UCD Michael Smurfit
Graduate Business School

FIN42040

CAPITAL MARKETS AND INSTRUMENTS (CMI)

Group 33

Abstract

Analysis of financial performance of companies Johnson and Johnson and CSX Corporation

October 2023

Group Assessment Submission Form

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Arpit – Report work and slides for Q7,8,9 and organized meetings.

Ross – Did the write up on the report for questions 1, 4 & 5. Assisted in formatting report. Reviewed excel calculations. Organized meetings.

Pranjal – Did calculations and prepared graphs for first 6 questions in excel file.

Shubh – Created new and adjusted existing slides in powerpoint, wrote about companies. Cross-checked answers of questions.

Harsh – Competed first 6 slides on powerpoint.

Capital Markets and Instruments

Group 33

Q1.

Johnson and Johnson (JNJ)

Johnson and Johnson is a multinational pharmaceutical company founded in 1886. The company has its headquarters based in New Brunswick, NJ, USA, and its CEO is Joaquin Duato. The company has operations in virtually every country in the world and employs approximately 152,700 employees.

JNJ's main business segments include **Consumer Health** (personal skin, oral, beauty healthcare), **Pharmaceuticals** (development of remedies for ailments pertaining to immunology, infectious diseases, neuroscience, etc.), and **MedTech** (medical devices). Pharmaceuticals is its biggest segment, generating $52 billion for the company in 2022. In 2021, the company announced plans to sell off the consumer health segment of the business to form a distinct, separate entity, Kenvue.

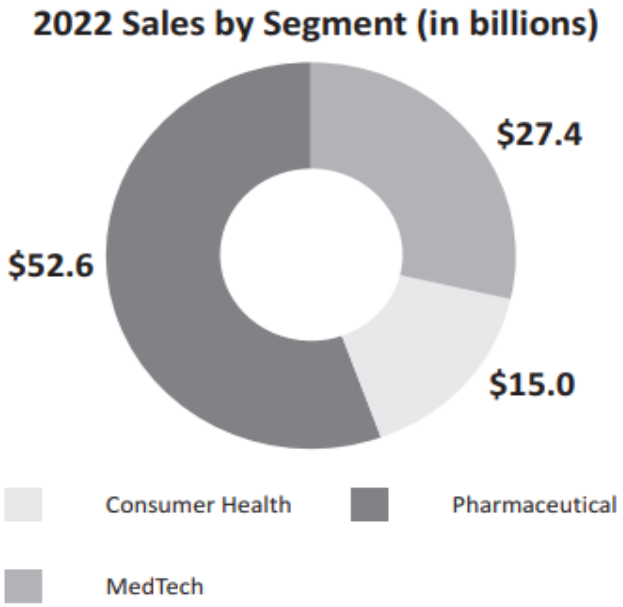


Figure 2 Sales by Segment (Johnson & Johnson Annual report, 2022)

Johnson and Johnson's biggest market is in the U.S., with the region accounting for over half of its global sales revenue in 2022, amounting to approximately $48 billion dollars. According to Mikulic (2023), the U.S. pharmaceuticals industry brought in about $529 billion in revenue in 2022. The U.S. also makes up 45% of the global pharmaceuticals market (Atradius Collections, 2022). The U.S. biotech industry was valued at approximately $190 billion and grew at a rate of 2.2% in 2022 (IBIS World, 2023).

