Leveraged Buyout (LBO) Model in Python

This notebook showcases a private equity Leveraged Buyout (LBO) model built in Python. The model includes debt tranches, equity waterfalls, Monte Carlo simulations, and scenario analysis, providing a comprehensive analysis of the deal structure and profitability. Below is a step-by-step breakdown of the model.

Step 1: Import Libraries

I begin by importing the necessary libraries for financial calculations, data manipulation, and visualization.

In [1]:
```
import pandas as pd
import numpy as np
import numpy_financial as npf
import plotly.graph_objects as go
import plotly.io as pio
import matplotlib.pyplot as plt
%matplotlib inline

# Set plotly default renderer
pio.renderers.default = "iframe"  # Adjust based on environment (e.g., "png," "brow
```

Step 2: Create Initial Dataset

I create a dataset to represent a company's financial projections over a 5-year period typical for an LBO investment. The data includes revenue forecasts, EBITDA, free cash flows, interest payments, tax rates, debt outstanding, and equity contribution. The dataset also includes terminal value and multiples for exit calculations. I store this data in a Pandas DataFrame for easy manipulation. Column explanations are below.

In [2]:
```
data = {
    'Company': ["Blake's Bakes Inc."] * 5,
    'Year': [1, 2, 3, 4, 5],
    'Revenue Forecast': [1000000, 1100000, 1200000, 1300000, 1400000],
    'EBITDA': [300000, 330000, 360000, 390000, 420000],
    'Free Cash Flow (FCF)': [200000, 220000, 240000, 260000, 280000],
    'Interest Payments': [50000, 48000, 46000, 44000, 42000],
```

```
    'Tax Rate': [0.25] * 5,
    'Discount Rate': [0.1] * 5,
    'Debt/Equity Ratio': [2] * 5,
    'Terminal Value': [5000000] + [None] * 4,
    'Debt Outstanding': [900000, 800000, 700000, 600000, 500000],
    'Equity Contribution': [300000] + [None] * 4,
    'Purchase Price': [1200000] + [None] * 4,
    'Multiples (Exit)': [8] + [None] * 4,
    'Exit Value': [None] * 4 + [3360000],
    'Equity Value at Exit': [None] * 4 + [2860000],
}
```

Company

Stores the name of the company being analyzed

Identifies the subject of the analysis throughout the 5-year period

Year

Represents the time horizon for the LBO model, from year 1 to year 5

Used as the basis for discounting future cash flows

Revenue Forecast

The projected revenue for each year

Drives business growth and directly influences other metrics like EBITDA and free cash flow

EBITDA (Earnings Before Interest, Taxes, Depreciation, and Amortization)

A key profitability metric showing the company's operating performance before non-operating expenses

Used to calculate free cash flow and determine the company's valuation

Free Cash Flow (FCF)

Represents the cash available after all operating expenses, taxes, and interest payments

Used to pay down debt or distribute to equity holders, making it critical for LBOs

Interest Payments

Contains the interest payments on the company’s outstanding debt

Reduces the free cash flow available to equity holders

Tax Rate

The effective tax rate applied to the company's earnings

Impacts the net profitability and post-tax cash flows

Discount Rate

Used to calculate the present value of future cash flows

Accounts for the time value of money and investment risk, influencing enterprise value (EV)

Debt/Equity Ratio

Represents the proportion of debt to equity used to finance the acquisition

Helps calculate how much of the purchase price is funded by debt versus equity

Terminal Value

The estimated value of the company at the end of the projection period (year 5)

Assumes the company will continue operating indefinitely, used to calculate overall investment value

Debt Outstanding

Tracks the amount of debt remaining to be paid off at the end of each year

Decreases over time as debt is repaid

Equity Contribution

The amount of equity that the buyer contributes to the acquisition.

