grading policy for this project.** See *Page 3 and 4*. Know where/how to earn points while implementing your project. PS: if you follow (no originality required) all the project's instructions and do them accurately and correctly, you should "get at least 85%" of this project score.

3. **About project delivery dates. There are TWO due dates.** See *Page 2, 11,* and project folder in *BlackBoard*.

4. **About what to submit for the project.** This affects your project grading score.
    a. See *Step #18.* There is a specific list of items you need to gather/compile for submission …
    b. … it also explains the file-naming conventions of your submitting project files.
    c. See the following pages after *Step #18* for *Sample Deliverables*. It will help you organize your Excel worksheets based on your project Steps and the required calculated data summary tables and plots.

5. **About where to submit for the project.** DO NOT email your project as an attachment to the instructor/TA.
    a. See *Step #18.* In particular, see Step #18 sub-item [g].
    b. At about the time the project is due, course *BlackBoard's* left-hand-side menu will have an *Assignments > Submit Domestic Portfolio Project* menu links for your submitting files. Additional instructions on doing so will be provided there.

6. **About the project's stock selection and its data.** You are NOT starting from scratch.
    a. You will be provided with an instructor-given personalized *"starter template and data" Excel file* See *Page 2, 11*.
    b. See *Step #1 sub-part [k]* for *suggested pre-screened stocks* that will meet the project's requirements -- to save you stock selection time.
    c. For stock **data requirements** in your project, see *Step #1* sub-parts *[a] through [f]*.
    d. See Step #1 sub-parts [l] through [p] on **how to download stock data**. To save you time, data is provided.

7. **About the project's Steps.** Described in detailed step-by-step instructions, please follow them (requires no originality on your part) and work through them sequentially from *Step #1 through Step #18*.

8. **About advice for this course's TWO portfolio projects**
    a. Yes, this project is a LOT of work and very TIME CONSUMING; each is *"only 10% of the course grade".*
    b. You are **almost certain to earn at least 8%** of the overall course grade; just follow the instructions.
    c. The same goes for the second half of semester's *International Equity Portfolio Project* …
    d. … at least **another 8%** of the overall course grade.
    e. **BOTH portfolio projects will help raise your overall course score** – exam(s) have a much lower average score.
    f. But you need to put in your **OWN** time, effort **unassisted and observing stated Academic Conduct spelled out in this assignment document**, submitted on time …
    g. … and it could be the difference between passing or failing this course.

9. **Any further questions.** Please ask instructor during classroom sessions.

<***updated 05/09/2025 1pm***> *ALL Phases are released at once due to short time frame of the project due date.*

About the Project, Observing Academic Conduct, Doing Your Own [unassisted] Work
please read pages 1,2,3,4 carefully before starting the project

- For this entire project (all Phases), you may use/assume the following [based on 05/09/2025]. No need to change it if your assignment is done over a few days or a few weeks; it won't impact your actual/final calculations significantly:
  - ✓ **Risk-free Rate k_{RF}**, also notated as **RFR = 4.08%** [U.S. 10-year T-Bill].
  - ✓ Market Risk Premium **$RP_M = k_M - k_{RF}$ = 4.00%** [how did we get this "magic" number?].
  - ✓ Therefore, Required Rate of Return of the Market **k_M = RFR + RP_M = 8.08%**.
- The entire project has **4 Phases**. Each Phase will be time-released to keep pace with successive lecture Modules. There are **two due dates**:
  1. Phase1 Step #1 [declaring the stocks in your portfolio],
  2. The entire project. See Step #18 for *Sample Deliverables*.
  - ➢ This project is time-consuming. It is recommended that you **start early, finish and submit** early to remove distraction and allow more time for you to focus on your exam (which carries a lot more points than this project).
- See BlackBoard *Announcements*, *Assignments* or *Documents* section for specific due dates and instructions.
- You will be using **your instructor-given personalized copy of the "starter template and data" Excel file** to complete all the steps in the project:

1. **IMPORTANT:** This is an individual project. DO NOT RECYCLE YOUR FRIEND'S PAST SEMESTER's PROJECT, i.e. **DO YOUR OWN WORK from scratch from your instructor-given Excel; no help from others.**
2. To enforce **Academic Code of Conduct**, **you MUST start your project by using your instructor-given personalized "starting template & data" Excel file which will be sent to you via BlackBoard's *Internal Messages***. Your personalized template file contains cookies and meta-data to individually track and watermark your own copy of the Excel file; use them as is to start and complete your project.
3. **DO NOT rename** your given Excel file**.**
4. **DO NOT delete** those existing **worksheets and its red banner**. Use your given personalized template data file and work with it by adding all the necessary steps and worksheets to complete the project.
5. **DO NOT start from your own new Excel file** and copy over those worksheets.
6. **DO NOT cut-paste** all or part of your work from other Excel files or worksheets that is not from your given personalized "starting template & data" Excel file.
7. Not following all of the above instructions will lead to **ZERO score** in this individual project.
8. Any **violation** of Academic Conduct during this Project will lead to an automatic **failure** in this course.

Color-coding Conventions for Data Plots

You MUST use the following color-codes for your indexes and stocks [ticker symbol arranged in **alphabetical order**] in your plots and data summary tables in Steps #3, #4, #5, #6, #7, #8, #12, #13, #15 [**or face point deductions**]:

Black	**solid black** line for **^SP500** benchmark [Step #3].
Gray	**dotted gray** line for **^Dow30** benchmark [Step #3].
Blue	**Stock A**
Turquoise	**Stock B**
Pink	**Stock C**
Orange	**Stock D** if needed in project.

Where A, B, C, D are your chosen domestic stocks **arranged in alphabetical order**, for example, "AXP", "BRK-B", "CVS", "DIS", etc. For additional guidance on this color convention, see respective steps and the posted Sample "Deliverables".

Grading policy for this project

A. **Due Dates.** This project have two due dates which will impact your score for this assignment. **Please check this assignment's folder [in the BlackBoard] for actual set of due dates**:

1) **Phase 1 Step #1.**
   a) **Propose** the required number of stocks in your Domestic Portfolio.
   b) Use course BlackBoard's ***Internal Messages*** to notify instructor of your choices.
   c) 10-point deduction per day late, for "bad" or "rejected" choice(s) of your domestic stock(s) from your proposal. See Step #1, in particular, item [k] for guidance.

2) **Entire Project.**
   a) See Step #18 *"The Entire Project's Deliverables"* for guidance.
   b) 10-point deduction per day late after due date of entire project.

B. **Point Deductions.** The following is a checklist, not exhaustive, but typical areas where a project loses points:

1) **Late on due dates** [A1] and/or [A2] -- 10-point deduction for each day past due.
2) **Unsuccessful Phase 1 Step #1 stock(s) proposal** -- 10-point deduction for "bad" or "rejected" choice(s) of your domestic stock(s) from your proposal.
   a) See Step #1. Proposed stocks must meet requirements [a] through [e] …
   b) … when in doubt, pick suggested, pre-screened list of stocks from item [k].
3) **Academic Conduct**. Did you observed project instructions stated in Page 2?
   a) Straightforward requirement: ***"do your own work unassisted"***.
   b) Did you recycle past semester's work? It is not your work and they are different.
   c) Did you use your instructor-given personalized *"starting template & data"* Excel file?
   d) Did you observe **Page 2, items [1] through [8]**?
   e) **Violation** of Academic Conduct in this project is an automatic 0-point for project and a **failing grade** in this course.
4) **Project Submit Files**. See Step #18 *"The Entire Project's Deliverables"* for guidance.
   a) You will be submitting two files -- an Excel file and a PDF file.
   b) File-naming convention is DomPortf-*LnameFname*. For example:
      - If name is SMITH, John, then two files will be DomPortf-*SmithJ*.xlsx and *SmithJ*.pdf
      - If name is ZHOU, Ziruo, then two files will be DomPortf-*ZhouZR*.xlsx and *ZhouJR*.pdf
   c) In any case, your filename prefix is already determined for you based on your instructor-given personalized *"starting template & data"* Excel file.
   d) 10-point deduction for not following above file-naming convention.
5) **Deliverables worksheet** in your project's Excel file.
   a) In your *instructor-given personalized starter template and data* Excel file, you may create as many worksheets as needed to organize, calculate, tabulate the Steps in this assignment …
   b) … however, you must consolidate your results in the ***"Deliverables"*** **worksheet**.
   c) This worksheet is already part of your instructor-given personalized *"starting template & data"* Excel file -- use it; don't create or cut-paste a new one.
   d) **Link your calculated results from other worksheets to this Deliverables worksheet**.
      i. For example, if you have created a new worksheet called *"Step 6"* to calculate the *Annual HPYs of the stock market indexes and your chosen stocks*, then its results should be tabulated in "***Deliverables" worksheet*** and linked from "Step 6" worksheet to "Deliverables" worksheet, e.g. Deliverables worksheet's cell E-19 is set equal to "Step 6" worksheet's cell L-10, "stock A's Period 1 HPY", etc.

ii. For example, if you have created a new worksheet called *"Step 3"* to calculate and then *Plot the Stock Performance Indexes*, then you should "redirect this plot" to the "Deliverables" worksheet.

e) **DO NOT CUT-PASTE calculated data values or plots from other worksheets to the "Deliverables" worksheet** -- it makes it difficult for the grader to *"trace"* the calculated values back to its original source and provide grader feedback for sources of error in calculations.

f) **When in doubt, follow exactly the Sample Deliverables** provided in the pages after Step #18 *"The Entire Project's Deliverables"*. You won't lose points for following the Sample's format.

6) **Other common areas of point deductions** in project deliverables:

a) In short, **see *Sample Deliverables*** -- did you leave out any of those items shown?

b) Did you follow *color-code conventions*? See Page 2.

c) Did you arrange your chosen stocks in *alphabetical order* in your Deliverables data summary tables, Step #6, #12, #15, and plots in Step #3, #7? PS: once alphabetized, each stock will be assigned according to the color-code convention in 6(b) and as stated in Page2.

d) Were there any calculation errors?

e) Were the summarized tables of calculations messy, sloppy, and disorganized?

f) For the plots, did you scale it properly?

g) For the plots, did you label them appropriately?

h) PS: just follow the ***Sample Deliverables***; you should be fine.

C. Final word about the two Portfolio Projects

1) Yes, this project is a LOT of work and very TIME CONSUMING; it is *"10% of the course grade".*

2) You are **almost certain to earn at least 8%** of the overall course grade; just follow instructions.

3) The same goes for the second half of semester's *International Equity Portfolio Project* …

4) … at least **another 8%** of the overall course grade.

5) **BOTH portfolio projects will help raise your overall course score** -- exam(s) have a much lower average score.

6) But you need to put in your **OWN** time, effort **unassisted and observing stated Academic Conduct spelled out in this assignment document**, submitted on time …

7) … and it could be the difference between passing or failing this course.

Step #1 Internal Message the instructor your selected domestic (U.S.) stocks in your portfolio.

See this assignment's BlackBoard folder for Phases and due dates. You must *Internal Message* instructor [via BlackBoard] with your choice of stocks in your portfolio. See instructions below:

PS: BEFORE you start downloading your stocks' data, see item [i]. Also, a set of **pre-screened stock prices Excel data file is provided**. Then read on with the following instruction.

You will be building a portfolio of 3 domestic (U.S.) stocks. In order to make this assignment work, your proposed stocks must meet the following **requirements**:

a) It must be **U.S. publicly traded** only because its long-run **historical stock prices** are easily available and downloadable from most (free) financial websites.

b) Stock must have been listed **since 01/01/2000**; we need data from this date **till the current month** [notated *CM*] of the **current year** [notated *CY*] **this assignment.** So, your last data point should be *current_month/01/current_year*.

c) Its **average** of the **annual rate of returns** during **2000~current year** must be **between 6% and 20%**.
(Yeah, 2008~2010 were horrible years … but most of it was recovered during 2011~2017 and it got even better during 2018 and surprisingly the first two Covid years. PS: unfortunately, with Covid-19, it could be a few volatile and tough years forward). **Reasons** for these requirements:

   i) Stocks are not risk-free investments. And they certainly do not guarantee positive returns. **Negative returns** make one of the learning objectives of this project less apparent.

   ii) **Negative returns** also will lead to **negative stock Beta**, a calculation you will be required to perform and plot in this project.

   iii) On the other hand, having an average of the stock's annual **HPY higher than 20% causes scaling problems** when plotting various results (in particular, the Efficient Frontier) throughout this project. PS: which is why we don't pick Apple, Amazon, et al -- performing too well since the year 2000.

   iv) So, for **practical purpose and learning objectives in this project**, we have this limit. But in practice all investors should strive for better returns relative to their acceptable level of risk taken on them. For example, during this holding period, had you invested in any of these S&P500 stocks [not limited to a particular sector], you would have retired a long time ago: Apple [19,000+%!!!]; MasterCard [7,000+% and insufficient data]; Gilead Sciences [5,000+%]; UnitedHealth Group [9,000+%]; Nike [3,000+%]; Cummins [3,000+%]; Amazon [4,000+%]; Cognizant Technology Solutions [4,000+%]; Union Pacific [3,300%+]; Google [2,000+% and insufficient years]; Starbucks [2,400+%]; etc.

d) Each of the stocks in your portfolio must be "**well diversified**", typically coming from different sectors (industry) of the economy. For example an all-energy Exxon-Mobile + Chevron + Conoco Philips would be a bad idea, while Exxon-Mobile (energy) + Microsoft (technology, computer services) + Johnson&Johnson (healthcare), etc. would probably be a better set of stocks.

e) At least one stock in your portfolio must have a **dividend history** since year 2000, whether quarterly or annually over these years. One part of this project requires you to use its dividend history to calculate its stock price using the **Dividend Discount Model** [DDM].

f) Note that it is OK for more than one student to pick the same ONE or TWO stocks in their portfolio but not EXACTLY the same set of stocks. If you overlap in only 2, that is fine. The instructor will assume that each student is **doing his/her own (individual) work** on the selected stocks.

g) The **approval** of the choice of stocks in your portfolio is **based on a first-come-first-serve basis**. So, *Internal Message* the instructor [via BlackBoard] as soon as possible.

h) This Project is **not graded on who will have the highest portfolio return** during the observed period. It is based on the process of collecting your data; calculating, plotting, compiling, and then reporting these results in the specified manner.

i) PS: if you do not wish to use U.S. domestic stocks, **you are allowed to propose your own stocks from another single country**. Then those proposed stocks are "domestic" with respect to that country. For example, all-Chinese stocks, all-EU stocks, all-Latin American stocks, etc. **BUT you must still**

i. **Meet the data requirements as spelled out in above steps [b] thru [f]**,
ii. You need to find out that country's Risk-free Rate (**RFR**), i.e. its 7- or 10-year T-Note rate.
iii. And you need to collect its corresponding stock market index data (**the market**).
iv. And you need to estimate that country's Market Risk Premium RP_M. PS: it may not be 4.00%.

- PS: in a separate (international) portfolio project [second half of semester], you will have a chance to work on non-US stocks and non-US stock market indexes.

j) PS: if you decide on U.S. stocks, you do not have to limit your choice of U.S stocks to the pre-screened list in [k] below.

- Choose something you are interested in or you plan to follow …
- … and might have a future interest in investing in that stock, or even employment prospect.
- However, whichever stocks you choose to use, you must still meet those **requirements [a] thru [f]**.

k) Suggestions on how to screen for your stocks

If you already are an experienced investor, you could use any of the free or commercially available stock screener apps to help you; most of them comes with your online stock trading account. However, if you do not have this resource, it is not an issue. In fact, one of the goals of this course is to teach you to build and look for stock information manually; it is part of the learning process.

To save you time, the following is a list <*see next page*> of **some pre-screened S&P500 stocks** **which might meet the above requirements** [a] through [e] at the time of assignment. They are organized by sectors [and listed in order of sector weight] as defined by the Global Industry Classification Standards (GICS), a system developed by Morgan Stanley Capital International (MSCI) and Standard & Poor's (S&P):

Pick a total of **3** stocks in your portfolio …

- ✓ Pick at most one stock from any 3 of the 11 **sectors** [vertical column]. This satisfies the **well-diversified requirement** [d],
- ✓ At least one of stock in your portfolio has a dividend payout history [marked with *]. This satisfies the **dividend history requirement** [e].
- ✓ PS: if you pick a stock from the **Consumer Discretionary** sector, you should not pick another stock from the **Consumer Staples** sector, and vice versa. This is because both sectors on a broader sense are still Consumer-related stocks. In the U.S. economy, the consumer economy represents a significant portion of the nation's economic activity and GDP. Although there are some leads/lags between them in the economic cycle, they could be more correlated than with the other sectors of the economy. So, meeting the well diversified required [d] would not be as apparent in your project.

SELECT FROM THIS LIST OF PRE-SCREENED STOCKS. PS: *stocks marked with a * have a* ***dividend payout history since 2000*** *or earlier. To be* ***well-diversified*** *, you should pick each stock from a different sector.* ***Stock candidates*** *listed in order by index weight within sector:*

Sectors

Consumer Discr	Consumer Staples	Energy	Financials	Health Care	Industrl	Materials	Tech	Utilities	Comm Services	Real Estate
HD*	PG*	XOM*	BRK-B	JNJ*	HON*	ECL*	MSFT*	DUK*	CMCSA*	PLD*
MCD*	KO*	CVX*	JPM*	MRK*	MMM*	APD*	INTC*	D*	DIS*	EQR*
LOW*	PEP*	COP*	WFC*	PFE*	UPS*	NEM*	ORCL	SO*	EA	ARE*
TGT*	WMT*	SLB*	AXP*	ABT*	WM*	VMC*	TXN*	SRE*	VZ*	IRM
EBAY	COST	HES*	USB*	AMGN	FDX*	MLM*	ADP*	XEL*		
CCL*	KMB*	HAL*	GS*	LLY*	LUV*	IP*	INTU	ED*		
	WBA*	MRO*	PNC*	CVS*	GD*	IFF*	ADI			
	HSY*		SCHW*	BAX						

<11/07/2021>

Sourced from Yahoo! Finance

DO NOT select and use the following stocks in your portfolio. Because:

- insufficient data over the required observed period,

- negative returns or average of annual HPY > 17%.

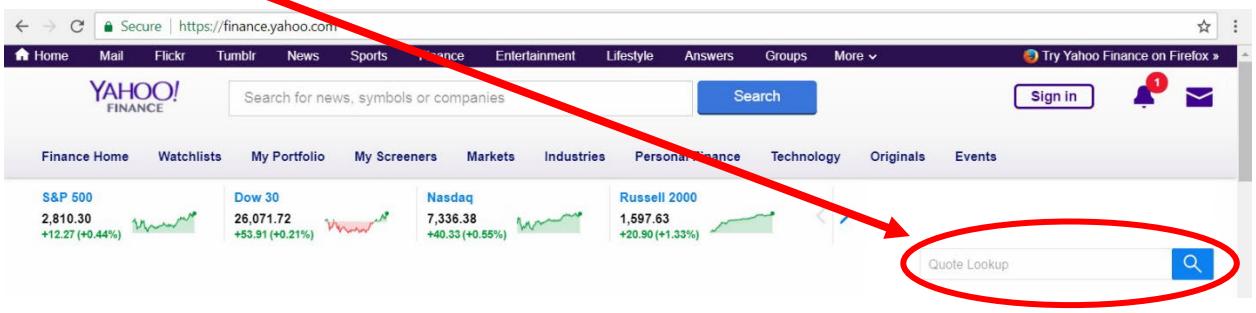
- no dividend payouts or insufficient dividend history.

AMZN #1	PM #5	PSX #3	BAC #3	UNH* #3	BA* #1	LIN #1	AAPL #2	NEE* #1	FB #1	**AMT #1**
NKE* #4	MO* #6	MPC #5	C #5	MDT* #5	UNP* #3	DD #3	V* #3	EXC* #5	GOOG #2	CCI #2
SBUX #5	MDLZ* #7	EOG #7	CME #8	TMO #8	UTX*	SHW* #5	MA #4	AEP* #6	GOOGL #3	SPG* #4
BKNG #7	COST #8	KMI #8	CB #9	ABBV #9	LMT* #5	PPG #8	CSCO #6	PEG* #9	CHTR #4	EQIX #5
TJX #8	CL* #9	OXY #9	SPGI #12	DHR* #11	GE* #8	DOW #6	ADBE #7	WEC* #11	T* #6	PSA* #6
GM #10	EL #11	VLO #10	ICE #13	BMY* #12	CAT* #9	BLL* #9	CRM #8	ES* #12	ATVI #7	WELL #7
DG #11	SYY* #13	OKE* #11	MS* #14	GILD #14	NOC* #10	LYB #10	IBM* #9	PPL* #18	NFLX #8	**AVB* #9**
ROST* #12	GIS* #14	WMB #12	BLK #15	CELG #15	RTN* #11	NUE* #15	PYPL #12		TWTR #11	SBAC #10
YUM* #13	STZ #15	PXD #13	MMC*#16	BDX* #17	CSX* #12	CE #17	ACN #13		TTWO #15	DLR #11
F* #14	ADM* #18	FANG #17	AIG #17	ANTM #19	DE* #13	FCX #18	NVDA #14		CBS #16	VTR*#12
VFC* #18	MNST #19	CXO #18	AON #18	ISRG #20	NSC* #14	CF #20	AVGO #15		CTL #17	BXP* #16
DLTR #19	KR #21	DVN* #22	BK* #24	CI* #21	CMI* #29	FMC #21	COM* #16		FOXA* #18	WY* #15
BBY #30	CLX* #22	APA #25	MET* #26	VRTX #26		EMN* #23	MU #21		DISCK #19	O #13
MGM #33	KHC #24	COG* #28		BIIB #28		MOS* #26	CTSH #26		DISH #20	ESS* #14
	SJM* #27			MCK* #33	airlines	SEE #30			VIAB #21	HCP* #17
				REGN #34	DAL #24				TRIP #26	CBRE #19
					UAL #39					HST* #20
					AAL #54					VNO* #26

… <u>Then do a quick verification of your choice of the stocks in your portfolio</u>

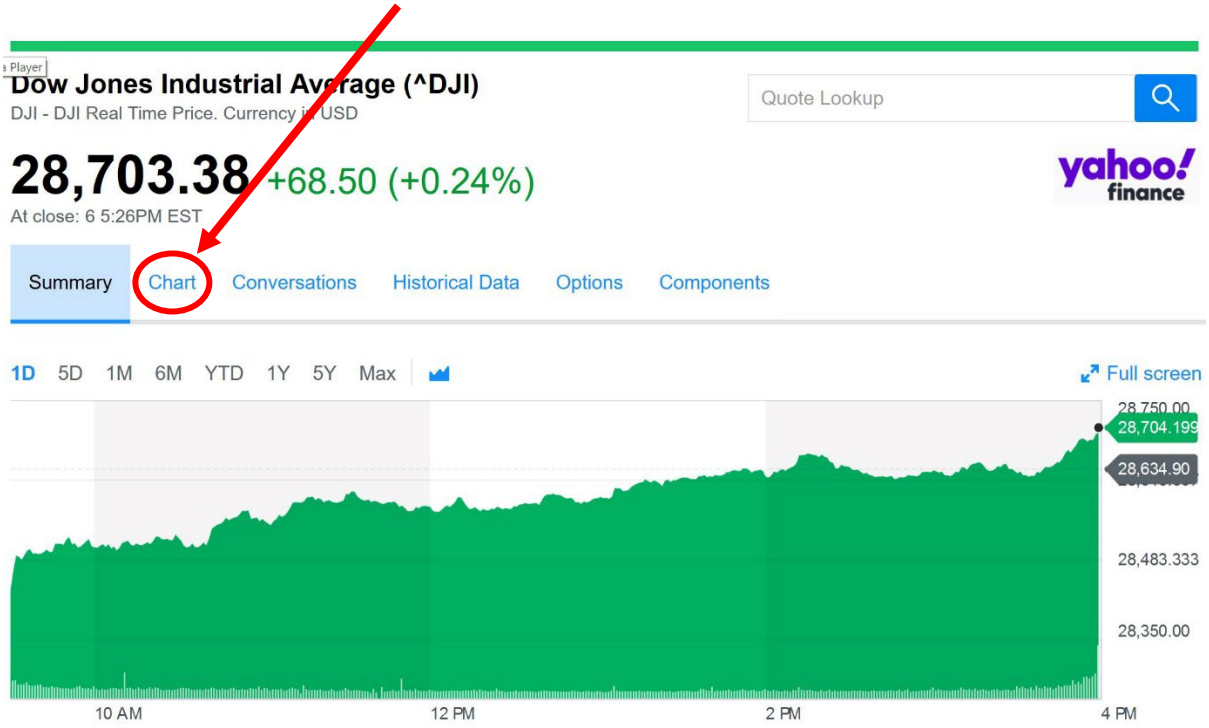
For example use **finance.yahoo.com** to help you visually confirm the above requirements:

l) In the "**Quote Lookup**" **search box** [near the top right of screen],



enter **^DJI** [†see note below] and then click the Look Up button. You should get the **Dow Jones Industrial Index** (^DJI) summary screen. This index is one of your two **portfolio benchmark index**.

m) On the chart of this index, click on the "**Chart**" tab to access additional display features for charting data:



† In Yahoo! Finance website, the market index **search notation** for the Dow30 index is **^DJI**, and S&P500 is **^GSPC**. In this project documentation, it is conveniently notated with the alternate, more **recognizable ^Dow30** and **^SP500** respectively.

n) Then click on the **Date Range** to specify our **portfolio's holding period: from 01/01/2000 to** *current_month/01/current_year*.

o) And click on the **Comparison Link** to add our **second portfolio benchmark index S&P500** to the chart:

p) Finally use the Comparsion Link's "Search symbols or companies" to add **your selected portfolio stocks** to the chart:

PS: You DO NOT have to submit the above Yahoo! plot; it is used as a visual check of your selected stocks.

q) For **convenience in grading**, please **strictly observe** use the following **color codes** for your **indexes** and **stocks** [ticker symbol arranged in **alphabetical order**] in the plots in your portfolio project (or you will lose grading points):

^SP500	**black**	[SP500 benchmark index **^SP500**]. † see note below.
^Dow30	**gray dotted**	[Dow30 benchmark index **^Dow30**].
first stock	**blue**	[ticker symbol with the lowest alphabetical order, e.g. **AXP**].
second stock	**turquoise**	[ticker symbol with the lowest alphabetical order, e.g. **BRK-B**].
third stock	**pink**	[ticker symbol with the highest alphabetical order, e.g. **CVS**].
fourth stock	**orange**	[ticker symbol with the highest alphabetical order, e.g. **DIS**] If required in project.

† In Yahoo! Finance website, the market index **search notation** for the Dow30 index is **^DJI**, and S&P500 is **^GSPC**. In this project documentation, it is conveniently notated with the alternate, more **recognizable ^Dow30** and **^SP500** respectively.

Phase 1 Step #1 Deliverables

a) [From Step #1 (a) thru (f)] Select and declare your domestic (U.S) 3-stock portfolio.

b) ***Internal Message*** **the instructor [via BlackBoard] your portfolio's choice of these stocks** arranged in **alphabetical order**, e.g. *"AXP, BAX, CVX, DIS"*; *"JNJ, MSFT, PG, UPS"*; etc.

c) **See assignment folder in BlackBoard for Phases and due dates.**

d) Late points will be assessed if you fail to meet this deadline.

e) Once instructor received and approved your choice of countries, he will *Internal Message* you your given personalized copy of the "starter template" Excel file :

1. **IMPORTANT:** This is an individual project. DO NOT RECYCLE YOUR FRIEND'S PAST SEMESTER's PROJECT, i.e. **DO YOUR OWN WORK from scratch from your given Excel; no help from others.**
2. To enforce **Academic Code of Conduct**, **you MUST start your project by using your instructor-given personalized "starting template & data" Excel file which will be Internal E-mailed to you in BlackBoard**. Your personalized template file contains cookies and meta-data to individually track and watermark your own copy of the Excel file; use them as is.
3. **DO NOT rename** your given Excel file**.**
4. **DO NOT delete** those existing **worksheets and its red banner**. Use your given personalized template data file and work with it by adding all the necessary steps and worksheets to complete the project.
5. **DO NOT start from you own new Excel file** and copy over those worksheets.
6. **DO NOT cut-paste** all or part of your work from other Excel files or worksheets that is not from your given personalized "starting template & data" Excel file.
7. Not following all of the above instructions will lead to **ZERO score** in this individual project.
8. Any **violation** of Academic Conduct during this Project will lead to an automatic **failure** in this course

Reminder:

- **For Phase 1, you only need to declare your selected stocks, i.e. Step #1 by the due date …**
- … the sooner you declare, the more choices you have on picking your preferred stocks for your domestic portfolio: I am trying to discourage students from having a portfolio with the same set of stocks [OK to have an overlap of some of the stocks but not the complete set].
- Once approved [via my *Internal Messages* reply], you can proceed to the remaining steps in Phase 1.
- The entire project has **4 Phases**; each Phase will be time-released to keep pace with successive lectures. **The entire project may be submitted any time BEFORE due date**; see assignment folder for due date.

