Fin629A: Fixed Income Analytics
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ANALYTICAL SUMMARY

In this research, we present you with the company Walt Disney, its features and business strategy, as well as crucial financial parameters to consider before investing in their bonds. We examined **three** Walt Disney bonds to discover their specific characteristics and to develop an immunized portfolio. Finally, the Walt Disney bonds were compared against the bonds of its competitors as well as their treasury benchmarks to assess whether they were a good investment choice given all of the possibilities.

We **compared** Disney bonds to those of Paramount and Netflix, to conclude that Disney bonds compare better, and we investigated the why. We also compared them in accordance with their ratings.

The duration and convexity of all three bonds were also established in order to derive a better understanding of their behavior as market conditions change. We formulated different yield-to-price curves to understand the relationship between duration, convexity, and price of the bond with the help of data visualization tools. Two of the three bonds which were short-term and long term were used to form a projected immunized portfolio.

We also conducted our calculations in **Python** for a better understanding and accurate results.

We implemented a **Portfolio plan**, where we picked the bond **ETFs** and s&p500 and calculated the hedge ratio of the portfolio with respect to s&p500 to protect the investment.

ABOUT WALT DISNEY

Disney, a prominent player in the **entertainment industry**, has successfully delivered exceptional content that resonates with audiences of all ages.
The Walt Disney Company is a century old, one of the largest and illustriously diversified conglomerates with a **valuation of $233 Billion**.
It ranks 53rd in the fortune 500 list of most valued companies in the world.
The company's businesses are aligned into four major segments including **media networks, theme park experiences, consumer products, filmed entertainment, and direct-to-consumer business.**
Its unwavering commitment to **family-friendly entertainment** and **focus on innovation** has made it a renowned global brand.
The Walt Disney Company is also one of the few corporates ever to have sold bonds with 100-year maturities to institutional and retail investors.
The headquaters of the company is located in United States Of America
Walt Disney has **acquired a total of 22 companies** , the largest acquisition till date was in 2017 when it acquired twenty-first century fox .

CUSTOMER SEGMENT

Disney’s customer segments are broadly divided into three:

Mass Market: People who seek leisure and entertainment;

Families: Families who seek family-friendly entertainment;

Kids and Young People: Young people seeking relatable entertainment and information

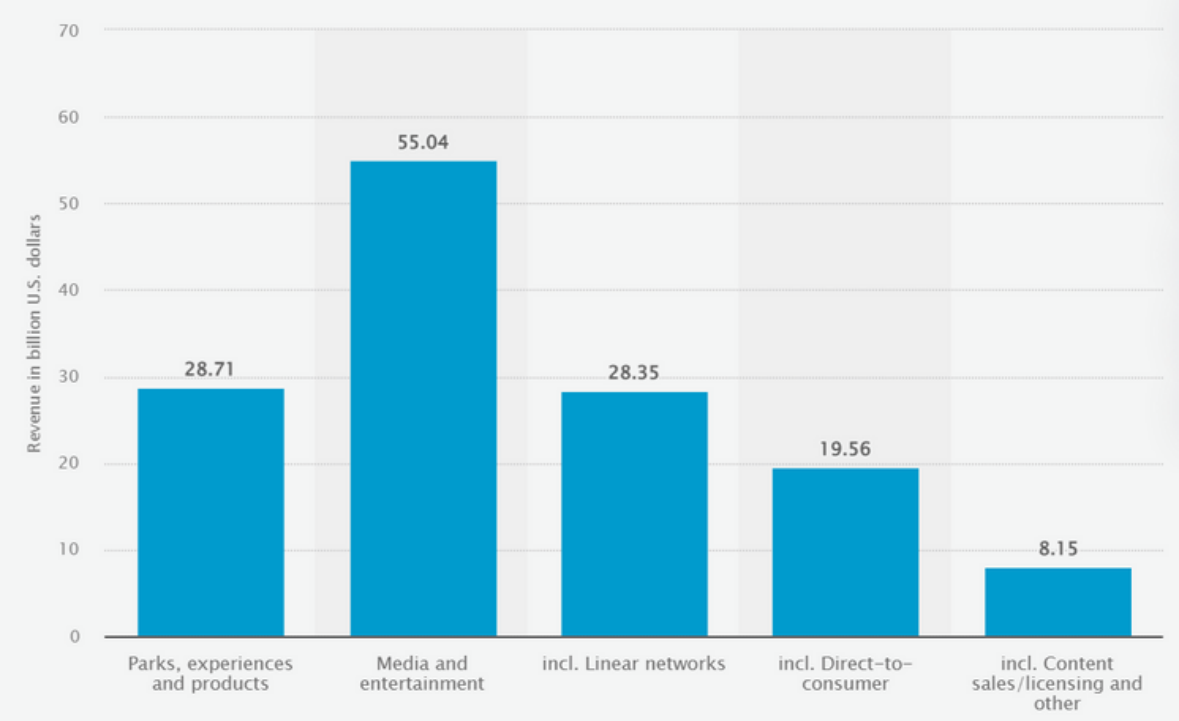
CURRENT ACTIVITIES

Disney’s activities are created to ensure entertainment for their customers.

Content Creation
Branding
Marketing
Licensing
Operations
Market research

REVENUE BREAKDOWN

Revenue of the Walt Disney Company in the fiscal year 2022, by operating segment(in billion U.S. dollars)



DISNEY'S COMPETITORS

Disney is a multifaceted family entertainment and media company. Disney's competitors include Paramount, Netflix, Sony Pictures, Time Warner Inc., and CBS. In the subsequent section of the research, we will compare Disney's bonds with Netflix and Paramount.

