

# BCG\_GenAI

May 23, 2024

#BCG GenAI

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Project:

Create an AI-powered chatbot that can analyze and provide insights on corporate financial performance from 10-K and 10-Q financial documents.

Requirements:

Efficiency: The solution must reduce time taken to analyze financial documents compared to traditional methods.

Accuracy: Chatbot should provide precise and reliable financial insights backed by thorough data analysis.

User-friendly interface: The chatbot should be intuitive and easy to use for the client's diverse client base, regardless of their financial expertise.

Scalability: The solution should be scalable, capable of handling an increasing number of documents and user queries.

## 0.0.1 Import Excel file

From <https://www.sec.gov/edgar/searchedgar/companysearch> website pull the following figures from the 10-K for the last three years.

Total Revenue, Net Income, Total Assets, Total Liabilities, and Cash flow from operating activities.

Companies: Apple, Tesla, Microsoft.

```
[ ]: import pandas as pd
```

```
[ ]: df = pd.read_excel('/content/BCG_GenAI.xlsx')
df
```

```
[ ]:
      Company  Year  Total Revenue  Net Income  Total Assets  \
0  Microsoft  2023         211915         72361         411976
1  Microsoft  2022         198270         72738         364840
2  Microsoft  2021         168088         61271         333779
3      Tesla  2023          96773         14974         106618
```

4	Tesla	2022	81462	12587	82338
5	Tesla	2021	53823	5644	62131
6	Apple	2023	383285	96995	352583
7	Apple	2022	394328	99803	352755
8	Apple	2021	365817	94680	351002

	Total Liabilities	Cash Flow from operating activities
0	205753	87582
1	198298	89035
2	191791	76740
3	43009	13256
4	36440	14724
5	30548	11497
6	290437	110543
7	302083	122151
8	287912	104038

### 0.0.2 Calculate Shareholder Equity

```
[ ]: df['Shareholder Equity'] = df['Total Assets']-df['Total Liabilities']
```

### 0.0.3 Sort dataframe

```
[ ]: df = df.sort_values(by=['Company', 'Year'])
df
```

```
[ ]:      Company  Year  Total Revenue  Net Income  Total Assets  \
8      Apple  2021      365817      94680      351002
7      Apple  2022      394328      99803      352755
6      Apple  2023      383285      96995      352583
2  Microsoft  2021      168088      61271      333779
1  Microsoft  2022      198270      72738      364840
0  Microsoft  2023      211915      72361      411976
5      Tesla  2021      53823      5644      62131
4      Tesla  2022      81462      12587      82338
3      Tesla  2023      96773      14974      106618
```

	Total Liabilities	Cash Flow from operating activities	Shareholder Equity
8	287912	104038	63090
7	302083	122151	50672
6	290437	110543	62146
2	191791	76740	141988
1	198298	89035	166542
0	205753	87582	206223
5	30548	11497	31583
4	36440	14724	45898

3

43009

13256

63609

```
[ ]: df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Index: 9 entries, 8 to 3
Data columns (total 8 columns):
#   Column                                Non-Null Count  Dtype
---  -
0   Company                              9 non-null      object
1   Year                                9 non-null      int64
2   Total Revenue                       9 non-null      int64
3   Net Income                          9 non-null      int64
4   Total Assets                        9 non-null      int64
5   Total Liabilities                   9 non-null      int64
6   Cash Flow from operating activities 9 non-null      int64
7   Shareholder Equity                  9 non-null      int64
dtypes: int64(7), object(1)
memory usage: 648.0+ bytes
```

#### 0.0.4 Calculate year-over-year growth

```
[ ]: # Calculate year-over-year growth
df['Revenue Growth (%)'] = df.groupby(['Company'])['Total Revenue'].
    .pct_change() * 100
df['Income Growth (%)'] = df.groupby(['Company'])['Net Income'].pct_change() * 100
df['Asset Growth (%)'] = df.groupby(['Company'])['Total Assets'].pct_change() * 100
df['Liabilities Growth (%)'] = df.groupby(['Company'])['Total Liabilities'].
    .pct_change() * 100
df['Equity Growth (%)'] = df.groupby(['Company'])['Shareholder Equity'].
    .pct_change() * 100
df['CF Operating Activities Growth (%)'] = df.groupby(['Company'])['Cash Flow
    from operating activities'].pct_change() * 100
```

```
[ ]: df
```

```
[ ]:      Company  Year  Total Revenue  Net Income  Total Assets  \
8      Apple  2021      365817      94680      351002
7      Apple  2022      394328      99803      352755
6      Apple  2023      383285      96995      352583
2  Microsoft  2021      168088      61271      333779
1  Microsoft  2022      198270      72738      364840
0  Microsoft  2023      211915      72361      411976
5      Tesla  2021       53823       5644       62131
4      Tesla  2022       81462      12587       82338
```