As the class declares their portfolios, I will update them periodically and re-post these declarations to BlackBoard.

Step #2 Download your selected stocks' monthly prices since 1/1/2000.

a) Use the beginning of the month date range 01/01/2000 to current month of this assignment.

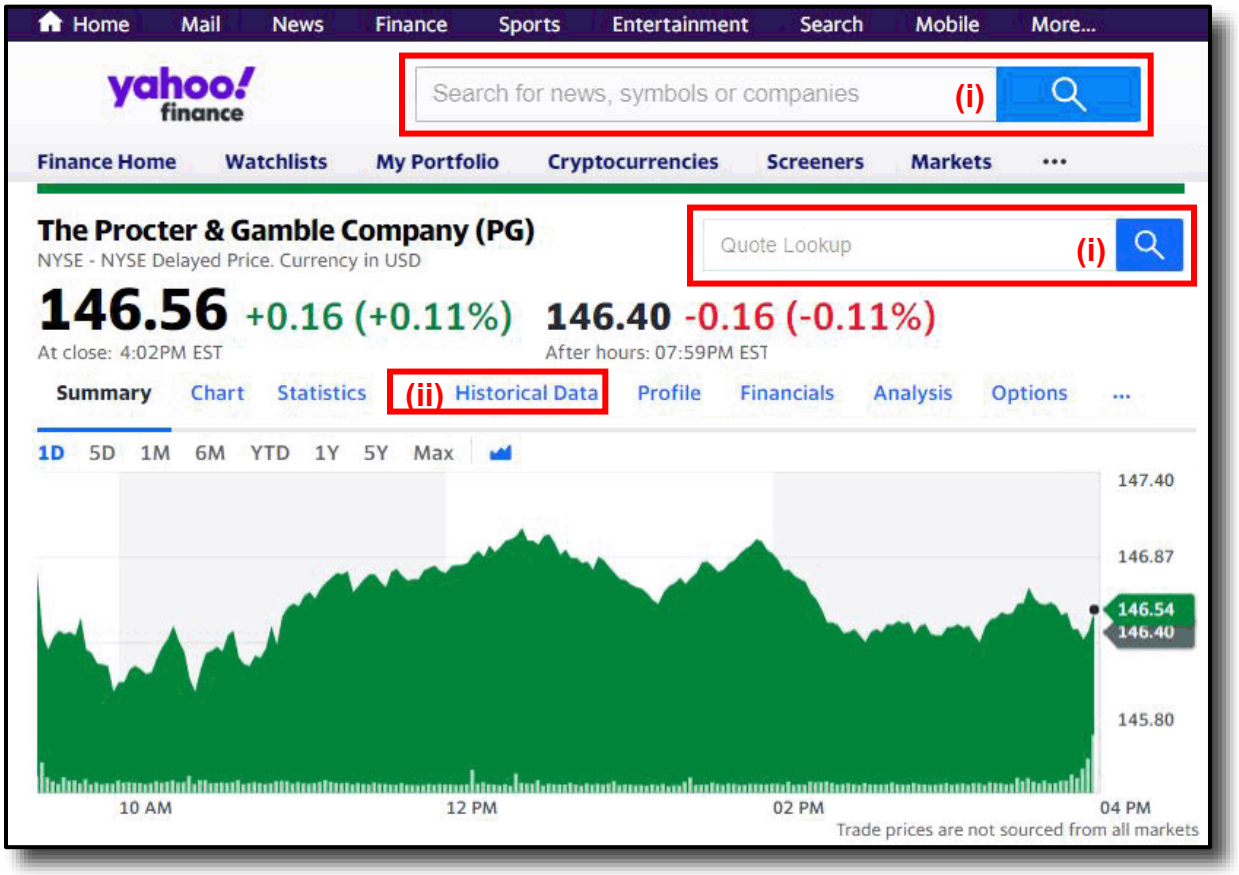
b) Typical place to **download stock price data** from is **Yahoo! Finance**, *www.finance.yahoo.com*. If you have other more convenient/familiar sources to download from, that is also OK; all you really need is monthly historical stock prices for your chosen stocks and the required indexes.

Due to the dated nature of this assignment guidance document, the following screen shots might look a little different from the one you will be using and seeing. Please note the following:

- Irrelevant info, tabs and pop-up ads have been de-cluttered from the screen shots.
- Also, websites frequently change/refresh the appearance of their web pages from time to time to include additional web features and advertisement placements.
- In any case, they are similar enough to what you will be actually seeing.

(i) At the top or top-right home page, in the ***Quote Lookup*** search box, enter your selected stock's ticker symbol, for example "PG" for *Proctor and Gamble*. Or type in the full name of the company.

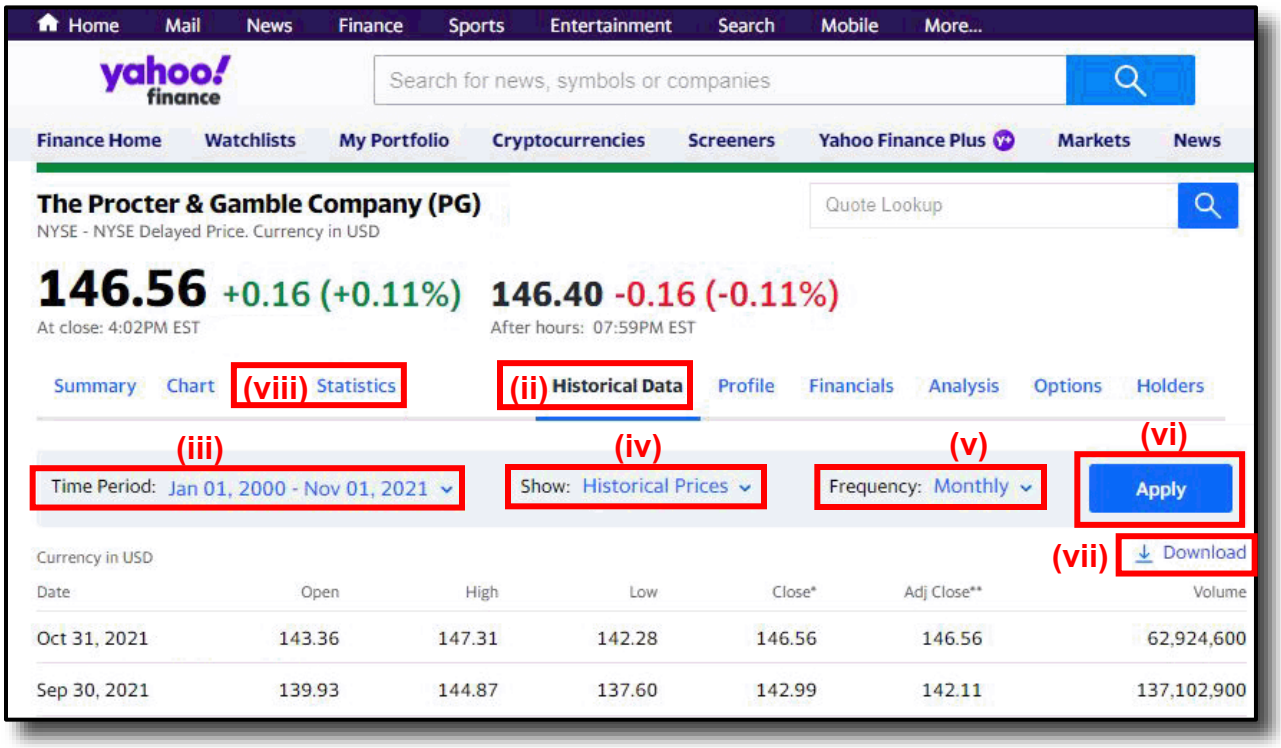
(ii) Click on the **Historical Data** tab.



(iii) In the **Time Period** box, use the ˅ pull-down list to specify date range, for example 01/02/2000 to *current month/02/current year*.

(iv) In the **Show** box, use the ˅ pull-down list to select the **Historical Prices** item.

(v) In the **Frequency** box, use the ˅ pull-down list to select the **Monthly** item.



(vi) Then click the **Apply** button to retrieve the monthly data according to the earlier settings. Below it you will see stock price data for the remaining part of your browser's scrolling screen.

(vii) Finally click the **Download** to download the stock's monthly price data. Please note the following:

- The data will be downloaded onto your system in *"CVS tab delimited"* format. You should be able to open it using Excel …
- … note that the data is NOT necessarily arrange in any date order.
- IMPORTANT: make sure you sort the data in **chronological order** (from oldest to most recent date. PS: you do this by highlighting all the rows and columns of data and then using Excel's *Data > Sort > Sort by > Date* to sort them in chronological order.
- Then copy-and-paste only the ***Date*** and ***Adj Close*** columns to your assignment template file. PS: ignore the other columns of trading data not required in this assignment -- *Open, High, Low, Close, Volume*.
- Note also there is a difference between the *Close* price of the stock and the *Adj(usted) Close* price of the stock:
  - The ***Closing Price*** is the actual price of the stock at the end of the trading day.
  - The ***Adjusted Closing Price*** is the retroactively adjusted prices of the stock for any dividend payout or stock split for that date. For example, if there is a 1 share becomes 2 shares stock split today, then ALL historical prices prior to today will be *"adjusted by dividing by 2 to provide continuity in returns before and after the stock split"*. **Your assignment should use this Adj Close stock prices** -- since it accounts for dividend payouts and stock splits, it simplifies the calculation of periodic rates of returns of your chosen stocks in this assignment.
- **Warning: some stocks and indexes** (especially Dow30 and S&P500) **DO NOT have the Download (data) link**. If this is the case:

- Open an temporary Excel file and/or create a temporary worksheet.
- After clicking the Apply button, go to the webpage to directly highlight ALL the data rows from Date to Adj Close and copy/paste them to the worksheet.
- Then follow the above *"sort data in **chronological order** and copy-paste only **Date** and **Adj Close** columns"* instructions only your assignment Excel file.

c) Perform **download stock price data** using instructions from above step (b) for **your chosen stocks from Step #1**.

d) **In addition**, you will also need the columns of data for ***"mystery stock X?"***, **S&P500** [your portfolio benchmark] and **Dow30** [another popular narrower stock index]. PS: the latter are typically notated as ^SP500 and ^Dow30 with a ^ "hat sign" because they are stock indexes.

- In Yahoo! Finance website, the market index **search notation** for the Dow30 index is **^DJI**, and S&P500 is **^GSPC**.
- In this assignment documentation, it is conveniently notated with the alternate, more **recognizable ^Dow30** and **^SP500** respectively with a ^ "hat sign" because they are stock indexes.
- PS: **S&P500** is the broader U.S. stock market index -- in Investments, it is a "proxy", a representative or approximate, of the entire U.S. stock market -- it uses 505 of the biggest U.S. companies to proxy the entire U.S. stock market which is made up of thousands of stocks. It is often used as a performance benchmark against an investor's portfolio of investments.
- PS: **Dow30** is another popular but much narrower (30-stock) stock market index.

e) Thus, you will have the following columns of stock prices. For example, the following is a layout of the **monthly** historical prices (beginning of month):

		Monthly Stock Prices Adjusted Close ($)					
Period	**Date**	**^SP500**	**^Dow30**	**WhatsX?**	**A**	**B**	**C**
0	01/01/2000	1,394.46	10,940.53	3.74	22.20	12.02	25.99
1	02/01/2000	1,366.42	10,128.31	3.79	20.39	12.43	22.66
2	03/01/2000	1,498.58	10,921.92	3.84	22.58	13.86	14.64
3	04/01/2000	1,452.43	10,733.91	3.82	25.24	12.94	15.41
:	:	:	:	:	:	:	:
:	:	:	:	:	:	:	:
n	*current month*	5,657.79	41,252.35	9.60	303.01	149.25	164.98

PS: Above data may be different from your assignment data because of actual date you will be doing your assignment. It also depends on your choice of stocks used in your assignment. Your last dated data point will be *current month*/01/*current year* in *Period n*.

f) For **convenience in grading**, please **strictly observe** use the following **color codes** for your **indexes** and **stocks** [ticker symbol arranged in **alphabetical order**] in the plots in your portfolio project (or you will lose grading points):

^SP500	**black**	SP500 benchmark index **^SP500**]. † see note below.
^Dow30	**gray dotted**	Dow30 benchmark index **^Dow30.**
first stock	**blue**	ticker symbol with the lowest alphabetical order, e.g. **A**
second stock	**turquoise**	ticker symbol with the second lowest alphabetical order, e.g. **B**
third stock	**pink**	ticker symbol with the third lowest alphabetical order, e.g. **C**
fourth stock	**orange**	ticker symbol with the highest alphabetical order, e.g. **D** if required in project.

† In Yahoo! Finance website, the market index **search notation** for the Dow30 index is **^DJI**, and S&P500 is **^GSPC**. In this project documentation, it is conveniently notated with the alternate, more **recognizable ^Dow30** and **^SP500** respectively.

Step #3 Baseline these stock prices as well as the S&P500 and Dow30 at Index 100 and plot them.

a) Indexes are defined and base-lined in a number of different ways. Since we will be plotting performances as a rate of return, our Baseline Index is defined as *"the HPY since beginning of observation (baseline) date 1/1/2000"*.
   - Define the first stock price at the beginning of the observation date as p(0).
   - Let all subsequent monthly stock prices be p1, p2, p3, and so on. Generically, these stock prices are notated as p_t for the t^{th} monthly observation.
   - Then the respective stocks' index value at a particular time *t*, i.e. ix_t, can be calculated as:

$$ix_t = \frac{p_t}{p_0} - 1$$

b) In effect, the stock index ix_t is really the Holding Period Yield HPY_t for successively longer and longer holding periods (*t* months) since the beginning of the observation date.

c) The following is an Excel-like numerical example of calculating Index values for S&P500:

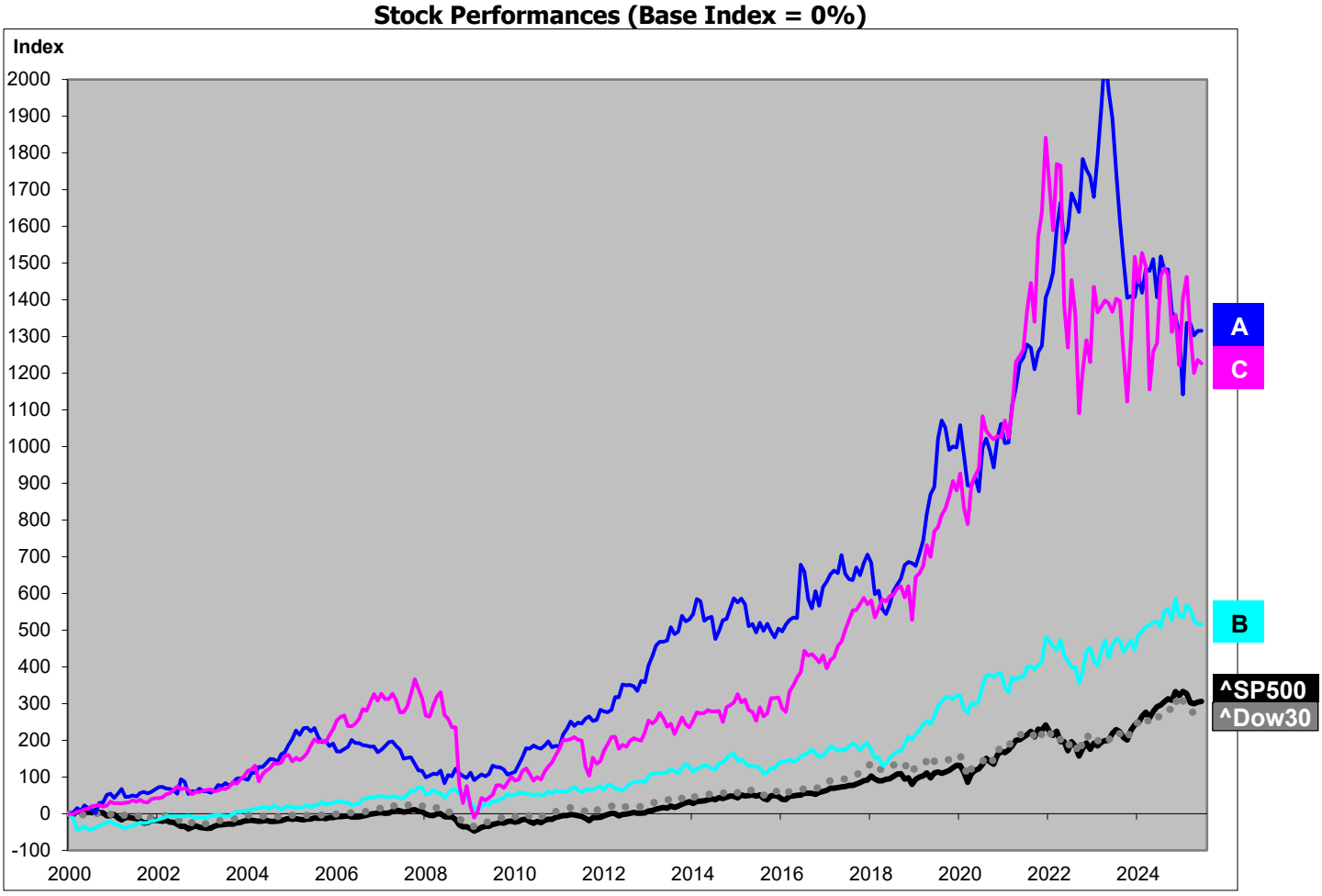
Column:	A	B	C	D	E
Row	Period t	Observed Date	**Adj Close ^SP500**	**Calculated Index**	Comments & instructions
1	0	01/01/2000	1,394.46	**0.00%**	Cell C1: this is p(0), the base value. Cell D1: the Index starts at 0.00% at the beginning of observation period.
2	1	02/01/2000	1,366.42	**-2.01%**	Cell D2: Index = (C2/C1)-1 = -2.01%.
3	2	03/01/2000	1,498.58	**7.47%**	Cell D3: Index = (C3/C1)-1 = 7.47%.
	:	:	:	:	For each period t, we take its stock price p(t) and always divide by p(0), the base value, not the previous observation's stock price. i.e. we are not calulating the change in in stock prices from one period to the next but the change from current period p(t) from the base value p(0).
	n-1	*prev month*	5,631.79	:	Tips: A convenient way to calculate each Index value is to use (Cn/C1) - 1, where Cn is the cell of the current row, and C1 is a way to lock on to the p(0) base value cell.
	n	*current month*	5,657.79	**305.73%**	The final period.

PS: Above data may be different from your assignment data because of actual date you will be doing your assignment. Your last dated data point will be *current month*/01/*current year* in *Period n*.

d) Repeat the above Index value calculations for ^Dow30 and your selected stocks.

e) Then plot all you calculated Indexes on the same chart. The following is an example:
PS: for **convenience in grading**, please **strictly observe** use the following **color codes** for your indexes and **stocks** [ticker symbol arranged in **alphabetical order**] in the plots in your portfolio project (or you will lose grading points):

^SP500	**black**	SP500 benchmark index **^SP500**]. † see note below.
^Dow30	**gray dotted**	Dow30 benchmark index **^Dow30.**
first stock	**blue**	ticker symbol with the lowest alphabetical order, e.g. **A**
second stock	**turquoise**	ticker symbol with the second lowest alphabetical order, e.g. **B**
third stock	**pink**	ticker symbol with the third lowest alphabetical order, e.g. **C**
fourth stock	**orange**	ticker symbol with the highest alphabetical order, e.g. **D** if required in project.



f) How to read this Index chart:

- The index starts at 0% (since 1/1/2000).
- Stocks are priced individually in **absolute** dollar terms. By base-lining it from 0%, this allows us to plot stock performances **relative** to each other from a **common starting point** (baseline) and also against the ^SP500 and ^Dow30, which are our benchmarks.
- Upward trend indicates the stock price increase.
- An index of 145 at time t, for example, indicates that the stock has increased by 145% from its original value since the beginning of the observed period, i.e. HPY_t = 145%.

Step #4 Compute your stocks' monthly HPYs, then their risk-return characteristics, and ρ among them.

PS: **Monthly HPY** (holding period yield) is the portfolio technical term for **monthly rate of return** of an investment, in this case, stocks and indexes.

For each of the stocks as well as the benchmarks ^SP500 and ^Dow30 and *mystery stock X*, do the following:

a) **Calculate the monthly Holding Period Yields (HPY)**.

- Let all historical monthly stock prices be p0, p1, p2, p3, and so on. Generically these stock prices are notated as p_t for the t[th] monthly observation.
- Then the respective stock's HPY during period (month) *t*, i.e. HPY_t, can be calculate as:

$$HPY_t = \frac{p_t}{p_{t-1}} - 1$$

where *t* is a specific period (month) and *t-1* is its previous period.

- The following is an Excel-like numerical example of this process for ^SP500's HPYs:

Column:		A	B	C	D	E
		Period t	Observed Date	**Adj Close ^SP500**	**Calculated HPY**	Comments & instructions
Row	1	0	01/01/2000	1,394.46	**-**	Cell C1: this is the p(0) at beginning of holding period. Cell D1: start of holding period, no HPY yet.
	2	1	02/01/2000	1,366.42	**-2.01%**	Cell D2: HPY1 = (C2/C1) - 1 = -2.01%. This is the HPY during period 1.
	3	2	03/01/2000	1,498.58	**9.67%**	Cell D3: HPY2 = (C3/C2) - 1 = 9.67%. This is the HPY during period 2.
		:	:	:	:	For each period t, we are just calculating the HPY_t of this period, i.e. the percentage change from p_{t-1} to p_t.
		n-1	*prev month*	5,631.79	:	Once you have set up the Excel formula to calculate the periodic HPY in cell D2, just drag this cell all the way down to the last period to calculate the rest of the periodic HPYs.
		n	*CM/01/CY*	5,657.79	**0.46%**	The final period.

PS: Above data may be different from your assignment data because of actual date you will be doing your assignment. Your last dated data point will be *current month*/01/*current year* in *Period n*. ***CM*** and ***CY*** denotes current year and current month.

b) From each stocks as well as the ^SP500's, ^Dow30's, *Mystery Stock X* monthly HPYs in (a), **calculate the average from all its monthly HPYs**. The relevant Excel formula for doing this is "AVERAGE". You can use Excel's Help pull-down menu, go into the Microsoft Excel Help and then search for "AVERAGE" to learn more about how to use this function.

c) From each stocks as well as the ^SP500's, ^Dow30's, *Mystery Stock X* monthly HPYs in (a), **calculate the sample standard deviation of its monthly HPYs**. The relevant Excel for doing this is "STDEV".

d) From each stocks as well as the ^SP500's, ^Dow30's, *Mystery Stock X* monthly HPYs in (a), **calculate the coefficient of correlation of each pair of monthly HPYs**. The relevant Excel for doing this is "CORREL".

e) From each stock as well as the ^SP500's, ^Dow30's, *Mystery Stock X* monthly HPYs in (a), **calculate the covariance of each pair of monthly HPYs**. The relevant Excel for doing this is "COVAR".

f) Then summarize all of the **monthly** statistics in a 2-by-2 table, such as the following:

PS: Data below may be different from your assignment data because of actual date you will be doing your assignment. It also depends on your choice of stocks used in your assignment. Your last dated data point will be *current_month*/01/*current_year* in *Period n*.

monthly		Monthly HPYs (%)					
Period	Date	^SP500	^Dow30	WhatsX?	A	B	C
0	01/01/2000	-	-	-	-	-	-
1	02/01/2000	-2.01%	-7.42%	1.20%	3.38%	-12.81%	-1.22%
2	03/01/2000	9.67%	7.84%	1.39%	11.57%	-35.42%	6.50%
3	04/01/2000	-3.08%	-1.72%	-0.48%	-6.67%	5.29%	2.62%
:	:	:	:	:	:	:	:
:	:	:	:	:	:	:	:
n	*current month*	0.46%	0.34%	0.10%	-0.01%	-0.19%	-0.71%
Avg Mthly HPYs		0.56%	0.53%	0.32%	1.03%	0.73%	1.21%
Stdev Mthly HPYs		4.39%	4.29%	1.23%	5.77%	5.08%	8.18%

Covar	^SP500	^Dow30	WhatsX?	A	B	C	Correl
^SP500		0.94921	0.11841	0.10203	0.26497	0.61747	^SP500
^Dow30	0.00178		0.07703	0.14922	0.33693	0.57045	^Dow30
WhatsX?	0.00006	0.00004		0.07629	0.10553	0.30167	WhatsX?
A	0.00026	0.00037	0.00005		0.21615	0.15504	A
B	0.00059	0.00073	0.00007	0.00063		0.24026	B
C	0.00221	0.00199	0.00030	0.00073	0.00100		

- Cells highlighted in green are the **Coefficient of Correlation (ρ)** statistics between each pair of stocks/indexes.
- Cells highlighted in light purple are the **Covariance** statistics between each pair of stocks/indexes.
- PS: the relationship between Coefficient of Correlation and Covariance of two stocks A and B is: **$Covar(A,B) = \sigma_A \times \sigma_B \times \rho_{AB}$** …
- … the use of Covariance values will come in handy for calculating portfolio standard deviation in the next steps.

Step #5 Download your stocks' annual stock prices and benchmark data.

*<this sounds like Step #2; now you are doing it **annually**>*

a) From Step #2, you have already downloaded the monthly stock prices. So, extract the **beginning of the year** stock prices from it, e.g. 01/01/2000, 01/01/2001, 01/01/2002, etc. thru January of the *current_year*.

b) If the *current_month* is NOT January, add *current_month*/01/*current_year* as your **last data "annual" point**. Why?

i) **Treat the current partial year as a full (period) year of data** so that at least we get to calculate the risk-return characteristics of the stocks and indexes **up till the month you do the assignment**.

ii) So, if the assignment is done in the *Fall*, we are about *10 months into the current year*; that is close enough to an entire year.

iii) PS: even if it the assignment is done in *Spring or Summer1*, at the beginning of a calendar year, *only a few months* into the current year (e.g. February or May), it may be worth including this as the *last "annual" data point* -- for example, during "extreme" stock market price movements, the few months that transpired during the current year do "feel like an entire year". This was so during the *COVID months and that year)*.

iv) Thus, your **last two annual data points** should be *period n-1* which corresponds to first day of the current year [CY], generically denoted as *01/01/CY*, and *period n* which corresponds to the first day of the current month [CM], generically denoted as *CM/01/CY*. Note: ***PY*** is denoted **previous year**.

c) Also extract the corresponding annual index data for the ^SP500, ^Dow30, and *Mystery Stock X?*. These will be your portfolio benchmarks.

d) For example, the following is a layout of the annual historical prices:

annual		Annual Stock Prices Adjusted Close ($)					
Period	Date	^SP500	^Dow30	WhatsX?	A	B	C
0	01/01/2000	1,394.46	10,940.53	3.71	11.92	25.83	7.86
1	01/01/2001	1,366.01	10,887.36	4.21	17.05	18.70	10.10
2	01/01/2002	1,130.20	9,920.00	4.53	20.54	21.73	11.18
3	01/01/2003	855.70	8,053.81	4.87	19.17	23.37	12.78
4	01/01/2004	1,131.13	10,488.07	5.11	22.91	28.15	17.08
5	01/01/2005	1,181.27	10,489.94	5.32	36.15	30.21	19.05
6	01/01/2006	1,280.08	10,864.86	5.40	32.13	34.28	27.82
7	01/01/2007	1,438.24	12,621.69	5.64	32.66	38.34	33.54
8	01/01/2008	1,378.55	12,650.36	6.14	23.71	39.48	28.85
9	01/01/2009	825.88	8,000.86	6.30	25.26	33.67	9.49
10	01/01/2010	1,073.87	10,067.33	6.83	25.50	39.22	14.97
11	01/01/2011	1,286.12	11,891.93	7.16	33.64	41.47	21.81
12	01/01/2012	1,312.41	12,632.91	7.77	45.13	42.75	21.40
13	01/01/2013	1,498.11	13,860.58	7.96	60.06	52.69	27.83
14	01/01/2014	1,782.59	15,698.85	7.95	76.67	55.39	27.84
15	01/01/2015	1,994.99	17,164.95	8.48	80.51	62.86	33.49
16	01/01/2016	1,940.24	16,466.30	8.43	71.09	62.91	30.41
17	01/01/2017	2,278.87	19,864.09	8.54	87.22	69.68	38.97
18	01/01/2018	2,823.81	26,149.39	8.72	93.39	70.82	53.53
19	01/01/2019	2,704.10	24,999.67	8.89	92.34	81.92	58.57
:	:	:	:	:	:	:	:
:	:	:	:	:	:	:	:
n-1	***01/01/PY***	6,040.53	44,544.66	9.42	147.98	163.96	118.20
n	***CM/01/CY***	5,657.79	41,252.35	9.60	168.66	158.98	104.29

PS: Above data may be different from your assignment data because of actual date you will be doing your assignment. It also depends on your choice of stocks used in your assignment.

