Assignment #5: Waterfall Distribution

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Questions

- Assume a developer has no money to invest but has found a development opportunity. His uncle is willing to invest with him 100% of the equity but requires the following terms:

  - No developer fee allowed
  - First, annual 15% IRR to the uncle
  - Then split will be 30% to the developer and 70% to the uncle.

  a) Assuming an 'all equity' deal of $10mm TDC, what will be the developer's profit if he sells the project for $20mm after 2 years?

  Calculations:
  Given:

  - Total Development Cost (TDC): $10,000,000
  - Sell Price (SP): $20,000,000
  - Years: 2
  - Target IRR: 15%
  - Uncle Share: 70%
  - Developer Share: 30%

  To find uncle's required return for 15% IRR:

  $$\text{Required Return} = \text{TDC} \times (1 + \text{IRR})^n$$

  $$\text{Required Return} = 10,000,000 \times (1 + 0.15)^2 = \$13,225,000$$

  Remaining profit after uncle's return:

  $$\text{Remaining Profit} = \text{Sell Price} - \text{Uncle's Required Return}$$

  $$\text{Remaining Profit} = 20,000,000 - 13,225,000 = \$6,775,000$$

  Developer's profit (30% of remaining):

  $$\text{Developer's Profit} = \text{Remaining Profit} \times \text{Developer Share}$$

  $$\text{Developer's Profit} = 6,775,000 \times 0.30 = \$2,032,500$$

  Uncle's profit (70% of remaining):

  $$\text{Uncle's Profit} = \text{Remaining Profit} \times \text{Uncle Share}$$

  $$\text{Uncle's Profit} = 6,775,000 \times 0.70 = \$4,742,500$$

  b) Assuming an 'all equity' deal of $10mm TDC and cashing out after 2 years. What should be the minimum profit so the developer doesn't work for free.

  Calculations:
  To find the minimum sell price to meet 15% IRR:

  $$\text{Minimum Sell Price} = \frac{\text{Uncle's Required Return}}{1 - \text{Developer Share}}$$

  $$\text{Minimum Sell Price} = \frac{10,000,000 \times (1 + 0.15)^2}{1 - 0.30} = \frac{13,225,000}{0.70} = \$18,892,857.14$$

  Minimum profit for developer:

  $$\text{Minimum Profit} = \text{Minimum Sell Price} - \text{TDC}$$

  $$\text{Minimum Profit} = 18,892,857.14 - 10,000,000 = \$8,892,857.14$$

- Assume the developer was able to finance the project with 50% debt. TDC is now $11mm due to the financing costs and the developer sells the project after 2 years for $20m. The developer invests 20% of the equity, the uncle 80% and the developer gets 40% promote after 15% IRR.

  - What is the split now after the 15% hurdle is met?

  Calculations:
  Given:

  * Total Development Cost with Debt (TDC): $11,000,000
  * Debt Ratio (DR): 50%
  * Equity Needed (EN): $TDC \times (1 - DR)$
  * Developer Equity: 20% of Equity Needed
  * Uncle Equity: 80% of Equity Needed
  * Promote Share: 40%

  Equity Needed (EN):

  $$\text{Equity Needed} = 11,000,000 \times (1 - 0.50) = \$5,500,000$$

  Developer Equity (20% of Equity Needed):

  $$\text{Developer Equity} = 5,500,000 \times 0.20 = \$1,100,000$$

  Uncle Equity (80% of Equity Needed):

  $$\text{Uncle Equity} = 5,500,000 \times 0.80 = \$4,400,000$$

  Uncle's required return for 15% IRR:

  $$\text{Uncle's Required Return} = 4,400,000 \times (1 + 0.15)^2 = \$5,818,750$$

  Remaining profit after debt and uncle IRR:

  $$\text{Remaining Profit} = \text{Sell Price} - (\text{TDC with Debt} \times \text{Debt Ratio}) - \text{Uncle's Required Return}$$

  $$\text{Remaining Profit} = 20,000,000 - (11,000,000 \times 0.50) - 5,818,750 = \$8,681,250$$