KEY FINANCIAL STATISTICS

Market Cap - $ 181.90 B

PE Ratio - 54.24

Debt to Equity Ratio - 0.5

Return on Equity - 3.5%

Gross Margin - 33.4%

Return on Asset - 2.07%

EBIDTA - $11.9 B

Levered Free Cash Flow - $4.86 B

Return on Capital - 7.50%

Interest Coverage Ratio - 4.4

SWOT ANALYSIS

STRENGTH:

DIVERSIFIED OFFERINGS
MARKET EXPERIENCE

WEAKNESS:

RELY ON NORTH AMERICA
BRAND CONFUSION

OPPORTUNITY:

TREND ADAPTATION
GLOBAL EXPANSION

THREAT:

COMPETITION
HUGE OVERHEAD COSTS

BOND ISSUE CHARACTERISICS

CUSIP	Type	Maturity	Frequency	YTM	Coupon Rate	callable / Non - callable	Call Date
254687FZ4 Corp	Long Term	01-01-2051	Semi - Annual	3.6	3.6	Callable	07-13-2050
254687FL5 Corp	Medium Term	09-01-2029	Semi - Annual	2.166	2	Callable	06-01-2029
254687FV3 Corp	Short Term	01-13-2026	Semi - Annual	1.798	1.75	Non - Callable	-

DETAILED DESCRIPTION

Guarantor: The notes will be guaranteed fully and unconditionally by TWDC Enterprises 18 Corp

Securities Offered: $1,500,000,000 1.750% notes due 2026
$1,000,000,000 2.200% notes due 2029
$2,750,000,000 3.600% notes due 2051

Ranking of our Bonds: These bonds will be Walt Disney's senior unsecured obligations and will rank pari passu with all other unsecured and unsubordinated indebtedness outstanding from time to time

Trustee of our Bonds: Citibank N.A

LONG TERM BOND

Coupon Rate	Maturity Date
3.600%	01/13/2051

Symbol	CUSIP	Next Call Date	Callable
DIS4986752	254687FZ4	07/13/2050	Yes

Last Trade Price	Last Trade Yield	Last Trade Date	US Treasury Yield
$79.20	4.995%	05/11/2023	—

Trade History Prospectus

Price/Yield Chart

Price Chart | **Yield Chart**

05/13/2020 - 05/11/2023 Zoom: 5D 1M 3M YTD 1Y 3Y 5Y 10Y Max

— Yield

Classification Elements

Bond Type	US Corporate Debentures
Debt Type	Senior Unsecured Note
Industry Group	Industrial
Industry Sub Group	Service/Leisure
Sub-Product Asset	CORP
Sub-Product Asset Type	Corporate Bond
State	—
Use of Proceeds	—
Security Code	—
Special Characteristics	
Medium Term Note	N

Issue Elements

Offering Date	05/11/2020
Dated Date	05/13/2020
First Coupon Date	01/13/2021

MEDIUM TERM BOND

Coupon Rate	Maturity Date
2.000%	09/01/2029

Symbol	CUSIP	Next Call Date	Callable
DIS4880254	254687FL5	06/01/2029	Yes

Last Trade Price	Last Trade Yield	Last Trade Date	US Treasury Yield
$87.87	4.213%	05/11/2023	—

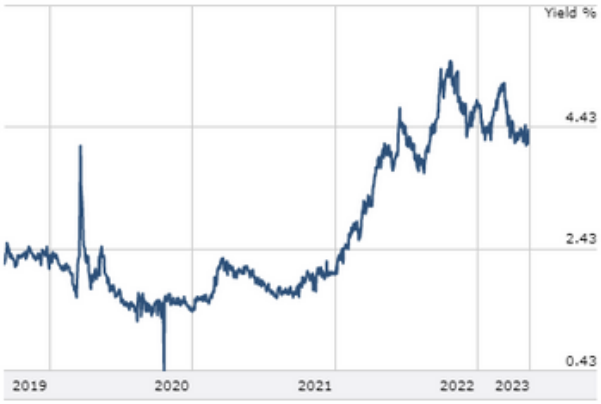
Trade History Prospectus

Price/Yield Chart

Price Chart | **Yield Chart**

09/05/2019 - 05/11/2023 Zoom: 5D 1M 3M YTD 1Y 3Y 5Y 10Y Max

— Yield



Classification Elements

Bond Type	US Corporate Debentures
Debt Type	Senior Unsecured Note
Industry Group	Industrial
Industry Sub Group	Service/Leisure
Sub-Product Asset	CORP
Sub-Product Asset Type	Corporate Bond
State	—
Use of Proceeds	—
Security Code	—
Special Characteristics	
Medium Term Note	N

Issue Elements

Offering Date	09/03/2019
Dated Date	09/06/2019
First Coupon Date	03/01/2020

SHORT TERM BOND

Coupon Rate	Maturity Date
1.750%	01/13/2026

Symbol	CUSIP	Next Call Date	Callable
DIS4986748	254687FV3	—	Yes

Last Trade Price	Last Trade Yield	Last Trade Date	US Treasury Yield
$94.19	4.075%	05/11/2023	—

Trade History Prospectus

Price/Yield Chart

Classification Elements

Bond Type	US Corporate Debentures
Debt Type	Senior Unsecured Note
Industry Group	Industrial
Industry Sub Group	Service/Leisure
Sub-Product Asset	CORP
Sub-Product Asset Type	Corporate Bond
State	—
Use of Proceeds	—
Security Code	—

Special Characteristics

Medium Term Note	N

Issue Elements

Offering Date	05/11/2020
Dated Date	05/13/2020
First Coupon Date	01/13/2021

BOND YIELDS

- A bond yield refers to the return an investor receives on their investment in a bond. It is the rate of interest that a bond pays out annually divided by its price
- The price of a bond and its yield are inversely related. As the price of a bond goes up, its yield goes down.
- when interest rates rise, bond yields also rise, as investors demand a higher return to compensate for the increased risk of inflation.
- Bond yields reflect the bond's investment return as a percentage of its face value and are influenced by interest rates, inflation, the creditworthiness of the issuer, and market demand.
- The health of the economy can be inferred by monitoring bond yields, making it a key area of interest for investors and economists.

CURRENT YIELD

- The current yield of a bond measures the annual income an investor can expect to receive from the bond relative to its current market price. It is expressed as a percentage and is calculated by dividing the bond's annual coupon payment by its current market price.

- Investors use the current yield to evaluate whether a bond is offering a competitive return relative to other investments with similar risk profiles

CURRENT YIELD OF WALT DISNEY'S BONDS

Metrics	Short Term	Medium Term	Long Term
Coupon Rate	1.75	2	3.6
Current Price	$93.70	$86.89	$79.88
Current Yield	1.89%	2.30%	4.50%

CURRENT YIELD OF COMPETITOR'S BONDS

	Paramount	Netflix
Metrics	Short Term	Medium Term
Coupon Rate	1.75	2
Current Price	$93.70	$86.89
Current Yield	1.89%	2.30%

YIELD TO MATURITY

- Yield to maturity (YTM) is a measure of the total return an investor can expect to receive on his bonds if it is held until the bond matures.