Step #6 Compute your stocks' annual HPYs, then their risk-return characteristics, and the ρ among them .

As in Step #3, for each of the stocks as well as the benchmarks ^SP500, ^Dow30 and *Mystery Stock X?*, calculate:

a) Calculate the annual Holding Period Yields (HPY).
b) Calculate the average of its annual HPYs.
c) Calculate the standard deviation of its annual HPYs.
d) Calculate the coefficient of correlation of each pair of stocks and benchmarks.
e) Calculate the covariance of each pair of stocks.
f) Then summarize all of the **annual** statistics in a 2-by-2 table, such as the following:

annual			Annual HPYs (%)					
Period	Date	Year	^SP500	^Dow30	WhatsX?	A	B	C
0	01/01/2000	-	-	-	-	-	-	-
1	01/01/2001	2000	-2.04%	-0.49%	13.62%	43.07%	-27.61%	28.51%
2	01/01/2002	2001	-17.26%	-8.89%	7.41%	20.48%	16.20%	10.63%
3	01/01/2003	2002	-24.29%	-18.81%	7.70%	-6.66%	7.55%	14.35%
4	01/01/2004	2003	32.19%	30.22%	4.81%	19.51%	20.42%	33.64%
5	01/01/2005	2004	4.43%	0.02%	4.07%	57.75%	7.31%	11.52%
6	01/01/2006	2005	8.36%	3.57%	1.62%	-11.10%	13.50%	46.05%
7	01/01/2007	2006	12.36%	16.17%	4.30%	1.62%	11.83%	20.56%
8	01/01/2008	2007	-4.15%	0.23%	8.98%	-27.39%	2.97%	-13.98%
9	01/01/2009	2008	-40.09%	-36.75%	2.54%	6.54%	-14.72%	-67.10%
10	01/01/2010	2009	30.03%	25.83%	8.45%	0.96%	16.51%	57.72%
11	01/01/2011	2010	19.76%	18.12%	4.80%	31.88%	5.72%	45.73%
12	01/01/2012	2011	2.04%	6.23%	8.48%	34.16%	3.10%	-1.90%
13	01/01/2013	2012	14.15%	9.72%	2.48%	33.10%	23.25%	30.02%
14	01/01/2014	2013	18.99%	13.26%	-0.05%	27.66%	5.12%	0.05%
15	01/01/2015	2014	11.92%	9.34%	6.59%	5.01%	13.48%	20.28%
16	01/01/2016	2015	-2.74%	-4.07%	-0.58%	-11.71%	0.09%	-9.19%
17	01/01/2017	2016	17.45%	20.63%	1.36%	22.69%	10.76%	28.15%
18	01/01/2018	2017	23.91%	31.64%	2.03%	7.07%	1.64%	37.36%
:	:	:	:	:	:	:	:	:
:	:	:	:	:	:	:	:	:
n-1	***01/01/CY***	***PY***	18.86%	11.92%	-0.34%	11.32%	-12.11%	13.17%
n	***CM/01/CY***	***CY***	2.33%	1.32%	-0.41%	1.23%	2.13%	1.24%

Avg Annual HPYs	**6.73%**	**6.33%**	**3.71%**	11.22%	13.72%	8.19%
Stdev Annual HPYs	**17.18%**	**15.11%**	**4.71%**	15.45%	21.75%	12.94%

Covar	^SP500	^Dow30	WhatsX?	A	B	C	Correl
^SP500		0.96	-0.03	0.71	0.20	0.52	^SP500
^Dow30	0.023947		-0.01	0.71	0.19	0.46	^Dow30
WhatsX?	-0.000212	-0.000084		-0.07	0.14	-0.03	WhatsX?
A	0.018031	0.015934	-0.000523		0.47	0.16	A
B	0.007178	0.005858	0.001335	0.015190		0.10	B
C	0.011077	0.008548	-0.000180	0.002977	0.002790		

PS: Above data may be different from your assignment data because of actual date you will be doing your assignment. It also depends on your choice of stocks used in your assignment.

g) PS: In Steps #3 and #5, why do stocks and indexes risk-return statistics in monthly AND then in annual HPYs?

i. Since one year is an extremely long period, there may be a LOT of price and index movement during a year (remember the COVID-19 years?). With **monthly data**, we get **more data points** and tighter in-between periodic data to get better coefficient of correlation ρ as well as Beta β measurements.

ii. With **annual data**, a stock's or an index's risk-return statistics are typically reported on an annual basis. Also, we will need its **annual** (not monthly) statistics to calculate the portfolio's risk-return values and build the Minimum Variance Frontiers MVFs and Efficient Frontier EF in the following steps.

End of Phase1 … to be continued: more Steps will be released when we do more lectures …

<there are about another 28+ more pages …
… don't panic; a few steps at a time and you have to keep up with the lectures, readings, and problem sets>

Beginning of Phase 2 in subsequent pages …
*<**updated 05/09/2025 11am**; I will release later steps on a later date …>*
<for now, focus on doing the assigned steps …>
*<… you should be ready for this **Efficient Frontier (EF)**, **Capital Allocation Line (CAL)**, and **Investor Utility Curve (IUC)** stuff once you complete Module #3 lecture>*

Step #7 Compute and plot all your pairs of 2-stock Minimum Variance Frontiers MVFs.

For each of your stock pairings (e.g. stock A-B), in 5% portfolio weight intervals:

a) Calculate the weighted return of this 2-stock portfolio …

$$E(R)_{2\text{-asset}} = w_A R_A + w_B R_B$$

- where R_A and R_B is the average return of the **annual** HPYs of the stocks as calculated in Step #6,
- and w_A and w_B are the portfolio weights of the two stocks which add up to 100%.

b) … calculate its corresponding **2-stock standard deviation**

$$\sigma_{2-asset} = \sqrt{(w_A\sigma_A)^2 + (w_B\sigma_B)^2 + 2w_A w_B Cov(A,B)}$$

- where σ_A and σ_B is the standard deviation of the annual HPYs of the stocks as calculated in Step #6,
- Note that the above is a more convenient formula when using Excel since the pair of stocks' *Covariance* can be easily/directly calculated using Excel's COVAR function. In Portfolio Theory, it is equivalent to the following more recognizable but harder to calculate formula (more terms):

$$\sigma_{2-asset} = \sqrt{(w_A\sigma_A)^2 + (w_B\sigma_B)^2 + 2w_A w_B \sigma_A \sigma_B \rho_{A,B}}$$

Since they are related as

$$Cov(A,B) = \sigma_A \sigma_B \rho_{A,B}$$

Thus, each pair of calculation from above Step (a) and (b) represents a "single dot" of Risk-Return data for a 2-asset portfolio with a specific Asset Allocation weight (what % of investment in A, what % in B) combination.

c) From Steps (a) and (b), you thus calculate the Risk-Return of the 2-stock pair (e.g. A-B) in 5% Asset Allocation weight intervals 0%-100%, 5%-95%, 10%-90%, 15%-85%, ... , 90%-10%, 95%-5%, 100%-0%. This collection of "dots" will allow you to derive graphically the **Minimum Variance Frontier MVF** of this 2-stock pair.

d) Then repeat Steps (a), (b), and (c) for the other 2-stock pairs A-C, B-C.

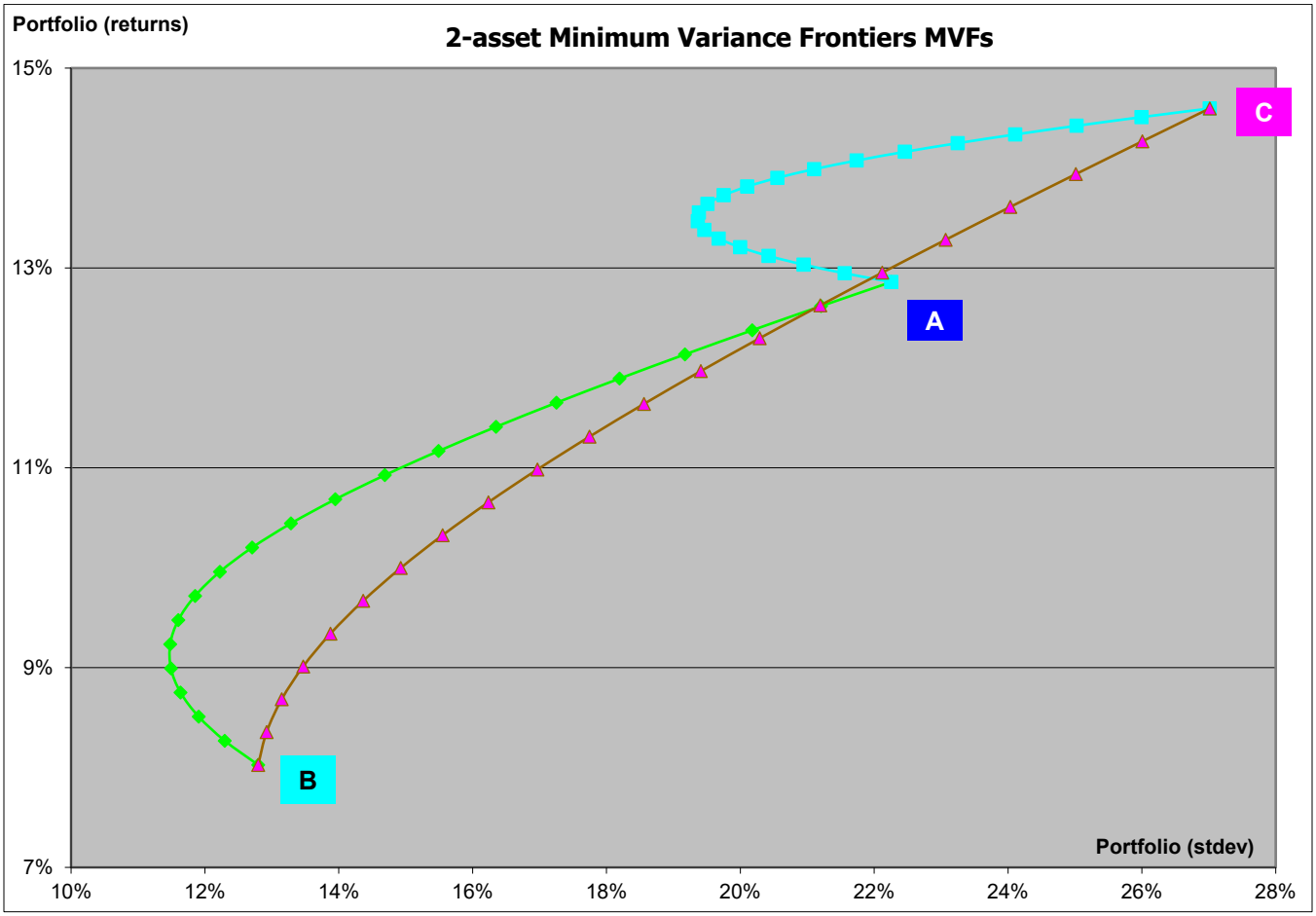
e) Finally. Plot all these **2-asset Minimum Various Frontiers MVFs** on a single graph. And make sure you label the stocks at the end-points of these MVFs.

f) For example, the following is a sample of the Risk-Return calculations of the 2-asset portfolios and their respective plots of the Minimum Variance Frontiers:

2-asset wghts		A-B Risk-Return		A-C Risk-Return		B-C Risk-Return	
w1	w2	E(σ)	E(R)	E(σ)	E(R)	E(σ)	E(R)
0%	100%	12.79%	8.03%	27.01%	14.60%	27.01%	14.60%
5%	95%	12.30%	8.27%	26.00%	14.51%	26.01%	14.27%
10%	90%	11.91%	8.51%	25.02%	14.42%	25.01%	13.94%
15%	85%	11.64%	8.75%	24.11%	14.34%	24.03%	13.61%
20%	80%	11.49%	8.99%	23.25%	14.25%	23.07%	13.28%
25%	75%	11.48%	9.23%	22.46%	14.16%	22.12%	12.95%
30%	70%	11.60%	9.48%	21.74%	14.07%	21.19%	12.62%
35%	65%	11.85%	9.72%	21.10%	13.99%	20.29%	12.30%
40%	60%	12.22%	9.96%	20.55%	13.90%	19.41%	11.97%
45%	55%	12.70%	10.20%	20.10%	13.81%	18.56%	11.64%
50%	50%	13.28%	10.44%	19.75%	13.73%	17.75%	11.31%
55%	45%	13.95%	10.68%	19.51%	13.64%	16.97%	10.98%
60%	40%	14.69%	10.93%	19.38%	13.55%	16.23%	10.65%
65%	35%	15.49%	11.17%	19.37%	13.47%	15.55%	10.33%
70%	30%	16.35%	11.41%	19.46%	13.38%	14.93%	10.00%
75%	25%	17.25%	11.65%	19.68%	13.29%	14.36%	9.67%
80%	20%	18.19%	11.89%	20.00%	13.21%	13.88%	9.34%
85%	15%	19.17%	12.13%	20.42%	13.12%	13.47%	9.01%
90%	10%	20.18%	12.38%	20.95%	13.03%	13.15%	8.68%
95%	5%	21.21%	12.62%	21.56%	12.95%	12.92%	8.35%
100%	0%	22.26%	12.86%	22.26%	12.86%	12.79%	8.03%

PS: Above data will probably be different from your assignment's Risk-Return calculations because of actual date you will be doing your assignment. And it certainly depends on your choice of stocks used in your portfolio construction.

Consequently the **shapes of the MVFs** is dependent of the Risk-Return characteristics of each of your chosen stocks in your portfolio, i.e. the "dot position" of each of your stocks, A, B, C, etc.



g) Comments on relative location of the stocks and shapes of Minimum Variance Frontiers:

- The shapes of your 2-asset Minimum Variance Frontiers will vary depending on the relative location of your chosen stocks -- in general, stocks' Risk-Return "dot location" should "typically" cluster in the "**northeastern corridor**" …
- … this "natural" location is based on the adage, "**taking on higher risks requires a higher (expected) return**", i.e. stocks with lower standard deviation "typically" have lower expected returns while stocks with higher standard deviation typically have higher expected returns.
- BUT this **adage is NOT always true** -- **in the real world** financial markets,
  i) There are **no absolute law that binds the returns to its risk**,
  ii) All investors are **risk-averse** -- they expect higher returns to compensate them for taking on higher expected risk → the **key word is expect** → whether a riskier investment can deliver correspondingly higher **actual** returns is another matter.
  iii) So, investors need to make a **distinction** between expected and actual.
- For example, there are exceptional companies that out-perform the overall market …
  i) … there are also "weaker" companies that under-perform below the market's expectations.
  ii) And then there are good companies with higher returns but lower standard deviation, i.e. lower variability in HPYs, than not-so-good companies.
- As seen in the above graph, all the chosen stocks are "normally priced" as aligned in the "northeastern corridor"
  i) Among the chosen stocks, stock C has the least amount of returns and least amount of risk (stdev) …
  ii) … while stock D has the most amount of returns and most amount of risk.
  iii) Which of the chosen stocks is best? ➔ how does the **Coefficient of Variation** of each of the stock compares?

Step #8 Compute and plot your portolfio's Minimum Variance Frontier MVF.

For the stocks (e.g. stock A-B-C), in 5% portfolio weight intervals:

a) Calculate the weighted return of your portfolio …

$$E(R)_{portpolio} = w_A R_A + w_B R_B + w_C R_C$$

where R_A, R_B, R_C are the average returns of the **annual** HPYs of the stocks as calculated in previous step, and w_A, w_B, w_C are the portfolio weights of your stocks that add up to 100%.

b) … and calculate its corresponding **portfolio standard deviation**

$$\sigma_{3-asset} = \sqrt{(w_A \sigma_A)^2 + (w_B \sigma_B)^2 + (w_C \sigma_C)^2 + 2w_A w_B Cov(A,B) + 2w_A w_C Cov(A,C) + 2w_B w_C Cov(B,C)}$$

where σ_A, σ_B, σ_C are the standard deviations of the annual HPYs of the respective stocks as calculated in previous step,

and Cov(x,y) is the covariance between each pair of stocks as calculated in previous step.

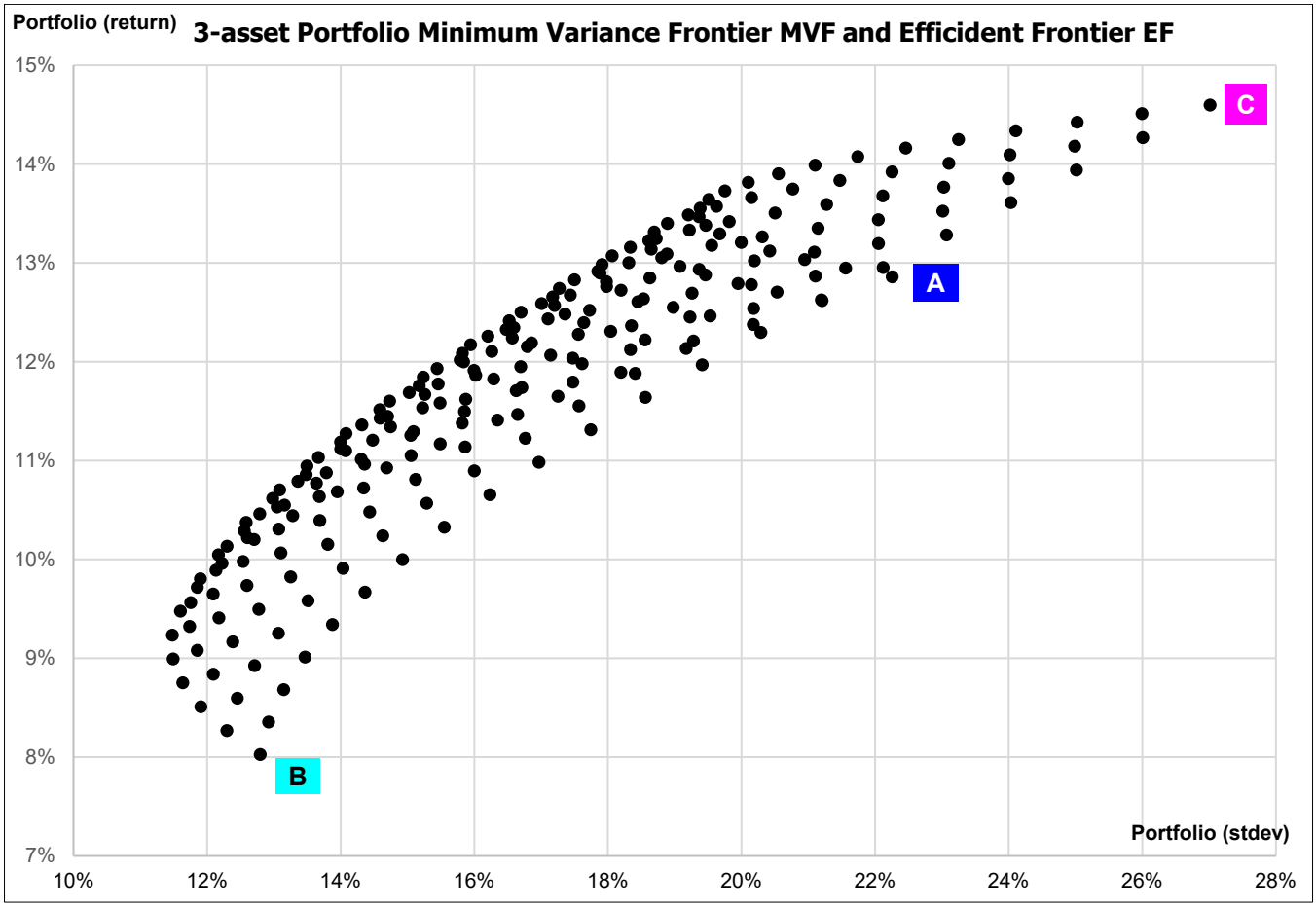
Thus, each pair of calculation from above Step (a) and (b) represents a "single dot" of Risk-Return data for your portfolio with a specific Asset Allocation weight combination.

c) From Steps (a) and (b), you thus calculate the Risk-Return of your portfolio (e.g. A-B-C) in 5% Asset Allocation weight intervals 0%-0%-100%, 0%-5%-95%, 0%-10%-90%, 0%-15%-85%, ... , 100%-0%-0%. This collection of "dots" will allow you to derive graphically the **Minimum Variance Frontier** of your portfolio. For example:

Asset Allocation weights			A-B-C 3-asset Risk-Return	
A	B	C	E(R)	E(stdev)
0%	0%	100%	14.60%	27.01%
0%	5%	95%	14.27%	26.01%
0%	10%	90%	13.94%	25.01%
0%	15%	85%	13.61%	24.03%
0%	20%	80%	13.28%	23.07%
0%	25%	75%	12.95%	22.12%
0%	30%	70%	12.62%	21.19%
0%	35%	65%	12.30%	20.29%
0%	40%	60%	11.97%	19.41%
:	:	:	:	:
:	:	:	:	:
85%	15%	0%	12.13%	19.17%
90%	0%	10%	13.03%	20.95%
90%	5%	5%	12.70%	20.53%
90%	10%	0%	12.38%	20.18%
95%	0%	5%	12.95%	21.56%
95%	5%	0%	12.62%	21.21%
100%	0%	0%	12.86%	22.26%

PS: the above **AA weights are given as a worksheet** in your instructor-given personalized "starter template and data" Excel file. To save time, you may use those rows of AA weights to calculate the corresponding Risk-Return of each of these "portfolio dots". PS: if they are not there, it is just as simple to type out the AA weights.

d) Finally, scatter-plot [not line-plot] your portfolio's Minimum Variance Frontier. For example:



PS: the above plot will probably be different from that of your assignment's -- this is because the **shape of 3-asset MVF and EF** is dependent of the Risk-Return characteristics of each of your chosen stocks in your portfolio, i.e. the "dot position" of each of your stocks, A, B, C.

The sequence of dots at the **entire outer edge** ["the envelope"] is the ***Minimum Variance Frontier MVF*** of your multi-stock portfolio,

- and those outer-edge portfolio dots on the "**top half**" of the MVF which are more efficient than the "bottom half" of the MVF represent the ***Efficient Frontier EF*** of your portfolio.

Step #9 Compute and "set up" the Capital Allocation Line CAL.

The sequence of steps to "set-up", compute, and prepare to plot the CAL is a little tricky (I know of no textbook that offers the following steps):

- **The Capital Allocation Line (CAL)** is a plot of expected returns E(R) against the portfolio's expected standard deviation E(σ). This has the same set of axes as the Efficient Frontier.
- We need to compute the "dots" of the CAL to "match" the scale of the Efficient Frontier …
- … in a later step, we will super-impose this CAL onto the Efficient Frontier plot.

a) Determine the maximum value of the x-axis (portfolio stdev):

- From the previous step's calculation of your portfolio's Minimum Variance Frontier, find your **maximum portfolio standard deviation** (e.g. 27.02%).
- Add a few more % to this maximum portfolio standard deviation to make sure CAL will plot up to and a little beyond to this value, e.g. *max = 28%*.

b) Determine the number of plot points for the CAL:

- The number of plot points is actually already determined from the previous step's 3-asset Minimum Variance Frontier. In this step, we computed the 3-asset portfolio's Risk-Return "dots" in "5% Asset Allocation portfolio weight increments" from 0%-0%-100%, 0%-5%-95%, 0%-10%-90%, 0%-15%-85%, …, 95%-5%-0%, 100%-0%-0%. This should correspond to 231 unique Risk-Return "dots" with these AAs …
- … thus, the number of plot points, *#pts*, is 231.
- Reminder: your personalized "starter template and data" Excel file already has an AA worksheet with these weight (row) combinations corresponding to these plot points.
- However, we will number these plots points starting at 0 thru 230 (since the x-axis starts at 0).

c) Arbitrarily set the slope of the CAL, *"m"*, for example, *m = 0.50*:

- We need to arbitrarily set the slope *"m"* of CAL so that we can compute the CAL "dots".
- Make the value of the slope *"m"* of CAL an input cell variable in your Excel …
- … once we plot the CAL, we will visually inspect and adjust the slope of CAL accordingly and have the rest of the Excel automatically re-calculate and plot the CAL "dots".

d) Determine the current **Risk-Free Rate** (RFR):

- Use the 10-year U.S. T-Bill rate as a proxy for the risk-free rate RFR …
- … see page 2 of project document for assumed value.

e) Compute the CAL "dots":

- CAL is typically an upward-sloping straight line.
- Thus, its graphical formula is straight-forward: "$y = mx + c$"
- where m is the slope of the CAL line, as arbitrarily set as 0.50 in step (c),
- and c is the y-axis intercept, determined as **RFR** in step (d).
- From step (b), going through all the plot points from $i = 0, i = 1, i = 2, i = 3, \ldots$ through $i = 230$:

    1. We will calculate the x-values of the portfolio standard deviation in equal increments from 0% through the maximum value, *max*, as determined in step (a) using the following:

$$x\text{-}axis\text{-}value = i \times max \div \#pts\_to\_plot$$

2. We will calculate the corresponding y-values expected return E(R) using the straight line formula:

$$y\text{-}axis\ value = \text{slope} \times x\text{-}axis\text{-}value + \text{RFR}$$

where x-axis-value is each of the calculated values from [1] from *i = 0, i = 1, i= 2, …. i = 230*.

- The following is an example of the computed CAL "dots":

	inputs
max x-value	28%
#pts	231
slope	0.50
(intercept) RFR	4.08%

	CAL	
i	**y: E(R)**	**x: E(stdev)**
0	4.08%	0.00%
1	4.14%	0.12%
2	4.20%	0.24%
3	4.26%	0.36%
4	4.32%	0.48%
5	4.38%	0.61%
6	4.44%	0.73%
7	4.50%	0.85%
8	4.56%	0.97%
	:	:
	:	:
223	17.60%	27.03%
224	17.66%	27.15%
225	17.72%	27.27%
226	17.78%	27.39%
227	17.84%	27.52%
228	17.90%	27.64%
229	17.96%	27.76%
230	18.02%	27.88%

Step #10 Compute and "set up" the Investor Utility Curve IUC.