  Promote (40% of remaining):

  $$\text{Promote} = 8,681,250 \times 0.40 = \$3,472,500$$

  Developer's profit:

  $$\text{Developer's Profit} = (\text{Remaining Profit} - \text{Promote}) \times \text{Developer Equity} + \text{Promote}$$

  $$\text{Developer's Profit} = (8,681,250 - 3,472,500) \times 0.20 + 3,472,500 = \$4,514,250$$

  Uncle's profit:

  $$\text{Uncle's Profit} = (\text{Remaining Profit} - \text{Promote}) \times \text{Uncle Equity}$$

  $$\text{Uncle's Profit} = (8,681,250 - 3,472,500) \times 0.80 = \$4,167,000$$

  - What is the value of the promote (the promote size)?

  $$\text{Promote} = \$3,472,500$$

  - What's a better deal for the developer: the terms under question #1 or #2?

  $$\text{Better deal for developer} = \text{Deal 2 (50\% Debt Financing)}$$

Formulas

- Present Value (PV): $PV = \frac{FV}{(1 + IRR)^n}$

- Minimum Sell Price (SP): $SP = \frac{UR}{(1 - DS)}$

- Equity Needed (EN): $EN = TDC \times (1 - DR)$

Calculation Step	Developer ($)	Uncle ($)	Notes
Initial Total Development Cost (TDC)	10,000,000.00	10,000,000.00	TDC: Total Development Cost
Sell Price (SP)	20,000,000.00	20,000,000.00	SP: Sell Price
Target IRR	15.00%	15.00%	IRR: Internal Rate of Return
Years	2	2	
Uncle Share	70.00%	70.00%	
Developer Share	30.00%	30.00%	
Uncle's required return (15% IRR)		13,225,000.00	PV = FV / (1 + IRR)^n
Remaining profit	6,775,000.00	6,775,000.00	
Developer's profit (30% of remaining)	2,032,500.00		
Uncle's profit (70% of remaining)		4,742,500.00	
Minimum sell price to meet 15% IRR	18,892,857.14		SP = UR / (1 - DS)
Minimum profit for developer	8,892,857.14		
Total Development Cost with Debt (TDC)	11,000,000.00	11,000,000.00	
Debt Ratio (DR)	50.00%	50.00%	
Equity Needed (EN)	5,500,000.00	5,500,000.00	EN = TDC * (1 - DR)
Developer Equity (20% of equity needed)	1,100,000.00		
Uncle Equity (80% of equity needed)		4,400,000.00	
Uncle's required return (15% IRR)		5,818,750.00	PV = FV / (1 + IRR)^n
Remaining profit after debt and uncle IRR	8,681,250.00	8,681,250.00	
Promote (40% of remaining)	3,472,500.00		
Developer's profit	4,514,250.00		
Uncle's profit (remaining after promote)		4,167,000.00	
Better deal for developer	Deal 2 (50% Debt Financing)		