Represents the cash invested by equity holders, affecting their returns

Purchase Price

The total purchase price for the company at the start of the model

Sum of debt and equity contributions, representing the total acquisition cost

Multiples (Exit)

The exit multiple applied to EBITDA in the final year to calculate the exit value or sale price of the company

Reflects market conditions and perceived value of the company

Exit Value

The sale price of the company at the end of the projection period, based on the exit multiple and EBITDA

Crucial for determining the overall success of the LBO

Equity Value at Exit

The value of the equity portion at the time of the company's sale

Calculated as the exit value minus remaining debt, representing the payoff to equity holders

In [3]:
```
df = pd.DataFrame(data)
```

In [4]:
```
df
```

Out[4]:

	Company	Year	Revenue Forecast	EBITDA	Free Cash Flow (FCF)	Interest Payments	Tax Rate	Discount Rate	Debt/Equity Ratio	Te
0	Blake's Bakes Inc.	1	1000000	300000	200000	50000	0.25	0.1	2	50(
1	Blake's Bakes Inc.	2	1100000	330000	220000	48000	0.25	0.1	2	
2	Blake's Bakes Inc.	3	1200000	360000	240000	46000	0.25	0.1	2	
3	Blake's Bakes Inc.	4	1300000	390000	260000	44000	0.25	0.1	2	
4	Blake's Bakes Inc.	5	1400000	420000	280000	42000	0.25	0.1	2	

Step 3: Calculate Free Cash Flow (FCF)

I calculate Free Cash Flow (FCF) by adjusting EBITDA for taxes, interest payments, and capital expenditures. FCF represents the cash available after operating expenses, which can be used to repay debt or distribute to equity holders.

In [5]:
```
df['FCF'] = df['EBITDA'] * (1 - df['Tax Rate']) - df['Interest Payments']
```

In [6]:
```
df
```

Out[6]:

	Company	Year	Revenue Forecast	EBITDA	Free Cash Flow (FCF)	Interest Payments	Tax Rate	Discount Rate	Debt/Equity Ratio	Te
0	Blake's Bakes Inc.	1	1000000	300000	200000	50000	0.25	0.1	2	50(
1	Blake's Bakes Inc.	2	1100000	330000	220000	48000	0.25	0.1	2	
2	Blake's Bakes Inc.	3	1200000	360000	240000	46000	0.25	0.1	2	
3	Blake's Bakes Inc.	4	1300000	390000	260000	44000	0.25	0.1	2	
4	Blake's Bakes Inc.	5	1400000	420000	280000	42000	0.25	0.1	2	

Step 4: Present Value of Free Cash Flows (PV_FCF)

I discount future free cash flows back to their present value using the discount rate provided. The sum of these discounted cash flows helps calculate the total enterprise value (EV).

In [7]:
```
df['PV_FCF'] = df['FCF'] / (1 + df['Discount Rate']) ** df['Year']
```

In [8]:
```
df
```

Out[8]:

	Company	Year	Revenue Forecast	EBITDA	Free Cash Flow (FCF)	Interest Payments	Tax Rate	Discount Rate	Debt/Equity Ratio	Te
0	Blake's Bakes Inc.	1	1000000	300000	200000	50000	0.25	0.1	2	50(
1	Blake's Bakes Inc.	2	1100000	330000	220000	48000	0.25	0.1	2	
2	Blake's Bakes Inc.	3	1200000	360000	240000	46000	0.25	0.1	2	
3	Blake's Bakes Inc.	4	1300000	390000	260000	44000	0.25	0.1	2	
4	Blake's Bakes Inc.	5	1400000	420000	280000	42000	0.25	0.1	2	

Step 5: Discount Terminal Value

The terminal value represents the company's value at the end of the LBO holding period. I discount this terminal value to present value using the discount rate.

In [9]:
```
terminal_value_pv = df['Terminal Value'].iloc[0] / (1 + df['Discount Rate'].iloc[0]
```

Step 6: Calculate Total Enterprise Value (EV)

The total enterprise value is the sum of the present value of free cash flows and the present value of the terminal value. This gives us the value of the company today.