The sequence of steps to "set-up", compute, and prepare to plot the **Investor Utility Curve (IUC)** is a little tricky but similar to the way we set up the CAL in the previous step:

- The **Investor Utility Curve (IUC)** is a plot of investor expected returns E(R) against the portfolio's expected standard deviation E(σ) given the investor's level of risk aversion and expected utility in the financial markets.
- This plot has the same set of axes as the Minimum Variance Frontier.
- Conceptually, generically and graphically, it is specified by the formula $U = E(R) - 0.5A\sigma^2$.
- It is usually convex in shape and "upward curving from left to right" …
- … how "curvy" it is depends on the **Risk-Aversion Index *A***.
- … and how high or low the IUC is depends on the **Investor Utility value *U***.
- We need to compute the "dots" of the IUC to "match" the scale of the Efficient Frontier …
- … in a later step, we will super-impose this IUC along with the CAL onto your portfolio's Minimum Variance Frontier.

a) We already have the maximum value of the x-axis (portfolio stdev) from the previous CAL step (e.g. *max = 28%*)

b) We already have the number of plot points from the previous CAL step (e.g. *#pts_to_plot = 231*)
   - Again, we will number these plots points starting at 0 (since x-axis starts at 0) through 230.

c) Arbitrarily set the **Investor Utility value *U*** of the IUC, for example *U = 5.00%*
   - We need to arbitrarily set this "height" of IUC so that we can compute the IUC "dots".
   - Make the IUC value an input cell variable in your Excel …
   - … once we plot the *IUC*, we will visually inspect and raise or lower the "height" of IUC accordingly and have the rest of the Excel automatically re-calculate the IUC "dots".

d) Arbitrarily set the **Risk-Aversion Index *A*** of the IUC, for example, *A = 25*
   - We need to arbitrarily set the "curvature" of the IUC so that we can compute the IUC "dots".
   - Make the *A* value an input cell variable in your Excel …
   - … once we plot the IUC, we will visually inspect and change the curvature of the IUC accordingly and have the rest of the Excel automatically re-calculate and plot the IUC "dots".

e) Compute the IUC "dots":
   - From step (b), going through all the plot points from *i = 0, I = 1, i= 2, i = 3, …* through *i = 230*:

     1. We will calculate the *x*-values of the portfolio standard deviation in equal increments from 0% through the maximum value, *max*, as determined in step (a) using the following:

        $$x\text{-}axis\text{-}value = i \times max \div \#pts\_to\_plot$$

        In fact, we can use the same set of x-axis values as calculated in the CAL step.

     2. We will calculate the corresponding *y*-values investor expected return E(R) using the IUC formula:

        $$y\text{-}axis\text{-}value = U + 0.5 \times A \times (x\text{-}axis\text{-}value)^2$$

        where *x-axis-value* is each of the calculated values from [1] from *i = 0, i = 1, i= 2, …. i = 230*.

- The following is an example of the computed IUC "dots":

	inputs
max x-value	28%
#pts	231
Risk Aversion Index *A*	25
Utility Value *U*	5.0%

	IUC	
i	**y: E(R)**	**x: E(stdev)**
0	5.00%	0.00%
1	5.00%	0.12%
2	5.01%	0.24%
3	5.02%	0.36%
4	5.03%	0.48%
5	5.05%	0.61%
6	5.07%	0.73%
7	5.09%	0.85%
	:	:
	:	:
224	97.15%	27.15%
225	97.98%	27.27%
226	98.80%	27.39%
227	99.64%	27.52%
228	100.47%	27.64%
229	101.31%	27.76%
230	102.15%	27.88%

$$E(R) = U + 0.5A\sigma^2$$

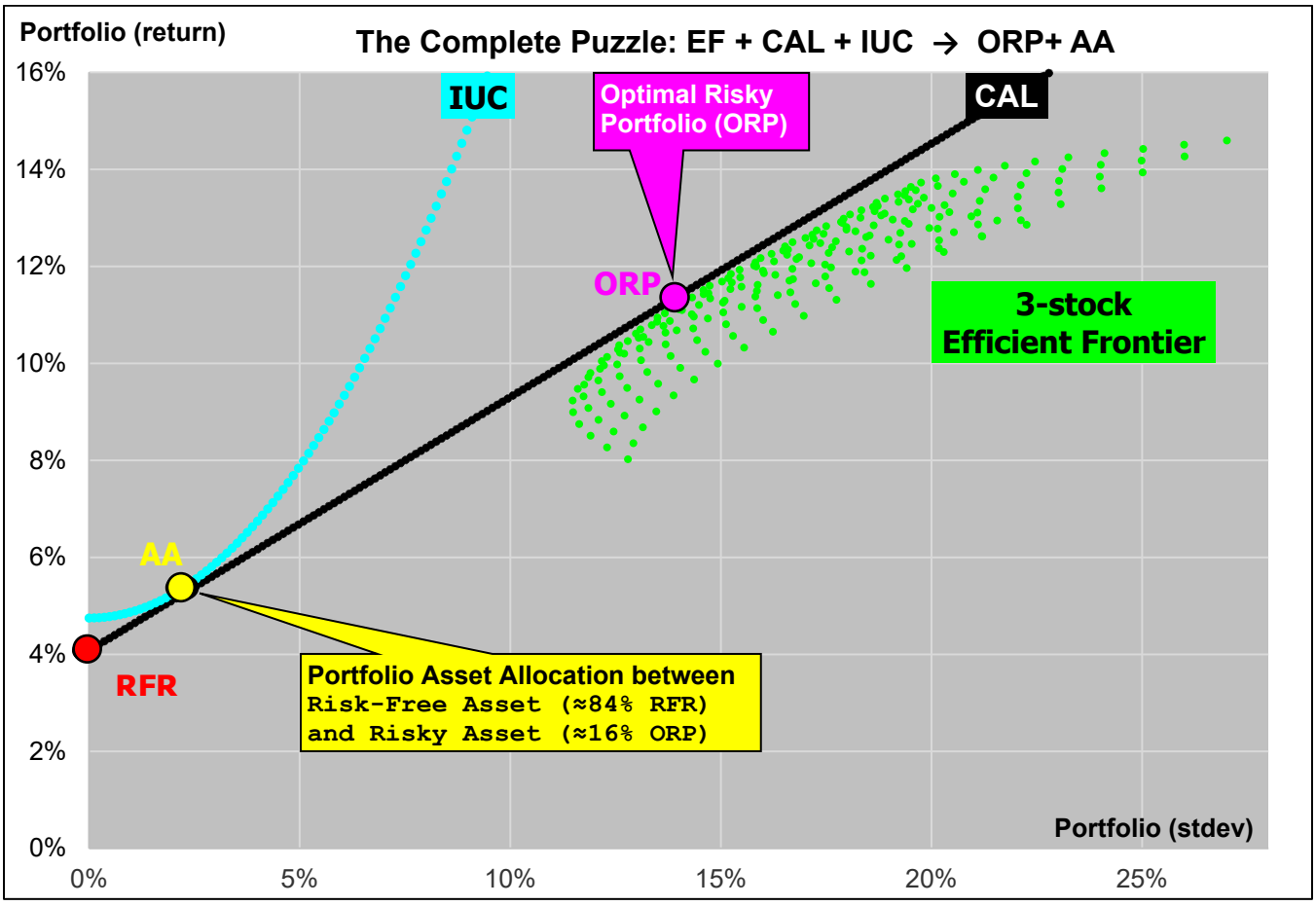
Step #11 Plot the Minimum Variance Frontier, the CAL, and the IUC on a single graph.

a) From the calculated *x*- and *y*-values from the previous three steps, plot the Minimum Variance Frontier, the Capital Allocation Line (CAL), and the Investor Utility Curve (IUC) on the same graph.

b) **Adjust the slope of the CAL** as was arbitrarily (0.5) set in Step #9 such that it is visually **tangent to the Efficient Frontier**.
- Then label this tangent point as the **Optimal Risk Portfolio (ORP)** point "***ORP***" ["pink dot" below].

c) **Adjust the IUC** as was arbitrarily (5.0%) set in Step #10 such that it is visually **tangent to the CAL**:
- (i) **Adjust the Utility Value *U*** of the IUC as arbitrarily set in Step #10 to raise or lower the IUC.
- (ii) **Adjust the Risk Aversion Index *A*** of the IUC as was arbitrarily set in Step #10 to increase or decrease the curvature of the IUC (students are free to choose an arbitrarily *A*-value).
- (iii) Then label this tangent point as the **Asset Allocation point "AA"** ["yellow dot" below] …
- (iv) … and approximate in % portfolio weights the asset allocation between Risk-Free Assets (RFR) and Risky Assets (ORP).

For example, the following is a combined plot of all elements in **Markowitz Portfolio Theory**:



(v) PS: How do we estimate the **AA** between the **%RFR** and the **%ORP** assets? Hint:
- We can do it the "low-tech" way.
- Use a ruler to measure the distance from RFR to "ORP", for example 10.0 centimeters.
- Then measure the distance from RFR to "AA", for example 1.6 centimeters.
- Since "AA" is a lot closer to RFR than to "ORP", the RFR AA-weighted influence on the overall portfolio would be larger, i.e. the %AA of RFR = 100% - (1.6 ÷ 10.0) = 84%.
- And the %ORP is the other 16%.

End of Phase2

… to be continued: more Steps will be released when we do more lectures …
<there are about another 18+ more pages …
… don't panic; a few more steps at a time>

Beginning of Phase 3 in subsequent pages …
<***updated 05/09/2025 1pm****; I will release later steps on a later date …>*
<for now, focus on doing the assigned steps …>
<… if you have the proper Corporate Finance pre-requisite, the ***Beta****,* ***SML****, and* ***DDM*** *stuff in this phase should look familiar to you.>*

Step #12 Do scatter plot, trendline, and derive the respective Beta of respective stocks.

For each of your portfolio's stock, do the following:

a) Do a **scatter plot** of each stock's monthly HPYs (on the y-axis) against the S&P500's monthly HPYs (on the x-axis). You should already have the monthly HPY data from previous Step #4.

b) Also introduce a **trendline*** on this same plot.
   - You do this from the pull-down menu Chart, and then "Add Trendline".
   - Under the tab for Options:
     - ✓ You may also check on "Display equation on chart"
     - ✓ You may also check on "Display R-squared value on chart"

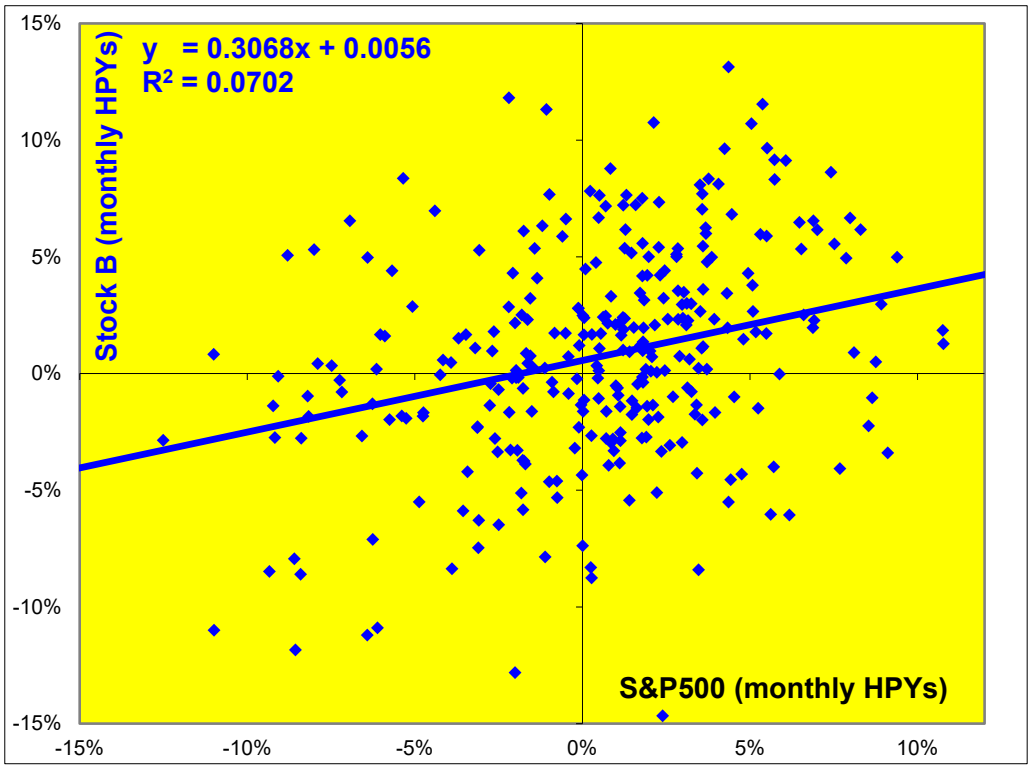
   *PS: depending on the version of your Excel, the above trendline feature might be located in a different menu; so you might need to look around for this feature.

c) Derive the following **linear regression statistics** from the above scatter plot and trendline:
   - The stock's **Beta β**, which is the slope of the trendline. You have this data in (b) if you display the equation on the graph. You can also use the Excel formula "SLOPE".
   - The **intercept** of the trendline. You have this data in (b) if you display the equation on the graph. You can also use the Excel formula "INTERCEPT" to calculate it.
   - The **R-square** of the trendline. You have this data in (b) if you display the equation on the graph. You can also use the Excel formula "RSQ" to calculate it.

For example, the following is a scatter plot and its companion linear regression trendline:

Stock B	
Beta =	0.3068
Intercept =	0.0056
R^2 =	0.0702

Date	^SP500	B
02/01/2000	-2.01%	-12.81%
03/01/2000	9.67%	-35.42%
04/01/2000	-3.08%	5.29%
05/01/2000	-2.19%	11.82%
06/01/2000	2.39%	-14.66%
07/01/2000	-1.63%	0.44%
08/01/2000	6.07%	9.13%
09/01/2000	-5.35%	8.36%
10/01/2000	-0.49%	6.62%
11/01/2000	-8.01%	5.31%
12/01/2000	0.41%	4.76%
01/01/2001	3.46%	-8.41%
02/01/2001	-9.23%	-1.39%
03/01/2001	-6.42%	-11.21%
04/01/2001	7.68%	-4.07%
05/01/2001	0.51%	7.63%
06/01/2001	-2.50%	-0.68%
07/01/2001	-1.07%	11.32%
:	:	:
:	:	:
prev month	1.13%	-1.41%
current mth	0.46%	-0.19%



← your last data point should be *current_month* /01/*current_year* .

d) Finally, prepare a summary table for the stocks as well as the ^SP500 and ^Dow30 benchmarks. Note that the average of the annual HPYs, its standard deviation, and the monthly Coefficient of Correlation data were already calculated from some of the previous steps; we are just consolidating our results and reporting them in this table:

Step #6	<*annual* risk-returns>					
Avg	7.09%	6.39%	3.82%	12.86%	8.03%	14.60%
Stdev	17.38%	15.17%	4.50%	22.26%	12.79%	27.01%

Step #4, #12	<*monthly* Betas & Correls>					
Beta	1.00	0.93	0.03	0.13	0.31	1.15
Intercept	-	0.00	0.00	0.01	0.01	0.01
R^2	-	0.90	0.01	0.01	0.07	0.38
Correl	^SP500	^Dow30	WhatsX?	A	B	C
^SP500		0.95	0.12	0.10	0.26	0.62
^Dow30			0.08	0.15	0.34	0.57
WhatsX?				0.08	0.11	0.30
A					0.22	0.16
B						0.24

PS: Above data may be different from your assignment data because of actual date you will be doing your assignment. It also depends on your choice of stocks used in your assignment and your last dated data point.

Step #13 Plot SML, each stock's Beta-Return point, and if each are over- or under-valued

a) With the derived stocks' Beta and their corresponding average of their annual HPYs, do a scatter plot the stocks' Beta-Return point.

b) Also draw the **Security Market Line SML**:
- The SML starts from the RFR at Beta = 0.00 and must pass through the Market "M".
- By definition, the Market "M" has a Beta of 1.00 and its k_M = *RFR + Market Risk Premium* RP_M.
- See page 2 of this assignment document for assumed values for **RFR** and $\mathbf{k_M}$.

The sequence of steps to "set-up", compute, and prepare to plot the SML and indicated the returns of your selected stocks relative to the SML is a little tricky. But it is done in a similar fashion to how we plot the CAL and the IUC. You need to set up two set "data series" in your plot:

(I) Plotting the SML

SML is a plot of Capital Asset Pricing Model **CAPM's** required rate of returns (y-axis) against the Beta values (x-axis). We will need to compute the "dots"; if they are close enough, it will depict the line of the SML.

c) Determine your maximum Beta for your plot:
- This value is gotten from among your stocks, the ^SP500, the ^Dow30, and the Market return (e.g. 1.10).
- Add another 10% to this maximum Beta to make sure the SML will plot up to this value, e.g. *max_Beta_in_plot = 1.21*.

d) Determine the number of plot points for the SML:
- Most Beta are no more than 2.0. So, 200 points to plot should suffice. Thus *#pts_to_plot = 200*. If after you plot the SML and it looks a little grainy, you can increase the plot points to more.
- We will number these plots points starting at 1 thru 200.
- PS: x-axis starts at 0. This point will be plotted by the other plot which includes the RFR with a Beta of 0.00.

e) Compute the slope of the SML:
- This is simply: *slope_m = (Market Return* k_M *– RFR) ÷ 1.00 = Market Risk Premium ÷ 1.00*
- PS: by definition of the SML, the Market Return k_M has a Beta of 1.0.

f) Compute the SML "dots":
- SML is typically an upward-sloping straight line.
- Thus, its graphical formula is straight-forward: "$y = mx + c$"
  - where m is the slope of the SML line as calculated in (e),
  - and c is the y-axis intercept, which has a value equal to the RFR (i.e. Beta = 0.00).
- From step (d), going through all the plot points from $i = 1, i= 2, i = 3, \ldots$ through $i = 200$:

  1. We will calculate the x-values of the each Beta value in equal increments from 0.00 through the maximum Beta value as determined in step (c) using the following:

     $$x\text{-}axis\text{-}value = i \times max\_Beta\_in\_plot \div \#pts\_to\_plot$$

  2. We will calculate the corresponding y-values expected return E(R) using the straight-line formula:

     $$y\text{-}axis\text{-}value = slope\_m \times x\text{-}axis\text{-}value + RFR$$

     where x-axis-value is each of the calculated values from [1] from $i = 1, i= 2, \ldots. i = 200$.

- The following is an example of the computed SML "dots":

	inputs	
# of plot points	200	
your max Beta	1.10	
additional Beta	10%	
RFR	4.08%	
max Beta in plot	1.21	*10% above max Beta*
computed slope	4.00%	*= (kM - RFR) / 1.0*

The SML Betas & Required Return		
i	**x: Beta**	**y: E(R)**
1	0.0061	4.10%
2	0.0121	4.13%
3	0.0182	4.15%
:	:	:
:	:	:
195	1.1798	8.80%
196	1.1858	8.82%
197	1.1919	8.85%
198	1.1979	8.87%
199	1.2040	8.90%
200	1.2100	8.92%

PS: Above data may be different from your assignment data because of actual date you will be doing your assignment. It also depends on your choice of stocks used in your assignment, your last dated data point, and your chosen stocks' calculated Betas.

(II) Plotting the Return-Beta dots of your selected stocks

g) On the same graph, plot the Return-Beta dots of your selected stocks.

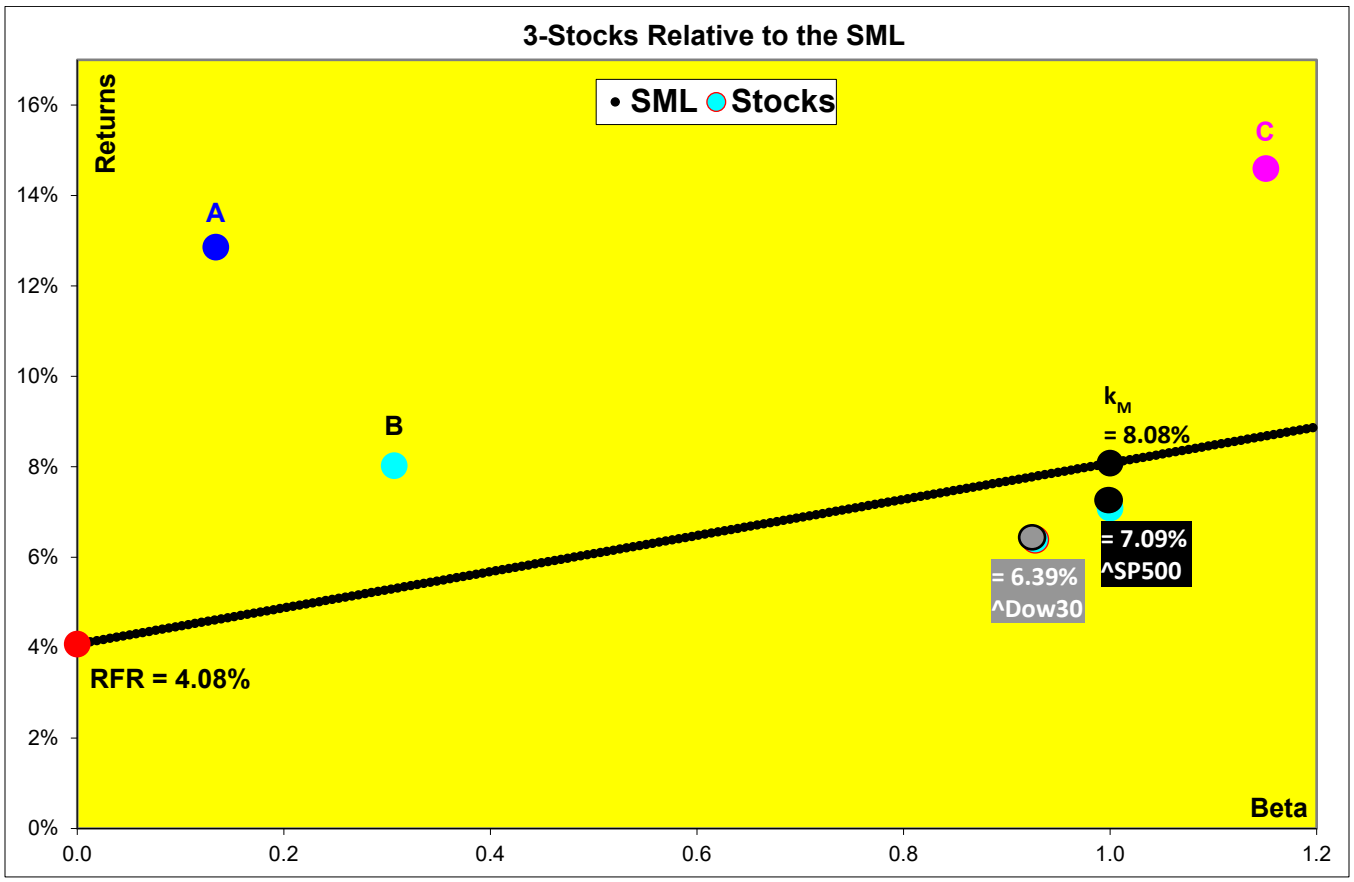
h) Also plot Return-Beta dots of ^SP500 [proxy of the Market], ^Dow30, and the RFR. For example,

Stocks and Betas		
	x: Beta	**y: E(R)**
R(A)	0.13	12.86%
R(B)	0.31	8.03%
R(C)	1.15	14.60%
^SP500	1.00	7.09%
^Dow30	0.93	6.39%
k_M	1.00	8.08%
RFR	0.00	4.08%

PS: Above data may be different from your assignment data because of actual date you will be doing your assignment. It also depends on your choice of stocks used in your assignment, your last dated data point, and your chosen stocks' calculated Betas.

For example, the following is a sample of the Return-Beta dots of the selected stocks, ^SP500 [proxy of the Market], ^Dow30, RFR, and k_M in relation to the SML:

- This is a tricky plot; make sure you go into the plot's "Source Data" and define the two "Series" X- and Y-values correctly.
- Where necessary, reduce the size of the "dots" for the SML line to make it thinner.
- Where necessary, increase the size of the Return-Beta "dots" for the selected stocks.
- Finally, use the draw tool to label the selected stocks, the ^SP500, the Market, and the RFR.



PS: Above data may be different from your assignment data because of actual date you will be doing your assignment. It also depends on your choice of stocks used in your assignment, your last dated data point, and your chosen stocks' calculated Betas.

i) **Note problem with ^SP500 as a proxy for "the market"**:

- We have used the "standard textbook **long-run average Market Risk Premium RP_M of 4.00%**".
- With the *current_month-current_year* assumed RFR of **4.08%**, then according to CAPM, the implied Required Rate of Return of the Market k_M [by definition with a Beta of 1.00] **should be 8.08%**.
- BUT the S&P500's **actual** annual average rate of return is only **7.09%** during this observed period (2000 ~ *current_year*) …
- … the question becomes **how do we reconcile any differences** between these two rates, the actual versus the theoretical CAPM-SML?

  (i) Is the **^SP500** (only 503 of the biggest stocks; small companies not represented) a valid **proxy** (approximate representation) for "the **entire market**"? This is a common practice used and assumed by many market practitioners.

  (ii) Or, is the academically "assumed **Market Risk Premium RP_M of 4.00%**", a long-run historical average, no longer valid?

  (iii) Comments: during the *"easy years of the dot-com era"* (1990~2005), the RP_M was closer to 4.00%. But during the worst of the Subprime Crisis from 2008-2012, the market suggests that that event had "pushed up" the Market Risk Premium [thereby increasing the required rate of return of the "market"] …

  (iv) … on the other hand, with the "ultra-low" level of interest rates during the 2013~2017 global slowdown and its associated "Quantitative Easing due to Financial Crisis" from a number of Central Banks, the market pendulum had swung the other way: "pushing down" the Market Risk Premium.

(v) Then, at the beginning of 2020, with the emergence of **COVID-19**, a health crisis which quickly impacted the global economy and the financial markets, **the Market Risk Premium had "immediately" been "re-priced" to a lot more than the "old long-run average 4.00%"**. From empirical analysis of the Covid-19 2020 data year, the **"appropriate" RP_M was closer to a "more fearful new" RP_M of 5.50% rather than the older 4.00%**.

(vi) And, just as quickly at the **beginning of 2021**, as fears eased with the effective management of the Covid-19 pandemic with vaccines and masks, a new U.S. government administration, more to-be-legislated U.S. economic stimulus and infrastructure spends, AND better prospects of a global economic recovery, the **Market Risk Premium RP_M** "fell back closer to the recent long run average" at **5.00%"**, **rather than the older 4.00%**.

(vii) And in **2022**, entering the third year of the Covid-19 pandemic, with a milder variant BUT significant **inflation** pressures [supply chain issues, oil shortage due to Russian sanctions] BUT balanced by the still-robust economy in the U.S., the **current RP_M is "has fallen back to the implied usual 4.00%"**.

(viii) And now, as we moved through the beginning of **2025**, our empirical data "seems to imply" that the Market Risk Premium is "a lot lower" than 4.00% -- but can that be? Because globally, many nations are facing "more" economic and market uncertainties caused by Inflation and supply chain disruptions, and now **tariff threats** from U.S. -- so, should this situation command a "larger" Market Risk Premium? Or, is it that the current SP500 is significantly mispriced and the market has yet to correct enough to bring it closer to CAPM conditions?

j) **According to Capital Asset Pricing Model CAPM**, ***"correctly priced stocks should lie ON the companion Security Market Line SML based on its Beta"***.

Identify whether each of your chosen stock's actual average of its annual HPY based on its corresponding calculated Beta is above (below) the SML. Also include ^SP500 and ^Dow30 benchmarks in your plot/analysis.

(i) If they are **NOT ON the SML**, then these stocks are **not priced correctly according to CAPM**.

(ii) If a stock's actual return is **above (below)** the SML, it would be considered **undervalued (overvalued)**.

(iii) In the above graph:

- Stocks A, B, C, and D are **"far" above the SML** and hence **significantly undervalued** relative to the SML, i.e. their actual returns outperformed the CAPM theory-suggested returns based on their Beta risk measurement.
- The ^SP500 is **sizeably overvalued** relative to the SML. Because the difference is about **0.99%**, the **^SP500 is NOT a close proxy** for the entire market at the moment.
- Similarly, ^Dow30 is also **sizeably overvalued** relative to the SML [**1.40%** difference]. For sure, the ^Dow30 which is made up of only 30 stock components, is not the market proxy.