- The YTM is an important measure for bond investors because it provides a more accurate estimate of the bond's total return than the nominal yield or current yield, which only considers the annual coupon payments

- YTM can be used to compare the relative value of different bonds with similar characteristics, such as credit rating and maturity.

YIELD TO MATURITY OF WALT DISNEY'S BONDS

Metrics	Short Term	Medium Term	Long Term
Coupon Rate	1.75	2	3.6
Current Price	$93.70	$86.89	$79.88
Maturity	13-01-2026	01-09-2029	01-01-2051
YTM	4.02%	4.52%	4.93%

YIELD TO MATURITY OF COMPETITOR'S BONDS

	Paramount	Netflix
Metrics	Short Term	Medium Term
Coupon Rate	2.9	3.625
Current Price	$91.81	$95.25
Maturity	15-01-2027	15-03-2030
YTM	6.50%	4.24%

YIELD TO CALL

- Yield to call (YTC) is a measure of the yield an investor can expect to receive if a callable bond is called or redeemed by the issuer before its scheduled maturity date

- Yield to Call is similar to YTM calculation but takes into account the possibility of the bond being called or redeemed before its maturity date.

- The YTC calculation assumes that the bond will be called on the first call date. If the bond is not called on that date, the investor will continue to receive coupon payments until the next call date

- The yield to call is important for bond investors who are considering callable bonds as it helps them understand the potential yield they could receive if the bond is called before its maturity date

YIELD TO CALL OF WALT DISNEY'S BONDS

Metrics	Short Term	Medium Term	Long Term
Coupon Rate	1.75	2	3.6
Current Price	$93.70	$86.89	$79.88
Next Call Date	N/A	01-06-2029	13-07-2050
Call Price	100	100	100
Call Frequency	N/A	-	-
YTC	N/A	4.58%	4.93%

YIELD TO CALL OF COMPETITOR'S BONDS

Metrics	Paramount Short Term	Netflix Medium Term
Coupon Rate	2.9	3.625
Current Price	$91.81	$95.25
Next Call Date	10-15-2026	3-15-2030
Call Price	100	100
YTC	6.02%	4.43%

YIELD TO WORST

- The yield to worst (YTW) of a bond is the lowest possible yield an investor can expect to receive if certain conditions occur, such as the bond being called or redeemed before maturity.

- The yield to worst takes into account the bond's yield under each possible call scenario, as well as its yield if it is held until maturity

- The yield to worst is for bond investors because it takes into account the possibility that the bond may be called or redeemed early, which can impact the bond's return.

- Yield to worst helps investors understand the potential downside risk associated with a bond investment

YIELD TO WORST OF WALT DISNEY'S BONDS

Metrics	Short Term	Medium Term	Long Term
Current Price	$93.70	$86.89	$79.88
YTM	4.02%	4.52%	4.93%
YTC	N/A	3.61%	4.89%
Yield to Worst	N/A	3.61%	4.89%

YIELD TO WORST OF COMPETITOR'S BONDS

Metrics	Paramount Short Term	Netflix Medium Term
Current Price	2.9	3.625
YTM	6.50%	4.24%
YTC	6.02%	4.43%
Yield to Worst	6.02%	4.24%

BOND RATINGS

WHAT ARE BOND RATINGS?

Bond ratings are an evaluation of the creditworthiness of a bond issuer, typically conducted by credit rating agencies such as Moody's, Standard & Poor's, and Fitch Ratings.

These ratings are based on the bond issuer's ability to repay its debts, including interest payments on its bonds, and are expressed as letter grades.

The ratings range from AAA to D, with AAA being the highest rating and D being the lowest. A bond with a higher rating is considered to be less risky and more likely to be paid back in full and on time than a bond with a lower rating.

WHY ARE THESE RATINGS IMPORTANT?

- Assessing credit risk: A higher rating indicates a lower risk of default, while a lower rating indicates a higher risk of default.

- Pricing and liquidity: The credit rating of a bond can impact its pricing and liquidity. Higher-rated bonds typically trade at lower yields than lower-rated bonds because investors demand a higher return to compensate for the increased risk.

RATINGS OF WALT DISNEY'S BONDS

Bonds	Moody's Ratings and Rating dates	S&P Ratings and Rating Dates
Short - term	A2 05/11/2020	BBB+ 11/18/2020
Medium - term	A2 09/03/2019	BBB+ 11/18/2021
Long - term	A2 05/11/2020	BBB+ 11/18/2022
Competitor Ratings		
Paramount (Short - term)	Baa2 11/06/2019	BBB- 03/29/2023
Netflix (Medium)	Baa3 03/292023	BBB 10/25/2021

DEFAULT PROBABILITIES

	Default Probabilities	
Companies	1 Year	2 Year
Walt Disney	0.0167%	0.2580%
Paramount	1.34%	4.1300%
Netflix	0.0453%	0.4464%

From the table above, we can infer that the average default probability on all Walt Disney Bonds is approximately 292 basis points lower than its competitors Paramount and Netflix, making Walt Disney bonds a safer bet given a larger market share and higher liquidity.

DURATION AND CONVEXITY

- The duration of a bond is a measure of its sensitivity to changes in interest rates.

- it is the weighted average time to maturity, with the relative present values of the cash flows serving as the weights

- The modified duration is a variant of the duration that has been altered to take into account shifting yield to maturities

- Convexity is a metric that expresses how the length of a bond alters when the interest rate varies in the relationship between bond prices and bond yields

Bonds	Short Term	Medium Term	Long Term
Maturity	13-01-2026	01-09-2029	13-01-2051
Duration (Macaulay)	2.9186	5.67	16.2348
Modified Duration	2.857	5.5449	15.8373
Convexity	9.7145	34.5642	366.108

- As an inference to our table above, the longer maturity bonds tend to become more sensitive to interest rate changes than the shorter maturity bonds.

