FINANCIAL ANALYTICS IN R

Introduction to Valuations & Financial Analytics

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Motivation: What are valuations?

- Estimate of the economic value of a new investment opportunity
- Investment opportunities can be companies or projects
- Help decide whether to invest or how to prioritize options
- Not only dimension considered! Also strategy, mission, etc.
- Common tool: discounted cashflow (DCF) analysis

Motivation: Why should a data scientist care?

- Your models may serve as inputs
- Using such models could help build the business case for data science projects

Anatomy of a cashflow

- Business inputs and assumptions
- Financial calculations
- Discounted cashflow analysis (summary metrics)

Anatomy of a cashflow model: business assumptions

	Price/Unit	10		**Tax Rate**	20%	
	Cost/Unit	5		**Discount Rate**	8%	
	1	**2**	**3**	**4**	**5**	**6**
Units Sold	150	175	200	200	200	200
Revenue	1,500.00	1,750.00	2,000.00	2,000.00	2,000.00	2,000.00
Direct Expenses	(750.00)	(875.00)	(1,000.00)	(1,000.00)	(1,000.00)	(1,000.00)
Gross Profit	750.00	875.00	1,000.00	1,000.00	1,000.00	1,000.00
Operating Expenses	(50.00)	(50.00)	(50.00)	(50.00)	(50.00)	(50.00)
Operating Profit	700.00	825.00	950.00	950.00	950.00	950.00
Interest Expense	(50.00)	(50.00)	(50.00)	(50.00)	(50.00)	(50.00)
Total Income	650.00	775.00	900.00	900.00	900.00	900.00
Tax	(130.00)	(155.00)	(180.00)	(180.00)	(180.00)	(180.00)
Net Income	520.00	620.00	720.00	720.00	720.00	720.00
Cash Adjustments	(400.00)	50.00	50.00	50.00	50.00	50.00
Cashflow	120.00	670.00	770.00	770.00	770.00	770.00
Discounted Cashflow	111.00	574.00	611.00	566.00	524.00	485.00
NPV	2,871.00					

Anatomy of a cashflow model: financial calculations

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Anatomy of a cashflow model: model analysis

	Price/Unit	10		**Tax Rate**	20%	
	Cost/Unit	5		**Discount Rate**	8%	
	1	**2**	**3**	**4**	**5**	**6**
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Revenue	1,500.00	1,750.00	2,000.00	2,000.00	2,000.00	2,000.00
Direct Expenses	(750.00)	(875.00)	(1,000.00)	(1,000.00)	(1,000.00)	(1,000.00)
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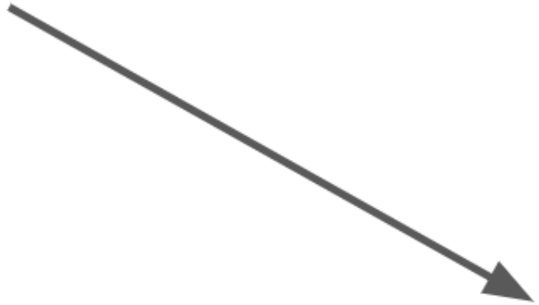
NPV	2,871.00					

A note on formatting

Metric	1	2	3	4	5	6
Received	100.00	200.00	300.00	400.00	500.00	500.00
Spent	150.00	175.00	200.00	225.00	250.00	250.00



Metric	Month	Value
Received	1	100
Received	2	200
Received	3	300
Received	4	400
Received	5	500
Received	6	500
Spent	1	150
Spent	2	175
Spent	3	200
Spent	4	225
Spent	5	250
Spent	6	250

FINANCIAL ANALYTICS IN R

Let's practice!

FINANCIAL ANALYTICS IN R

Business Models & Writing R Functions

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Parts of a Business Model

- Operating Revenues
- Expenses
  - Direct
  - Operating

Operating Revenue

Consumer Product

- Units Sold (Sales Quantity)
- Price / Unit

```
revenue <- units_sold * price_per_unit
```

Operating Revenue

Consumer Subscription

- Number Subscribers
- Price / Subscription
- Growth/Churn?
- Advertising?

```
number_subscribers <- base_subscribers * (enroll_rate - churn_rate)
revenue <- number_subscribers * price_subscription +
           ads_played * price_per_ad
```

Direct Expenses

Direct Expenses: Expenses directly tied to production of good/service

Consumer Product

- Cost of goods sold (e.g. cups, beans)
- Servicing costs (e.g barista's labor for time spent directly making a drink)

```
expenses <- units_sold * cost_per_unit
```

Operating Expenses (OpEx) / Overhead

Operating expenses: Non-production expenses incurred while running the core business

- Sales, general, and administrative (SGA) costs, like:
  - Marketing & advertising
  - Accounting department salaries
- Wear-and-tear on equipment

Accrual Basis

- Recognize revenues as **earned**
  - when good/service provided
  - *not* when payment received
- Recognize expenses when **consumed** to earn revenue
  - when their output is recognized as revenue
  - *not* when we paid for them

Gross Profit

Gross Profit = Operating Revenue - Direct Expenses

```
revenue <- sales_quantity * price_per_unit
direct_expenses <- sales_quantity * cost_per_unit
gross_profit <- total_revenue - direct_expenses
```