3	Tesla	2023	96773	14974	106618
---	-------	------	-------	-------	--------

	Total Liabilities	Cash Flow from operating activities	Shareholder Equity	\
8	287912	104038	63090	
7	302083	122151	50672	
6	290437	110543	62146	
2	191791	76740	141988	
1	198298	89035	166542	
0	205753	87582	206223	
5	30548	11497	31583	
4	36440	14724	45898	
3	43009	13256	63609	

	Revenue Growth (%)	Income Growth (%)	Asset Growth (%)	\
8	NaN	NaN	NaN	
7	7.793788	5.410858	0.499427	
6	-2.800461	-2.813543	-0.048759	
2	NaN	NaN	NaN	
1	17.956071	18.715216	9.305858	
0	6.882030	-0.518299	12.919636	
5	NaN	NaN	NaN	
4	51.351653	123.015592	32.523217	
3	18.795267	18.964010	29.488207	

	Liabilities Growth (%)	Equity Growth (%)	\
8	NaN	NaN	
7	4.921990	-19.682993	
6	-3.855232	22.643669	
2	NaN	NaN	
1	3.392756	17.293011	
0	3.759493	23.826422	
5	NaN	NaN	
4	19.287678	45.325017	
3	18.026894	38.587738	

	CF Operating Activities Growth (%)
8	NaN
7	17.409985
6	-9.502992
2	NaN
1	16.021631
0	-1.631942
5	NaN
4	28.068192
3	-9.970117

## 0.1 Calculate ratios

Ratio formulas are based on [www.investopedia.com](http://www.investopedia.com).

```
[ ]: df['Net Profit Margin'] = df['Net Income']/df['Total Revenue']
df['Debt Ratio'] = df['Total Liabilities']/df['Total Assets']
df['Debt_to_Equity Ratio'] = df['Total Liabilities']/ df['Shareholder Equity']
df['Equity Multiplier'] = df['Total Assets']/df['Shareholder Equity']
df['Cash Flow Coverage Ratio'] = df['Cash Flow from operating activities']/
↳df['Total Liabilities']
```

```
[ ]: df
```

```
[ ]:      Company  Year  Total Revenue  Net Income  Total Assets  \
8      Apple  2021      365817      94680      351002
7      Apple  2022      394328      99803      352755
6      Apple  2023      383285      96995      352583
2  Microsoft  2021      168088      61271      333779
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0  Microsoft  2023      211915      72361      411976
5      Tesla  2021       53823       5644       62131
4      Tesla  2022       81462      12587       82338
3      Tesla  2023       96773      14974      106618
```

```
      Total Liabilities  Cash Flow from operating activities  Shareholder Equity  \
8              287912              104038              63090
7              302083              122151              50672
6              290437              110543              62146
2              191791              76740              141988
1              198298              89035              166542
0              205753              87582              206223
5              30548              11497              31583
4              36440              14724              45898
3              43009              13256              63609
```

```
      Revenue Growth (%)  Income Growth (%)  Asset Growth (%)  \
8              NaN              NaN              NaN
7              7.793788              5.410858              0.499427
6             -2.800461             -2.813543             -0.048759
2              NaN              NaN              NaN
1             17.956071             18.715216              9.305858
0              6.882030             -0.518299             12.919636
5              NaN              NaN              NaN
4             51.351653             123.015592             32.523217
3             18.795267             18.964010             29.488207
```

```
      Liabilities Growth (%)  Equity Growth (%)  \
8              NaN              NaN
```

7	4.921990	-19.682993
6	-3.855232	22.643669
2	NaN	NaN
1	3.392756	17.293011
0	3.759493	23.826422
5	NaN	NaN
4	19.287678	45.325017
3	18.026894	38.587738