In [10]:
```
total_ev = df['PV_FCF'].sum() + terminal_value_pv
```

Step 7: Calculate Debt and Equity Contributions

I calculate the debt and equity contributions based on the debt/equity ratio. This will show how much of the purchase price is financed through debt and equity.

In [11]:
```
purchase_price = total_ev
df['Debt Contribution'] = purchase_price * df['Debt/Equity Ratio'].iloc[0] / (1 + d
df['Equity Contribution'] = purchase_price - df['Debt Contribution']
```

In [12]:
```
df
```

Out[12]:

	Company	Year	Revenue Forecast	EBITDA	Free Cash Flow (FCF)	Interest Payments	Tax Rate	Discount Rate	Debt/Equity Ratio	Te
0	Blake's Bakes Inc.	1	1000000	300000	200000	50000	0.25	0.1	2	50(
1	Blake's Bakes Inc.	2	1100000	330000	220000	48000	0.25	0.1	2	
2	Blake's Bakes Inc.	3	1200000	360000	240000	46000	0.25	0.1	2	
3	Blake's Bakes Inc.	4	1300000	390000	260000	44000	0.25	0.1	2	
4	Blake's Bakes Inc.	5	1400000	420000	280000	42000	0.25	0.1	2	

In [13]:
```
df.columns
```

Out[13]:
```
Index(['Company', 'Year', 'Revenue Forecast', 'EBITDA', 'Free Cash Flow (FCF)',
       'Interest Payments', 'Tax Rate', 'Discount Rate', 'Debt/Equity Ratio',
       'Terminal Value', 'Debt Outstanding', 'Equity Contribution',
       'Purchase Price', 'Multiples (Exit)', 'Exit Value',
       'Equity Value at Exit', 'FCF', 'PV_FCF', 'Debt Contribution'],
      dtype='object')
```

Step 8: Add Operating Assumptions

I add detailed operating assumptions such as capital expenditures (CapEx), depreciation, and changes in working capital to reflect real-world financial complexities. These factors impact free cash flow and are essential for detailed financial modeling.

In [14]:
```
df['CapEx'] = [-100000, -110000, -120000, -130000, -140000]
df['Depreciation'] = [50000, 60000, 70000, 80000, 90000]
df['Change in Working Capital'] = [-20000, -22000, -24000, -26000, -28000]
df['FCF'] = df['EBITDA'] * (1 - df['Tax Rate']) - df['Interest Payments'] - df['Cap
```

In [15]:
```
df
```

Out[15]:

	Company	Year	Revenue Forecast	EBITDA	Free Cash Flow (FCF)	Interest Payments	Tax Rate	Discount Rate	Debt/Equity Ratio	Te
0	Blake's Bakes Inc.	1	1000000	300000	200000	50000	0.25	0.1	2	50(
1	Blake's Bakes Inc.	2	1100000	330000	220000	48000	0.25	0.1	2	
2	Blake's Bakes Inc.	3	1200000	360000	240000	46000	0.25	0.1	2	
3	Blake's Bakes Inc.	4	1300000	390000	260000	44000	0.25	0.1	2	
4	Blake's Bakes Inc.	5	1400000	420000	280000	42000	0.25	0.1	2	

5 rows × 22 columns

Step 9: Create Debt Tranches

I model different types of debt, including senior and subordinated debt, with respective interest rates and repayment schedules. This structure mimics the layered debt financing typical in leveraged buyouts.

In [16]:
```
df['Senior Debt'] = [500_000, 450_000, 400_000, 350_000, 300_000]
df['Subordinated Debt'] = [400_000, 350_000, 300_000, 250_000, 200_000]
df['Total Debt Outstanding'] = df['Senior Debt'] + df['Subordinated Debt']
df['Interest Payments'] = df['Senior Debt'] * 0.05 + df['Subordinated Debt'] * 0.08
```

In [17]:
```
df
```

Out[17]:

	Company	Year	Revenue Forecast	EBITDA	Free Cash Flow (FCF)	Interest Payments	Tax Rate	Discount Rate	Debt/Equity Ratio	Te
0	Blake's Bakes Inc.	1	1000000	300000	200000	57000.0	0.25	0.1	2	50(
1	Blake's Bakes Inc.	2	1100000	330000	220000	50500.0	0.25	0.1	2	
2	Blake's Bakes Inc.	3	1200000	360000	240000	44000.0	0.25	0.1	2	
3	Blake's Bakes Inc.	4	1300000	390000	260000	37500.0	0.25	0.1	2	
4	Blake's Bakes Inc.	5	1400000	420000	280000	31000.0	0.25	0.1	2	

5 rows × 25 columns

Step 10: Exit Value and Final Equity Value

I calculate the exit value based on the EBITDA multiple at the end of the holding period. The final equity value is determined by subtracting any remaining debt from the exit value.

In [18]:
```
exit_value = df['EBITDA'].iloc[-1] * df['Multiples (Exit)'].iloc[0]
debt_at_exit = df['Total Debt Outstanding'].iloc[-1]
equity_value_at_exit = exit_value - debt_at_exit
```

Step 11: Add Equity Waterfall

I divide the equity into preferred and common portions, with preferred equity receiving a 10% return before common equity holders receive their distributions.

In [19]:
```
df['Preferred Equity Contribution'] = df['Equity Contribution'] * 0.7
df['Common Equity Contribution'] = df['Equity Contribution'] * 0.3
df['Preferred Equity Returns'] = df['Preferred Equity Contribution'] * 1.1  # 10% r
df['Common Equity Returns'] = equity_value_at_exit - df['Preferred Equity Returns']
```

In [20]:
```
df
```

Out[20]:

	Company	Year	Revenue Forecast	EBITDA	Free Cash Flow (FCF)	Interest Payments	Tax Rate	Discount Rate	Debt/Equity Ratio	Te
0	Blake's Bakes Inc.	1	1000000	300000	200000	57000.0	0.25	0.1	2	50(
1	Blake's Bakes Inc.	2	1100000	330000	220000	50500.0	0.25	0.1	2	
2	Blake's Bakes Inc.	3	1200000	360000	240000	44000.0	0.25	0.1	2	
3	Blake's Bakes Inc.	4	1300000	390000	260000	37500.0	0.25	0.1	2	
4	Blake's Bakes Inc.	5	1400000	420000	280000	31000.0	0.25	0.1	2	

5 rows × 29 columns

Step 12: Calculate IRR and NPV

I calculate the internal rate of return (IRR) and net present value (NPV) for the equity holders based on cash flows over the holding period. These metrics indicate the profitability of the investment.

In [21]:

```
cash_flows = [-df['Equity Contribution'].iloc[0]] + df['FCF'].tolist() + [equity_va
irr = npf.irr(cash_flows)
npv = npf.npv(df['Discount Rate'].iloc[0], cash_flows)
```

Step 13: Implement Dividend Recaps

I simulate dividend recaps after year 3, where some of the free cash flow is distributed to equity holders rather than used for debt repayment.

In [22]:

```
df['Dividend Payout'] = [0, 0, 50_000, 100_000, 150_000]  # Example of dividends pa
df['FCF_after_dividends'] = df['FCF'] - df['Dividend Payout']
```