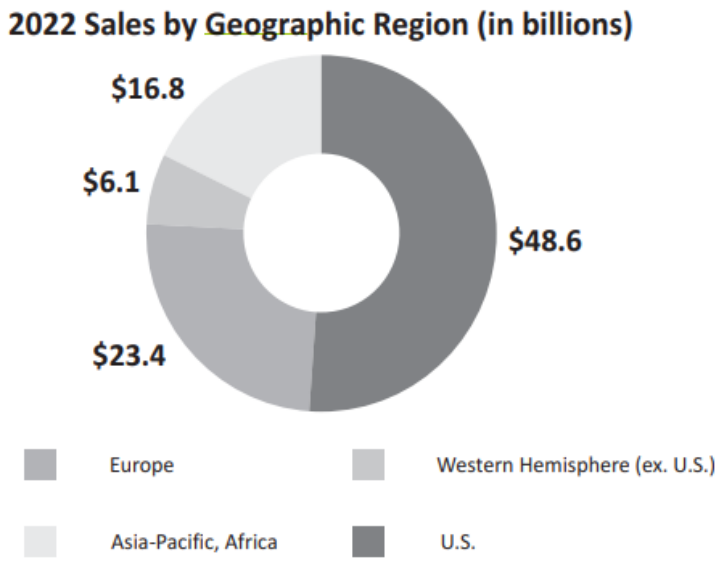
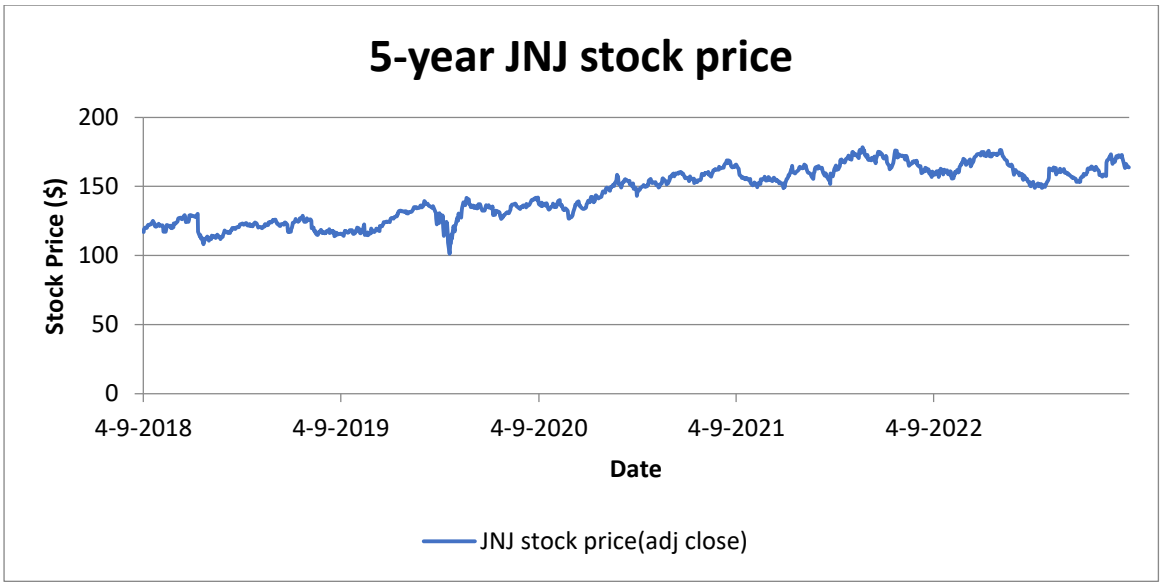


Figure 1 Sales by Geographic Region (Johnson & Johnson, 2022)

In 2022, Johnson and Johnson had $187.37 billion in total assets and $110.574 billion in liabilities, EPS of $6.83 and diluted EPS of $6.73. The average shares outstanding were 2,625.2B.



As we can see above, JNJ's stock price displays low volatility and hasn't fluctuated much over the 5-year period, indicating a potentially low Beta.

CSX Corporation (CSX)

CSX Corporation, established in 1980 via a merger, is an American holding company primarily focused on rail transportation and real estate in North America. Based in Jacksonville, it is one of the nation's leading rail and intermodal transportation suppliers with a network that encompasses about 20,000 route miles of track across 23+ states in US. Nearly two-thirds of Americans live within CSX's service territory. CSX has access to over 70 ocean, river, and lake port terminals along the Atlantic and Gulf Coasts. The company also has access to Pacific ports through alliances with Western railroads.

CSX moves a broad portfolio of products across the country in a way that minimizes the effect on the environment, takes traffic off an already congested highway system, and minimizes fuel consumption and transportation costs.

Major Subsidiaries:

1. CSX Transportation: is a Class I railroad operating in the eastern US and Canada.
2. Conrail: Conrail was the primary Class I railroad in US (1976-1999). While it no longer operates trains it continues to do business as an asset management and network services
3. Winston-Salem Southbound Railway
4. P&L Transportation, Inc.: It is a railroad holding company in the United States jointly owned by the management of the P&L Railway and CSX.

Comparing the above chart with JNJ, we can see that CSX is much more volatile, and in general seems to respond more aggressively to marketwide events (therefore expect higher beta). The price trends for both JNJ and CSX indicate that apart from a major drop around March 2020 (marketwide black swan event due to COVID), both stocks have generally appreciated and are similar in trend (hence expecting positive correlation).

Q2.

Annualized daily returns: Annual returns are calculated by assuming that the stock price changes at the same rate as it did that day (over the last day) for the next year. By the very nature of its calculation, annualized daily return tends to be a very jumpy metric, especially for volatile (high-beta) stocks.

Assuming 252 working days in a year:

$$Annualized\ daily\ log\ returns\ =\ 252 * \ daily\ log\ return\ =\ 252\ *\ ln(\frac{S_{today}}{S_{prev}})$$

For Johnson and Johnson (JNJ):
Mean annualized daily return = 6.75%
Variance of annualized daily return = 0.04261
Standard Deviation = $\sqrt{Variance}$ = 0.206

For CSX Corporation (CSX):
Mean annualized daily return = 5.47%
Variance of annualized daily return = 0.09039
Standard Deviation = $\sqrt{Variance}$ = 0.301