(iv) **Conclusion:** historically, **CAPM** as a risky pricing model, is **far from perfect**. For one, it uses a single variable, Beta, to price the required rate of return of a risky security -- the market is a LOT more complicated than that. *More on this in our classroom lectures and other methods for pricing risky returns.*

(v) **Prediction**: **IF** the COVID situation (we are nearly done? Resurgence in U.S./Europe/Asia with the less lethal but more infectious [but not fatal] Omicron BA2 variants – XBB.1.5 and BQ.1.1) continues to improve and the re-opening and resumption (China finally) of global economy, the Market Risk Premium R_{PM} will revert closer to the lower long-run average, i.e. from the recent 5.50% to 5.00% to 4.50% and heading towards 4.00% and hopefully stay there. **B**UT 2022 was the Year of Inflation and continued disruptions, 2023 the "back to normal" year … **is 2024 a better recovering year and hopefully with lower inflation?**

- … the **Ukraine-Russia situation is far from over + the start of Israel-Hamas conflict + China having a "soft" economy (property sector crisis?) + global climate extremes** continue to create ***"a lot of complications in the markets"***.
- And now, at the **beginning of 2025** with a new U.S. government administration [Trump] and **threats of tariffs** and illegal immigrant deportations, these situations could introduce **more political uncertainty** that might **overflow to the financial markets**.
- PS: we are already seeing a **stock market slowdown and potential downturn (especially AI-related Tech sector) and *"widening of spreads"*** among different credit ratings. *I encourage you to take an advanced course in Fixed Income.*

Step #14 Use DDM to value one of your chosen stock. Is this valuation equals to the traded price in the market?

*PS: This Step #14 is an attempt to value one of your chosen stock using **Dividend Discount Model DDM**. It is a LENGTHY step and therefore broken down into sub-parts Step #14A, #14B, #14C, #14D, #14E.*

Step #14A Tabulate your chosen stock's annual dividend payout and its annual dividend growth rates

*As specified in Step #1, one of your stocks in your portfolio must have a **periodic dividend payout** since 2000. Reminder: you only need to do DDM on ONE of your chosen stocks, not all of them.*

a) From previous step, sort the downloaded **periodic dividend data**, in chronological order, see *column [A]:*

[A] Date	[B] Quarterly Dividends	[C] Year	[D] Annual Dividends	[E] dividend growth	
01/19/2000	0.16000	2000	$0.6700	-	
04/18/2000	0.16000	2001	$0.7300	8.96%	
07/19/2000	0.17500	2002	$1.1350	55.48%	
10/18/2000	0.17500	2003	$0.8650	-23.79%	
01/17/2001	0.17500	2004	$0.9775	13.01%	
04/18/2001	0.17500	2005	$1.0900	11.51%	
07/18/2001	0.19000	2006	$1.2100	11.01%	
10/17/2001	0.19000	2007	$1.3600	12.40%	
01/16/2002	0.19000	2008	$1.5500	13.97%	
04/17/2002	0.19000	2009	$1.7200	10.97%	
06/03/2002	0.34500	2010	$1.8860	9.65%	***[F] … is there a predictable growth pattern?***
07/17/2002	0.20500	2011	$2.0570	9.07%	
10/16/2002	0.20500	2012	$2.2110	7.49%	
01/22/2003	0.20500	2013	$2.3680	7.10%	
04/15/2003	0.20500	2014	$2.5340	7.01%	
07/16/2003	0.22750	2015	$2.6330	3.91%	
10/22/2003	0.22750	2016	$2.6730	1.52%	
01/21/2004	0.22750	2017	$2.7400	2.51%	
04/21/2004	0.25000	2018	$2.8410	3.69%	
07/21/2004	0.25000	:	:	:	
10/20/2004	0.25000	:	:	:	
01/19/2005	0.25000	*prev_Yr*	*$3.9620*	6.05%	*previous year of assignment*
04/20/2005	0.28000	*curr_Yr*	*$4.1280*	4.19%	*current year of assignment*
07/20/2005	0.28000		**[G] Average =**	**8.16%**	***[H] ← ? projected constant dividend growth rate gc?***
10/19/2005	0.28000				
:	:				
:	:				

b) For most stocks (e.g. JP Morgan; Proctor & Gamble, Exxon-Mobil; etc.), at least North American stocks, dividends if paid out, occur on a **quarterly** basis. See illustrated data, *column [B]* -- dividends (sometimes to 4 decimal places) were paid out regularly per quarter in the months of January, April, July, and October. PS: during exceptional year(s) of company profits, the company can pay out an "extra" dividend, sometimes called an "extra-ordinary dividend", as in the case of 06/03/2002 above.

c) Create a column by year, see above *column [C]*.

d) For convenience (although less accurate in valuation of the stock), aggregate these quarterly dividends over each entire year (e.g. Q1 Jan, Q2 April, Q3 July, Q4 October), *see above column [D].* For example, during the year 2000, the total dividend paid out were \$0.1600 + \$0.1600 + \$0.1750 + \$0.1750 = \$0.6700.

   i. PS: the above *"curr_Yr"* denotes the dividends (thus far). You should use the actual current year of your assignment …

   ii. … If only ONE dividend has been paid for the current year, and we are expecting THREE more quarterly dividends, then take this Q1 dividend and multiply by FOUR to project the total dividends to be paid out for the current year.

   iii. Similarly, if THREE dividends has been paid out for the current year, you take the sum of these dividends and multiply it by "4 divided by 3" to project the full year of dividend.

   Thus, we will be doing **Constant Growth Model CGM** valuation over **annual periods of years**, from Year 2000 to *Current_Year*.

e) **Calculate the historical annual dividend growth rate** over these years. This is the percentage change of dividend from one year to the next. For example, from Year 2000 to Year 2001, the dividend growth rate is (0.73 – 0.67) ÷ 0.67 = 8.96%. Do this for subsequent years' dividend growth rate. See *column [E].*

f) *See item [F].* Take a **visual look** at the dividend growth rate from one year to the next. This is where classroom CGM method runs into market reality -- **can you spot a consistent trend in dividend growth rate from one year to the next?** Yeah, it is not that simple actually -- most companies' dividend payout policy are not that predictable/trendy:

- They are subject to the economic cycles and competitive forces in the market …
- … this will translate to revenues, costs, and working capital and capital expenditures needed, …
- … which leads to amount of earnings from which dividends are being paid out from one year to the next.

g) In any case, we need to **project the constant dividend growth rate g_c** for the next and future years of this stock. "One way" to do this is take the **average of the annual dividend growth rates** of the stock over the number of years of observation. *See item [G]*.

h) *See item [H]* with regard to this calculated average annual dividend growth rate. **Is this average the g_c?** Some comments on this issue:

- Some stocks (e .g. Consolidated Edison) have extremely predictable annual dividend growth rates. Spotting such a consistent trend is easy: e.g. growth rate declined slowly and steadily in subsequent years indicating a maturity within the industry and a slowdown (to a constant rate) of earnings growth.
- In other instances, a company's earnings are more volatile, leading to corresponding large ups and downs in dividend payouts from one period to the next (e.g. Exxon-Mobil and the above example).
- This is quite common with stocks which are more vulnerable and *highly correlated to economic and business cycles [termed cyclical stocks that are correlated to economic boom and recessions]* -- **this is one issue and challenge with using Constant Growth Model CGM** -- the stock you are doing CGM valuation ***"has yet to reach a predictable or consistent dividend payout policy"***.
- Yet, in this part of the assignment, **we are forcing the issue by doing a CGM valuation on your chosen stock**.

i) In any case, hold on to that calculated **average annual dividend growth rate [8.16%]**. In a later step, we will probably need to "adjust down" the average to a lower number and the **use a range of constant dividend growth rates g_c to *"bracket"*** the uncertainty in dividend payouts when using in CGM valuation of this stock.

Step #14B Estimate the discount rate k_e to use on the CGM

a) In DDM, we value the stock by using a discount rate to do a *"net present value of all future projected dividends"*. In the case of an assumed (indefinite) constant dividend growth rate $\mathbf{g}_c$, i.e. the **CGM** valuation of the stock simplifies to:

$$PV(stock) = \frac{D_1}{k_e - g_c} = \frac{D_0(1+g_c)}{k_e - g_c}$$

b) Since we are doing a current (today) CGM valuation of the stock, the most **"recent dividend" D_0** is the above dividend at *Year "curr_Yr"*, i.e. *$4.1280*. PS: you should use the actual current year of your assignment.

c) And we *"sort of"* have **an estimate of g_c** from previous Step #14A [g] and [i]. This gives us an **estimate of D_1** from $D_0 \times (1 + g_c)$.

What remains is an estimate of the equity required rate of return (k_e) of this stock. For the moment, based on what we have learned in this course, **there are TWO ways to estimate k_e**:

PS: The following data and calculated numbers may be different from your assignment data and calculations because of the actual date you will be doing your assignment. It also depends on your choice of stock used in your assignment and your last dated data point.

d) **Method 1 to estimate ke: use Capital Asset Pricing Model CAPM.**

Use a financial portal such as Yahoo! Finance, search for the stock, and click on the **Statistics** tab. Find the stock's reported **Beta** under the ***Stock Price History*** section. For example, this stock's Beta is 0.45, *"derived using monthly returns from the past 5 years"*.

(i) Then apply the **CAPM formula** to get the CAPM-suggested ***k_e***. For example, using the assumptions for k_{RF} and k_M at the beginning of this document,

$k_e = k_{RF} + \beta_s(k_M - k_{RF})$
$= k_{RF} + \beta_s(RP_M)$
$= 4.08\% + 0.45(4.00\%)$
k_e = 5.88% [CAPM method using Beta lookup from a financial portal]

(ii) PS: We can also apply the **CAPM formula** using the Beta we calculated for this stock in a previous Step #12. For example, using the assumptions for k_{RF} and k_M at the beginning of this document,

$k_e = k_{RF} + \beta_s(k_M - k_{RF})$
$= k_{RF} + \beta_s(RP_M)$
$= 4.08\% + 0.31(4.00\%)$
k_e = 5.32% [CAPM method using our own calculated Beta]

In any case, these estimated *k_e "looks too low"*, which is why we sometimes need other methods like **Method 2** below.

e) **Method 2 to estimate ke: use "Own-Bond-Yield-Plus-Judgmental-Risk-Premium OBYPJRP".**

We have done this before in a previous assignment or lecture module or a prior course. If this company also issues bonds, go **find its bond Yield to Maturity YTM**. The instructions is repeated at the end of this document as ***"Appendix: [2A] Using Moody's to find bond info".***

(i) For example, let's say we estimated this stock's bond yield at **k_d = 5.75% [YTM]**. PS: in this assignment guidance document, k_d is "5.75%" [Proctor & Gamble]. You should use your chosen stock's actual bond yield k_d.

(ii) Using this OBYJPRP method, $k_e = k_d$ + *Judgmental Risk Premium*
$= 5.75\% + 4.00\%$
k_e = 9.75% [OBYPJRP method]

PS: The point is not to spend too much time to be accurate about it because in most of our analysis, **we will be using a range of ballpark k_e** to do equity valuation and analysis on it. See next step's CGM.

f) Now, back to the previous two steps, (d) and (e), why do we use a number of methods to estimate k_e? This question being posed highlights **the prevailing issue of Investment and financial market analysis**, and in this part of the assignment, **equity valuation** in particular:

(i) ***"There are no laws of physics in finance".*** For example, Newton's *F = ma* works on Earth and Einstein's $e = mc^2$ works in the known parts of the universe …

(ii) … ***"In Finance, there are only models and theories"***. So, the **CAPM**, the **Beta**, the **SML** we learned about in the classroom does not govern/guarantee the behavior of a stock price and its valuation in the financial market.

(iii) And we see this issue in Finance in Method 2 by just adding a ***"Judgmental"* Risk Premium** to the company's bond's k_d (YTM). Wow, that is really professional! Is it 3% or 4% or 5%? This is exactly what we are doing in the classroom and sometimes in the workplace.

(iv) See also item (g) below; more wishy-washy techniques in Finance. PS: and we pay you $150K annual salary to do this in the workplace.

g) **Which k_e should we use?** In this document's example, we have a k_e = *5.88% and 5.32% [CAPM method]* and a k_e = *9.75% [OBYPJRP method]*. **Further guidelines** on how to arrive at a final k_e

(i) If the estimated k_e from all the methods are "close enough" in value to each other, for example 6.00%, 6.75%, 7.15%, etc., then *"take the average of all the estimated k_e"*.

(ii) If some of the estimated k_e is either *"too low"* or *"too high"*, ignore those "outlier" extreme values and settle on the remaining "*reasonable"* estimated k_e.

(iii) When in doubt, it is also ok to be **conservative** and *"take the higher, reasonable k_e and not do averages of k_e"*. Why? This is the general rule of conservative Accounting, Finance, Management, and even Engineering, *"**Underestimate cash inflows** (revenues, cost savings, investment rates, et al), **overestimate cash outflows** (costs, expenses, borrowing rates, TVM discount rates, et al)".*

h) So, in this document's example, k_e = 5.88% as well as 5.32% [CAPM method] is *"way too low"* and rejected, while the other is accepted. **We will settle on an estimated k_e = 9.75% [OBYPJRP method]**.

Step #14C Estimate the constant dividend growth rate g_c to use on the CGM

a) In order for CGM to work, one of the conditions of the valuation is **g_c must be less than k_e**; see denominator of the CGM formula.

b) Furthermore, as described Step #14A, (f) through (i), the average of the annual dividend growth rate for a company that is still growing (in revenues and earnings) tends to be a high rate; sometimes even higher than its k_e; i.e. this won't work in the CGM formula -- *the denominator states that g_c must be less than k_e*.

c) What this implies is that the company's business/market/industry *"has yet to mature and settle down",* because it is still growing to a consistent/stable, more predictable pattern of revenues and earnings and thereby has yet to stabilize to a consistent constant dividend payout rate in the form of g_c.

d) In this part of the assignment, **"we are forcing CGM valuation"** on the stock that has yet to reach this g_c …

e) … one way to do this is to set a g_c by *"**adjusting down** the average of the annual dividend growth rates to a lower rate that it is expected to grow constantly in the future"*. [BUT who knows when/if that happens]

f) Using the previous estimated values:
   (i) From Step #14B (h), we have **k_e = 9.75%** [OBYPJRP method]
   (ii) From Step #14A (i), we have **average annual dividend growth rate = 8.16%**
   - Here is the problem we were referring to earlier: dividend growth g is almost > k_e …
   - … with (k_e – g_c) as the denominator in the CGM valuation formula, as the difference between these two rates get small, it will have an "asymptotic effect" on V_0 being infinitely large in value.

g) **How should we set g_c?** The conservative approach is to **lower-adjust** the average annual dividend growth rate ***"closer to GDP growth rate (why?)"***. Some guidelines:

   (i) If your stock is in the U.S., the long-run annual GDP growth rate is 2.00%. In China, it is at least 5.00%. In the Eurozone (Germany, France, Italy, Spain, et al), it is about 1.50%.

   (ii) Check which industry your stock is in. Is it in the Energy, Financial, Healthcare, Industrial, Technology, or the Utilities, etc.? For example, in the U.S.
   - The Technology sector grows at a much higher rate than the country's annual GDP growth rate. So, it could be *"up to 6% or even 10%"*.
   - The Healthcare sector also grows at a rate higher than GDP growth rate, about *"4% or 5%".*
   - On the other hand, the Energy and Utilities sectors are below average, *"may be 1%".*
   - PS: if you don't know the long-run growth rate of that sector, just use the country's annual GDP rate.

   (iii) Guideline (ii) also applies relatively to other countries within the respective sectors. In the case of China, we are dealing with correspondingly "higher growth rates". Conversely, in Europe, lower rates.

   (iv) Finally, lower-adjust the stock's **g_c to less than k_e** and **closer to the long-run growth rate** with that of the stock's sector.

h) In this document's example, we could use a g_c of 4.00% (the stock in this example is in the Consumer Staples industry sector).

> PS: The point is not to spend too much time to be accurate about it because in most of our analysis, **we will be using a range of ballpark g_c** to do equity valuation and analysis on it. See next step's CGM.

Thus, we can settle on a **range of dividend g_c** from **0.00% [most conservative no-growth] … to a "comfortable" 3.00% … and all the way to 7.00% [very optimistic]** .

Step #14D Implement stock valuation using CGM with a range of k_e and g_c

a) From the previous steps, we can now use CGM to calculate the stock's price **using a range of k_e** (± 0.25% and ± 0.50%) **and a range of constant dividend growth rates g_c** [gc0, gc1, gc2, gc3, gc4, gc5].
   - PS: since in the following example we are using six columns of different g_c, starting at g_c = 0% …
   - … we will have one-fifth increments of g_c up till the maximum range of 7.00%.

b) The following is an example of a **two-dimensional matrix** of CGM valuation (highlighted in yellow) using these ranges of estimated g_c and k_e:

Notation:

inputs

$$V_0 = \frac{D_1}{k_e - g}$$

Dividends						
D0	**$4.1280**	$4.1280	$4.1280	$4.1280	$4.1280	$4.1280
D1	$4.1280	$4.1858	$4.2436	$4.3014	$4.3592	$4.4170

			assumed dividend growth rates g_c					
			gc0	gc1	gc2	gc3	gc4	gc5
			0.00%	1.40%	2.80%	4.20%	5.60%	7.00%
assumed discount rate k_e	k1	9.25%	$44.63	$53.32	$65.79	$85.18	$119.43	$196.31
	k2	9.50%	$43.45	$51.68	$63.34	$81.16	$111.77	$176.68
	k_e	9.75%	$42.34	$50.13	$61.06	$77.50	**$105.04**	**$160.62**
	k4	10.00%	$41.28	$48.67	$58.94	$74.16	$99.07	**$147.23**
	k5	10.25%	$40.27	$47.30	$56.96	$71.10	$93.75	$135.91
			DDM Valuation V_0					

actual stock price: P_0 = $158.65

<CM/CD/CY>

c) As seen above, **CGM** (same for multi-stage DDM) **valuation is extremely sensitive** to the assumptions in g_c and k_e. In the above valuation matrix, it can vary by as much as a 100% or even more -- compare above matrix's bottom-left cell valuation [$40.27] to that of the upper-right cell [$196.31] -- such a wide range of valuation results. PS: you will encounter this situation in your own DDM. One should ask the following questions:

- **"How useful is this CGM model?"**
- **And "how good must your estimates (projections) be in order for the valuation to have any accurate and useful meaning?**
- **And can you avoid the "sensitivity DDM valuation" problem?** [$40.27 ~ $196.31]

d) PS: the above highlighted cells' **$105.04 $160.62 $147.23** valuation **$V_0$** is closest to the closing market price **P_0** of this stock [**$158.65.** *current_month/current_day/current_year*]. It would seem that market expectations of this stock with regard to its historical dividend payout, the project dividend payout [via g_c] and the market required rate of return of the stock k_e has been "fairly", or rather insensibly priced into the current valuation of this stock. **Why?**

- Had it been "fairly priced", the pair of V_0 valuation cells in the above matrix would have fallen on the row with k_e = 9.75% because this is the (more reliably) estimated discount rate (than the other g_c DDM variable) for this stock …
- … instead, the actual market **P_0 suggests** that using this CGM, the **"implied k_e should be" ranges from 9.5% to 10.0% -- this would also imply the constant dividend growth gc is a "very high" 7.0%.**
- Alternatively, we could also interpret the above DDM Valuation matrix that **"implied k_e should be" closer to the lower 9.50%** and that **"implied g_c" is at under 7.00%**.
- PS: this is one of those few times this project is done each semester that we see this anomaly -- I suspect this has to do with the **recent "upward Inflation pressure"** -- it "*pushes up our estimated k_e by a larger amount than expected in such a short time*" and causes the valuation V_0 to be discounted by a larger rate.
- **If this analysis is correct**, this stock price "should" continue to "remain lower" since it hasn't quite caught up with the effects of future reduced Inflation and "the adjustment of interest rates in the market". BUT if Inflation continues to abate (go lower), V_0 (hence P_0) can continue to go up.

e) In fact, based on the current market traded stock price, if it is "trading at fair valuation", then "working backwards" from this price, the "**market-implied** future dividend growth rate **g_c**, according to DDM is "closer to ***7.00%***", much lower than the "25-year broad average of 8.16%" of this stock; see prior Step #14A, [a] and [i].

Step #14E Learning Outcome of the DDM part of this assignment (nothing to calculate here)

1) This sub-part are concluding remarks of Step #14 of this assignment – it illustrates a very common and important activity in investment analysis and financial market analysis: ***"Is the security traded [P_0] in the market fairly valued [V_0]?"***

2) If an analyst or trader believes that it is **under/over -valued**, then s/he will "**long/short** that security".

3) This is the **role of a financial market**; it is a forum for ***"price discovery"***. If the **market is efficient** (all relevant information available to market participants), then it will be factored into the price of the security quickly, correctly and fairly.

4) BUT the market, in particular the s**tock market, exhibits extreme deviation from market efficiency** for at least the following reasons:

    a. Stock markets are extremely **complicated**.

    b. Stock markets have very **diverse participants** = each group can have very different trading/investing objectives.

    c. Participants can have very **different activity horizon or holding period** -- day trading, short-term, longer-term, investing for retirement (40 years from now), buy-and-hold (till death), etc.

    d. Stock markets are sometimes used as an *"arena for **speculation**, i.e. like a casino"*.

        i. It was the case of the stock market in the **United States** eighty years ago; recently "Robinhood".

        ii. PS: it is somewhat speculative in the **Chinese stock market** at times, part of it due to *"lack of alternative avenues of investments"*. In the past, and it still is to a certain degree, it was/is either the real estate or the stock market. Where else can an investor put his/her money to work?

    e. Stock markets can also have a significant group of "inexperienced" investors. Their behavior can **distort** and/or **magnify** market momentums, e.g. longer/higher bull markets, lower/extended bear markets *[see "Robinhood and GameStop versus the Hedge Funds" during the 2020 Year of COVID]* …

    f. … **even "professionals" can exhibit such psychological traits**. In fact, **Behavioral Finance** is a new area in Investment Science. **Alan Greenspan**, a famous former Chairman of the U.S. Federal Reserve (1987~2006, central bank), coined the phrase ***"Irrational Exuberance"*** (= extreme overvaluation?) during a speech at the *American Enterprise Institute (12/5/1996)* -- he was referring to the fact that the S&P500 was up 23% during that year. PS: this term was later amplified by Nobel Prize winner **Robert Shiller** (2000, professor of Economics, Yale University) in describing an **asset bubble**.

    g. The market certainly will have "**mood swings** the other way", the companion ***Irrational Despair***, leading to extended market depression.

    h. Finally, there is no escaping the fact that the **financial market is really REALLY uncertain and complicated**. So, stock prices do react quickly (**volatility**) to any new bit of good/bad news. PS: we have very good models to predict hurricanes but we still have yet to do the same for financial markets; **it is this complex**.

5) A final word from our beloved Warren Buffett, "**Price** P_0 is what you pay, **Value** V_0 is what you get". Your job is to identify the differences and trade/invest accordingly.

$P_0 \neq V_0$
This is the justification for paying you at least US$150,000 if you are a good investment analyst.

End of Phase3

… to be continued: more Steps will be released when we do more lectures …
<there are about another 5 more pages …
… a few more steps and we are done with this Project>

Beginning of Phase4 [final phase] in subsequent pages …
<PS: For now, just use the stated description and formulas to calculate the various risk-adjusted measures of returns. We will go over them in lecture later, during the second half of the semester.>

<updated 05/09/2025 2pm; just 5 more pages …
… plus instructions to assemble the printed deliverables>

See assignment folder in BlackBoard for project due date.
See end of this document for how and what needs to be submitted and in what particular format.

Step #15 Compute Jensen's Alpha, Treynor measure, Sharpe Ratio, and the Information Ratio

There are a number of measures of returns of a stock: some are relative to the SML or its Beta while others are benchmarked against the prevailing RFR or a broad index.

In any case, the set we are interested in using are based on the broad concept of "**return-adjusted-risk-adjusted**" measures of the investments. Since an investment in a particular asset may carry or be exposed to different amounts or even types of risks, these measures of returns allows us to "**compare apples-to-apples**" the (risk-adjusted) returns of the investments.

PS: just use the respective formulas for now in this Step. We will get to lecture coverage of this topic, the meaning and its use, during the second half of the semester.

For ^SP500, ^Dow30, and your selected stocks, notated as *i*, calculate the definition of the following return-adjusted-risk-adjusted measures:

a) **Jensen's Alpha** is the difference between the actual return (R_i) of the stock and the required rate of return of the stock as suggested by CAPM:

$$\text{Jensen's Alpha } \alpha_i = R_i - [RFR + \beta_i(k_M - RFR)]$$

See page 2 of project document for assumed values for **RFR** and $\mathbf{k_M}$.

Alpha in essence is the **excess return** an investor made above (below) the market-expected rate of return [based on CAPM] of that investment.

b) **Treynor measure** is the excess return above RFR adjusted for **systematic risk** as measured by it Beta:

$$T_i = \frac{R_i - RFR}{\beta_i}$$

c) **Sharpe Ratio** is the excess return above RFR adjusted for **total risk** as measured by its standard deviation of its periodic HPYs:

$$S_i = \frac{R_i - RFR}{\sigma_i}$$

d) **M2 Measure** uses the above Sharpe Ratio and the market's volatility:

$$M_i^2 = RFR + S_i \times \sigma_M$$

PS: we used ^SP500 as a proxy for the "market", i.e. the above σ_M is the sample standard deviation (calculated previously) of ^SP500's periodic HPYs.

e) **Information Ratio IR** requires a little bit more work. For each of the annual HPYs of a stock, calculate the **active return** which is defined as:

$$\text{Active Return}_{it} = R_{it} - B_t$$

where R_{it} is the return of stock *i* during year *t*
and B_t is the return of a benchmark (e.g. S&P500) during year t

Then find the standard deviation of Active Returns for all those years of observation.
Finally, take the difference of the average of the stock's return and the benchmark's and divide it by the standard deviation if this periodic active returns. For example:

	Annual HPYs (%) [Phase 1]					
Date	^SP500	^Dow30	WhatsX	A	B	C
01/01/2000	-	-	-	-	-	-
01/01/2001	-2.04%	-0.49%	13.62%	43.07%	-27.61%	28.51%
01/01/2002	-17.26%	-8.89%	7.41%	20.48%	16.20%	10.63%
01/01/2003	-24.29%	-18.81%	7.70%	-6.66%	7.55%	14.35%
01/01/2004	32.19%	30.22%	4.81%	19.51%	20.42%	33.64%
01/01/2005	4.43%	0.02%	4.07%	57.75%	7.31%	11.52%
01/01/2006	8.36%	3.57%	1.62%	-11.10%	13.50%	46.05%
01/01/2007	12.36%	16.17%	4.30%	1.62%	11.83%	20.56%
01/01/2008	-4.15%	0.23%	8.98%	-27.39%	2.97%	-13.98%
01/01/2009	-40.09%	-36.75%	2.54%	6.54%	-14.72%	-67.10%
01/01/2010	30.03%	25.83%	8.45%	0.96%	16.51%	57.72%
01/01/2011	19.76%	18.12%	4.80%	31.88%	5.72%	45.73%
01/01/2012	2.04%	6.23%	8.48%	34.16%	3.10%	-1.90%
01/01/2013	14.15%	9.72%	2.48%	33.10%	23.25%	30.02%
01/01/2014	18.99%	13.26%	-0.05%	27.66%	5.12%	0.05%
01/01/2015	11.92%	9.34%	6.59%	5.01%	13.48%	20.28%
01/01/2016	-2.74%	-4.07%	-0.58%	-11.71%	0.09%	-9.19%
01/01/2017	17.45%	20.63%	1.36%	22.69%	10.76%	28.15%
01/01/2018	23.91%	31.64%	2.03%	7.07%	1.64%	37.36%
01/01/2019	-4.24%	-4.40%	1.97%	-1.12%	15.67%	9.40%
:	:	:	:	:	:	:
:	:	:	:	:	:	:
prev_Yr	18.86%	11.92%	2.06%	11.32%	-12.11%	13.17%
curr_Yr	24.66%	16.76%	1.99%	25.99%	-20.63%	8.26%
Avg HPY:	**7.09%**	**6.39%**	**3.82%**	**12.86%**	**8.03%**	**14.60%**

Calculating Information Ratios:

active returns (R_{it} - R_{Bt})		
A	B	C
-	-	-
45.11%	-25.57%	30.55%
37.74%	33.47%	27.89%
17.63%	31.84%	38.64%
-12.68%	-11.77%	1.45%
53.31%	2.88%	7.09%
-19.46%	5.14%	37.68%
-10.74%	-0.52%	8.21%
-23.24%	7.12%	-9.83%
46.63%	25.37%	-27.01%
-29.06%	-13.52%	27.69%
12.12%	-14.05%	25.97%
32.11%	1.05%	-3.94%
18.95%	9.10%	15.87%
8.67%	-13.87%	-18.93%
-6.91%	1.57%	8.37%
-8.96%	2.83%	-6.45%
5.24%	-6.69%	10.70%
-16.84%	-22.27%	13.45%
3.12%	19.91%	13.64%
:	:	:
:	:	:
18.86%	11.92%	2.06%
-6.34%	-7.39%	1.89%
24.97%	15.22%	18.37%

stdev:

f) Finally , summarize all these measures of returns in a table.
For example:

IR:	0.23	0.06	0.41
	A	B	C

$$IR_i = \frac{Avg(R_{it}) - Avg(R_{Bt})}{\sigma_{(R_{it}-R_{Bt})}}$$

Step #6	<annual Risk-Returns>					
Avg	7.09%	6.39%	3.82%	12.86%	8.03%	14.60%
Stdev	17.38%	15.17%	4.50%	22.26%	12.79%	27.01%

Step #4, #12		<monthly Betas & Correls>				
Beta	1.00	0.93	0.03	0.13	0.31	1.15
Intercept	-	0.00	0.00	0.01	0.01	0.01
R^2	-	0.90	0.01	0.01	0.07	0.38
Correl	^SP500	^Dow30	WhatsX	A	B	C
^SP500		0.95	0.12	0.10	0.26	0.62
^Dow30			0.08	0.15	0.34	0.57
WhatsX				0.08	0.11	0.30
A					0.22	0.16
B						0.24

	Various Risk-Adjusted Measures of Returns [Step #15]						
Measure	"Market"	^Dow30	WhatsX	A	B	C	RFR
Actual	7.09%	6.39%	3.82%	12.86%	8.03%	14.60%	4.08%
CAPM	8.08%	7.79%	4.21%	4.62%	5.31%	8.68%	4.08%
Jensen	-0.99%	-1.40%	-0.39%	8.24%	2.72%	5.91%	← "alpha"
Treynor	0.03	0.02	-0.08	0.65	0.13	0.09	
Sharpe	0.17	0.15	-0.06	0.39	0.31	0.39	
M2	0.07	0.07	0.03	0.11	0.09	0.11	
IR	n/a	n/a	n/a	0.23	0.06	0.41	

PS: The above data and calculated numbers may be different from you assignment data and calculations because of actual date you will be doing your assignment. It also depends on your choice of stocks used in your assignment and your last data data point.