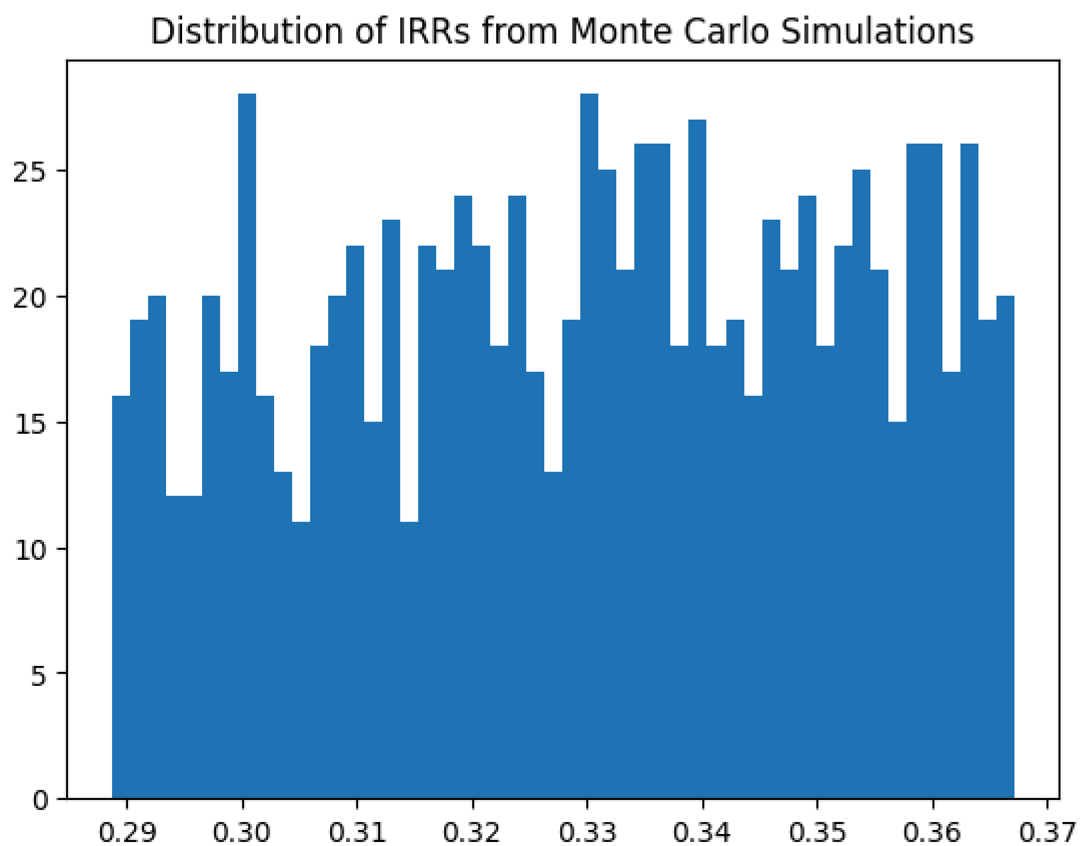
Step 14: Monte Carlo Simulation

I run a Monte Carlo simulation to test different exit multiples (ranging from 6x to 10x) and calculate the resulting IRRs across 1,000 different scenarios. This simulation helps us assess the risk and variability of returns.

In [23]:
```
n_simulations = 1000
irr_results = []
exit_multiples = np.random.uniform(6, 10, n_simulations)

for multiple in exit_multiples:
    exit_value_sim = df['EBITDA'].iloc[-1] * multiple
    equity_value_at_exit_sim = exit_value_sim - debt_at_exit
    irr_sim = npf.irr([-df['Equity Contribution'].iloc[0]] + df['FCF'].tolist() + [
    irr_results.append(irr_sim)

plt.hist(irr_results, bins=50)
plt.title('Distribution of IRRs from Monte Carlo Simulations')
plt.show()
```



Step 15: Scenario Analysis

I run scenario analysis to calculate IRRs under different exit multiples (6x, 8x, 10x). This helps us understand the sensitivity

of returns to different exit assumptions.

In [24]:
```
scenario_irrs = []
scenario_multiples = [6, 8, 10]

for multiple in scenario_multiples:
    exit_value_scenario = df['EBITDA'].iloc[-1] * multiple
    equity_value_at_exit_scenario = exit_value_scenario - debt_at_exit
    irr_scenario = npf.irr([-df['Equity Contribution'].iloc[0]] + df['FCF'].tolist(
    scenario_irrs.append(irr_scenario)

print("IRR Results for Different Exit Multiples:")
for multiple, irr_scenario in zip(scenario_multiples, scenario_irrs):
    print(f"Exit Multiple {multiple}: IRR = {irr_scenario:.2%}")
```

```
IRR Results for Different Exit Multiples:
Exit Multiple 6: IRR = 28.87%
Exit Multiple 8: IRR = 33.14%
Exit Multiple 10: IRR = 36.71%
```

Step 16: Visualizations

I create visualizations for debt repayment, free cash flow over time, and equity value at exit using Plotly. These charts help visualize the LBO model’s key metrics.