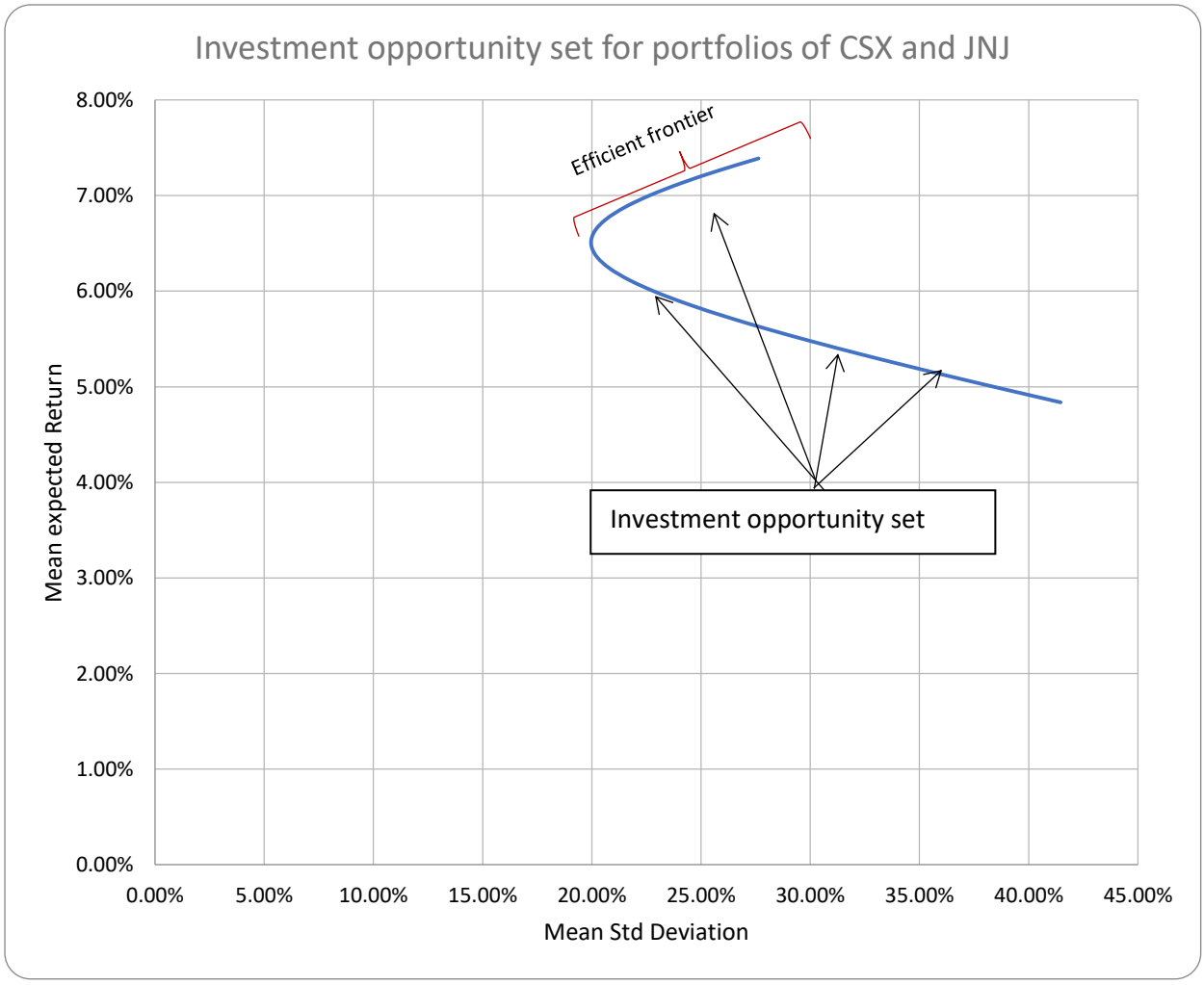
Covariance between JNJ and CSX (σ_{ab}) = 0.0281
Correlation coefficient = $\frac{\sigma_{ab}}{\sigma_a \sigma_b}$ = 0.4523

Q3.

Investment opportunity set: The investment opportunity set refers to the set of all possible combinations of portfolios drawn from every risky asset available to invest. For a 2-asset portfolio (JNJ and CSX in our case), it is the collection of all points on the graph of expected returns (y) vs. standard deviation (x) obtained by varying the weights of the stock. Mathematically, it shows up as a parabola.

Efficient frontier: It is the set of optimal portfolios that offer the highest returns for a given amount of risk. Assuming a 2-asset limitation to the investment opportunities, the efficient frontier is the same as the upper half of the parabola of the opportunity set described above.