- As duration increases, convexity also increases, causing the relationship between bond prices and interest rates to become more curved due to the greater impact of interest rate changes on bond prices

PRICE TO YIELD CURVE

- The bond price-yield relationship shows how a bond's price and yield to maturity are related, assuming other factors are constant.
- The bond price-to-yield relationship is commonly used to make informed investment decisions. When investors anticipate higher interest rates in the market, they may prefer less interest-rate-sensitive securities such as floating-rate bonds or shorter-duration bonds.
- The shape of the price-to-yield curve depends on factors like interest rates, the credit quality of the bond issuer, and market sentiment, and can be concave, convex, or straight.

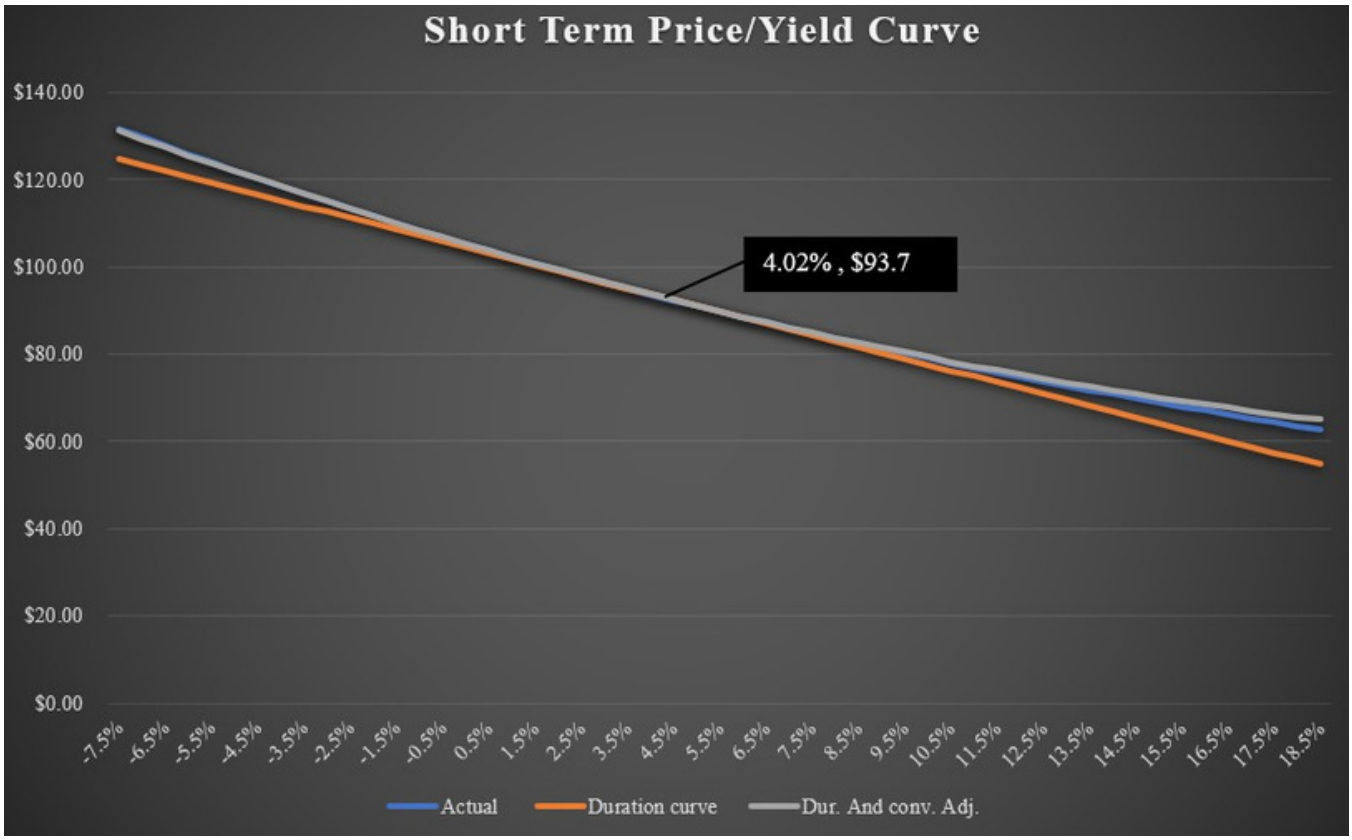
PRICE TO YIELD CURVES OF WALT DISNEY'S BONDS

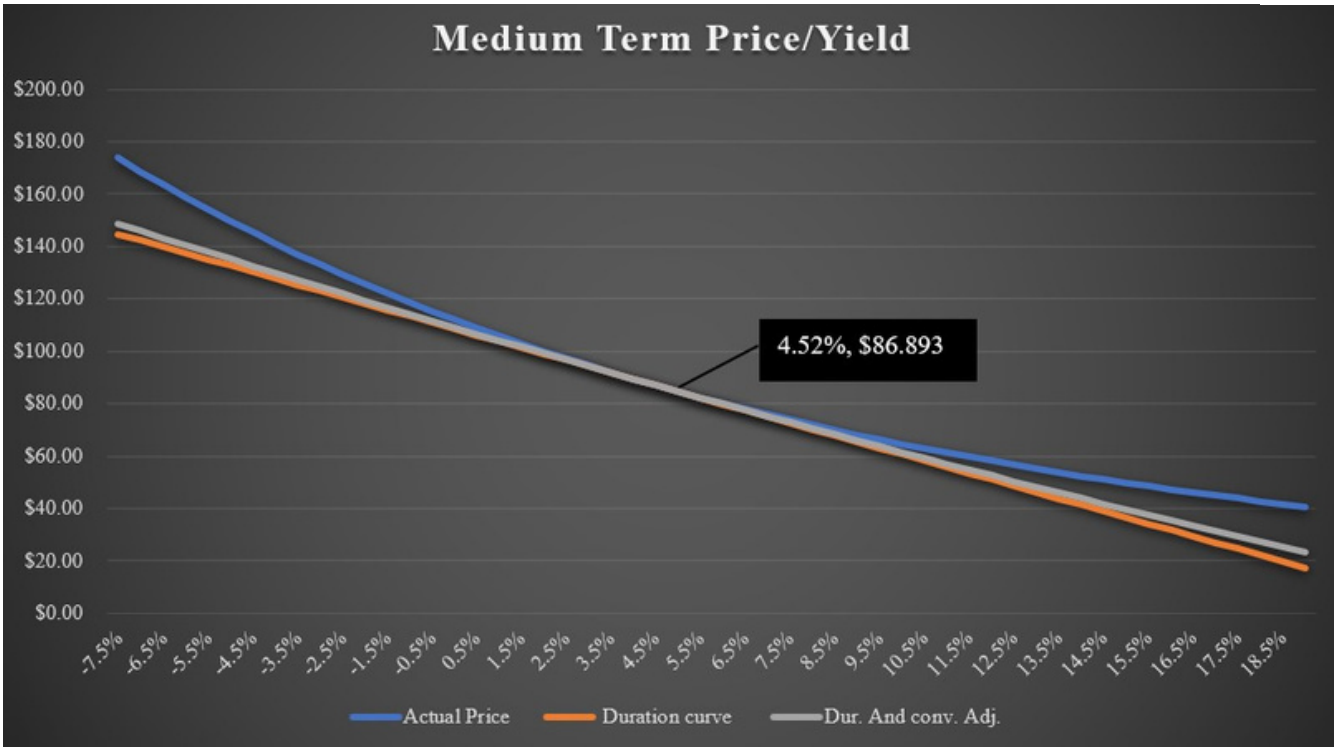
The Blue line in our graph shows the actual price of the bond. The grey line predicts prices using adjusted duration and convexity, whereas the orange line shows duration. The steeper the orange line, the more sensitive the connection. Duration always undervalues bonds. Duration assumes price fluctuates linearly with yield, which is plainly not true. Calculating prices with convexity minimizes the percentage error and improves price estimate.