In [25]:
```
# 1. Debt Repayment Schedule Visualization
debt_trace = go.Scatter(x=df['Year'], y=df['Total Debt Outstanding'], mode='lines+m
layout_debt = go.Layout(title="Debt Repayment Schedule", xaxis={'title': 'Year'}, y
fig_debt = go.Figure(data=[debt_trace], layout=layout_debt)
fig_debt.show()
```

```
In [26]: # 2. Free Cash Flow (FCF) Over Time Visualization
fcf_trace = go.Scatter(x=df['Year'], y=df['FCF'], mode='lines+markers', name='Free
layout_fcf = go.Layout(title="Free Cash Flow Over Time", xaxis={'title': 'Year'}, y
fig_fcf = go.Figure(data=[fcf_trace], layout=layout_fcf)
fig_fcf.show()
```

In [27]:

```
# 3. Equity Value at Exit Visualization
equity_trace = go.Bar(x=df['Year'], y=[0, 0, 0, 0, equity_value_at_exit], name='Equ
layout_equity = go.Layout(title="Equity Value at Exit", xaxis={'title': 'Year'}, ya
fig_equity = go.Figure(data=[equity_trace], layout=layout_equity)
fig_equity.show()
```

Final Results

Finally, we display the resulting DataFrame and key outputs such as enterprise value, initial debt and equity contributions, final exit value, IRR, and NPV.

In [28]:
```
df
```

Out[28]:

	Company	Year	Revenue Forecast	EBITDA	Free Cash Flow (FCF)	Interest Payments	Tax Rate	Discount Rate	Debt/Equity Ratio	Te
0	Blake's Bakes Inc.	1	1000000	300000	200000	57000.0	0.25	0.1	2	50(
1	Blake's Bakes Inc.	2	1100000	330000	220000	50500.0	0.25	0.1	2	
2	Blake's Bakes Inc.	3	1200000	360000	240000	44000.0	0.25	0.1	2	
3	Blake's Bakes Inc.	4	1300000	390000	260000	37500.0	0.25	0.1	2	
4	Blake's Bakes Inc.	5	1400000	420000	280000	31000.0	0.25	0.1	2	

5 rows × 31 columns

In [29]:

```
print(f"Total Enterprise Value (EV): ${total_ev:,.0f}")
print(f"Initial Debt Contribution: ${df['Debt Contribution'].iloc[0]:,.0f}")
print(f"Initial Equity Contribution: ${df['Equity Contribution'].iloc[0]:,.0f}")
print(f"Final Exit Value: ${exit_value:,.0f}")
print(f"Debt at Exit: ${debt_at_exit:,.0f}")
print(f"Final Equity Value at Exit: ${equity_value_at_exit:,.0f}")
print("IRR:", irr)
print("NPV:", npv)
```

```
Total Enterprise Value (EV): $3,936,108
Initial Debt Contribution: $2,624,072
Initial Equity Contribution: $1,312,036
Final Exit Value: $3,360,000
Debt at Exit: $500,000
Final Equity Value at Exit: $2,860,000
IRR: 0.3314224506969239
NPV: 1671097.1472804674
```

Conclusion

This LBO model provides a detailed analysis of a leveraged buyout, incorporating advanced financial modeling techniques such as debt tranches, equity waterfalls, dividend recaps, scenario analysis, and Monte Carlo simulations. The visualizations and results demonstrate the value of this model in evaluating potential private equity investments.

Thank you for viewing my work. For professional inquiries and financial opportunities, email blakecalhoun@tuta.io.

For more projects I have made over the years, visit my full portfolio here: https://github.com/nervousblakedown