Step #16 Do Histogram Analysis: are stock's periodic (monthly) HPYs normally distributed?

a) One of the **key assumptions in Markowitz Portfolio Theory** is that the periodic **HPYs** are **normally distributed**:

- It uses the statistical measure of standard deviations and averages of periodic HPYs as a measure of risk-return for each of the assets in a portfolio.
- Coefficient of Correlations are used to capture the co-movement of each pair of assets in the portfolio.
- Finally, the overall risk in a portfolio context, the **portfolio standard deviation**, is that formula we are now too familiar with.

b) But can we or should we make such a (theoretical) assumption (of normal distribution of periodic HPYs) in practice? To answer this critical question, we will do an **empirical analysis of the monthly HPYs** of ***"another Mystery Stock Y"***

(i) We can do so by constructing a **Histogram of this *Mystery Stock Y's* monthly HPYs**.

(ii) Find out the **minimum** and **maximum monthly HPY** of this "*Mystery Stock Y*".

(iii) Use a "**bin width" of 1.00%** to classify (i.e. frequency count) each of the HPYs.

(iv) Then create "bins" from this minimum value to the maximum value in increments of 1.00%.

(v) PS: **to save you time**, this ***Mystery Stock Y's data*** and the above Steps (i) through (iv) is already in your stock prices Excel template data file. Use that ***Histogram*** worksheet:

- ✓ We have calculated monthly HPYs from 01/01/2000 to *CM*/01/*CY*.
- ✓ If your actual date of this assignment is "more than a few weeks" after this guidance document have to be prepared/posted, you DO NOT need to download additional monthly stock prices to calculate the newer months of HPYs …
- ✓ … this stock is set up as a ***Mystery Stock Y*** -- so you don't have the actual stock name to download its data anyway.
- ✓ This is not a problem -- we have over 270 months of data points of HPYs -- this data, without the newer additional months, is large enough a data set to perform the Histogram analysis.

(vi) So, in your Excel's *Histogram* worksheet, select all of *Mystery Stock Y's* monthly HPYs, then go the Data tab to do a **Data Analysis** using Excel's **Histogram** feature.

(vii) In Excel's Histogram dialogue box, select "New Worksheet Ply" and select "Chart Output" to generate the histogram data and its corresponding plot.

c) Do a visual inspection of your plotted Histogram **…**

d) … Question: does ***Mystery Stock Y's*** monthly HPYs of this stock look normally distributed to you? **Indicate** on the Histogram whether its monthly HPYs is **normally or not normally distributed**.

If the periodic HPYs are not normally distributed, then we should not be using Average and Standard Deviation statistics as Risk-Return characteristics in Markowitz Portfolio Theory? [the Efficient Frontier, the CAL, the AA, etc. in this project]

e) The following is a sample Histogram. PS, it will look different from your *Mystery Stock Y*:

PS: The following data and plot may be different from your assignment data because of the actual date that you will be doing your assignment with a pre-loaded and calculated set of HPYs for *Mystery Stock Y*.

MinHPY	MaxHPY	*"Mystery*
-17.74%	13.38%	*Stock Y"*

BinStart	BinEnd	BinWidth
-18.00%	14.00%	1.00%

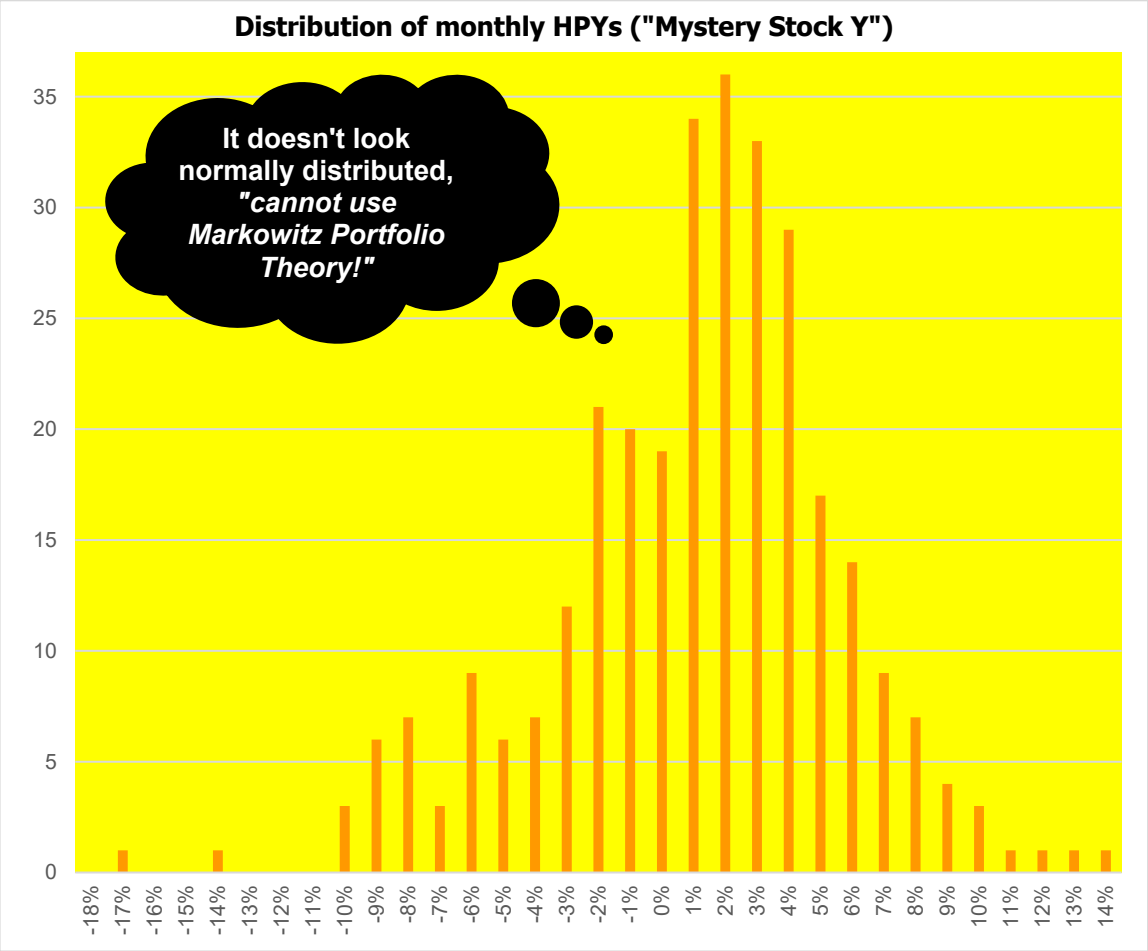
Instructions

#1 Set up bins of returns in 1% increments from MinHPY (rounded down to next full %) to MaxHPY (rounded up to next full %).

#2 Highlight monthly HPYs of the stock.

#3 Then go to Excel's Data tab and do > Data Analysis > Histogram,
For Input Range, select your range of HPY cells,
For Bin Range, select your range of Bin cells,
Select "New Worksheet Ply"
Select "Chart Output"

Bin	*Frequency*
-18%	0
-17%	1
-16%	0
-15%	0
-14%	1
-13%	0
-12%	0
-11%	0
-10%	3
-9%	6
-8%	7
-7%	3
-6%	9
-5%	6
-4%	7
-3%	12
-2%	21
-1%	20
0%	19
1%	34
2%	36
3%	33
4%	29
5%	17
6%	14
7%	9
8%	7
9%	4
10%	3
11%	1
12%	1
13%	1
14%	1
TOTAL:	305



[About Stock Valuation]

$P_0 \neq V_0$

"The price [P_0] you pay for a stock is not necessarily the value [V_0] you will get from it." … Warren Buffett.

[About Risk-Returns]

Distribution of periodic returns are NOT necessarily normally distributed.
Once again, the classroom ("rubber") DOEST NOT meet the market ("road").

Welcome to Investment Analysis and Portfolio Management.

Sorry to drag everyone through this long assignment and invalidating our classroom understanding of *Investment Analysis and Portfolio Theory*. But you need to download the market data and convince yourself that it is so. Hence this discipline is more an art than science; such skills are highly sought after in the market.

In any case, buy low sell high, save early and save often for your retirement, live long and prosper.

~ Chee, Senior Lecturer, Financial Management Programs, Course Developer

Step #17: Performance Attribution *The final step: breaking down the sources of return for an investment.*
[not part of this Project; we will do it during class lecture at end of semester; stay tuned]

Step #18 The Entire Project's Deliverables (did you follow closely all the Steps' instructions?

a) **Did you comply with all the instructions in Pages 2,3,4?**

b) **DO NOT rename your instructor-given personalized** "starting template & data" Excel file which I had Internal E-mailed you after you had responded to Phase1 Step #1. Submit your Excel as named; see (g) below.

c) On your given personalized Excel file, there should be a **Worksheet titled "Deliverables"**. DO NOT create a new one, DO NOT copy over another one from somewhere else [i.e. not doing your own work]. **Use that existing "Deliverables" worksheet to consolidate** all your results and charts. It makes it easier for the instructor to grade them. This worksheet should contain the following plots and summary tables:

- ✓ Step #3 Plot of Performance of ^Dow30, ^SP500, and your selected stocks.
- ✓ Step #6 Annual HPYs & Risk-Return statistics of ^Dow30, ^SP500, WhatsX?, your selected stocks.
- ✓ Step #7 Plots of the 2-asset Minimum Variance Frontiers.
- ✓ Step #8 Plot of your portfolio's Minimum Variance Frontier.
- ✓ Step #11 The Complete Puzzle: EF + CAL + IUC. And identify the ORP, the AA point and its % allocation.
- ✓ Step #4, #12 Scatter Plots and a summary table of the stocks' risk-return and Beta.
- ✓ Step #13 Plot of the SML and the Beta-Return points of RFR, ^Dow30, ^SP500 (the Market), your selected stocks. Specify whether your stocks are over- or under-valued relative to SML.
- ✓ Step #14 Matrix of DDM valuation using a range of g_c and k_e on one of your stocks with dividend history.
- ✓ Step #15 Various Risk-Adjusted Measures of Returns: Actual, CAPM, Jensen's Alpha, Treynor, Sharpe Ratio, and the Information Ratio of the Market, Indexes, and your stocks.
- ✓ Step #16 Histogram plot of monthly HPYs of one of your Mystery Stock Y.

Where convenient, you can combine some of the above deliverables, for example, the statistics, the Betas, the measures of returns. And it does not have to be arranged in sequence to the Steps.

d) **IMPORTANT:** You must arrange/make one or more (but not all) of the above Steps fit conveniently in the physical (printable) pages. Your pages can either be in portrait or landscape format.

- ➢ i.e. you should size these Deliverables such that when you use Excel's Print Preview, it should show one or more of the above deliverables in its totality and not span/overlap the page view. **[see sample Deliverables after this page; it is OK to follow this compact sequence]**

e) Then **print the "Deliverables" worksheet in PDF format and name the PDF file DomPortf-*yourname*.PDF**. You do this by doing a File > Print and then selecting "Adobe PDF" from the Printer pull-down menu. View this generated PDF output file to make sure your arranged deliverables meet the requirements in (c) and (d).

- ➢ ***yourname*** is the designated short name I used in your personalized Excel filename, e.g. DomPortf-*SmithK*.pdf; DomPortf-*XuSR*.pdf; DomPortf-*MullerG*.pdf; DomPortf-*ZhouZR,pdf*; etc.

f) **DO NOT paper-print** and submit your project deliverables.

g) In our course **BlackBoard**, click on left-hand-side menu *Submit Portfolio Projects Here*. You **submit TWO files**:

1) Click on "**Submit Domestic Portfolio Project Excel File**" to submit your DomPortf-*yourname* **Excel** file.
2) Click on "**Submit Domestic Portfolio Project PDF File**" to submit your DomPortf-*yourname* **PDF** file.

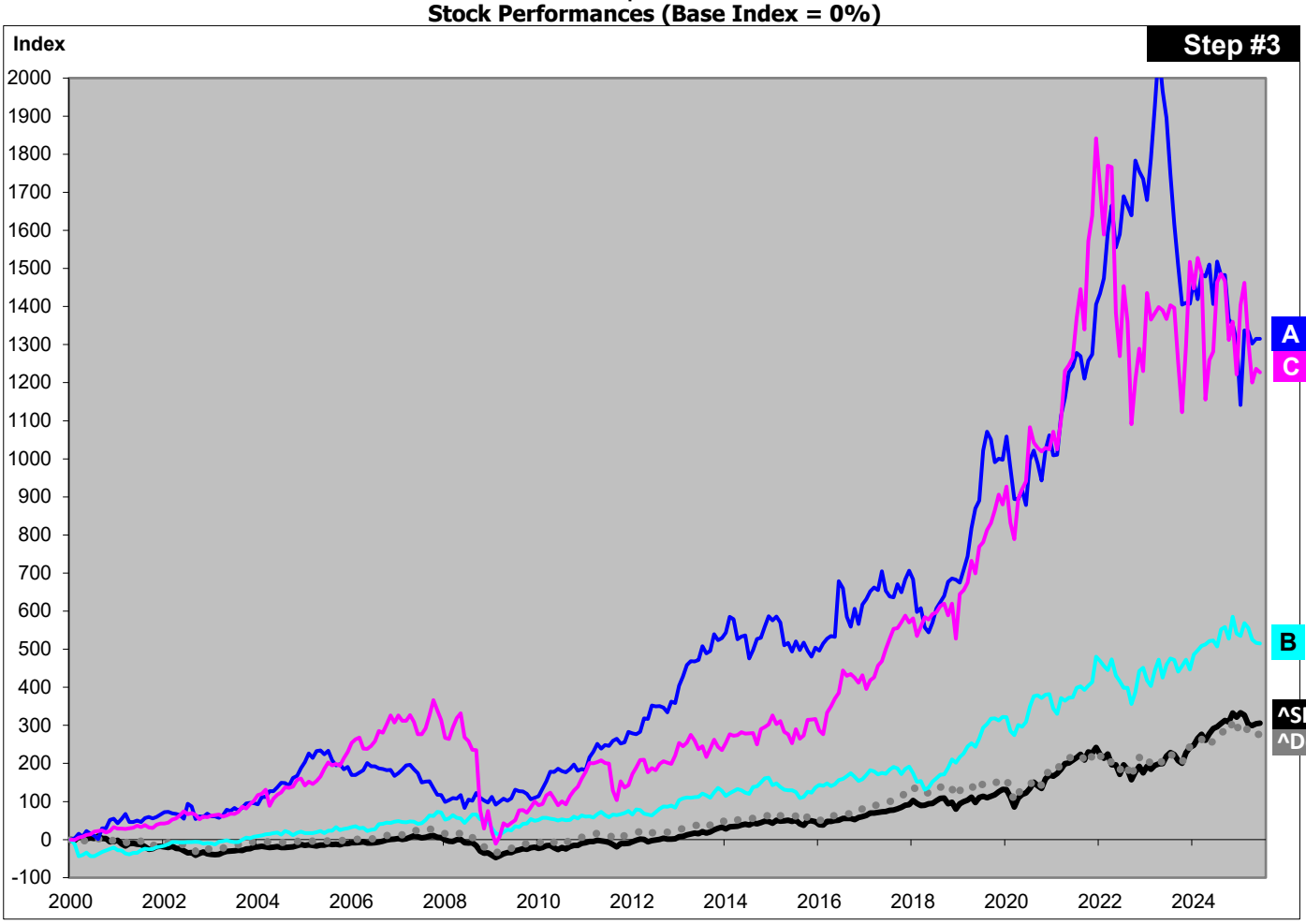
- ➢ PS: the file-naming convention of your Excel is already based on that template file mailed to you.
- ➢ PS: click on the "Browse My Computer" to locate/attach your file from your PC. Then click "Submit".

ENTIRE Individual Domestic Equity Portfolio Project
See project's folder in BlackBoard for due date

See the following pages for a sample of an Excel Worksheet deliverables …

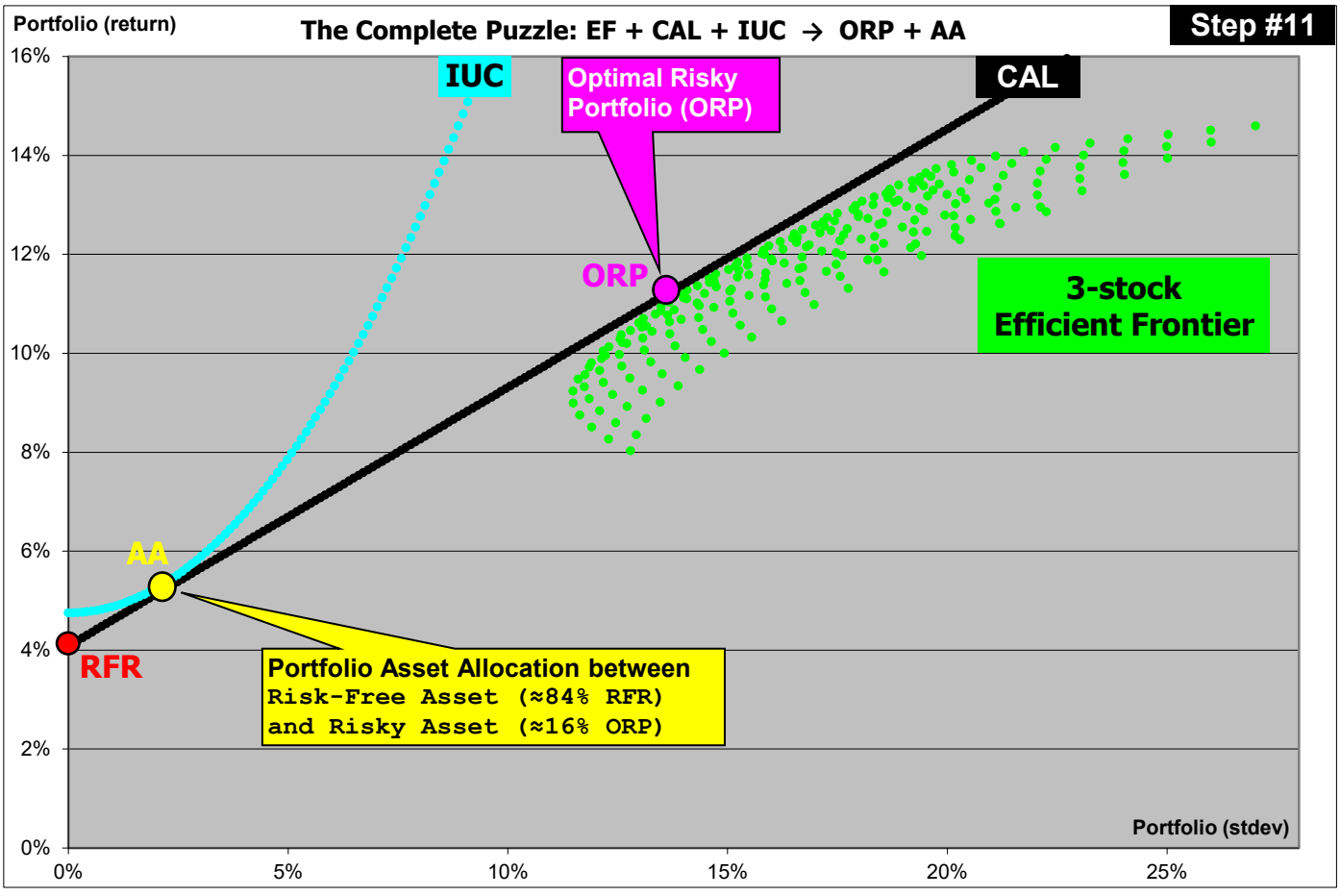
Individual Domestic (U.S) Equity Portfolio Project
<Sample Deliverables>

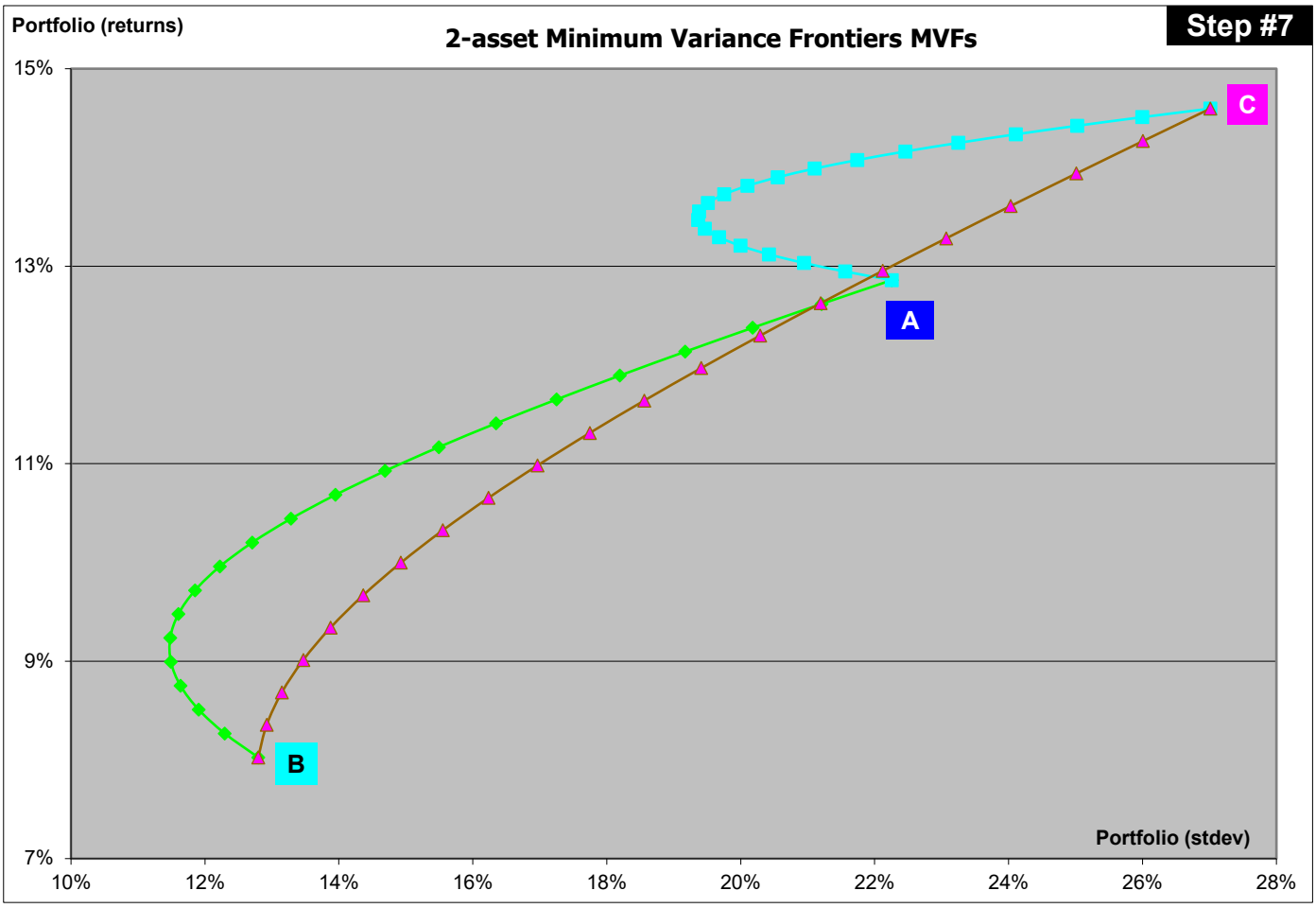
Stock Performances (Base Index = 0%)

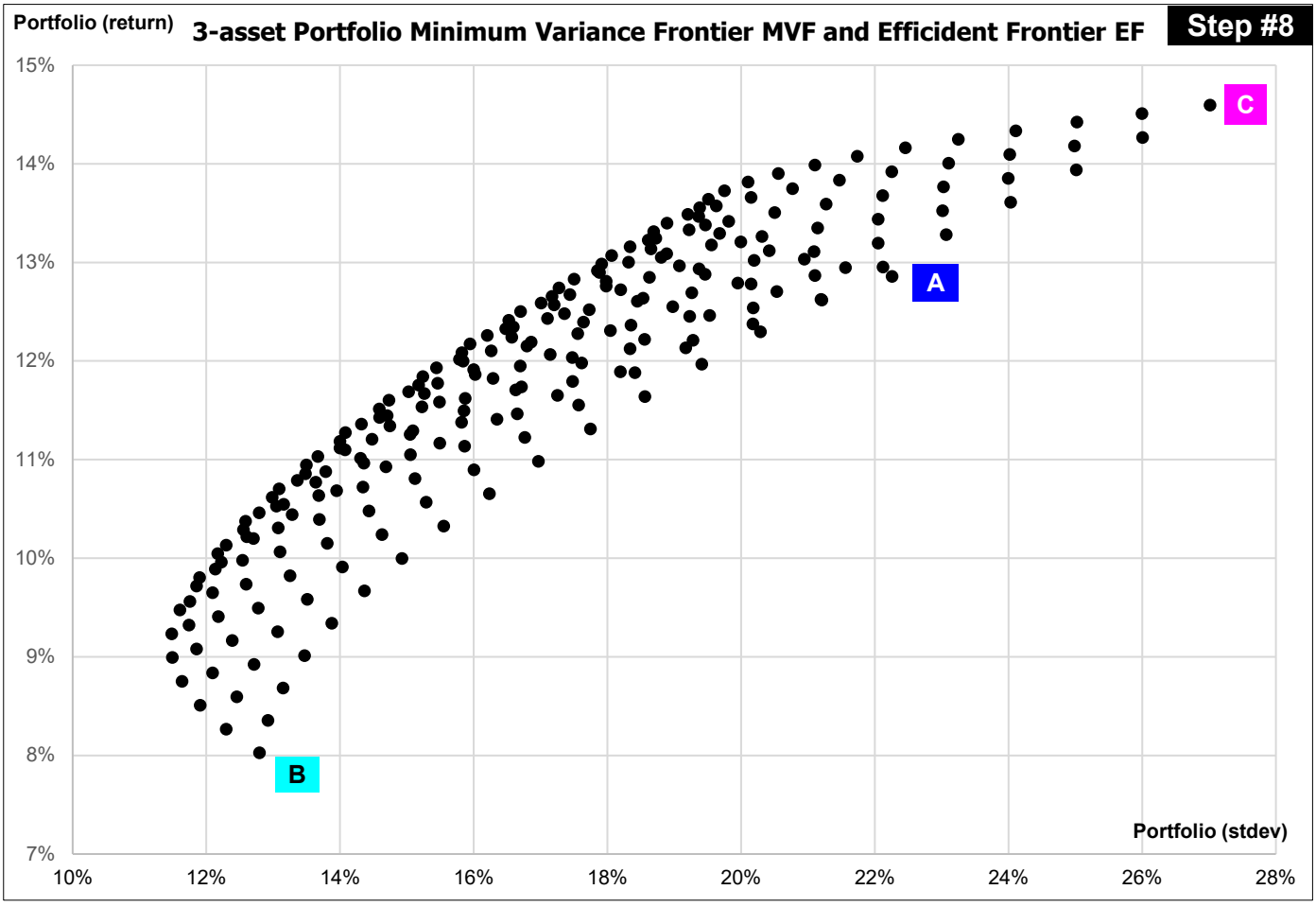


RFR = 4.08%

<updated 05/08/2025 9pm>




Step #7
2-asset Minimum Variance Frontiers MVFs
Portfolio (returns)
15%
13%
11%
9%
7%
10%
12%
14%
16%
18%
20%
22%
24%
26%
28%
Portfolio (stdev)
A
B
C