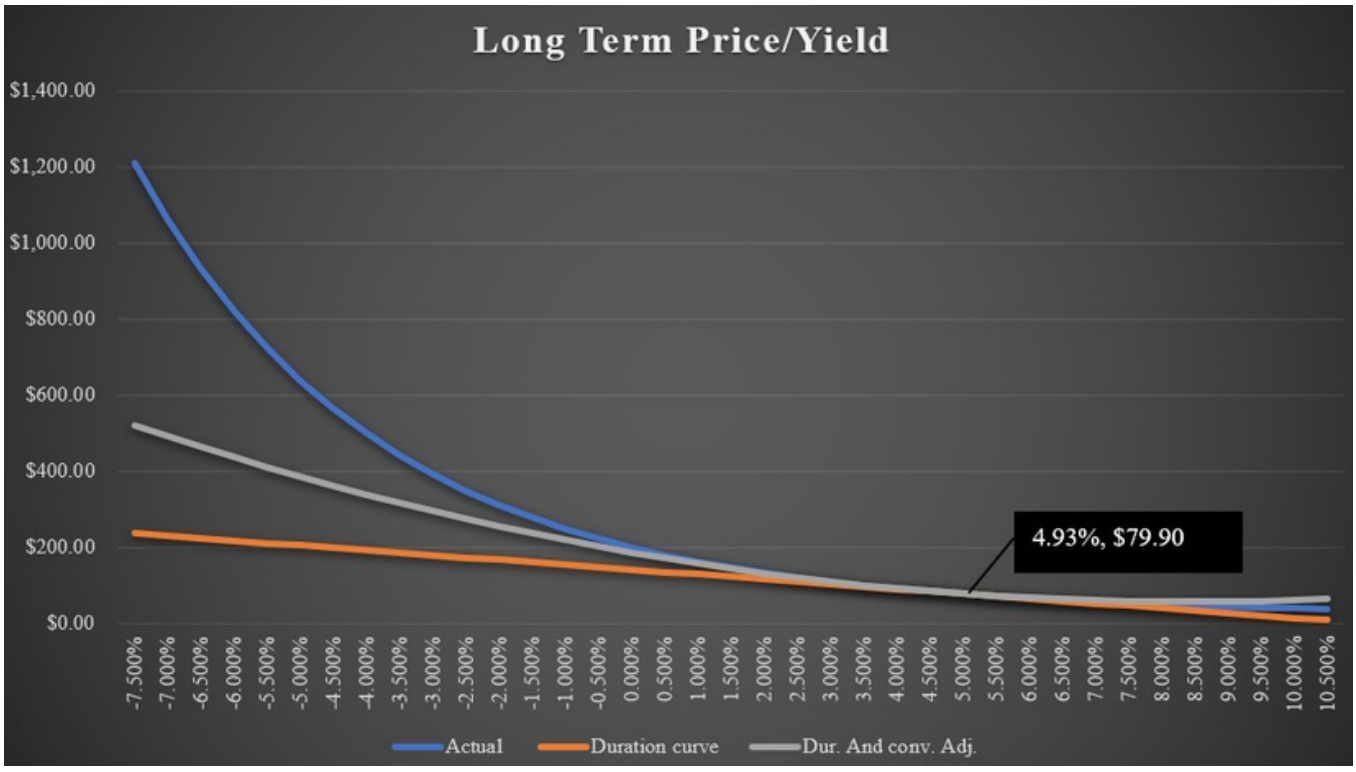
Convexity, which reduces with yield rises, is another risk factor. Bonds with higher convexity yield less because convexity is preferred. The graph shows the projected price change if an investor anticipates interest rates to fluctuate.

Price to Yield curves

In the graphs below we can observe that the curve shows a true approximation of the change in bond prices, with changes in interest rates. the convexity line is curving as the interest rates increase. this clearly shows that bond prices don't fall as much as duration assumes and the bond prices rise more when the interest rate decrease than when duration is taken into consideration.




Medium Term Price/Yield
$200.00
$180.00
$160.00
$140.00
$120.00
$100.00
$80.00
$60.00
$40.00
$20.00
$0.00
4.52%, $86.893
-7.5% -6.5% -5.5% -4.5% -3.5% -2.5% -1.5% -0.5% 0.5% 1.5% 2.5% 3.5% 4.5% 5.5% 6.5% 7.5% 8.5% 9.5% 10.5% 11.5% 12.5% 13.5% 14.5% 15.5% 16.5% 17.5% 18.5%
Actual Price
Duration curve
Dur. And conv. Adj.