For CSX and JNJ-based portfolios, these are plotted below:



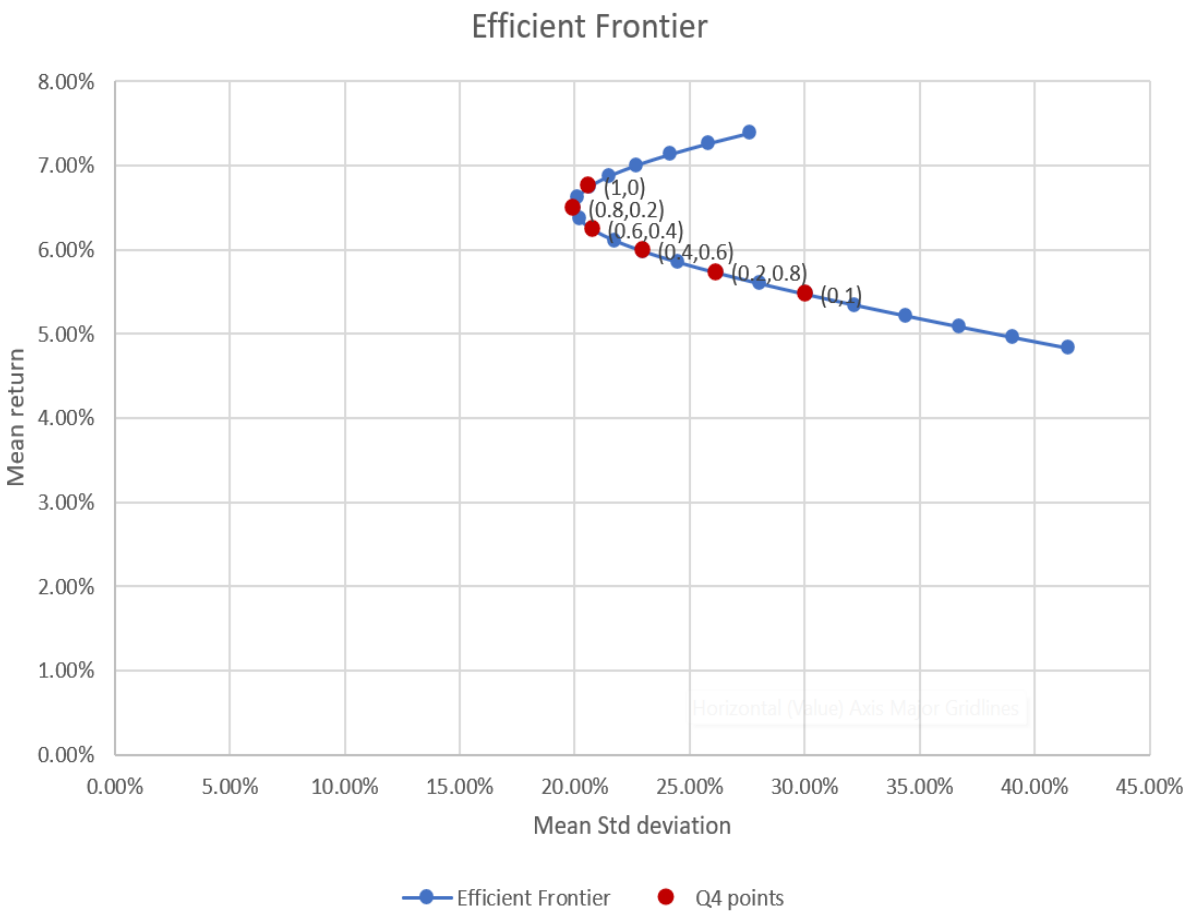
Q4.

Portfolio returns: $E(r_p) = W_1r_1 + W_2r_2$,
Portfolio Variance $\sigma^2_p = (w_1\sigma_1)^2 + (w_2\sigma_2)^2 + 2(w_1\sigma_1)(w_2\sigma_2)p_{12}$.

Returns and variances for the mentioned portfolios are as follows:

Portfolio weights		Portfolio Statistics	
JNJ	CSX	Return	St Dev
1	0	6.75%	20.64%
0.8	0.2	6.50%	19.97%
0.6	0.4	6.24%	20.80%
0.4	0.6	5.99%	22.98%
0.2	0.8	5.73%	26.18%
0	1	5.47%	30.06%

These points are plotted on the investment opportunity set below:



Q5.

The minimum variance portfolio aims to minimize risk and maximize return for a given combination of assets. For a 2-asset universe, minimum variance portfolio is obtained by minimizing the portfolio variance equation mentioned in the previous question.

Using calculus, we set $\frac{d\sigma_p}{dw_1} = 0$ and get:

$$W_1 = \frac{\sigma_2^2 - \sigma_{12}}{\sigma_1^2 + \sigma_2^2 - 2\sigma_{12}}; W_2 = 1 - W_1$$

We get W_{JNJ} = 0.81 and W_{CSX} = 0.19.

Also, standard deviation of this portfolio $\sigma_p = 19.96\%$

Interpretation: The higher proportion of JNJ is expected since the stock provides a greater average rate of return for lower volatility compared to CSX.

Minimum Variance Portfolio

W_{CSX}	0.19
W_{JNJ}	0.81

Minimum Standard deviation	19.96%

Q6.

Risk-free rate calculation: We used the daily variations in yield of **1-month US T-bills** to estimate the risk-free rate of return during this time period by taking a mean ($R_f = 1.64\%$).