Step #8
3-asset Portfolio Minimum Variance Frontier MVF and Efficident Frontier EF
Portfolio (return)
15%
14%
13%
12%
11%
10%
9%
8%
7%
10%
12%
14%
16%
18%
20%
22%
24%
26%
28%
Portfolio (stdev)
A
B
C

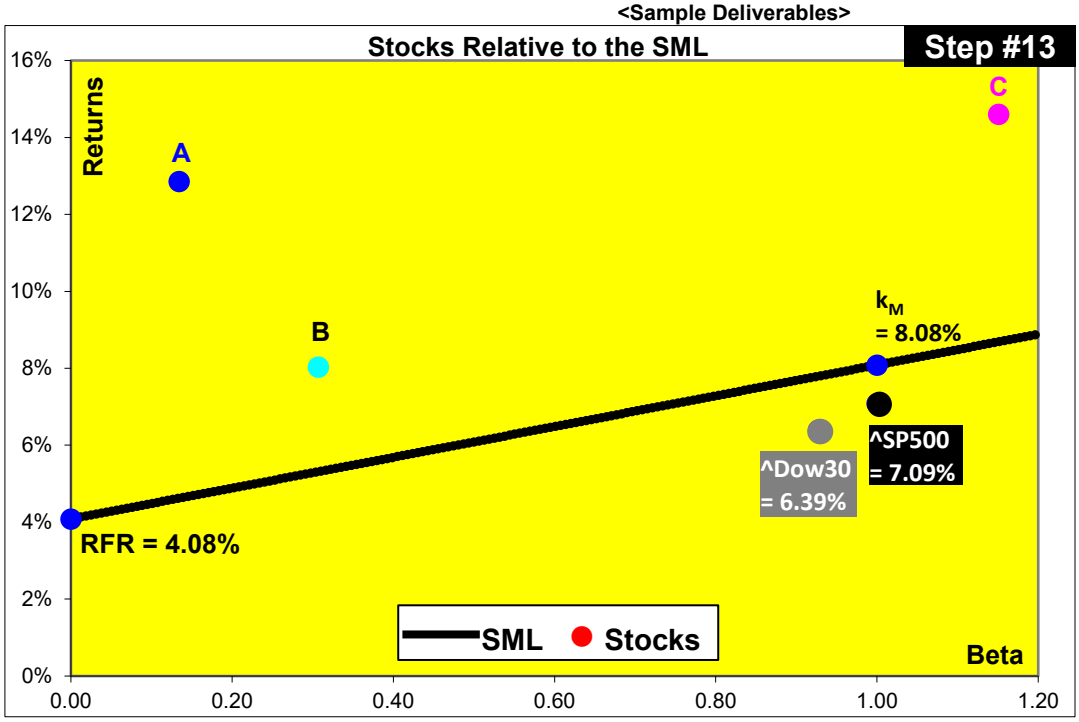
Individual Domestic (U.S) Equity Portfolio Project
<Sample Deliverables>

	Step #6	Annual HPYs (%)					
Date	Year	^SP500	^Dow30	WhatsX?	A	B	C
01/01/2000	-	-	-	-	-	-	-
01/01/2001	2000	-2.04%	-0.49%	13.62%	43.07%	-27.61%	28.51%
01/01/2002	2001	-17.26%	-8.89%	7.41%	20.48%	16.20%	10.63%
01/01/2003	2002	-24.29%	-18.81%	7.70%	-6.66%	7.55%	14.35%
01/01/2004	2003	32.19%	30.22%	4.81%	19.51%	20.42%	33.64%
01/01/2005	2004	4.43%	0.02%	4.07%	57.75%	7.31%	11.52%
01/01/2006	2005	8.36%	3.57%	1.62%	-11.10%	13.50%	46.05%
01/01/2007	2006	12.36%	16.17%	4.30%	1.62%	11.83%	20.56%
01/01/2008	2007	-4.15%	0.23%	8.98%	-27.39%	2.97%	-13.98%
01/01/2009	2008	-40.09%	-36.75%	2.54%	6.54%	-14.72%	-67.10%
01/01/2010	2009	30.03%	25.83%	8.45%	0.96%	16.51%	57.72%
01/01/2011	2010	19.76%	18.12%	4.80%	31.88%	5.72%	45.73%
01/01/2012	2011	2.04%	6.23%	8.48%	34.16%	3.10%	-1.90%
01/01/2013	2012	14.15%	9.72%	2.48%	33.10%	23.25%	30.02%
01/01/2014	2013	18.99%	13.26%	-0.05%	27.66%	5.12%	0.05%
01/01/2015	2014	11.92%	9.34%	6.59%	5.01%	13.48%	20.28%
01/01/2016	2015	-2.74%	-4.07%	-0.58%	-11.71%	0.09%	-9.19%
01/01/2017	2016	17.45%	20.63%	1.36%	22.69%	10.76%	28.15%
01/01/2018	2017	23.91%	31.64%	2.03%	7.07%	1.64%	37.36%
01/01/2019	2018	-4.24%	-4.40%	1.97%	-1.12%	15.67%	9.40%
01/01/2020	2019	19.28%	13.03%	9.85%	49.52%	32.81%	37.89%
01/01/2021	2020	15.15%	6.11%	4.63%	-4.23%	5.42%	14.03%
01/01/2022	2021	21.57%	17.17%	-3.11%	38.25%	28.29%	55.01%
01/01/2023	2022	-9.72%	-2.98%	-8.55%	16.04%	-9.06%	-15.45%
01/01/2024	2023	18.86%	11.92%	2.06%	-12.11%	13.17%	0.76%
06/01/2025	2025	-6.34%	-7.39%	1.89%	13.98%	-3.04%	-11.77%

Step #6	<*annual* Risk-Returns>					
Avg	7.09%	6.39%	3.82%	12.86%	8.03%	14.60%
Stdev	17.38%	15.17%	4.50%	22.26%	12.79%	27.01%

Step #4, #12	<*monthly* Betas & Correls>					
Beta	1.00	0.93	0.03	0.13	0.31	1.15
Intercept	-	0.00	0.00	0.01	0.01	0.01
R^2	-	0.90	0.01	0.01	0.07	0.38
Correl	^SP500	^Dow30	WhatsX?	A	B	C
^SP500		0.95	0.12	0.10	0.26	0.62
^Dow30			0.08	0.15	0.34	0.57
WhatsX?				0.08	0.11	0.30
A					0.22	0.16
B						0.24
C						

	Step #15	Various Risk-Adjusted Measures of Returns					
RFR	Measure	"Market"	^Dow30	WhatsX?	A	B	C
4.08%	Actual	7.09%	6.39%	3.82%	12.86%	8.03%	14.60%
4.08%	CAPM	8.08%	7.79%	4.21%	4.62%	5.31%	8.68%
"alpha"→	Jensen	-0.99%	-1.40%	-0.39%	8.24%	2.72%	5.91%
	Treynor	0.03	0.02	-0.08	0.65	0.13	0.09
	Sharpe	0.17	0.15	-0.06	0.39	0.31	0.39
	M2	0.07	0.07	0.03	0.11	0.09	0.11
	IR	n/a	n/a	n/a	0.23	0.06	0.41



A, B, and C are **significantly under-valued** relative to the SML.

^SP500 is **significantly over-valued** relative to the SML. (0.99% difference)

^Dow30 is also **significantly over-valued** relative to the SML. (1.40% difference)

*See corresponding **Jensen's Alpha** for these Indexes and stocks, which can be used to measure over-, under-valutation of stock's actual returns versus its CAPM returns.*

PS: Assumed Market Risk Premium RP_M = 4.00%

Year	Annual Dividends	dividend growth
2000	$0.6700	-
2001	$0.7300	8.96%
2002	$1.1350	55.48%
2003	$0.8650	-23.79%
2004	$0.9775	13.01%
2005	$1.0900	11.51%
2006	$1.2100	11.01%
2007	$1.3600	12.40%
2008	$1.5500	13.97%
2009	$1.7200	10.97%
2010	$1.8860	9.65%
2011	$2.0570	9.07%
2012	$2.2110	7.49%
2013	$2.3680	7.10%
2014	$2.5340	7.01%
2015	$2.6330	3.91%
2016	$2.6730	1.52%
2017	$2.7400	2.51%
2018	$2.8410	3.69%
2019	$2.9550	4.01%
2020	$3.1190	5.55%
2021	$3.4010	9.04%
2022	$3.6090	6.12%
2023	$3.7360	3.52%
2024	$3.9620	6.05%
2025	$4.1280	4.19%
		8.16%

← ? projected constant growth rate?

Stock Valuation Using DDM (with constant dividend growth gc) — **Phase3 Step #14**

Projections and assumptions

D_0 = $4.1280
g_c = 7.00%

k_d = 5.75%
RP_M = 4.00%
k_e = 9.75%

Aaa = 5.47% ←→ Baa = 6.21%
based on Moody's Credit Rating Aa3, interpolated
Market Risk Premium
← $k_e \approx k_d + RP_M$

	Ratings	Yields	Moody's Seasoned Corporate Bond Yield
0	Aaa	5.47%	https://fred.stlouisfed.org/series/DAAA
1	Aa1	5.56%	*linerarly interpolated*
2	Aa2	5.66%	*linerarly interpolated*
3	Aa3	5.75%	***[05/08/2025], since 10/27/2022*** **Step #14d, ix**
4	A1	5.84%	*linerarly interpolated*
5	A2	5.93%	*linerarly interpolated*
6	A3	6.03%	*linerarly interpolated*
7	Baa1	6.12%	*linerarly interpolated*
8	Baa2	6.21%	https://fred.stlouisfed.org/series/DBAA
	Baa3		
	Ba1		
	Ba2		

Notation:
inputs

$$V_0 = \frac{D_1}{k_e - g_c}$$

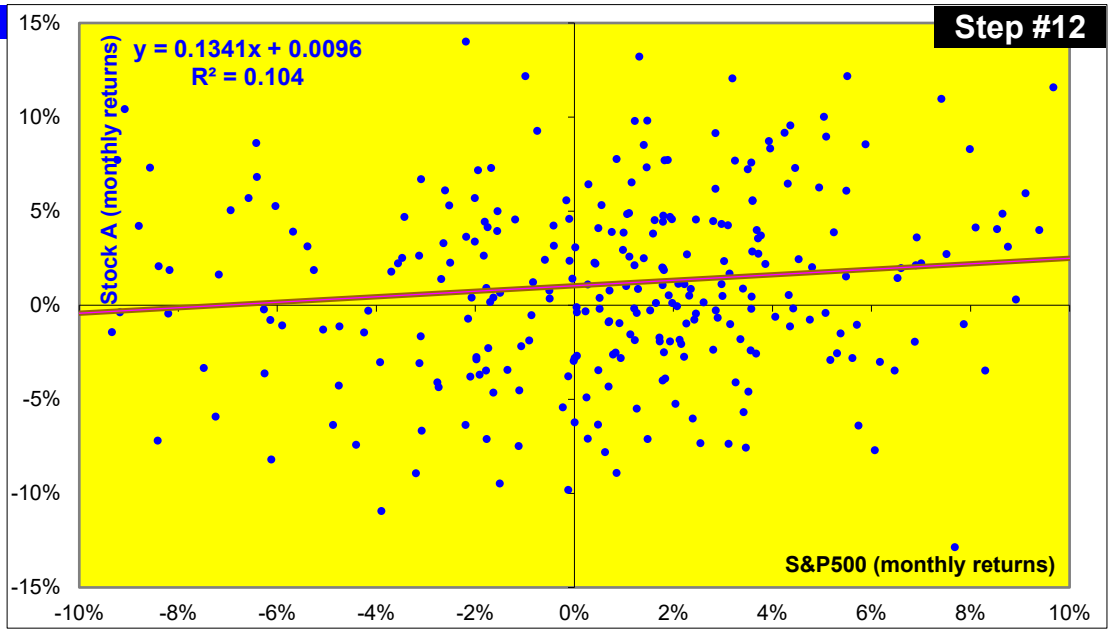
		Dividends					
D0		$4.1280	$4.1280	$4.1280	$4.1280	$4.1280	$4.1280
D1		$4.1280	$4.1858	$4.2436	$4.3014	$4.3592	$4.4170

			assumed constant dividend growth rates g_c					
			g0	g1	g2	g3	g4	g5
			0.00%	1.40%	2.80%	4.20%	5.60%	7.00%
assumed discount rate k_e	k1	9.25%	$44.63	$53.32	$65.79	$85.18	$119.43	$196.31
	k2	9.50%	$43.45	$51.68	$63.34	$81.16	$111.77	$176.68
	ke	9.75%	$42.34	$50.13	$61.06	$77.50	$105.04	$160.62
	k4	10.00%	$41.28	$48.67	$58.94	$74.16	$99.07	$147.23
	k5	10.25%	$40.27	$47.30	$56.96	$71.10	$93.75	$135.91
			DDM Valuation V_0					

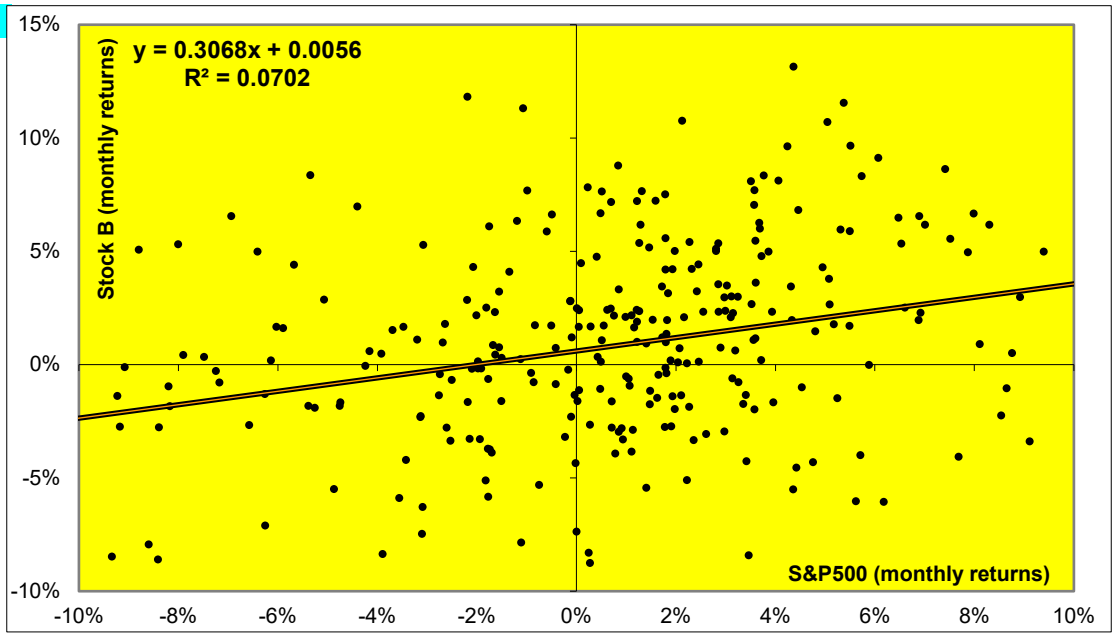
<05/08/2025>

actual stock price P0 = $158.65

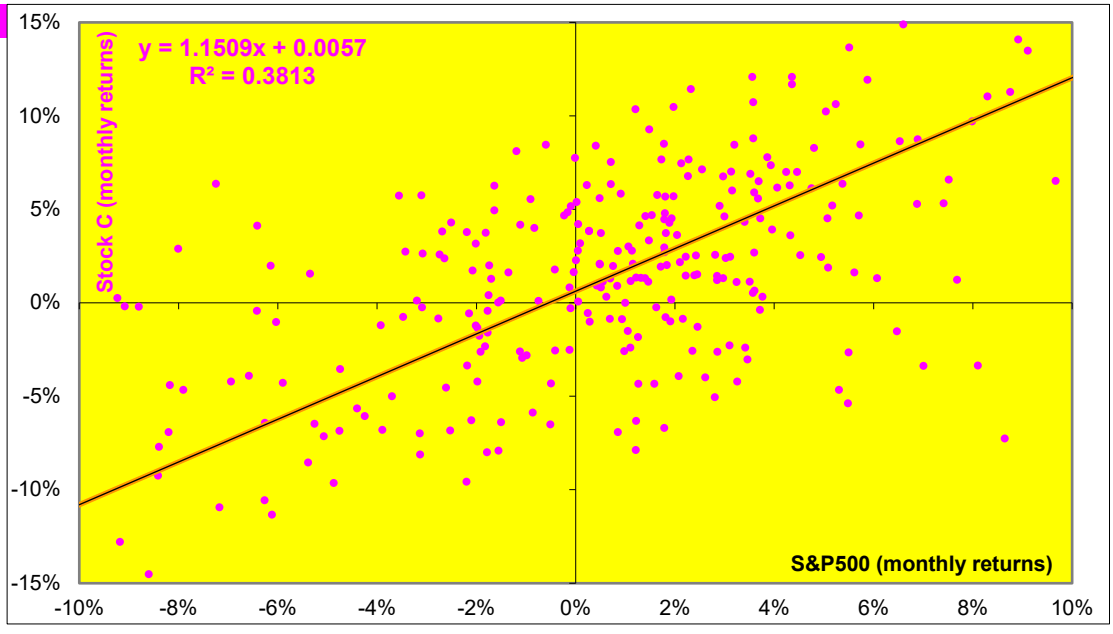
A


Step #12
y = 0.1341x + 0.0096
R² = 0.104
Stock A (monthly returns)
S&P500 (monthly returns)
15%
10%
5%
0%
-5%
-10%
-15%
-10%
-8%
-6%
-4%
-2%
0%
2%
4%
6%
8%
10%

B


y = 0.3068x + 0.0056
R² = 0.0702
Stock B (monthly returns)
S&P500 (monthly returns)
15%
10%
5%
0%
-5%
-10%
-10%
-8%
-6%
-4%
-2%
0%
2%
4%
6%
8%
10%

C


y = 1.1509x + 0.0057
R² = 0.3813
Stock C (monthly returns)
S&P500 (monthly returns)
15%
10%
5%
0%
-5%
-10%
-15%
-10%
-8%
-6%
-4%
-2%
0%
2%
4%
6%
8%
10%

Histogram Analysis of Monthly HPYs: is a stock's returns normally distributed?

MinHPY	MaxHPY	*"Mystery*
-17.74%	13.38%	*Stock Y"*

BinStart	BinEnd	BinWidth
-18.00%	14.00%	1.00%

Instructions

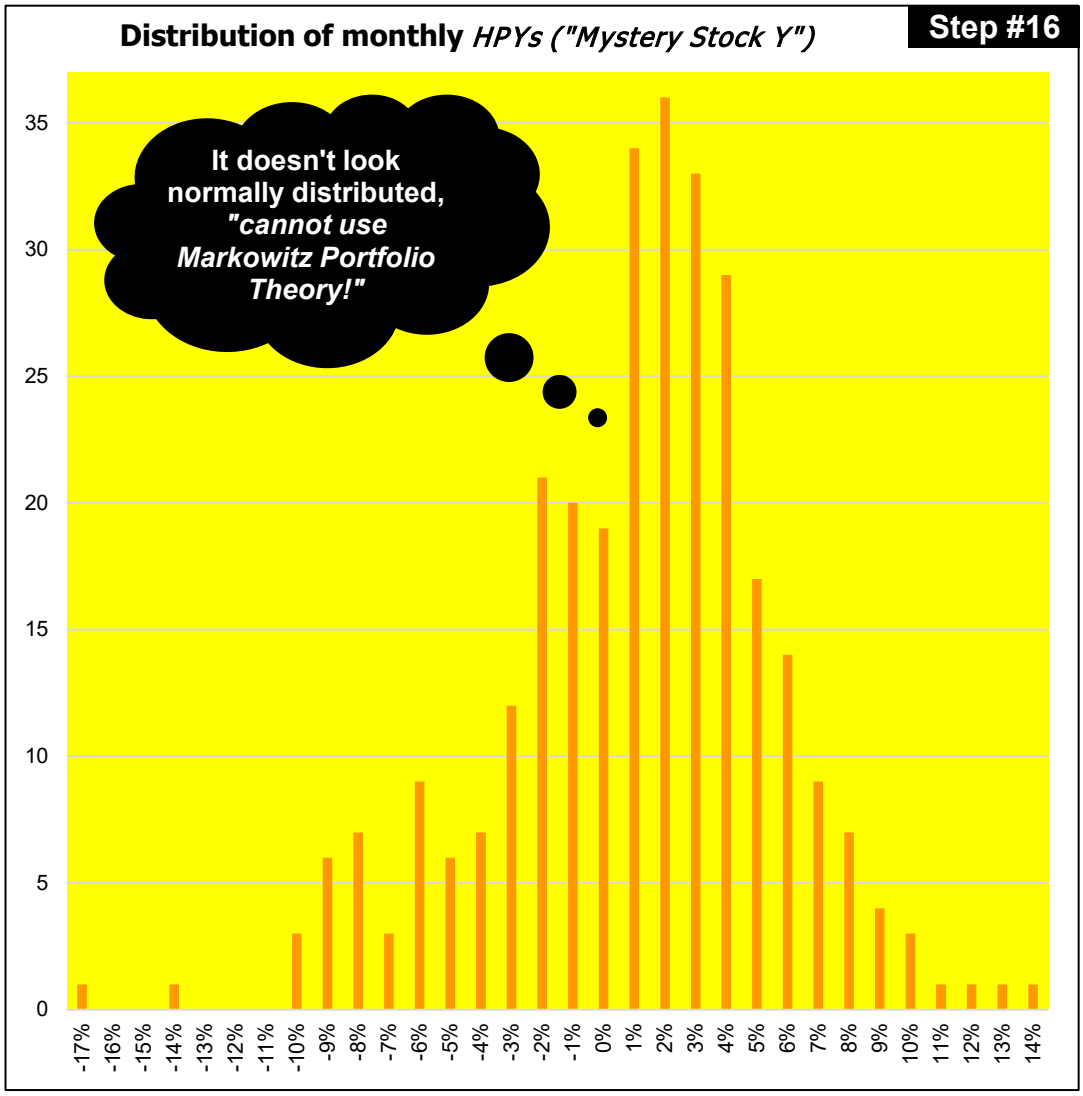
#1 Set up bins of returns in 1% increments from MinHPY (rounded down to next full %) to MaxHPY (rounded up to next full %).

#2 Highlight monthly HPYs of the stock.

#3 Then go to Excel's Data tab and do > Data Analysis > Histogram,
For Input Range, select your range of HPY cells,
For Bin Range, select your range of Bin cells,
Select "New Worksheet Ply",

Bin	*Frequency*
-18%	0
-17%	1
-16%	0
-15%	0
-14%	1
-13%	0
-12%	0
-11%	0
-10%	3
-9%	6
-8%	7
-7%	3
-6%	9
-5%	6
-4%	7
-3%	12
-2%	21
-1%	20
0%	19
1%	34
2%	36
3%	33
4%	29
5%	17
6%	14
7%	9
8%	7
9%	4
10%	3
11%	1
12%	1
13%	1
14%	1
TOTAL:	305

sis ToolPak".



Appendix: [2A] Using Moody's to find bond info -- Credit Ratings, estimating Bond Yield [k_d]

[1] Introduction

Fellow students,

A fair enough issue for starving students as well as instructor who have no premium paid/subscription access to market data such as bond information.

Having access and use of **Bloomberg** and **Moody's** would be great. These are premium financial data service portals:

- At Boston University's School of Management, we do have them, but recent COVID-19 situation have prevented physical access to these facilities.
- And Internet web-based remote access are not possible due to their strict control of valuable live data feeds -- you need their dedicated Bloomberg terminals.

The following is a starting point (but not limited to this) on where to look for bond data, in particular **Credit Rating information**, for the purpose of coming up with the important *"cost of debt, k_d"* of a company that issues bonds or a series of bonds. As you eventually progresses through your sequence of finance courses in our Financial Management Program, you will need this info for doing:

i. **Yield history of a company's bond**. Remember, once issued, their price will change, just like stocks being bought and sold, due to the credit quality of the bond, macroeconomic factors, financial health, etc. This will have an "inverse price-yield" movement on the company's bond.

ii. **Credit Rating.** The intuitive overall quality of the bond. Assumed to be a market-impartial assessment of the company's bond by credit ratings agencies such as *Fitch Ratings, Moody's, Standard and Poor's,* and even *Duff & Phelps*.

iii. **Peer Group Comparison**. Bonds, as in other financial securities, are often compared to their sector or industry peer group because most companies within the group are commonly impacted by macro-, microeconomic, and business cycles to a similar degree. Being highly correlated, this is a logical apples-to-apples relative quality comparison of the bonds among its peer group.

iv. **Deriving cost of equity k_e from k_d.** When all else fail, you use the *"own bond yield plus risk premium"* to estimate k_e to do equity analysis and valuation. This variable, in turn, is used in capital budgeting, cash flow analysis, and valuation of the company's publicly-traded stocks.