Long Term Price/Yield
$1,400.00
$1,200.00
$1,000.00
$800.00
$600.00
$400.00
$200.00
$0.00
4.93%, $79.90
-7.500% -7.000% -6.500% -6.000% -5.500% -5.000% -4.500% -4.000% -3.500% -3.000% -2.500% -2.000% -1.500% -1.000% -0.500% 0.000% 0.500% 1.000% 1.500% 2.000% 2.500% 3.000% 3.500% 4.000% 4.500% 5.000% 5.500% 6.000% 6.500% 7.000% 7.500% 8.000% 8.500% 9.000% 9.500% 10.000% 10.500%
Actual
Duration curve
Dur. And conv. Adj.

BOND IMMUNIZATION

What does bond immunization mean?

- Bond immunization is an investment strategy that aims to protect investors from interest rate fluctuations in the market
- This strategy involves creating a portfolio of bonds that are chosen in such a way that the portfolio's duration matches the investor's time horizon
- Bonds are held until maturity, the coupon payments are collected along the way and these payments are reinvested into the bonds. Through maintenance of the same duration over time, the investor accumlates the corpus needed to meet his future liability

Duration of portfolios we created for immunization

Bond Portfolio 1	Short Term Bond	Medium Term Bond	Long term Bond
Weights	27.99%	28.39%	43.61%
Portfolio Duration	9.702511015		

$(W_{st\ bond} * DUR_{st\ bond}) + (W_{mt\ bond} * DUR_{mt\ bond}) + (W_{t\ bond} * DUR_{lt\ bond})$

Bond Portfolio 2	Short Term Bond	Long term Bond
Weights	39.09%	60.91%
Portfolio Duration	11.18225357	

Bond Portfolio 3	Medium Term Bond	Long term Bond
Weights	39%	61%
Portfolio Duration	12.44466977	

- We created 3 different bond portfolios using various combinations of walt disney bonds.

- Our portfolio durations were calculated using the summation of the products of individual bond weights with their respective duration.

- Portfolio 1 shows the lowest duration of all the 3 portfolios, which indicates its lowest sensitivity to changes in interest rates, while Portfolio 3 happens to be the most sensitive toward these changes

Immunized Portfolio Returns and Recommendations

Investment Horizon	8 periods		
	Bond Portfolio 1	**Bond Portfolio 2**	**Bond Portfolio 3**
Bonds	ST + MT + LT Bond	ST + LT Bond	MT + LT Bond
Value at the end of 4 years	1243113.87	1335340.635	1007326.721
Return	**9.620%**	**11.599%**	**4.005%**

- The investment horizon for our portfolio immunization was 8 semi-annual periods, and the target corpus was set at $1 million USD

- The returns from our 3 portfolios show that Portfolio 2, comprising Walt Disney's short-term and long-term bonds, will provide the highest return with the lowest possible risk of interest rate sensitivity among the 3 portfolios.

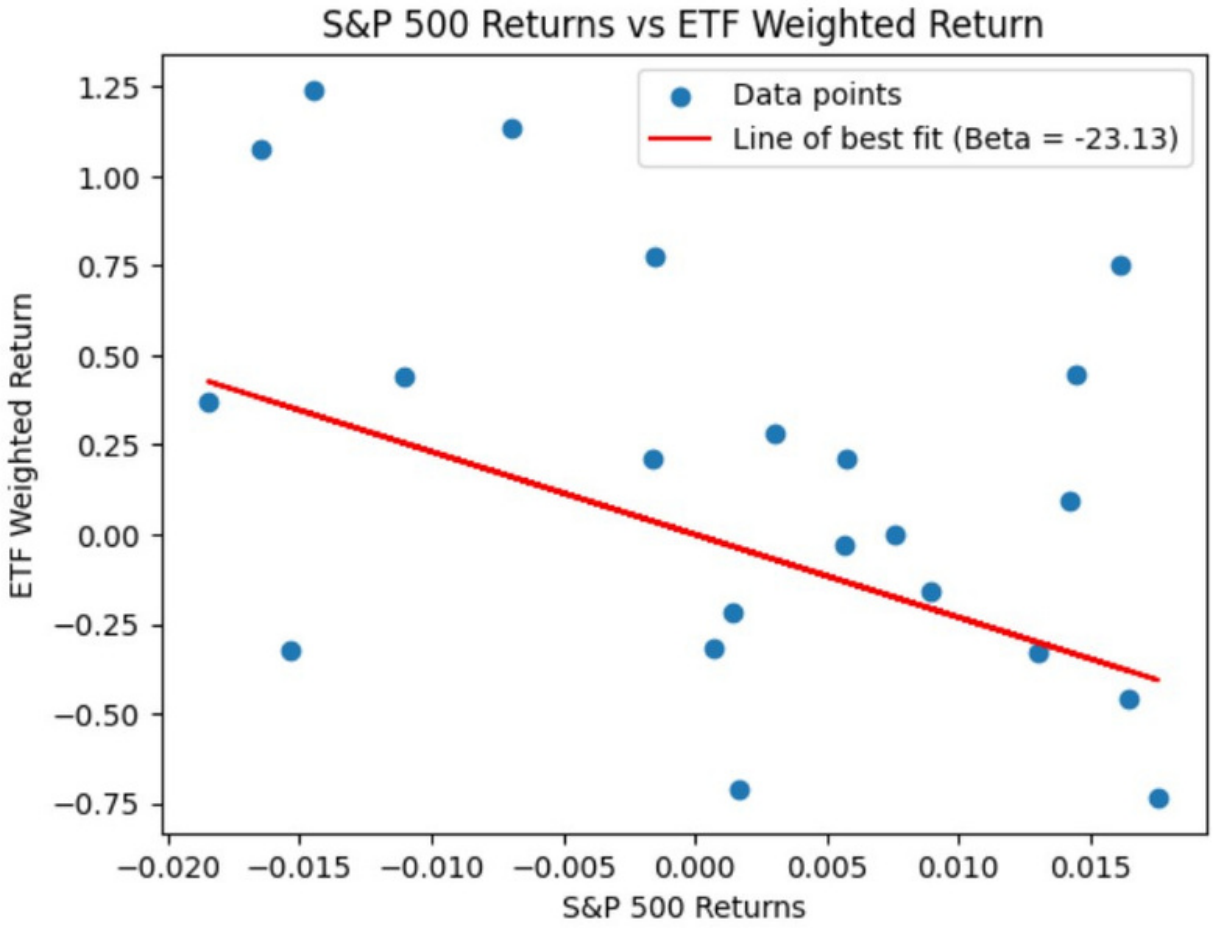
- Hence we recommend portfolio 2 as the immunized bond portfolio for our investors