Appendix: Code Implementation

```python
import pandas as pd
import numpy as np
import numpy_financial as npf

def calculate_irr(cash_flows):
    return npf.irr(cash_flows)

def goal_seek_for_irr(target_irr, initial_investment, years, initial_guess=1_000_000):
    step = 100_000
    tolerance = 0.0001
    max_iterations = 1000
    iteration = 0
    current_guess = initial_guess

    while iteration < max_iterations:
        cash_flows = [-initial_investment] + [0] * (years - 1) + [current_guess]
        irr = calculate_irr(cash_flows)

        if abs(irr - target_irr) < tolerance:
            return current_guess

        if irr < target_irr:
            current_guess += step
        else:
            current_guess -= step
            step /= 2

        iteration += 1

    raise ValueError("Goal seeking did not converge")

# Given data
sell_price = 20_000_000
tdc = 10_000_000
years = 2
target_irr = 0.15
uncle_share = 0.70
developer_share = 0.30


# Initial calculations for given data
uncle_required_return_1a = goal_seek_for_irr(target_irr, tdc, years)
remaining_profit_1a = sell_price - uncle_required_return_1a
developer_profit_1a = remaining_profit_1a * developer_share
uncle_profit_1a = remaining_profit_1a * uncle_share

minimum_sell_price_1b = (tdc * (1 + target_irr) ** years) / (1 - developer_share)
minimum_profit_1b = minimum_sell_price_1b - tdc

tdc_with_debt = 11_000_000
debt_ratio = 0.50
equity_needed = tdc_with_debt * (1 - debt_ratio)
developer_equity = 0.20
uncle_equity = 1 - developer_equity
promote_share = 0.40

uncle_required_return_2 = goal_seek_for_irr(target_irr, equity_needed * uncle_equity, years)
remaining_profit_2 = sell_price - (tdc_with_debt * debt_ratio) - uncle_required_return_2
promote = remaining_profit_2 * promote_share
developer_profit_2 = (remaining_profit_2 - promote) * developer_equity + promote
uncle_profit_2 = (remaining_profit_2 - promote) * uncle_equity

# Creating a DataFrame for better formatting and display
data = {
    "Calculation Step": [
        "Initial Total Development Cost (TDC)",
        "Sell Price (SP)",
        "Years",
        "Target IRR",
        "Uncle Share",
        "Developer Share",
        "Uncle's required return (15% IRR)",
        "Remaining profit",
        "Developer's profit (30% of remaining)",
        "Uncle's profit (70% of remaining)",
        "Minimum sell price to meet 15% IRR",
        "Minimum profit for developer",
        "Total Development Cost with Debt (TDC)",
        "Debt Ratio (DR)",
        "Equity Needed (EN)",
        "Developer Equity (20% of equity needed)",
        "Uncle Equity (80% of equity needed)",
        "Uncle's required return (15% IRR)",
        "Remaining profit after debt and uncle IRR",
        "Promote (40% of remaining)",
        "Developer's profit",
        "Uncle's profit (remaining after promote)",
        "Better deal for developer"
    ],
    "Developer ($)": [
        f"{tdc:,.2f}",
        f"{sell_price:,.2f}",
        f"{years}",
        f"{target_irr:.2%}",
        f"{uncle_share:.2%}",
        f"{developer_share:.2%}",
        "",
        f"{remaining_profit_1a:,.2f}",
        f"{developer_profit_1a:,.2f}",
        "",
        f"{minimum_sell_price_1b:,.2f}",
        f"{minimum_profit_1b:,.2f}",
        f"{tdc_with_debt:,.2f}",
        f"{debt_ratio * 100:.2f}%",
        f"{equity_needed:,.2f}",
        f"{equity_needed * developer_equity:,.2f}",
        "",
        "",
        f"{remaining_profit_2:,.2f}",
        f"{promote:,.2f}",
        f"{developer_profit_2:,.2f}",
        "",
        "Deal 1 (All Equity)" if developer_profit_1a > developer_profit_2 else "Deal 2 (50% Debt Financing)"
    ],
    "Uncle ($)": [
        f"{tdc:,.2f}",
        f"{sell_price:,.2f}",
        f"{years}",
        f"{target_irr:.2%}",
        f"{uncle_share:.2%}",
        f"{developer_share:.2%}",
        f"{uncle_required_return_1a:,.2f}",
        f"{remaining_profit_1a:,.2f}",
        "",
        f"{uncle_profit_1a:,.2f}",
        "",
        "",
        f"{tdc_with_debt:,.2f}",
        f"{debt_ratio * 100:.2f}%",
        f"{equity_needed:,.2f}",
        "",
        f"{equity_needed * uncle_equity:,.2f}",
        f"{uncle_required_return_2:,.2f}",
        f"{remaining_profit_2:,.2f}",
        "",
        "",
        f"{uncle_profit_2:,.2f}",
        ""
    ],
    "Notes": [
        "TDC: Total Development Cost",
        "SP: Sell Price",
        "",
        "IRR: Internal Rate of Return",
        "",
        "",
        "PV = FV / (1 + IRR)^n",
        "",
        "",
        "",
        "SP = UR / (1 - DS)",
        "",
        "",
        "",
        "EN = TDC * (1 - DR)",
        "",
        "",
        "PV = FV / (1 + IRR)^n",
        "",
        "",
        "",
        "",
        ""
    ]
}

df = pd.DataFrame(data)

# Pretty print the DataFrame as a table
print(df.to_string(index=False))
```