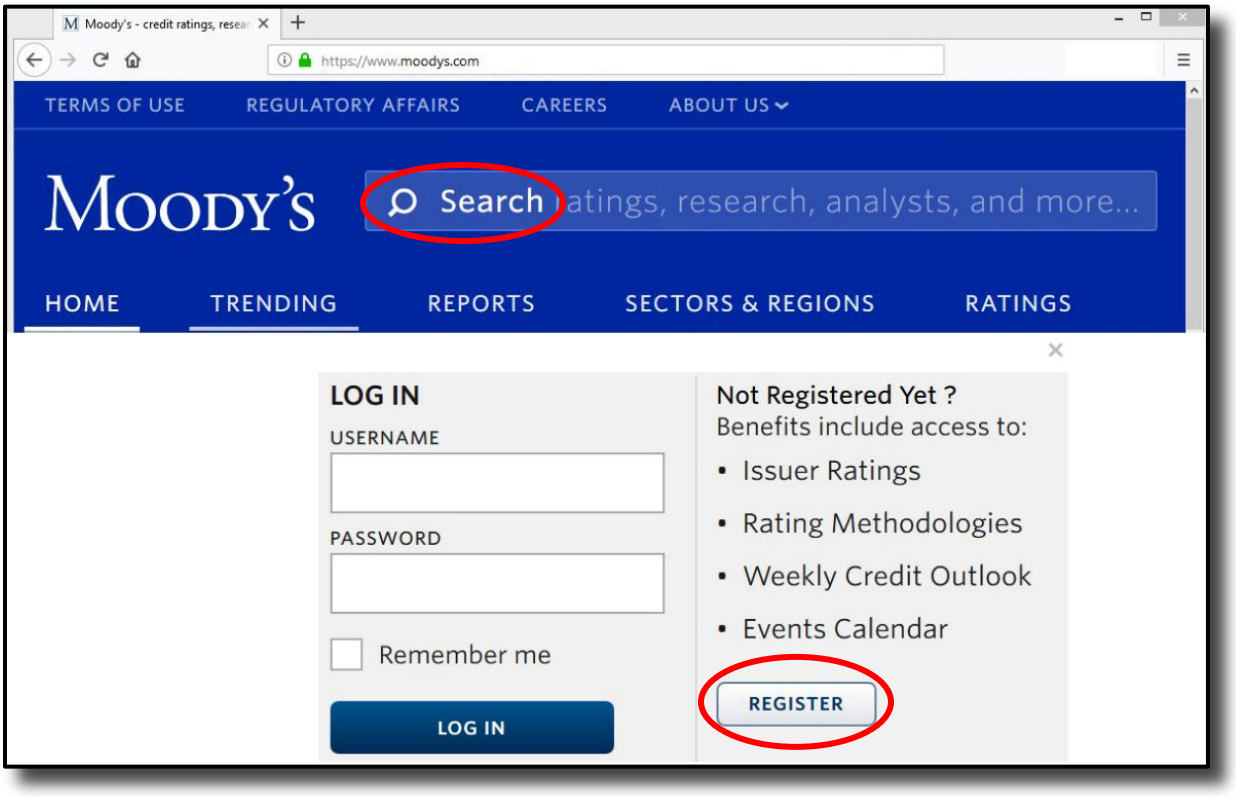
*PS: The data used/reported/illustrated in this guidance document is **dated** at the time of this bond lookup.*
***Yours will be different** based on:*

- *The actual date you will be doing your assignment,*
- *Your choice of bond(s) info lookup(s) used in your assignment,*
- *And the prevailing benchmark U.S. Treasury yields.*

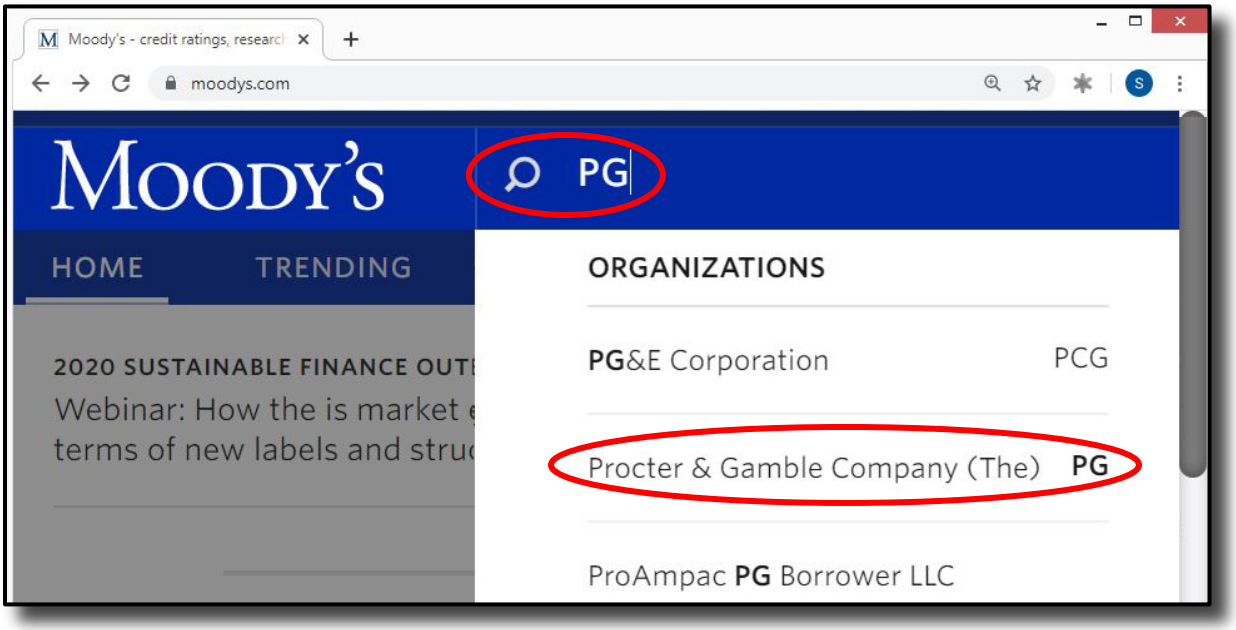
[2A] Using Moody's to find bond info

a. Go to https://www.moodys.com.

b. Use the following **search bar**, to enter your stock's ticker symbol. If this is the first time you are using this website, **Register** using an email address of your choice:

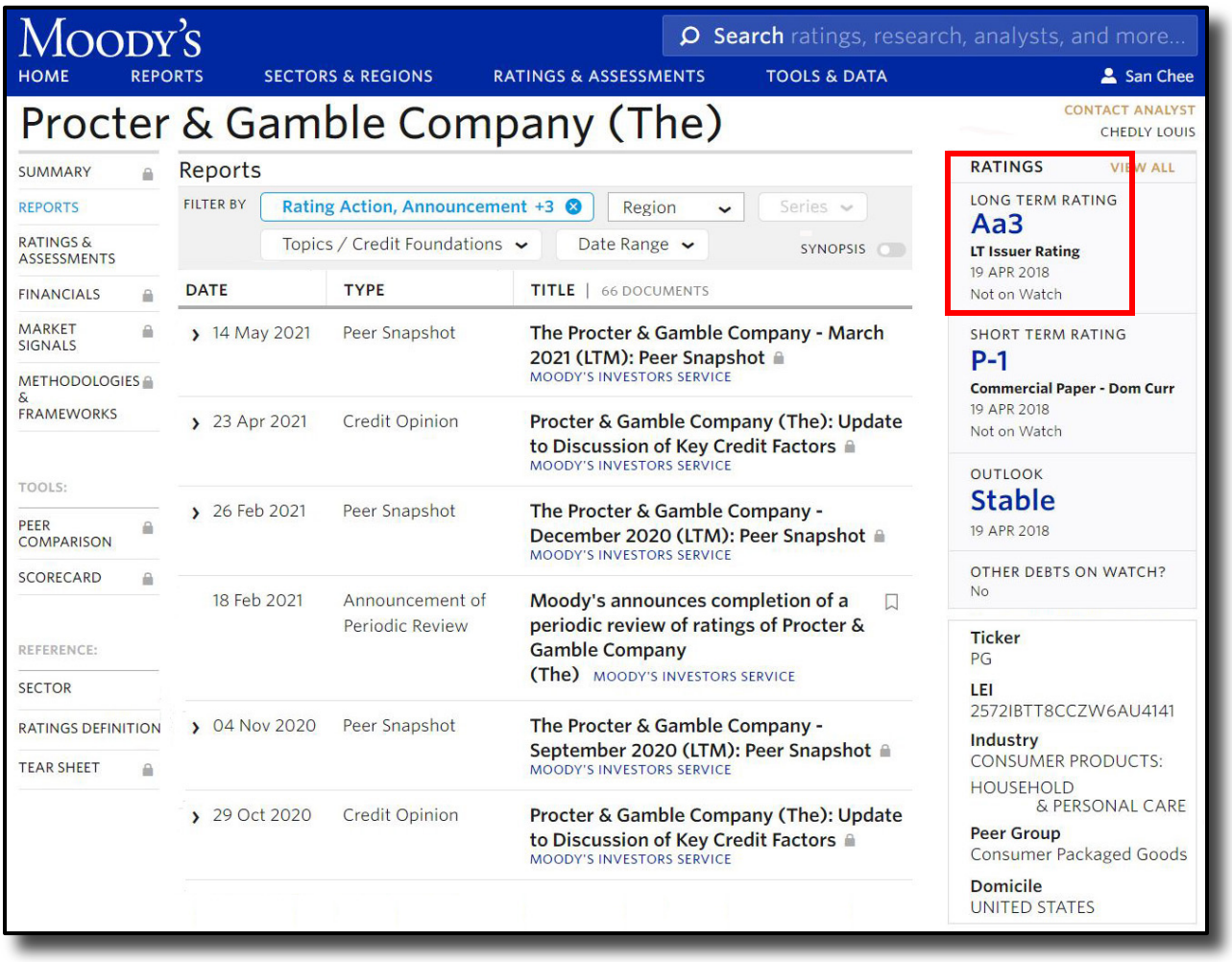


c. Proceed to enter the search using your stock's tick symbol, for example **"PG"** for **Proctor and Gamble**:



d. You should see a lot of credit-related information, for example:

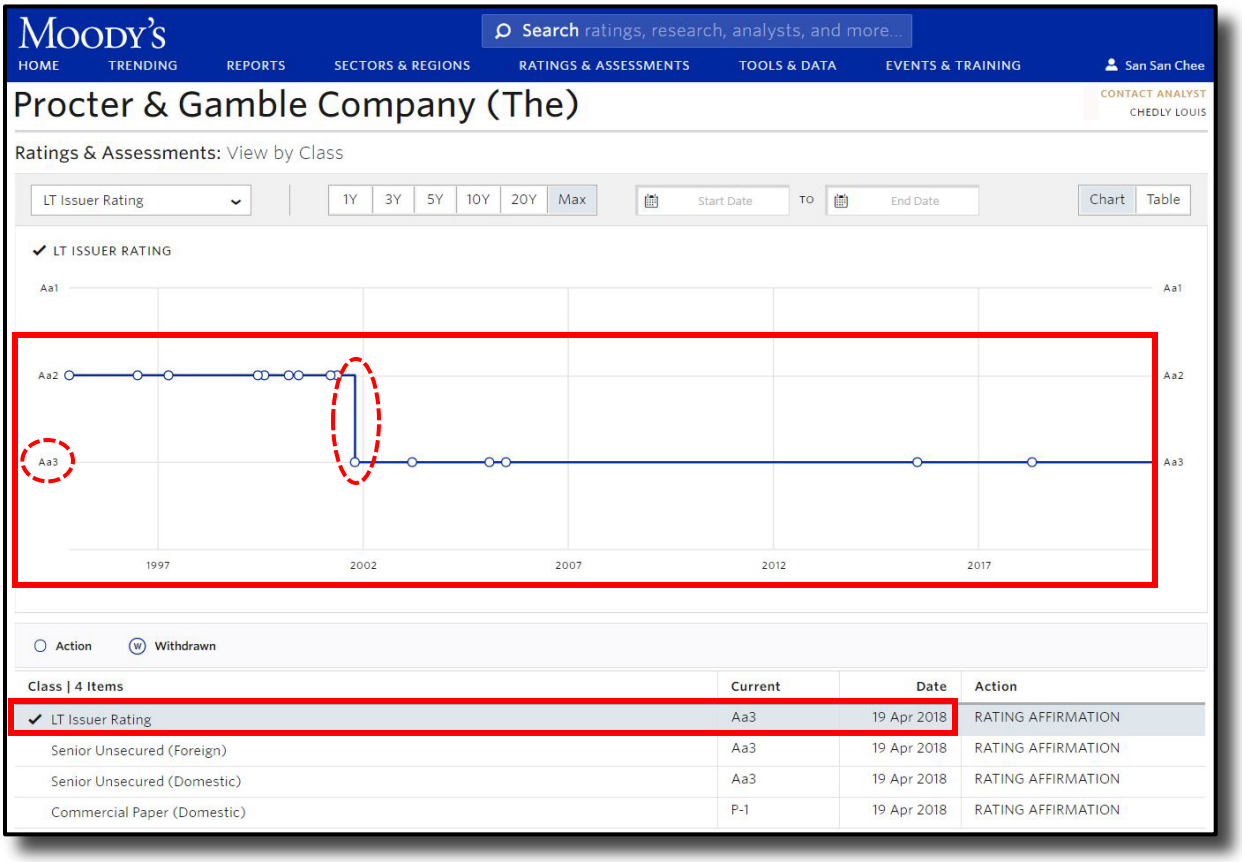
PS: items with a "lock" icon next to it means access to info on that is a paid service -- so, I lied, not all Moody's data is free; the free ones are public domain data and info they willingly give you.



The section we are interested in is the "**Long Term Rating**" section.

PS: don't worry about an "old" date -- for example, PG has been rated an **Aa3 since 19 April 2018** and had remained so till today.

e. Click on the left-hand-side "*Ratings & Assessments*" menu link to see a **history of PG's credit ratings**:
   - ✓ On 19 Oct 2001, PG was downgraded from Aa2 to Aa3 …
   - ✓ … and since that date, there had been a number of "**rating affirmation**", i.e. periodic review of credit rating, to confirm that its credit rating had stayed at Aa3 since.
   - ✓ In addition, PG is currently "**not on watch**" for potential near-future downgrade.

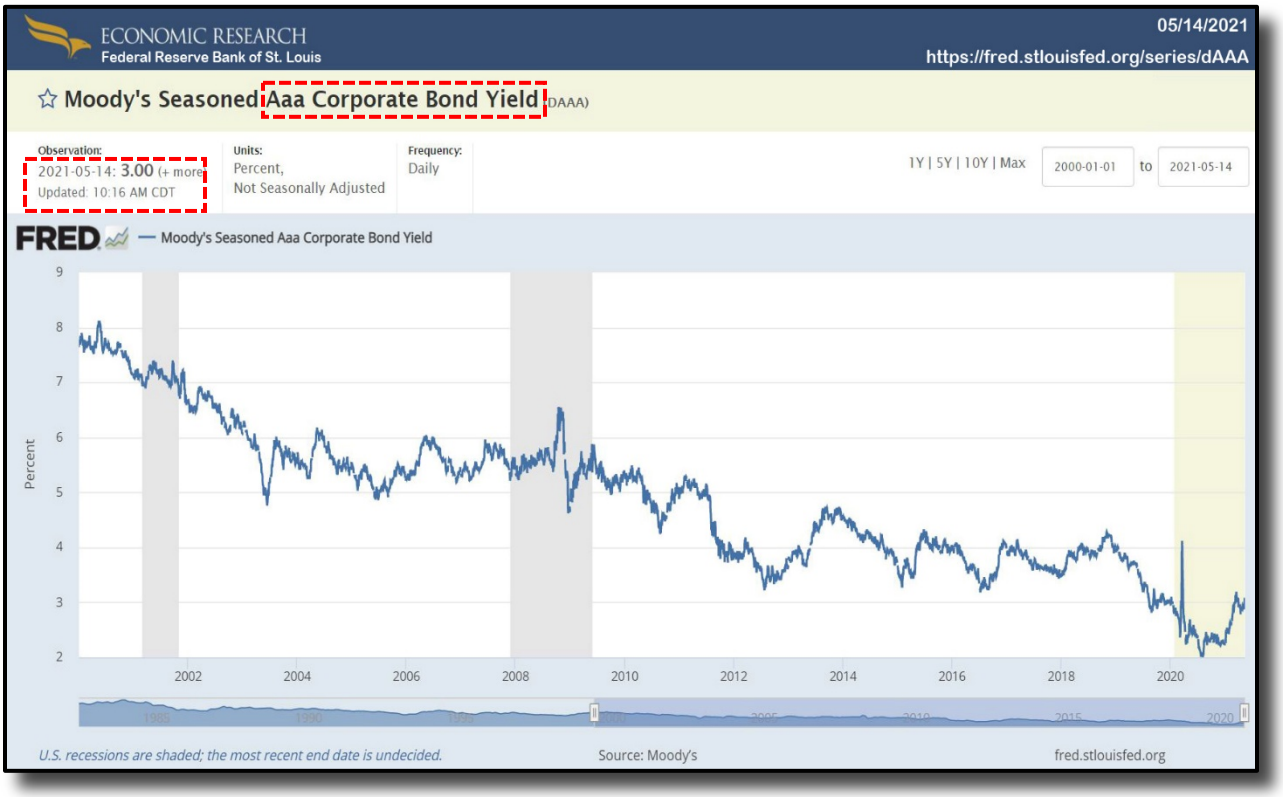


   - ✓ The following is also useful in find more about this company's bond:
   - ✓ Underneath the company name, the **bond issue** will have an **LEI number**. For example, in the above, we have *"LEI 25721BTTBCCZW6AU4141"*.
     - i. An LEI number is a *"Legal Entity Identifier"*. It is a unique number assigned on a global basis by participating government, institutions, agencies, and companies on all sorts of financial transactions and documents.
     - ii. Think of it as a unique Internet address or the more familiar North American *CUSIP* number.
     - iii. In any case, **take the LEI number of the company's bond issue, go to an Internet search engine** [Google Chrome, Firefox, etc.], and paste this LEI number in the search box …
     - *iv.* … you should be able to see a number of search results from various websites and financial portals. In particular, a common one would be **Cbonds** *cbonds.com:*
     - v. Thus, feel free to "chase" whichever search results you get from its LEI.

f. Now, how do you **translate PG's Aa3 credit rating** to its current market yield?

g. You need to look up the **current market's benchmark yields**, for example, the **Aaa** and the **Baa**, which are tracked by the Federal Reserve (with the help of Moody's) on a daily basis.

h. Go to the following URLs https://fred.stlouisfed.org/series/dAAA and https://fred.stlouisfed.org/series/dBAA and read off the current yield for these two corporate credit ratings. For example, **3.00%** for a **AAA** credit rating:



and **3.66%** for a **BAA** credit rating:

i. Using these two known credit ratings and their respective yields and also keeping in mind that there are "finer shades" of credit rating within some grades, **linearly interpolate PG's Aa3 credit rating**. For example:

	Ratings	Yields	Moody's Seasoned Corporate Bond Yield
0	**Aaa**	**3.00%**	https://fred.stlouisfed.org/series/dAAA
1	Aa1	3.08%	*linearly interpolated*
2	Aa2	3.17%	*linearly interpolated*
3	Aa3	3.25%	*linearly interpolated*
4	A1	3.33%	*linearly interpolated*
5	A2	3.41%	*linearly interpolated*
6	A3	3.50%	*linearly interpolated*
7	Baa1	3.58%	*linearly interpolated*
8	**Baa2**	**3.66%**	https://fred.stlouisfed.org/series/dBAA
	Baa3		
	Ba1		
	Ba2		
	Ba3		

j. Some explanation on how we interpolate the above yields:
- There are 8 grades of credit ratings from Aaa [= 3.00%] to Baa [= 3.66%].
- PG's Aa3 credit rating is 3 grades lower than Aaa.
- Therefore **Aa3 is linearly interpolated** as Aaa + 3 × (Baa2 – Aaa) ÷ 8
  = 3.00% + 3 × (3.66% - 3.00%) ÷ 8
  = **3.2475%**

k. Finally, we "**add 5.00% equity risk premium**" to **PG's 3.2475% bond yield** and "round it closest to units of 0.25% to arrive at **PG's k_e of 8.25%**.

> PS: The point is not to spend too much time to be accurate about it because in most of our analysis, **we will be using a range of ballpark k_e** to do equity valuation and analysis on it.

l. PS: How did we get this *"**5.00%**"* equity risk premium" to add from? See prior or separate lecture topic on *"long-run market risk premium RP_M"*.
- Historically, in the U.S. financial market, this has been determined to be as low as 4.00% as its *ultra-long run average* [past 50 years].
- During financial crisis and extreme economic disruption [Subprime and COVID-19], it was as high as 5.50%.
- And as market distress and panics subside, for example the second year of COVID [2021], it has "fallen a little" to 5.00%.

*PS: The data used/reported/illustrated in this guidance document is **dated** at the time of this bond lookup.*
***Yours will be different** based on:*
- *The actual date you will be doing your assignment,*
- *Your choice of bond(s) info lookup(s) used in your assignment,*
- *And the prevailing benchmark U.S. Treasury yields.*

Please note the following about use of this source:

*PS: Morningstar is **no longer a free service**; as of 2018, a (subscribed) Premium Access is required to view this data. **So, the section in the bottom is grayed out.***

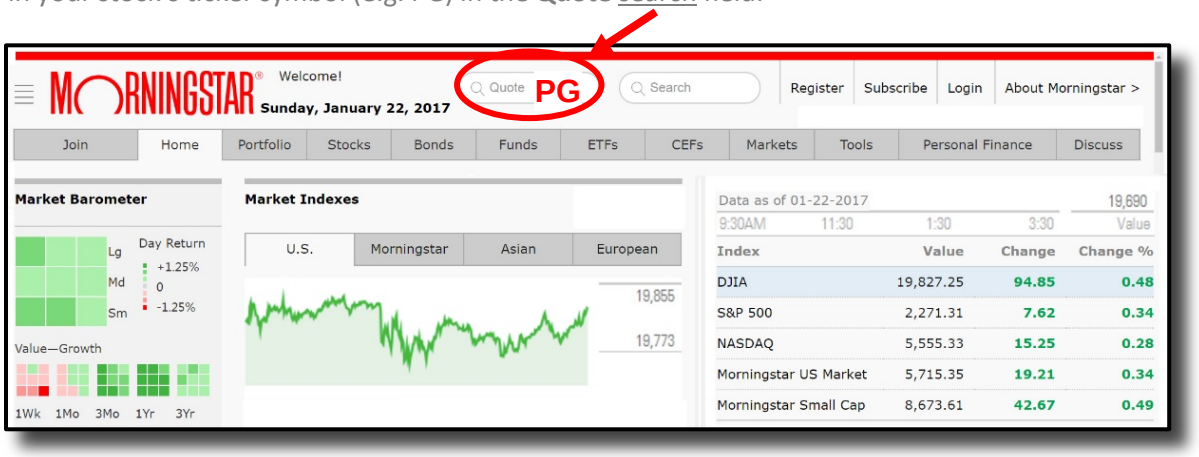
PS: even though we may not have access to MorningStar, this section below is not removed because if/when you start working professionally as an analyst, your company may have paid (subscribed) access to MorningStar – it is one of the more commonly used and "reliable" / "partial" (?) source of company and funds rating agencies.

[2B] Using Morningstar to find bond info

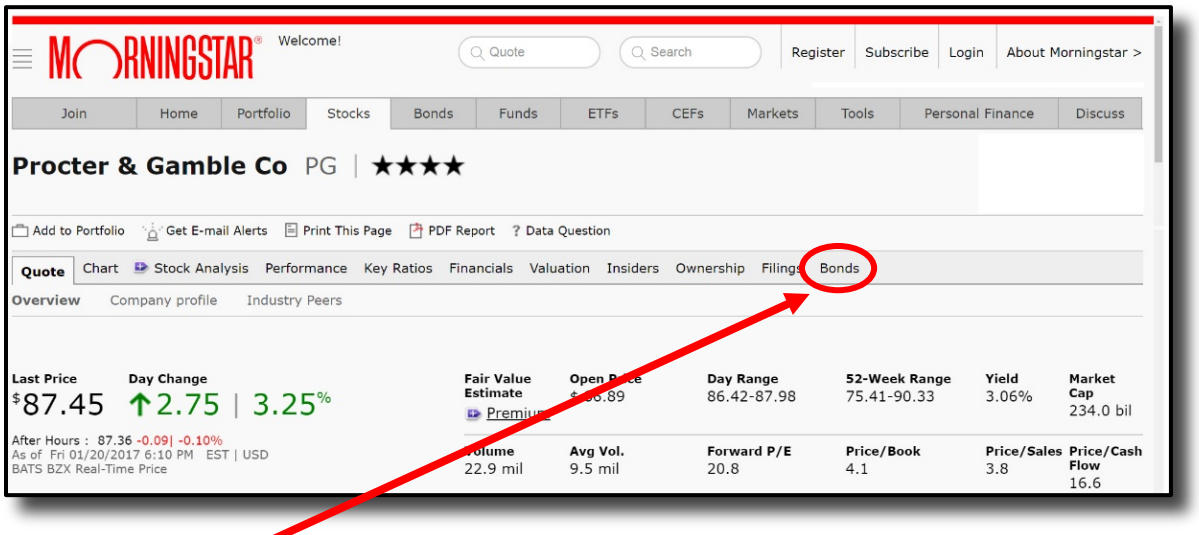
Morningstar is an American investment research services company. Found in 1984, it has established a good reputation for providing unbiased investment research reports, in particular, mutual funds. She has been referred to some as the *"ratings agency (Fitch, Moody's, S&P et al) of mutual funds".*

That reputation and expertise has also been extended to company research and the more recent popularity of Exchange-Traded Funds (ETF).

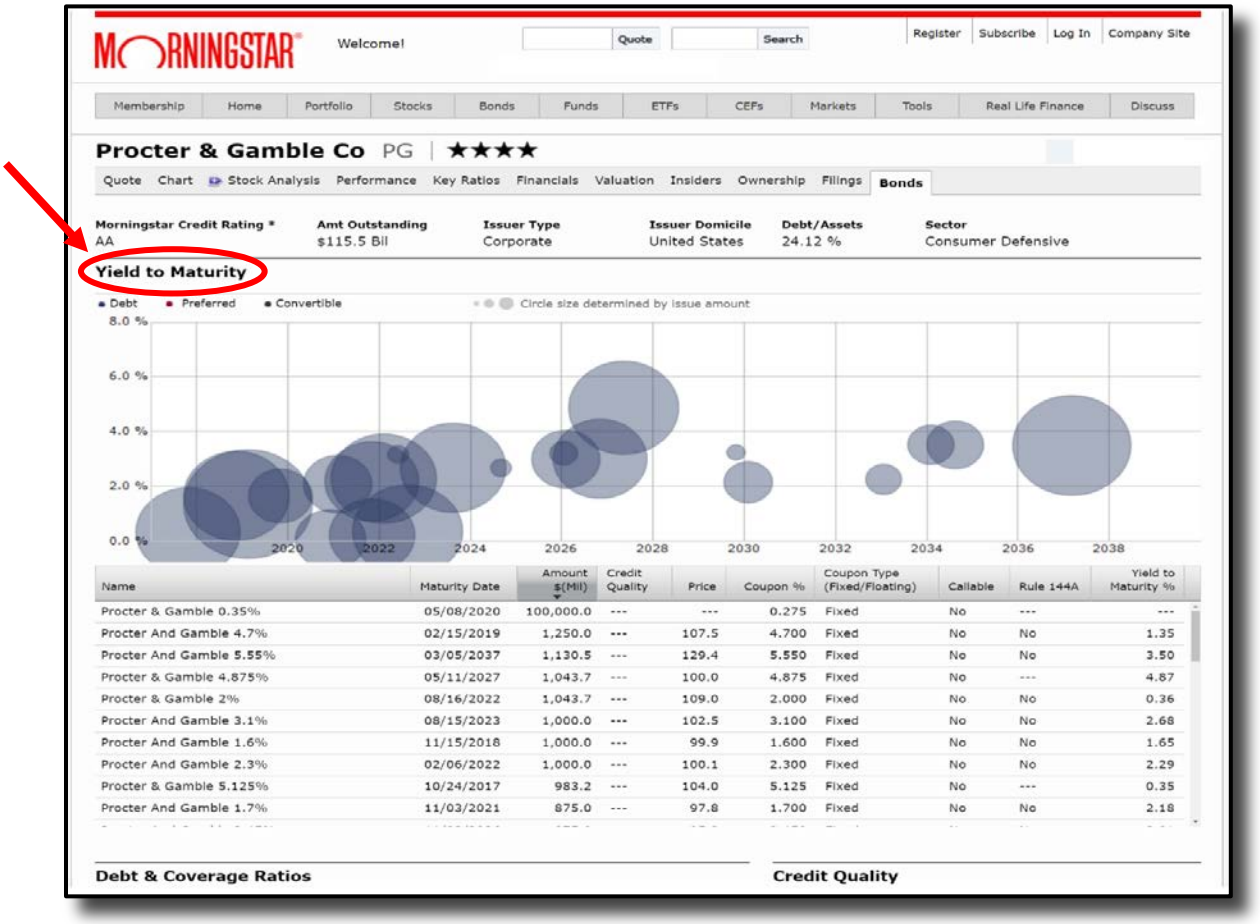
Go to **MorningStar** security and funds rating website www.morningstar.com rating website and put in your stock's ticker symbol (e.g. PG) in the **Quote** search field:



It will display stock-related information:



Click on the "**Bonds**" tab to see its yield information. Take a look at the **Yield to Maturity section**.



As is typical with most large companies with good credit ratings to borrow, it is very likely that there will be **numerous bond issues** over the years. As in the above illustration, each "bubble" corresponds to one bond issue: the size and location of the bubble indicates the face value, YTM, and maturity of each issue.

Taking into all these issues, the "rough average" YTM is about 2.75%.

Adding this 2.25% to the "4% equity risk premium", **we arrived at this stock's k_e of 6.25%**.

<updated 05/17/2021 5pm, for most recent iteration of AD712, 731, AD717 / reminder, do 719 for 2021 Fall>

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