Investment Hedging

BOND PORTFOLIO HEDGING USING
HEDGING USING BOND ETFS AND S&P 500

Hedging a bond portfolio using bond ETFs includes deliberately selecting ETFs to mitigate risks. Identifying risks and Choosing which bond portfolio risks to hedge. Hedging against interest rate risk since our portfolio consists of Medium-term and long-term bonds. Hedging against credit risk since our portfolio is only corporate bonds. We Selected Appropriate Bond ETFs such as Vanguard Tax-Exempt Bond Index Fund ETF,iShares US Treasury Bond ETF, and Schwab US TIPS ETF. These bond ETFs are projected to perform well in situations that might hurt our bond portfolio. To hedge interest rate risk, using short-term bond ETFs or ETFs with variable interest rates is generally a better alternative. Government bond ETFs are safer than corporate bonds for credit risk. For the portfolio hedging, we assume we set up on March 1, 2023, and we calculated the daily return of the bond ETFs and the daily returns of the s&p500 index. To calculate the beta of the portfolio we took the daily returns of weighted returns and regressed on the s&p500 futures return.

From the graph we can observe the Line of best fit i.e., our Beta is -23.13. keeping in mind the Fed was increasing the interest rate in March and the banking crisis was underway during this time.


S&P 500 Returns vs ETF Weighted Return
Data points
Line of best fit (Beta = -23.13)
ETF Weighted Return
S&P 500 Returns
1.25
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−0.020
−0.015
−0.010
−0.005
0.000
0.005
0.010
0.015

Appendix

EOD Friday April 21, 2023					
		[PARAMOUNT]		[NETFLIX]	
	Short	Comparable Short	Medium	Comparable Medium	Long
Coupon rate	1.77%	2.90%	2.00%	3.63%	3.60%
Nominal	1	1	1	1	1
Initial Price	99.93		99.69		99.875
Current price	93.703	91.811	86.893	95.249	79.957
nominal yield	1.77%	2.90%	2.00%	3.63%	3.60%
current yield	1.89%	3.16%	2.30%	3.81%	4.50%
Periods	6		12		56
Periods	6	5	12	19	56
Accrued interest *	0.143	0.234	0.161	1.510	0.290
Dirty price *	93.84558333	92.04461111	87.0541111	96.75941667	80.247
YTM *	4.02%	6.50%	4.52%	4.24%	4.93%
Expected ytm	4.02%	6.50%	4.51%	4.24%	4.93%
Call price*	Non-callable	100	100	100	100
YTC*	N/A	6.02%	4.58%	4.43%	4.93%
Default premium	0.003%		0.005%		0.001%
Risk premium	-2.49%		0.28%		-
Total premium	-2.48%		0.28%		-
Price computed usin	100.0344511		100.693982		106.1635183
Difference in price	-6.331451104		-13.800982		-26.20651832
Duration	2.873582872		5.52972251		16.16700352
Convexity	9.785342746		34.4560171		366.0108097

Period	3	years				
Cash Flow	***Disc. Factor***	***Pv cf***	***t x pvcf***		Coupon	1.750%
0.8750	0.9803	0.8578	0.8578		YTM	4.019%
0.8750	0.9610	0.8409	1.6817		Current Price	93.703
0.8750	0.9421	0.8243	2.4729			
0.8750	0.9235	0.8081	3.2322		Current yield	1.87%
0.8750	0.9053	0.7921	3.9607			
100.8750	0.8875	89.5239	537.1432			
			549.3486			
5.8627						
2.9313						
2.8736						

Short Term Bond

```
face_value = 100
coupon_rate = 0.0177
ytm = 0.0402
years = 3
frequency = 1

duration_coupon_bond = bond_duration(face_value, coupon_rate, ytm, years, frequency)
print(f"Duration = {duration_coupon_bond:.2f}")
```

✓ 0.0s

```
Duration = 2.95
```

Medium Term Bond

```
face_value = 100
coupon_rate = 0.02
ytm = 0.0452
years = 6
frequency = 1

duration_coupon_bond = bond_duration(face_value, coupon_rate, ytm, years, frequency)
print(f"Duration = {duration_coupon_bond:.2f}")
```

✓ 0.0s

```
Duration = 5.69
```

	Period	6	years			
Period	***Cash Flow***	***Disc. Factor***	***Pv cf***	***t x pvcf***	Coupon	2.00%
1	1	0.9779	0.9779	0.9779	YTM	4.52%
2	1	0.9563	0.9563	1.9126	Current Price	86.893
3	1	0.9352	0.9352	2.8055		
4	1	0.9145	0.9145	3.6581	Current yield	2.30%
5	1	0.8943	0.8943	4.4715		
6	1	0.8746	0.8746	5.2473		
7	1	0.8552	0.8552	5.9866		
8	1	0.8363	0.8363	6.6907	$80.07	
9	1	0.8179	0.8179	7.3607		
10	1	0.7998	0.7998	7.9979		
11	1	0.7821	0.7821	8.6033		
12	101	0.7648	77.2489	926.9869		
				982.6991		
Mac. Duration	11.3093					
Mac. Duration (y)	5.6547					
Mod. Duration	**5.5297**					

Long Term Bond

```
face_value = 100
coupon_rate = 0.036
ytm = 0.0493
years = 28
frequency = 1

duration_coupon_bond = bond_duration(face_value, coupon_rate, ytm, years, frequency)
print(f"Duration = {duration_coupon_bond:.2f}")
```