	CF Operating Activities Growth (%)	Net Profit Margin	Debt Ratio \
8	NaN	0.258818	0.820257
7	17.409985	0.253096	0.856354
6	-9.502992	0.253062	0.823741
2	NaN	0.364517	0.574605
1	16.021631	0.366863	0.543520
0	-1.631942	0.341462	0.499430
5	NaN	0.104862	0.491671
4	28.068192	0.154514	0.442566
3	-9.970117	0.154733	0.403393

	Debt_to_Equity Ratio	Equity Multiplier	Cash Flow Coverage Ratio
8	4.563512	5.563512	0.361353
7	5.961537	6.961537	0.404362
6	4.673462	5.673462	0.380609
2	1.350755	2.350755	0.400123
1	1.190679	2.190679	0.448996
0	0.997721	1.997721	0.425666
5	0.967229	1.967229	0.376359
4	0.793934	1.793934	0.404061
3	0.676146	1.676146	0.308215

## 0.2 Data Analysis

```
[ ]: df[df["Company"] == "Apple"]
```

	Company	Year	Total Revenue	Net Income	Total Assets	Total Liabilities \
8	Apple	2021	365817	94680	351002	287912
7	Apple	2022	394328	99803	352755	302083
6	Apple	2023	383285	96995	352583	290437

	Cash Flow from operating activities	Shareholder Equity \
8	104038	63090
7	122151	50672
6	110543	62146

	Revenue Growth (%)	Income Growth (%)	Asset Growth (%) \
8	NaN	NaN	NaN

7	7.793788	5.410858	0.499427
6	-2.800461	-2.813543	-0.048759

	Liabilities Growth (%)	Equity Growth (%)	\
8	NaN	NaN	
7	4.921990	-19.682993	
6	-3.855232	22.643669	

	CF Operating Activities Growth (%)	Net Profit Margin	Debt Ratio	\
8	NaN	0.258818	0.820257	
7	17.409985	0.253096	0.856354	
6	-9.502992	0.253062	0.823741	

	Debt_to_Equity Ratio	Equity Multiplier	Cash Flow Coverage Ratio
8	4.563512	5.563512	0.361353
7	5.961537	6.961537	0.404362
6	4.673462	5.673462	0.380609

### 0.2.1 Apple

#### Revenue Growth:

Revenue grew 7.8% from 2021 to 2022. Revenue decreased 2.8% from 2022 to 2023.

#### Net Income Growth:

Income grew 5.4% from 2021 to 2022. Net Income decreased 2.8% from 2022 to 2023.

#### Asset Growth:

Asset growth was flat. Assets grew 0.5% from 2021 to 2022 then decreased 0.05% from 2022 to 2023.

#### Liability Growth:

Liabilities grew more than Assets from 2021 to 2023 at 4.9% then decreased 3.9% from 2022 to 2023.

#### Cash Flow from Operating Activities Growth:

Cash flow from operations grew by 17% from 2021 to 2022 then decreased 9.5% from 2022 to 2023.

#### Net Profit Margin (Net Income/Total Revenue):

In 2021, the profit margin was 25.88%. In 2022, the profit margin was 25.31%. In 2023, the profit margin was 25.31%. The profit margin has remained steady.

#### Debt Ratio (Total Liabilities/Total Assets):

In 2021, 82% of assets were owned by Creditors. In 2022, 86% of assets were owned by Creditors. In 2023, 82% of assets were owned by Creditors. Apple relies heavily on borrowed funds.

#### Debt\_to\_Equity (Total Liabilities/Shareholder Equity):

In 2021, Apple had 4.56 dollars of debt for every dollar of equity. In 2022, Apple had 5.96 dollars of debt for every dollar of equity. In 2023, Apple had 4.67 dollars of debt for every dollar of equity.

#### Equity Multiplier (Total Assets/Shareholder Equity):

In 2021, Apple's assets were 5.56 larger than its equity. In 2022, Apple's assets were 6.96 larger than its equity. In 2023, Apple's assets were 5.67 larger than its equity. Based on the multiplier, approximately 80% of Apple's assets are financed by debt.