Turning business arithmetic into R functions

```
assumptions
```

time	sales
1	100
2	200
3	300
4	300
5	300
6	300

Turning business arithmetic into R functions

Let's write a basic function to take an `assumptions` dataset containing timeseries `sales` expectations and calculate gross profit.

```
calc_business_model <- function(assumptions, price_per_unit, cost_per_unit){

    model <- assumptions
    model$revenue <- model$sales * price_per_unit
    model$direct_expense <- model$sales * cost_per_unit
    model$gross_profit <- model$revenue - model$direct_expenses

    model

}
```

Using our function

```
assumptions
```

Time	Sales
1	100
2	200
3	300
4	300
5	300
6	300

```
calc_business_model(
    assumptions,
    price_per_unit = 10,
    cost_per_unit = 2
    )
```

time	sales	revenue	direct_expenses	gross_profit
1	100	1000	200	800
2	200	2000	400	1600
3	300	3000	600	2400
4	300	3000	600	2400
5	300	3000	600	2400
6	300	3000	600	2400

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Let's practice!

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Pro-Forma Income Statements

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From gross profits to operating income

$$\text{Gross Profit} = \text{Operating Revenue} - \text{Direct Expenses}$$
$$\text{Operating Income} = \text{Gross Profit} - \text{Overhead Expenses}$$

```
overhead_expense <- sga + depreciation + amortization
operating_profit  <- gross_profit - overhead_expense
```

From gross profits to operation income (2)

$$\text{Gross Profit} = \text{Operating Revenue} - \text{Direct Expenses}$$
$$\text{Operating Income} = \text{Gross Profit} - \text{Overhead Expenses}$$

```
overhead_expense <- sga + depreciation + amortization
operating_profit  <- gross_profit - overhead_expense
```

Depreciation?

- Accounting concept of matching costs to consumption of long-lived resources
- Many different approaches
  - Straight line, units produced, double-declining balance, etc.
- Called amortization for intangible assets

Straight-line depreciation in R

Depreciation: Recognized "cost" per period of using resource

- $\frac{\text{(Book Value - Salvage Value)}}{\text{Useful Life}}$

Book Value: Initial amount paid for resource (e.g. $50,000)

Useful Life: How long we intend to use resources (e.g. 10 years)

Salvage Value: Estimated value at the end of usage period (e.g. $10,000)

=> Depreciation = $\frac{50000-10000}{10}$ = 4,000

Straight-line depreciation in R

Depreciation: Recognized "cost" per period of using resource

- $\frac{\text{(Book Value - Salvage Value)}}{\text{Useful Life}}$

Book Value: Initial amount paid for resource (e.g. $50,000)

Useful Life: How long we intend to use resources (e.g. 10 years)

Salvage Value: Estimated value at the end of usage period (e.g. $10,000)

```
book_value <- 50000
salvage_value <- 10000
useful_life <- 10

depreciation_per_period <- (book_value - salvage_value)/useful_life
depreciation <- rep(depreciation_per_period, useful_life)
```

Levered versus unlevered valuations

Levered: Account for project financing (e.g. funded by loan, cash, or some combination) when computing value

- Deduct interest expense (Total Income = Operating Income - Interest Expense)
- Recognize benefit from interest expense "tax shield"

Unlevered: Do not account for project financing when computing value

- Represent overall value of project to enterprise
- Agnostic to financing decisions

Reaching net income

$$\text{Tax} = \text{Operating Income} * \text{Tax Rate}$$

(or Total Income x Tax Rate in the levered setting)

```
tax_rate <- 0.21
tax <- operating_income * tax_rate
```

Reaching net income

$$\text{Tax} = \text{Operating Income} * \text{Tax Rate}$$

(or Total Income x Tax Rate in the levered setting)

```
tax_rate <- 0.21
tax <- operating_income * tax_rate
```

$$\text{Net Income} = \text{Operating Income} - \text{Tax}$$

(or Total Income - Tax in the levered setting)

```
net_income <- operating_income - tax
```

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Let's practice!

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Adjustments to Net Income

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Income versus Cash

“However attractive the earnings numbers, we remain leery of businesses that never seem able to convert such pretty numbers into no-strings-attached cash.” - Warren Buffet

Income versus Cash

- **Timing**
  - Income is recognized as it is earned *(accrual basis)*
  - Cash is recognized as it is received/released *(cash basis)*
- **Scope**
  - Fixed-length income statement could completely ignore some major expenses

Adjustments to Net Income

- Add back depreciation/amortization

```
net_income <- revenue - direct_exp - op_ex - tax
cashflow <- net_income + depreciation_exp
```

Adjustments to Net Income

- Add back depreciation (amortization)
- Subtract out capital expenditures (CAPEX)

```
net_income <- revenue - direct_exp - op_ex - tax
cashflow <- net_income + depreciation_exp - capex
```

Adjustments to Net Income

- Add back depreciation (amortization)
- Subtract out capital expenditures (CAPEX)
- Adjust for changes to Net Working Capital (NWC)

```
net_income <- revenue - direct_exp - op_ex - tax
cashflow <- net_income + depreciation_exp - capex + nwc_changes
```

FINANCIAL ANALYTICS IN R

To the exercises and beyond!