The optimal portfolio is the one with the best ratio of return to risk i.e., the highest Sharpe ratio:

$$Sharpe\ ratio\ (S_p) = \frac{(R_p - R_f}{\sigma_p}), where$$

$$R_p = portfolio\ return, R_f: risk - free\ rate, \sigma_p$$
$$= standard\ deviation\ of\ the\ portfolio's\ excess\ return$$

For a 2-asset portfolio:

$$R_p = W_A R_A + W_B R_B,$$

$$\sigma_p^2 = W_A^2\sigma_A^2 + W_B^2\sigma_B^2 + 2W_A W_B \sigma_A \sigma_B, and$$

$$W_B = 1 - W_A.$$

Substituting these in Sharpe ratio calculation, we get:

$$S_p(W_A) = \frac{W_A R_A + (1 - W_A)R_B - R_f}{\sqrt{W_A^2\sigma_A^2 + (1 - W_A)^2\sigma_B^2 + 2W_A(1 - W_A)\sigma_{AB}}}$$

For finding the optimal portfolio, we maximize the Sharpe ratio:

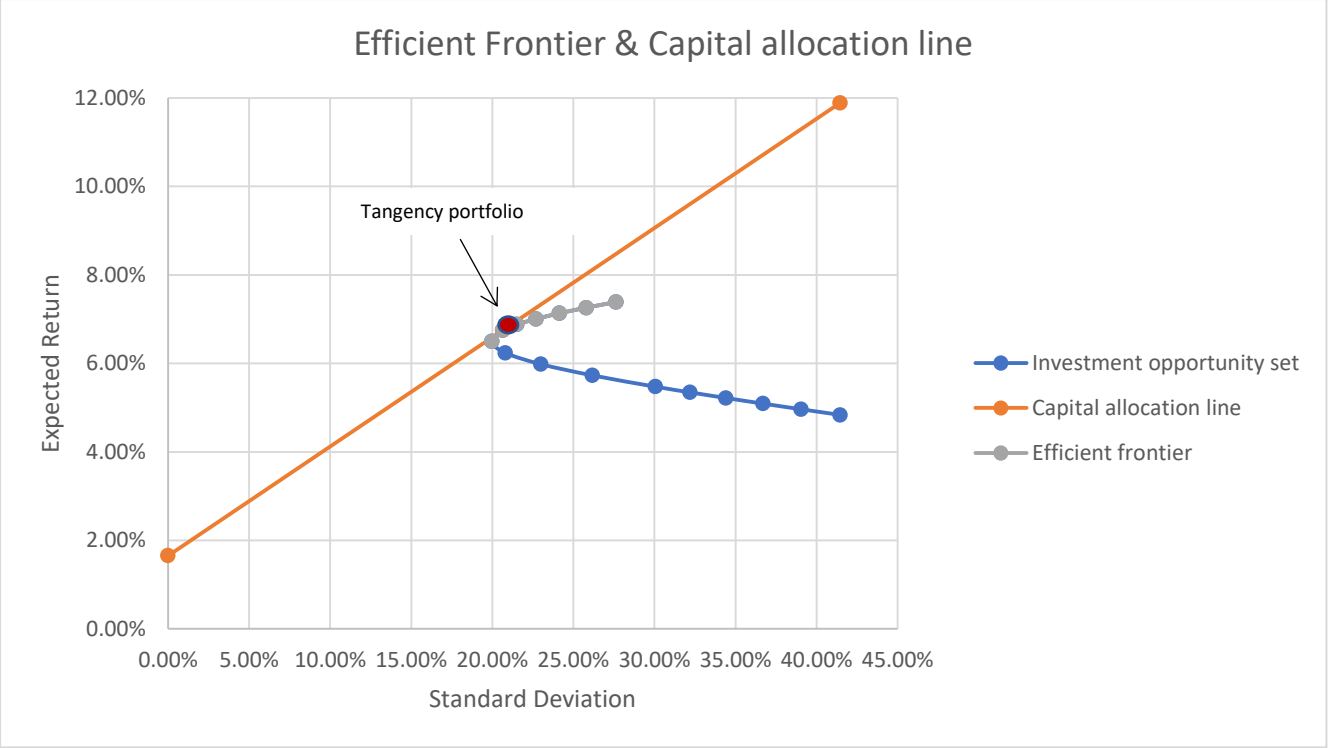
Setting $\frac{d(S_P)}{d(W_A)} = 0$ gives:

$$W_A = \frac{(R_A - R_f)\sigma_B^2 - (R_B - R_f)\sigma_{AB}}{(R_A - R_f)\sigma_B^2 + (R_B - R_f)\sigma_A^2 - (R_A - R_f + R_B - R_f)\sigma_{AB}};$$

$$W_B = 1 - W_A$$

Substituting the values, we get:

$$W_{JNJ} = 0.947; W_{CSX} = 0.053$$



We can verify this result by approximately comparing these weights with the Sharpe ratio obtained for portfolios that we plotted while calculating the investment opportunity set:

Step 4/Step	Portfolio	Weight-JNJ	weight-CSX	Portfolio-Risk	Portfolio-Return	Sharpe Ratio	
	1	1.5	-0.5	27.63%	7.39%	20.75%	
	2	1.4	-0.4	25.79%	7.26%	21.74%	
	3	1.3	-0.3	24.13%	7.13%	22.70%	
	4	1.2	-0.2	22.69%	7.01%	23.58%	
	5	1.1	-0.1	21.51%	6.88%	24.28%	
Max Sharpe ratio	6	1	0	20.64%	6.75%	24.69%	
	7	0.8	0.2	**19.97%**	**6.50%**	24.25%	
	8	0.6	0.4	20.80%	6.24%	22.05%	
	9	0.4	0.6	22.98%	5.99%	18.84%	
	10	0.2	0.8	26.18%	5.73%	15.57%	
	11	0	1	30.06%	5.47%	12.71%	
	12	-0.1	1.1	32.19%	5.35%	11.47%	
	13	-0.2	1.2	34.41%	5.22%	10.36%	
	14	-0.3	1.3	36.70%	5.09%	9.37%	
	15	-0.4	1.4	39.06%	4.96%	8.48%	
	16	-0.5	1.5	41.46%	4.84%	7.68%	
Optimal Portfolio		**1**	**0**	**20.64%**	**6.75%**	**Based on max Sharpe ratio**	

Q7.

$$U = r - k \times \sigma^2$$

For a portfolio consisting of 3 assets (2 risky and 1 risk-free), we have:

$r_c = w_p r_p + w_f r_f$

$\sigma_c^2 = w_p^2 \sigma_p^2$, since the risk (standard deviation) of a risk-free asset is 0.

,where c: complete (3-asset) portfolio, p: risky asset (2-asset) portfolio.

Substituting these in the utility function:

$$U(w_p) = (w_p r_p + w_f r_f) - k\,(w_p^2), where\ w_f = 1 - w_p$$

To maximize the Utility for the investor, we find the derivative of the Utility function:

$$\frac{dU}{dw_p} = r_p + r_f(-1) - 2\,k\,\sigma_p^2 w_p$$

Setting $\frac{dU}{dw_p} = 0$:

$$w_p = \frac{r_p - r_f}{2k\sigma_p^2}$$

$\frac{d^2U}{dw_p^2} = -2k\sigma_p^2 < 0$, which confirms that this value of w_p maximizes the Utility.

Setting k =2 (moderate (but positive) risk-aversion), we obtain:

$$w_p = 0.305; w_f = 0.694$$

Therefore, $w_{JNJ} = (0.947 * w_p) = 0.289; w_{CSX} = (0.053 * w_p) = 0.016;\ w_f = 0.694$

The coefficient of risk-aversion (k) quantifies the level of risk-aversion of the investor, therefore as k increases, the variance of the resulting portfolio decreases as the investor indicates his higher preference for a ”safer” portfolio. Thus, the weight of the risk-free asset keeps increasing as k rises.

Q8.

We chose S&P 500 as the market index for our calculations.

For the 5-year period, we get:

$$Mean\ annualized\ market\ log\ return\ (R_M) = 8.91\%$$

$$Market\ variance = 0.0479$$

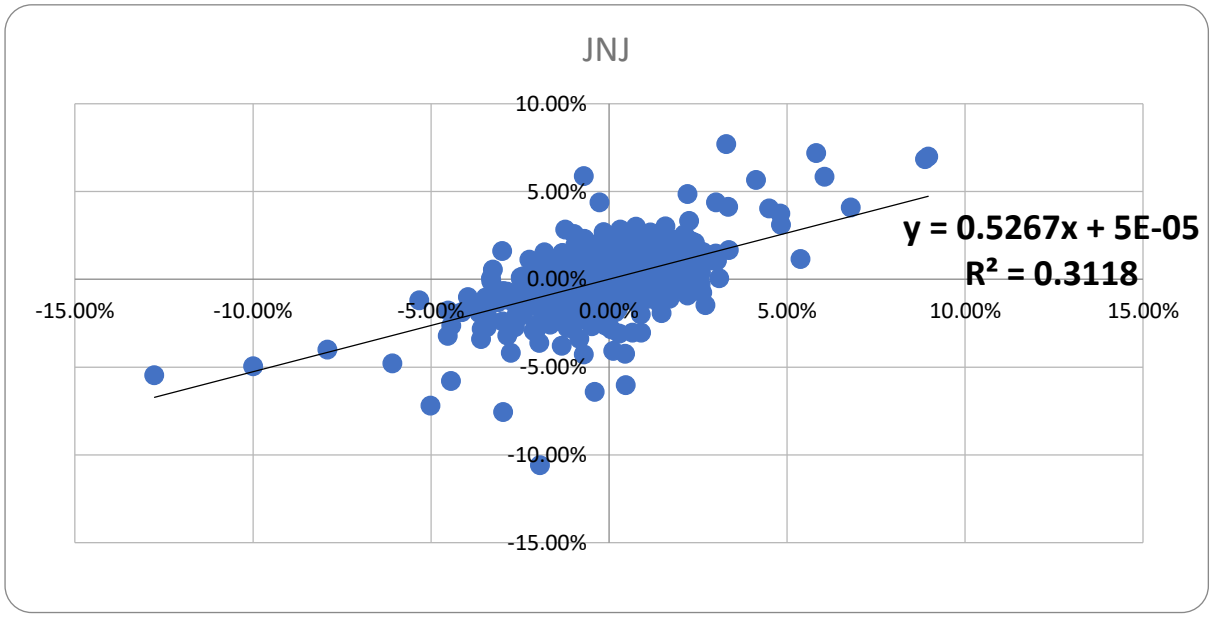
$$Market\ standard\ deviation = 0.2188$$