#### Cash Flow Coverage Ratio (Cash Flow from operating activities/Total Liabilities):

In 2021, the coverage ratio of .36 indicates it would take Apple 2.78 years to repay its debt. In 2022, the coverage ratio of .40 indicates it would take Apple 2.5 years to repay its debt. In 2023, the coverage ratio of .38 indicates it would take Apple 2.63 years to repay its debt.

```
[ ]: df[df["Company"] == "Microsoft"]
```

```
[ ]:
      Company  Year  Total Revenue  Net Income  Total Assets  \
2  Microsoft  2021      168088      61271      333779
1  Microsoft  2022      198270      72738      364840
0  Microsoft  2023      211915      72361      411976

      Total Liabilities  Cash Flow from operating activities  Shareholder Equity  \
2              191791              76740              141988
1              198298              89035              166542
0              205753              87582              206223

      Revenue Growth (%)  Income Growth (%)  Asset Growth (%)  \
2              NaN              NaN              NaN
1      17.956071      18.715216      9.305858
0      6.882030      -0.518299      12.919636

      Liabilities Growth (%)  Equity Growth (%)  \
2              NaN              NaN
1      3.392756      17.293011
0      3.759493      23.826422

      CF Operating Activities Growth (%)  Net Profit Margin  Debt Ratio  \
2              NaN              0.364517      0.574605
1      16.021631              0.366863      0.543520
0      -1.631942              0.341462      0.499430

      Debt_to_Equity Ratio  Equity Multiplier  Cash Flow Coverage Ratio
2              1.350755      2.350755      0.400123
1              1.190679      2.190679      0.448996
0              0.997721      1.997721      0.425666
```

## 0.2.2 Microsoft

### Revenue Growth:



Revenue increased 17.96% from 2021 to 2022. Revenue increased 6.88% from 2022 to 2023.

#### **Net Income Growth:**

Net Income increased 18.71% from 2021 to 2022. Net Income decreased 0.52% from 2022 to 2023.

#### **Total Asset Growth:**

Total Assets increased 9.3% from 2021 to 2022. Total Assets increased 12.92% from 2022 to 2023. Assets grew at least 3 times more than Liabilities.

#### **Total Liability Growth:**

Liabilities increased 3.4% from 2021 to 2022. Liabilities increased 3.76% from 2022 to 2023.

#### **Cash Flow from Operating Activities Growth:**

Cash flow grew 16.02% from 2021 to 2022. Cash flow decreased 1.63% from 2022 to 2023.

#### **Net Profit Margin (Net Income/Total Revenue):**

In 2021, the company generated 36 cents in profit for every dollar of revenue. In 2022, the company generated 37 cents in profit for every dollar of revenue. In 2023, the company generated 34 cents in profit for every dollar of revenue. The net profit margin has remained consistent.

#### **Debt Ratio (Total Liabilities/Total Assets):**

In 2021, 57% of assets were owned by creditors. In 2022, 54% of assets were owned by creditors. In 2023, 50% of assets were owned by creditors. The percentage of assets owned by creditors has steadily declined.

#### **Debt\_to\_Equity (Total Liabilities/Shareholder Equity):**

In 2021, Microsoft had 1.35 dollars of debt for every dollar of equity. In 2022, Microsoft had 1.19 dollars of debt for every dollar of equity. In 2023, Microsoft had .99 dollars of debt for every dollar of equity. The debt to equity ratio has steadily declined.

#### **Equity Multiplier (Total Assets/Shareholder Equity):**

In 2021, Microsoft's assets were 2.35 times equity. In 2022, Microsoft's assets were 2.19 times equity. In 2023, Microsoft's assets were 1.99 times equity. Half of Microsoft's assets are financed by debt. The numbers show a steady decreasing trend.

#### **Cash Flow Coverage Ratio (Cash Flow from operating activities/Total Liabilities):**

In 2021, the coverage ratio was .40 indicating it would take Microsoft 2.5 years to repay its debt. In 2022, the coverage ratio was .45 indicating it would take Microsoft 2.22 years to repay its debt. In 2023, the coverage ratio was .43 indicating it would take Microsoft 2.33 years to repay its debt.

```
[ ]: df[df["Company"] == "Tesla"]
```

```
[ ]: Company Year Total Revenue Net Income Total Assets Total Liabilities \
5 Tesla 2021 53823 5644 62131 30548
4 Tesla 2022 81462 12587 82338 36440
3 Tesla 2023 96773 14974 106618 43009
```

	Cash Flow from operating activities	Shareholder Equity	\
5	11497	31583	
4	14724	45898	
3	13256	63609	