✓ 0.0s

```
Duration = 16.83
```

	Period	28	years				
Period	***Cash Flow***	***Disc. Factor***	***Pv cf***	***t x pvcf***		Coupon	3.60%
1	1.8	0.9760	1.7567	1.7567		YTM	4.93%
2	1.8	0.9525	1.7145	3.4290		Current Price	79.9
3	1.8	0.9296	1.6733	5.0198			
4	1.8	0.9072	1.6330	6.5321			4.51%
5	1.8	0.8854	1.5938	7.9688			
6	1.8	0.8641	1.5554	9.3327		Mac. Duration	33.1306
7	1.8	0.8434	1.5180	10.6263		Mac. Duration (y)	16.5653
8	1.8	0.8231	1.4815	11.8524		**Mod. Duration**	**16.167**
9	1.8	0.8033	1.4459	13.0133			
10	1.8	0.7840	1.4112	14.1116			
11	1.8	0.7651	1.3772	15.1495			
12	1.8	0.7467	1.3441	16.1294			
13	1.8	0.7288	1.3118	17.0534			
14	1.8	0.7113	1.2803	17.9236			
15	1.8	0.6942	1.2495	18.7421			
16	1.8	0.6775	1.2194	19.5109			
17	1.8	0.6612	1.1901	20.2319			
18	1.8	0.6453	1.1615	20.9070			
19	1.8	0.6298	1.1336	21.5379			
20	1.8	0.6146	1.1063	22.1263			
21	1.8	0.5998	1.0797	22.6740			
22	1.8	0.5854	1.0538	23.1826			

Short-term bond

t	Cash Flow	Disc. Facto	Pv cf	t*(t+1)	pvcf * t*(t+1)		
1	0.8750	0.9803	0.8578	2	1.7155	Coupon	1.750%
2	0.8750	0.9610	0.8409	6	5.0452	YTM	4.019%
3	0.8750	0.9421	0.8243	12	9.8916	Current Price	93.704
4	0.8750	0.9235	0.8081	20	16.1613		
5	0.8750	0.9053	0.7921	30	23.7644	Convexity	39.1414
6	100.8750	0.8875	89.5241	42	3760.0111	**Convexity (y)**	**9.78534**
					$ 3,816.589		

Short Term Bond

+ Code + Markdown

```
face_value = 100
coupon_rate = 0.0175
ytm = 0.04019
years = 3
frequency = 2


convexity_semi_annual_bond = bond_convexity(face_value, coupon_rate, ytm, years, frequency)
print(f"Convexity = {convexity_semi_annual_bond:.2f}")
```

✓ 0.0s

```
Convexity = 39.17
```

```
Convexity = 39.17

Convexity_years = Convexity/2**2

print (f"Convexity (in years) = {Convexity_years:.2f}")
```

✓ 0.0s

```
Convexity (in years) = 9.79
```

Medium-term bond

t	*Cash Flow*	*Discount Factor*	*Pv cf*	*t*(t+1)*	*pvcf * t*(t+1)*
1	1.00	0.9779	0.9779	2	1.9558
2	1.00	0.9563	0.9563	6	5.7377
3	1.00	0.9352	0.9352	12	11.2218
4	1.00	0.9145	0.9145	20	18.2897
5	1.00	0.8943	0.8943	30	26.8282
6	1.00	0.8745	0.8745	42	36.7295
7	1.00	0.8552	0.8552	56	47.8903
8	1.00	0.8363	0.8363	72	60.2124
9	1.00	0.8178	0.8178	90	73.6021
10	1.00	0.7997	0.7997	110	87.9700
11	1.00	0.7821	0.7821	132	103.2310
12	101.00	0.7648	77.2417	156	12049.7077
					$ 12,523.38

Coupon	2.00%
YTM	4.52%
Current Price	86.893
Convexity	137.8240684
Convexity (y)	**34.4560171**

Medium Term Bond

+ Code + Markdown

```
face_value = 100
coupon_rate = 0.02
ytm = 0.0452
years = 6
frequency = 2

convexity_semi_annual_bond = bond_convexity(face_value, coupon_rate, ytm, years, frequency)
print(f"Convexity =  {convexity_semi_annual_bond:.2f}")
```

✓ 0.0s

```
Convexity =  137.84
```

```
convexity = 137.82

convexity_years = convexity/2**2

convexity_years
print (f"Convexity (in years) = {convexity_years:.2f}")
```

✓ 0.0s

```
Convexity (in years) = 34.45
```

Long-term bond

t	*Cash Flow*	*Disc. Factor*	*Pv cf*	*t*(t+1)*	*pvcf * t*(t+1)*
1	1.8	0.9759	1.7567	2	3.5134
2	1.8	0.9525	1.7144	6	10.2866
3	1.8	0.9296	1.6732	12	20.0783
4	1.8	0.9072	1.6329	20	32.6588
5	1.8	0.8854	1.5937	30	47.8097
6	1.8	0.8641	1.5553	42	65.3234
7	1.8	0.8433	1.5179	56	85.0025
8	1.8	0.8230	1.4814	72	106.6598
9	1.8	0.8032	1.4457	90	130.1173
10	1.8	0.7839	1.4110	110	155.2064
11	1.8	0.7650	1.3770	132	181.7672
12	1.8	0.7466	1.3439	156	209.6479
13	1.8	0.7286	1.3116	182	238.7052
14	1.8	0.7111	1.2800	210	268.8030
15	1.8	0.6940	1.2492	240	299.8131
16	1.8	0.6773	1.2192	272	331.6139
17	1.8	0.6610	1.1898	306	364.0908
18	1.8	0.6451	1.1612	342	397.1356
19	1.8	0.6296	1.1333	380	430.6463
20	1.8	0.6145	1.1060	420	464.5269

Coupon	3.60%
YTM	4.93%
Current Price	79.957
Convexity	1464.0432
Convexity (y)	**366.0108**

Long Term Bond

```
face_value = 100
coupon_rate = 0.0360
ytm = 0.0493
years = 28
frequency = 2

convexity_semi_annual_bond = bond_convexity(face_value, coupon_rate, ytm, years, frequency)
print(f"Convexity =  {convexity_semi_annual_bond:.2f}")
```

✓ 0.0s

```
Convexity =  1464.70
```

```
convexity = 1464.7

convexity_years = convexity/2**2

convexity_years
print (f"Convexity (in years) = {convexity_years:.2f}")
```

✓ 0.0s

```
Convexity (in years) = 366.18
```