Beta is a measure of the systemic risk (volatility) of the stock as compared to the volatility of the market as a whole. Therefore, by definition, a stock with a beta of 1 is just as volatile as the market, while a stock with beta > 1 indicates that the stock will move with more momentum than the overall market. Mathematically, beta is defined as:

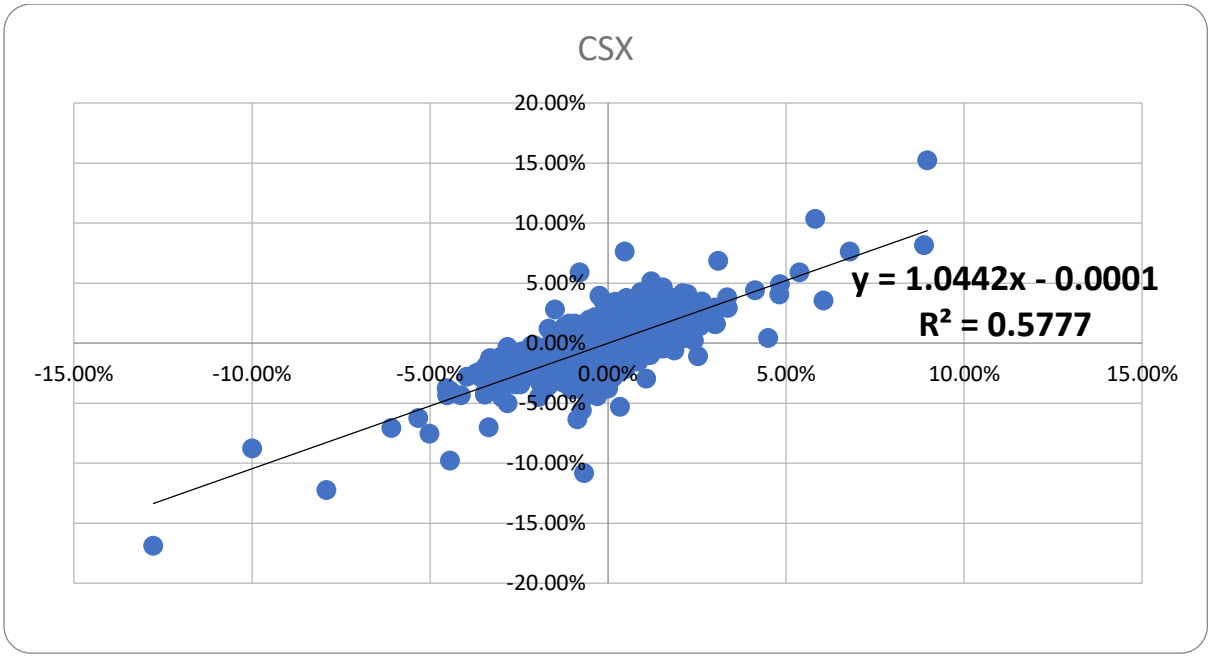
$$Beta\ (\beta_a) = \frac{Covariance(R_a, R_m)}{Variance(R_m)}$$

where a: stock, m: market.

We approximate the Beta for CSX and JNJ below by fitting an OLS regression model between each stocks excess return $(R_{stock} - R_f)$ on the y axis vs the excess market return $\left(R_M - R_f\right)$ for the 5 year period:



For JNJ, $y = 0.5267x + 0.00005; R^2 = 0.3118$



For CSX, $y = 1.0442x - 0.0001; R^2 = 0.5777$

Therefore, as mathematically beta would be the slope of these graphs,

$$\beta_{JNJ} = 0.5267;\ \beta_{CSX} = 1.0442$$

Therefore, JNJ is about half as volatile as the overall market, while CSX is just as volatile as the overall market.

The R^2 values indicate the amount of variance in the stock's return that is explained by the market (x) movement as approximated by the linear model (beta). Therefore, variations in CSX are more correlated and can be better explained by the variations in S&P as compared to those in JNJ's movements vs the market movement, as CSX's R^2 is higher. Used together, β and R^2 give a detailed picture of the expected performance.

Q9.