	Revenue Growth (%)	Income Growth (%)	Asset Growth (%)	\
5	NaN	NaN	NaN	
4	51.351653	123.015592	32.523217	
3	18.795267	18.964010	29.488207	

	Liabilities Growth (%)	Equity Growth (%)	\
5	NaN	NaN	
4	19.287678	45.325017	
3	18.026894	38.587738	

	CF Operating Activities Growth (%)	Net Profit Margin	Debt Ratio	\
5	NaN	0.104862	0.491671	
4	28.068192	0.154514	0.442566	
3	-9.970117	0.154733	0.403393	

	Debt_to_Equity Ratio	Equity Multiplier	Cash Flow Coverage Ratio
5	0.967229	1.967229	0.376359
4	0.793934	1.793934	0.404061
3	0.676146	1.676146	0.308215

### 0.2.3 Tesla

#### Revenue Growth:

Revenue grew 51.35% from 2021 to 2022. Revenue grew 18.8% from 2022 to 2023.

#### Net Income Growth:

Net Income grew 123% from 2021 to 2022. Net Income grew 18.96% from 2022 to 2023.

#### Total Asset Growth:

Assets grew 32.5 from 2021 to 2022. Assets grew 29.5% from 2022 to 2023.

#### Total Liability Growth:

Liabilities grew 19% from 2021 to 2022. Liabilities grew from 18% from 2022 to 2023.

#### Cash Flow from Operating Activities Growth:

Cash flow grew 28% from 2021 to 2022. Cash flow decreased 9.97% from 2022 to 2023.

#### Net Profit Margin (Net Income/Total Revenue):

In 2021, the company generated 11 cents for every dollar of revenue. In 2022, the company generated 16 cents for every dollar of revenue. In 2023, the company generated 16 cents for every dollar of revenue.

### **Debt Ratio (Total Liabilities/Total Assets):**

In 2021, 49% of assets were owned by creditors. In 2022, 44% of assets were owned by creditors. In 2023, 40% of assets were owned by creditors.

### **Debt\_to\_Equity (Total Liabilities/Shareholder Equity):**

In 2021, Tesla had .97 dollars of debt for every dollar of equity. In 2022, Tesla had .79 dollars of debt for every dollar of equity. In 2023, Tesla had .68 dollars of debt for every dollar of equity.

### **Equity Multiplier (Total Assets/Shareholder Equity):**

In 2021, Tesla's assets were 1.97 times equity. In 2022, Tesla's assets were 1.79 times equity. In 2023, Tesla's assets were 1.68 times equity. The ratio has decreased. Less than half of Tesla's assets are financed by debt.

### **Cash Flow Coverage Ratio (Cash Flow from operating activities/Total Liabilities):**

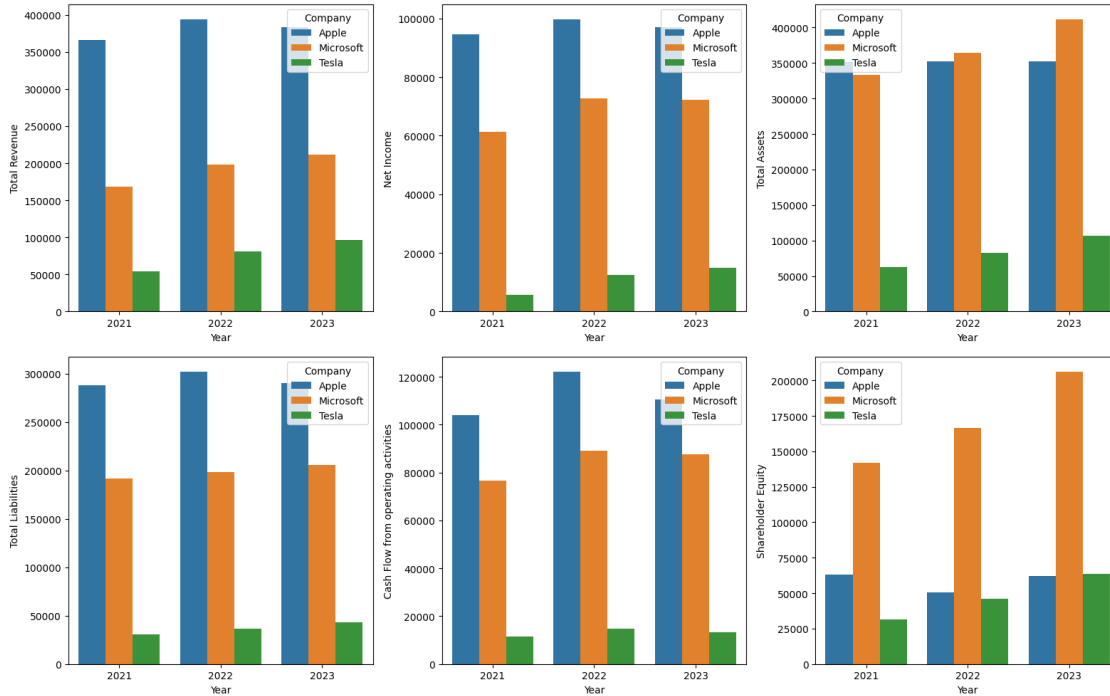
In 2021, the coverage ratio was .38 indicating it would take Tesla 2.63 years to repay its debt. In 2022, the coverage ratio was .40 indicating it would take 2.5 years for Tesla to repay its debt. In 2023, the coverage ratio was .31 indicating it would take Tesla 3.23 years for Tesla to repay its debt.