Jensen's alpha: is a risk-adjusted measure of an asset's performance that represents the excess return obtained in actual over the predicted performance of the asset as per the Capital Assets Pricing Model (CAPM). When, say, an asset manager outperforms on his portfolio in a risk-adjusted manner, they are said to deliver "alpha" to their clientele.

$$Alpha = R_i^{actual} - R_i^{expected\ as\ per\ CAPM}$$

As per CAPM, expected returns for stock i: $R_i = R_f + \beta(R_m - R_f)$

Using $R_f = 1.64\%, R_m = 8.91\%$:

$$R_{JNJ} = 1.64 + 0.5267(8.91 - 1.64) = 5.47\% R_{CSX} = 1.64 + 1.0442(8.91 - 1.64) = 9.23\%$$

Actual market returns for September 1:

	Date	Open	High	Low	Close*	Adj Close**
JNJ	Aug 31, 2023	163.37	163.57	161.28	161.68	161.68
	Sep 01, 2023	161.42	162.48	160.01	160.48	160.48
CSX	Aug 31, 2023	30.71	30.74	30.18	30.2	30.2
	Sep 01, 2023	30.48	30.76	30.34	30.63	30.63

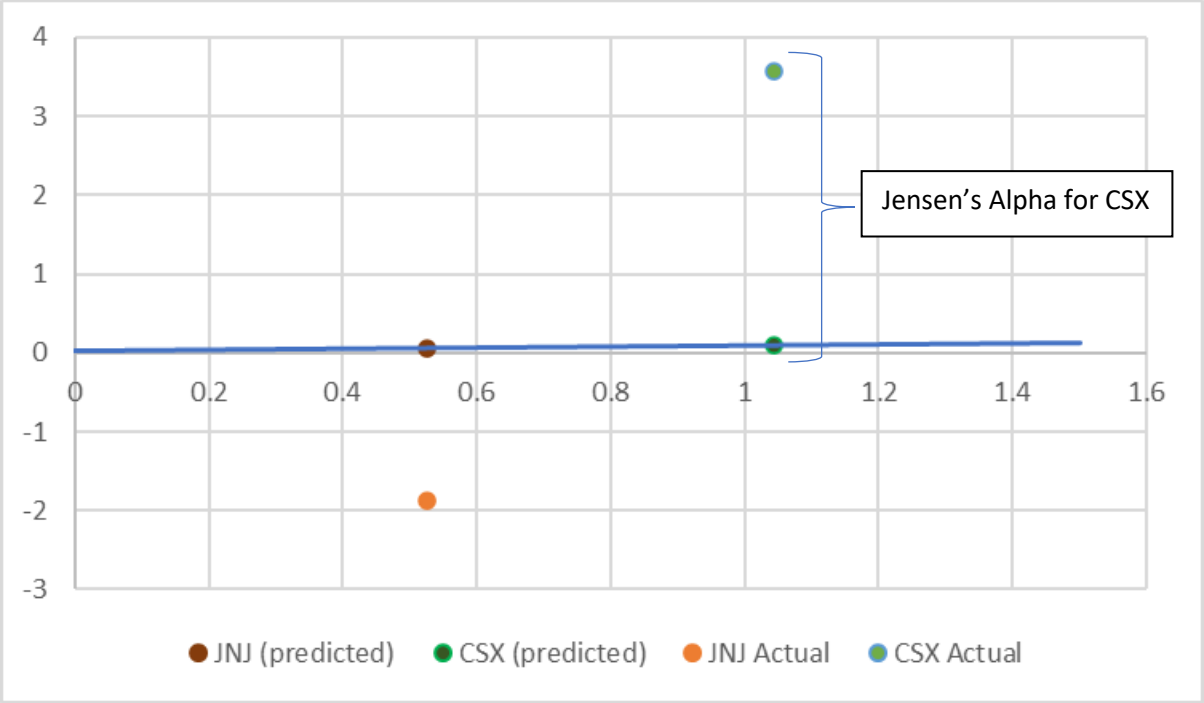
Therefore, Actual annualized log return on Sep 1 for JNJ: $R_{JNJ}^{actual} = ln\left(\frac{160.48}{161.68}\right) * 252 = -187.73\%$

Actual annualized log return on Sep 1 for CSX: $R_{CSX}^{actual} = ln\left(\frac{30.63}{30.2}\right) * 252 = 356.28\%$

Therefore,

$$alpha_{JNJ} = R_{JNJ}^{actual} - R_{JNJ}^{expected} = (-187.73\%) - 5.47\% = -193.20\%$$

$$alpha_{CSX} = R_{CSX}^{actual} - R_{CSX}^{expected} = 356.28\% - 9.23\% = 347.04\%$$



Interpretation of the alpha values obtained above:

As we can see in the above calculations, the actual return values are significantly different in magnitude as compared to the expected values for both JNJ and CSX. This is because for both stocks (and for all stocks in general), the daily variations in prices are much higher than other securities, which is due to a much larger standard deviation (volatility) of these assets compared to other "safer" assets like bonds etc.

Therefore, as we are only predicting 1 day in the future (on Sep 1) and then annualizing it (multiplying by 252 therefore making it a highly volatile calculation) and then comparing this return with the expected value (which is obtained as a 5 year average, and therefore has a significantly subsidised volatility), the two values are significantly different and thus also lead to very large alpha values as calculated above.

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