## **0.3 Data Visualization**

### **0.3.1 Facts**

```
[ ]: facts = ['Total Revenue', 'Net Income', 'Total Assets',  
             'Total Liabilities', 'Cash Flow from operating activities',  
             'Shareholder Equity']
```

```
[ ]: import seaborn as sns  
import matplotlib.pyplot as plt  
  
plt.figure(figsize=(16,10))  
  
for i, feat in enumerate(facts):  
    plt.subplot(2,3,i+1)  
    plt.tight_layout()  
    ax = sns.barplot(data=df, x='Year', y=df[feat], hue='Company')
```

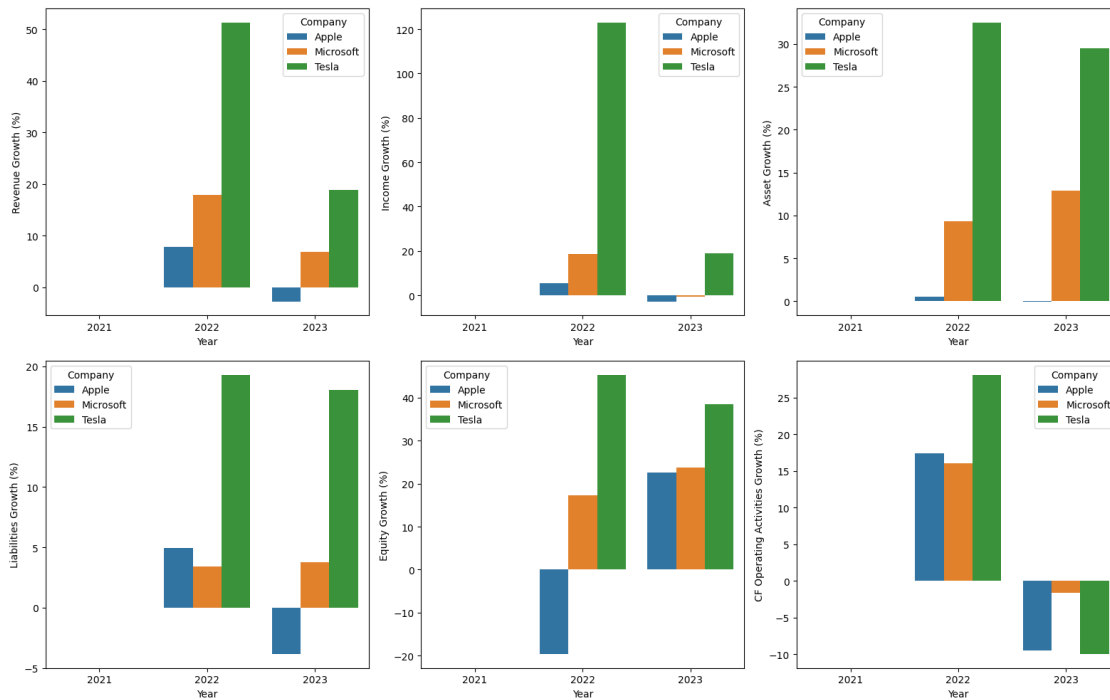


### 0.3.2 Growth

```
[ ]: growth = ['Revenue Growth (%)',
               'Income Growth (%)', 'Asset Growth (%)', 'Liabilities Growth (%)',
               'Equity Growth (%)', 'CF Operating Activities Growth (%)']
```

```
[ ]: plt.figure(figsize=(16,10))

for i, feat in enumerate(growth):
    plt.subplot(2,3,i+1)
    plt.tight_layout()
    ax = sns.barplot(data=df, x='Year', y=df[feat], hue='Company')
```

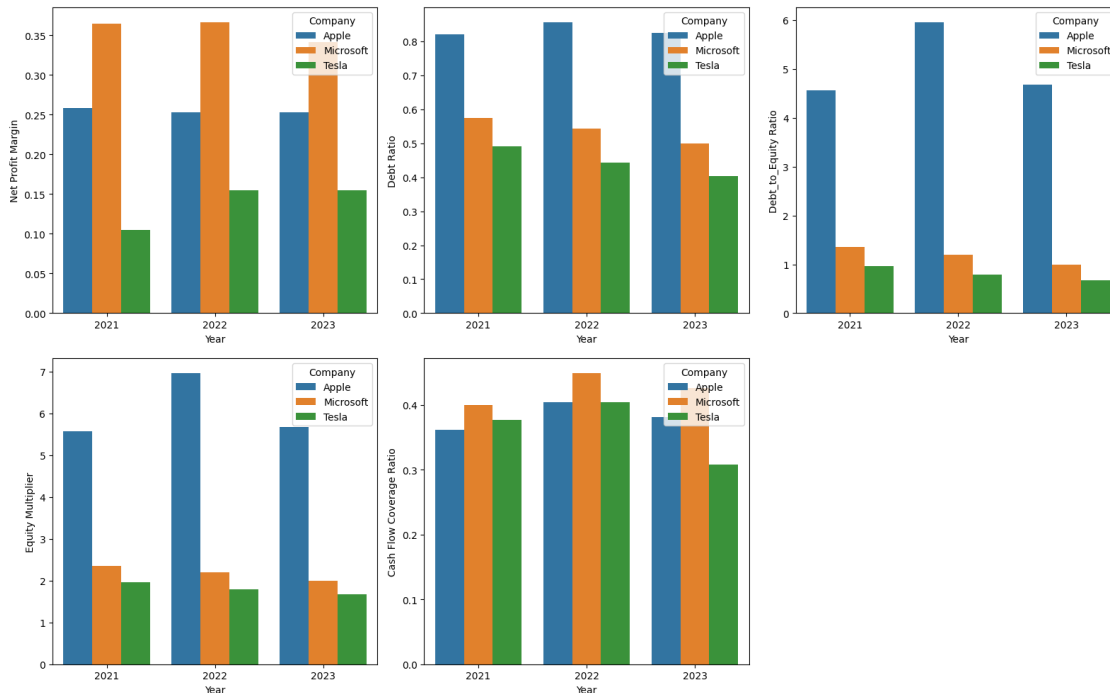


### 0.3.3 Ratios

```
[ ]: ratios = [
    'Net Profit Margin', 'Debt Ratio', 'Debt_to_Equity Ratio',
    'Equity Multiplier', 'Cash Flow Coverage Ratio']
```

```
[ ]: plt.figure(figsize=(16,10))

for i, feat in enumerate(ratios):
    plt.subplot(2,3,i+1)
    plt.tight_layout()
    ax = sns.barplot(data=df, x='Year', y=df[feat], hue='Company')
```



## 0.4 Summary

Analyzed data pulled from the 10-K reports of Microsoft, Apple, and Tesla for the period 2021 to 2023.

Data pulled from 10-K: Total Revenue, Net Income, Total Assets, Total Liabilities, and Cash flow from operating activities.

Highlights:

Microsoft had the highest shareholder equity and net profit margin for each year in the period.

Microsoft grew its assets triple the rate of its Liabilities.

Tesla had the highest growth for each of the data items pulled from the 10-K.

Tesla's cash flow from operating activities was very low.

Tesla had low debt and low debt ratios.

Tesla had unusually high revenue and net income growth in 2022.

Apple carried the most debt. 80% of its assets are owned by creditors.

Apple had the highest revenue, net income and cash flow from operating activities for each year in the period.

Apple did not perform well for year-over-year growth.

[ ]: