THE MANAGEMENT ACCOUNTING CONFERENCE

Financial Modelling, Forecasting & Simulation

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Outline

- Introduction to Financial Modelling
  - Financial Modelling in MS Excel
  - FAST Modelling principles
  - Planning ahead
- Setting up the financial model
  - Structure & principles
  - Assumptions
- Forecasting & simulation
  - Financial forecasts
  - Monte Carlo Simulation

LOS…

"Essentially, **all models are wrong, but some are useful.**" (Box, 1987).

Financial Modelling cont.

- Uses of Financial Models
- Who Builds Financial Models
- Examples of Financial Models

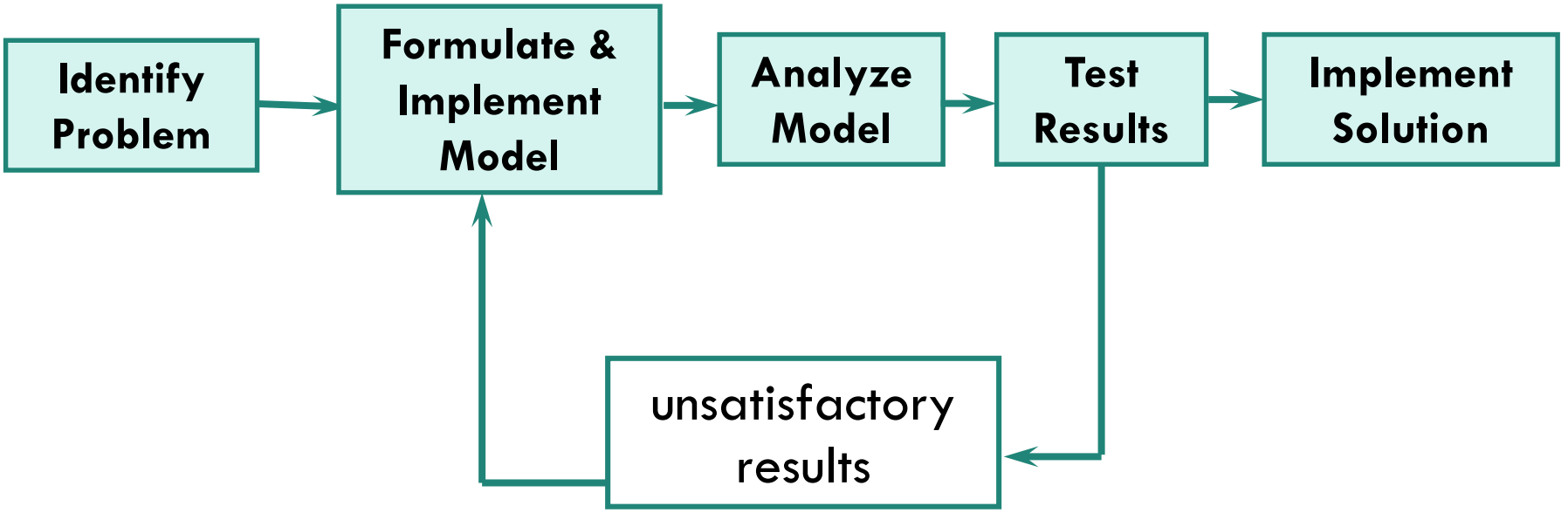
What is Financial Modelling?

What is Financial Modelling?

Financial Modelling – Simplification of a business problem into assumptions, framework e.t.c… A representation of reality

- Corporate
- Portfolio
- Options
- Bonds
- Other…

Modelling framework



The Modeling Process

1. **Step 1: Problem Definition** - Define the problem including the objectives and the parts of the organization that must be studied.

2. **Step 2: Data Collection** – Collect the data to estimate the value of parameters that affect the organization's problem.

3. **Step 3: Model Development** – Develop an analytical or simulation model.

4. **Step 4: Model Verification** – Determine whether the model is an accurate representation of reality.

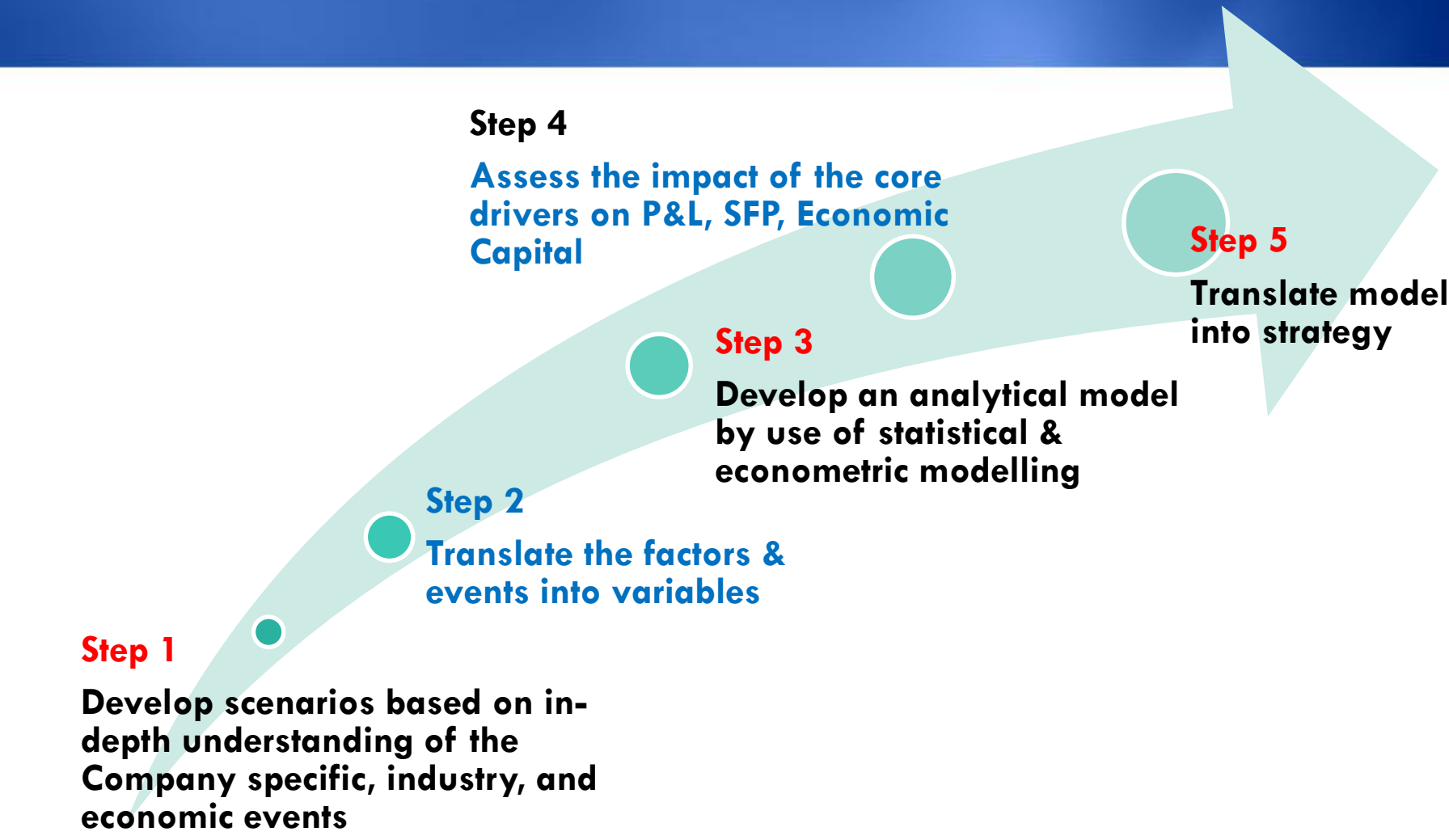
The Modeling Process

5. **Step 5**: **Optimization and Decision Making** – Given the model and a set of possible decisions, the analyst must choose the decision that best meets the organization's objectives.

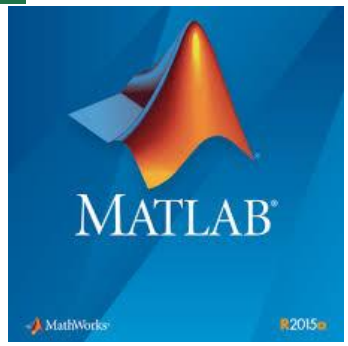
6. **Step 6**: **Model Communication to Management** – The analyst presents the model and the recommendations to the organization.

7. **Step 7**: **Model Implementation** – If the organization accepts the model then the analysts assists with implementation.

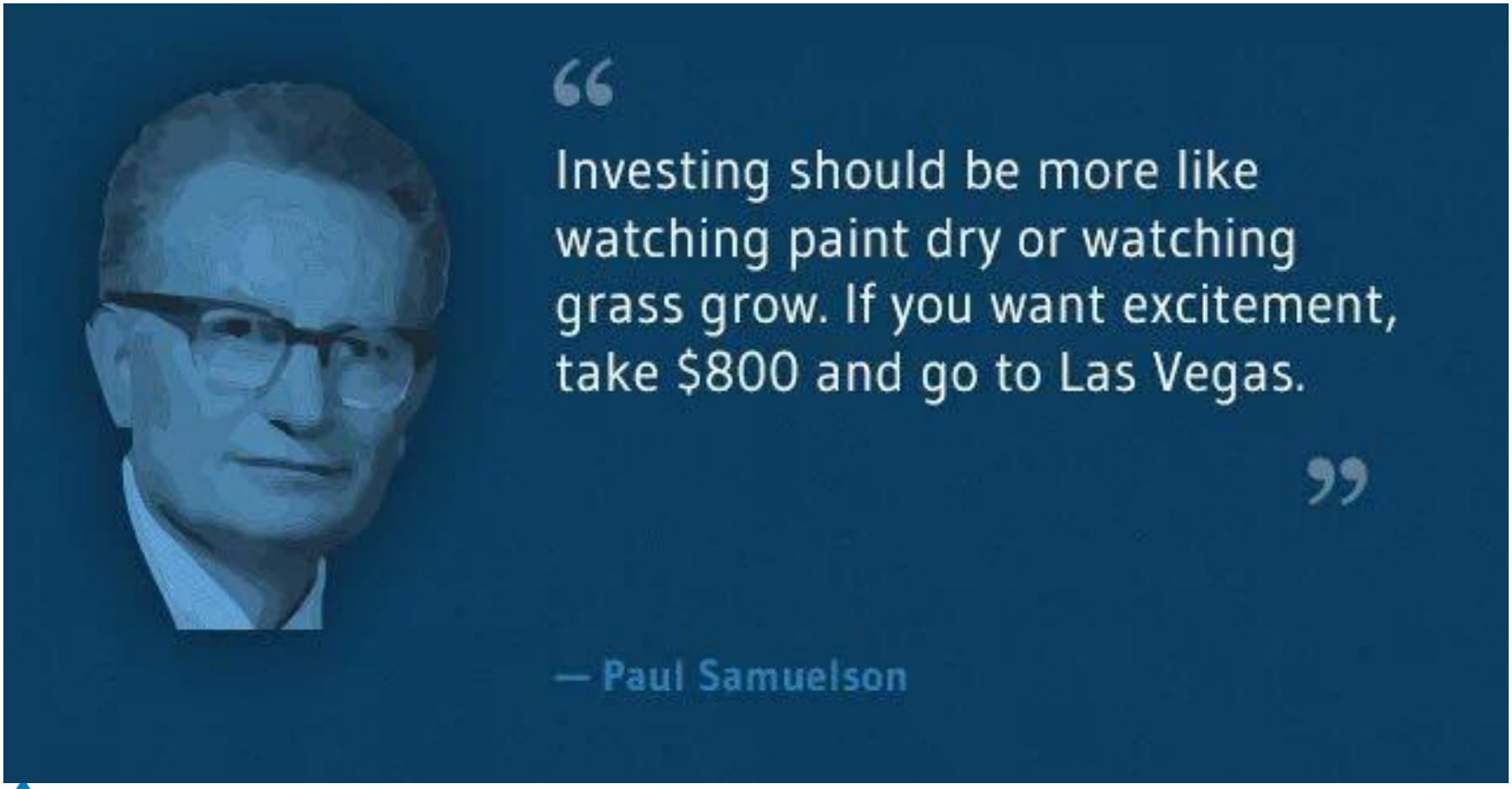
Summary optimization



Modeling tools



On Investing… in anything



FAST Modelling

Flexible

Accurate

Structured

Transparent

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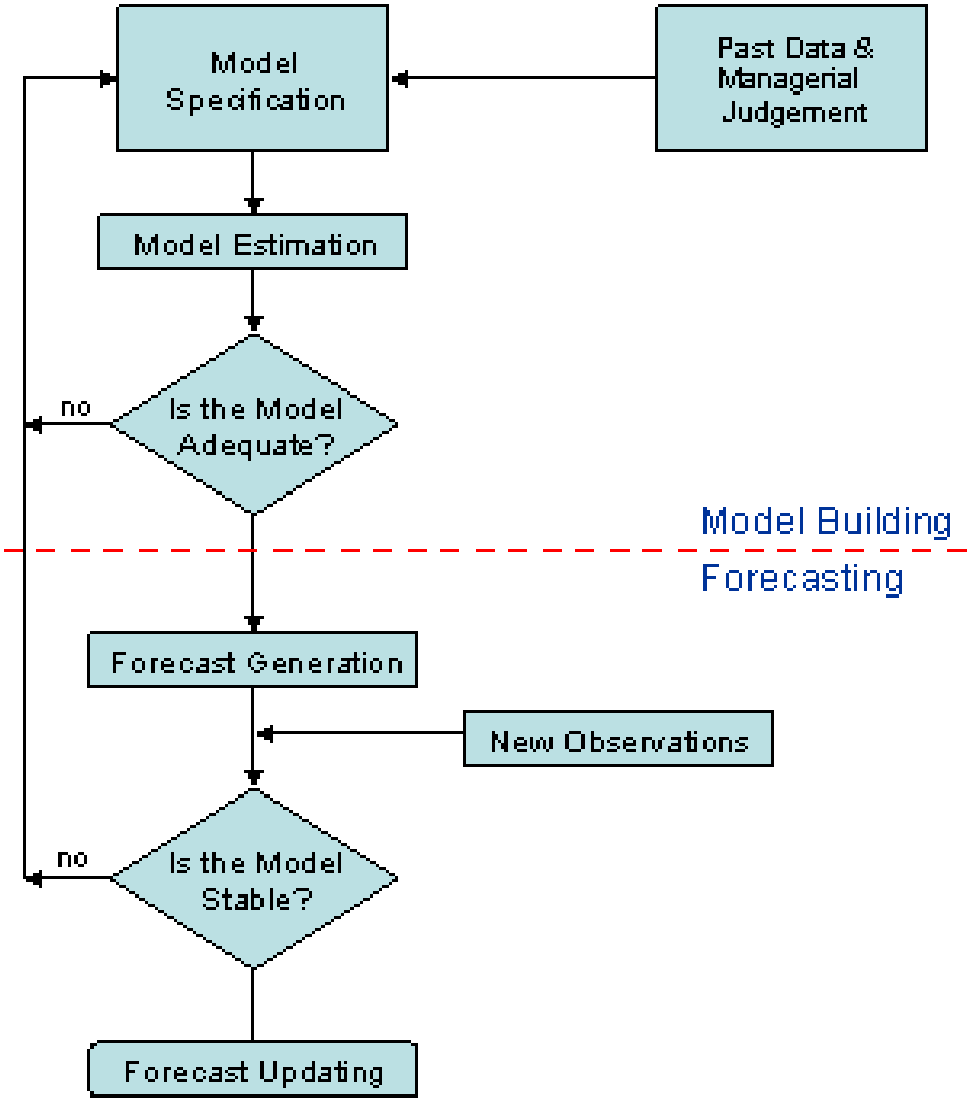
Mahiri QuantFin
Agility | Versatility | Execution

Planning ahead

- What is the end?
- What data do I need?
- What calculations do I need to perform?
- How will my reporting be done?
  - Financial summaries
  - Graphs
  - Key workings and assumptions
  - Key ratios

Linear modelling



Forecasting System:
The Model-Building and The Forecasting Phases

Let's get down to modelling...

Forecasting

- Refers to a tool used to predict future demand basing on past demand information/data

Importance;

- Strategic planning (long range planning)
- Finance and accounting (budgets and cost controls)
- Marketing (future sales, new products)
- Production and operations

Objectives of forecasting

- Give the fundamental rules of forecasting
- Calculate a forecast using a moving average, weighted moving average, and exponential smoothing
- Calculate the accuracy of a forecast

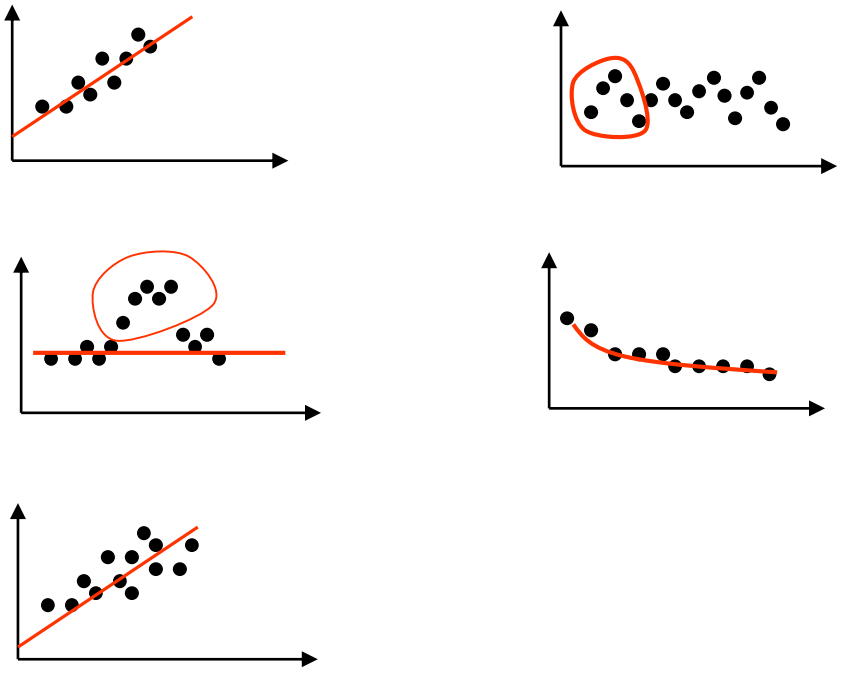
General characteristics of forecasts

- Forecasts are always wrong
- Forecasts are more accurate for groups or families of items
- Forecasts are more accurate for shorter time periods
- Every forecast should include an error estimate
- Forecasts are no substitute for calculated demand.

Forecasting is based on the assumption that the past predict the future. When forecasting, think carefully whether or not the past is strongly related to what you expect to see in the future.

What to consider when looking at past data

- Trends
- Seasonality
- Cyclical elements
- Autocorrelation
- Random variation



Types of forecasting

- Qualitative method-rely on subjective opinions from one or more experts. These include : Grass roots, market research ,panel consensus, historical analogy and Delphi method.

- Quantitative method-this rely on data and analytical techniques. These include : Time series, casual relationship and simulation.

How should we pick our forecasting model?

- **Forecasting model is based on:**
  - Data availability,
  - Time available for the forecast,
  - Required accuracy and resources.

Time series

a) Moving average

- The moving average model uses the last t periods in order to predict demand in period $t + 1$.
- There can be two types of moving average models: simple moving average and weighted moving average
- The moving average model assumption is that the most accurate prediction of future demand is a simple (linear) combination of past demand.

Time series.

Moving average

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Simple moving average

- **In the simple moving average models the forecast value is;**

$$F_{t+1} = \frac{A_t + A_{t-1} + \ldots + A_{t-n}}{n}$$

t is the current period.

F_{t+1} is the forecast for next period

n is the forecasting horizon (how far back we look),

A is the actual sales figure from each period

Weighted moving average

- **We may want to give more importance to some of the data;**

$$F_{t+1} = w_t A_t + w_{t-1} A_{t-1} + \ldots + w_{t-n} A_{t-n}$$

$$w_t + w_{t-1} + \ldots + w_{t-n} = 1$$

t is the current period.

F_{t+1} is the forecast for next period

n is the forecasting horizon (how far back we look),

A is the actual sales figure from each period.

w is the importance (weight) we give to each period

Why do we need the WMA models?

- Because of the ability to give more importance to what happened recently, without losing the impact of the past.
- How weights are chosen depends on;
  - the importance that we feel past data has
  - known seasonality (weights of past data can also be zero).

NB; WMA is better than SMA because of the ability to vary the weights

Exponential Smoothing (ES).

- The prediction of the future depends mostly on the most recent observation, and on the error for the latest forecast.
- The smoothing constant alpha α denotes the importance of past data.

Why use exponential smoothing?

1. Uses less storage space for data
2. Increased accuracy
3. Easy to understand
4. Little calculation complexity
5. There are simple accuracy tests

Exponential smoothing method

- Assume that we are currently in period *t*. We calculated the forecast for the last period (F_{t-1}) and we know the actual demand last period (A_{t-1}) …

$$F_t = F_{t-1} + \alpha(A_{t-1} - F_{t-1})$$

- The smoothing constant α expresses how much our forecast will react to observed differences…
- If α is low: there is little reaction to differences.
- If α is high: there is a lot of reaction to differences

Linear regression in forecasting

- Linear regression is based on

1. Fitting a straight line to data
2. Explaining the change in one variable through changes in other variables.

$$\text{Dependent variable} = a + b \times (\text{Explanatory variable})$$

By using linear regression, we are trying to explore which independent variables affect the dependent variable

How can we compare across forecasting models?

- We need a metric that provides estimation of accuracy
- Forecast Error; Errors can be:

1. Biased (consistent)
2. Random

Forecast error = Difference between actual and forecasted value (also known as *residual*)

Measuring Accuracy: MFE.

- MFE = Mean Forecast Error (Bias)
- It is the average error in the observations

$$\text{MFE} = \frac{\sum_{i=1}^{n} A_t - F_t}{n}$$

- A more positive or negative MFE implies worse performance; the forecast is biased.

Measuring Accuracy (MAD)

- MAD = Mean Absolute Deviation
- It is the average absolute error in the observations

$$\text{MAD} = \frac{\sum_{i=1}^{n} |A_t - F_t|}{n}$$

1. Higher MAD implies worse performance.
2. If errors are normally distributed, then $\sigma_\varepsilon = 1.25\text{MAD}$

Monte Carlo Simulation.

- Monte Carlo methods are stochastic techniques --meaning they are based on the use of random numbers and probability statistics to investigate problems.
- This method is often used when the model is complex, nonlinear, or involves more than just a couple of uncertain parameters

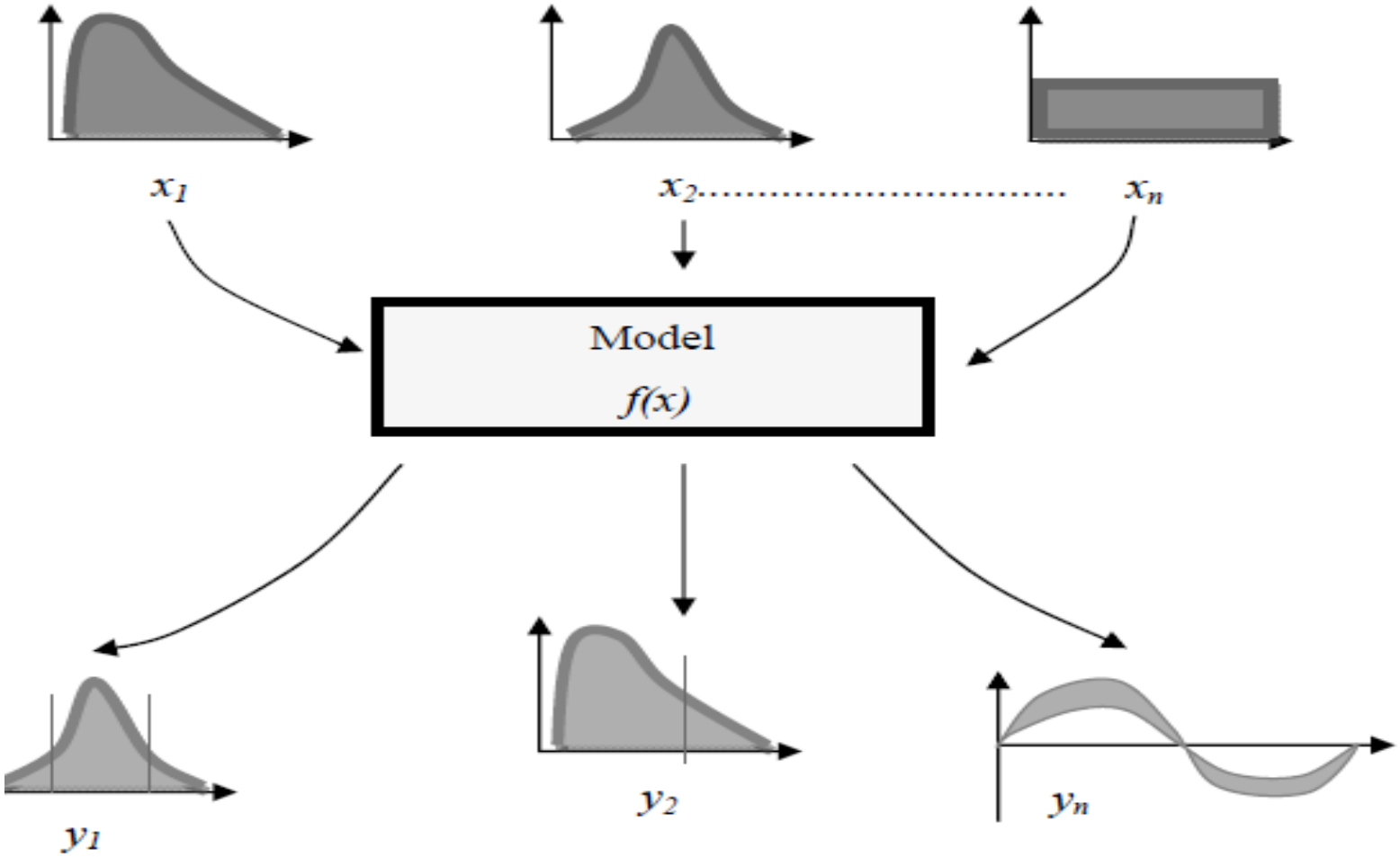
Importance of Monte Carlo Simulation

- Monte Carlo simulation furnishes the decision-maker with a range of possible outcomes and the probabilities they will occur for any choice of action.
- It shows the extreme possibilities—the outcomes of going for broke and for the most conservative decision—along with all possible consequences for middle-of-the-road decisions.
- Monte Carlo method analyzes uncertainty propagation, where the goal is to determine how *random variation*, *lack of knowledge*, or *error* affects the *sensitivity*, *performance*, or *reliability* of the system that is being modeled.

Monte Carlo Simulation

- Monte Carlo simulation - categorized as a sampling method because the inputs are randomly generated from *probability distributions* to simulate the process of sampling from an actual *population*.
- So, we try to choose a distribution for the inputs that most closely *matches data we already have*, or best represents our *current state of knowledge*.

Uncertainty propagation

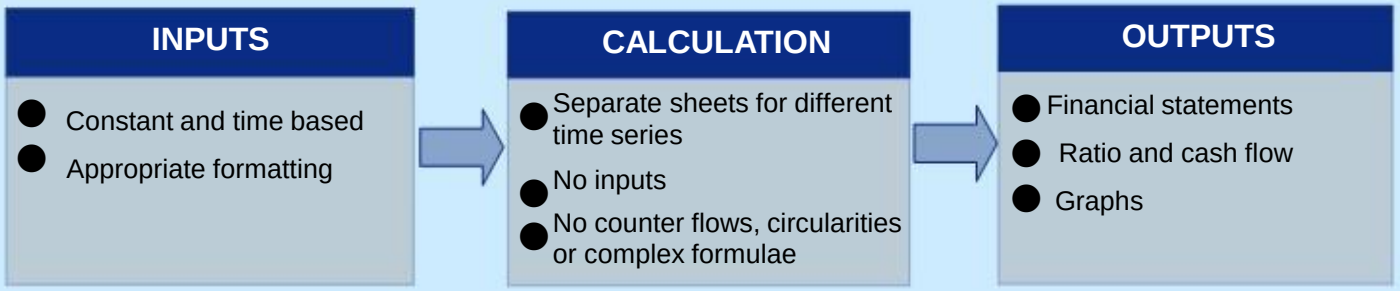


Monte Carlo Simulation

- Steps
  1. Create a parametric model, $y = f(x1, x2, \ldots, xn)$.
  2. Generate a set of random inputs, $xi1, xi2, \ldots, xin$.
  3. Evaluate the model and store the results as yi.
  4. Repeat steps 2 and 3 for $i = 1 \; to \; n$.
  5. Analyze the results using histograms, summary statistics, confidence intervals, etc.

Best practice rules

(1) Separate inputs, calculations and results



This separation makes it easier to

- locate the inputs
- summarise the assumptions being used in the work book
- ensure that each input is only entered once
- run sensitivities

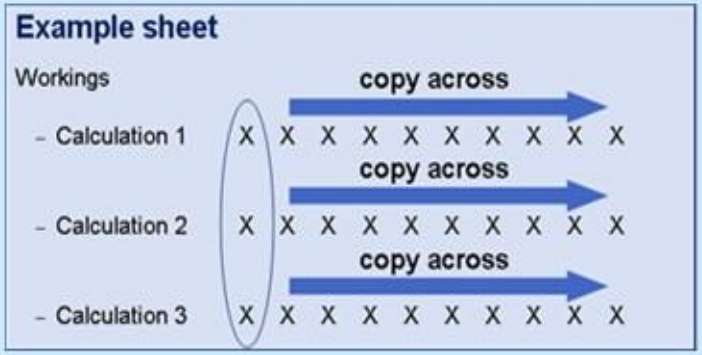
(2) Use separate worksheets and sections to display different 'themes' / 'issues'

For example, separate the inputs sheet into sections such as: fixed assets, tax, financing and so on…

Best practice rules

(3) Use consistent formula per row or column

Use the same formula across the whole row



- Makes it easier to test and build
- May require incorporation of timing flags (see later)
- Note total columns cannot be inserted in-between
- Used different formatting for deviant instances

(4) Use each column for the same time period throughout the work book

- Makes the work book easier to follow
- Gives the work book a consistent feel
- Easier to spot incorrect links between sheets

Jan 2009 appears in Column I on both worksheets

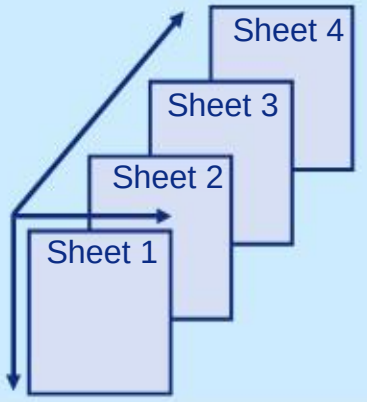
	A	B	H	I	J
1	Project X				
2	Inputs		Year no	1	2
3	All Checks Ok		Start date	01 Jan 09	01 Jan 10
4			End date	31 Dec 09	31 Dec 10

	A	B	H	I	J
1	Project X				
2	Outputs		Year no	1	2
3	All Checks Ok		Start date	01 Jan 09	01 Jan 10
4			End date	31 Dec 09	31 Dec 10

Best practice rules

(5) Logical calculation flowrefer to the left and above

- Arrange your work in the way Excel “thinks”
  - Speeds up calculation time
- The work book should “read like a book”
  - More user friendly



(6) Do not imbed hard coded numbers into calculations

- Imbedding hard-coded numbers into formulae means the work book becomes less transparent and less flexible to change
- Any hard -coded numbers should be stored as separate inputs in the “Inputs” worksheet

More flexible
F4 = F3*E2

	A	B	C	D	E	F	G
1							
2		Interest rate		%	6%		
3		Outstanding debt balance		SGD		1000	1500
4		Interest payable				60	90
5							
6		Outstanding debt balance		SGD		1000	1500
7		Interest payable				60	90

Less flexible:
F7 = F6*6%

Best practice rules

(7) Do not hide columns or rows

- work book becomes less transparent when hidden
- Coding may be accidentally overwritten

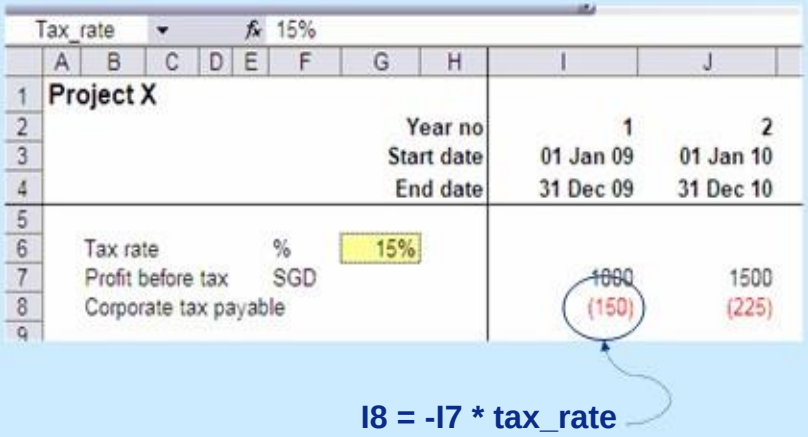
(8) Limit use of range names

Disadvantages

- Difficult to review
- Can become redundant
- Becomes increasingly difficult to come up with sensible names

Advantages

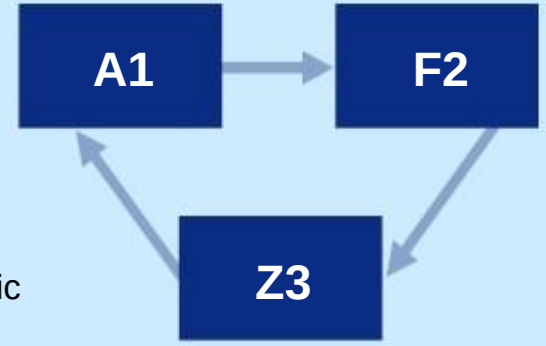
- Can give formulae more ‘meaning’
- Make macros more robust (we will see this later)
- Other useful tricks such as data validation / expanding ranges



Best practice rules

(9) Avoid circularities

- Work book may not calculate fully
- Other circularities may go undetected
- Use circular reference tool bar to trace and rectify
- Ways of rectifying include: alternative approximate calculations, algebraic solutions and copy & paste macros (later)



(10) Keep it simple

- Avoid nested IF functions
- Do not allow formulae to exceed the length of the formulae bar
- Better to have many simple calculations

Principles

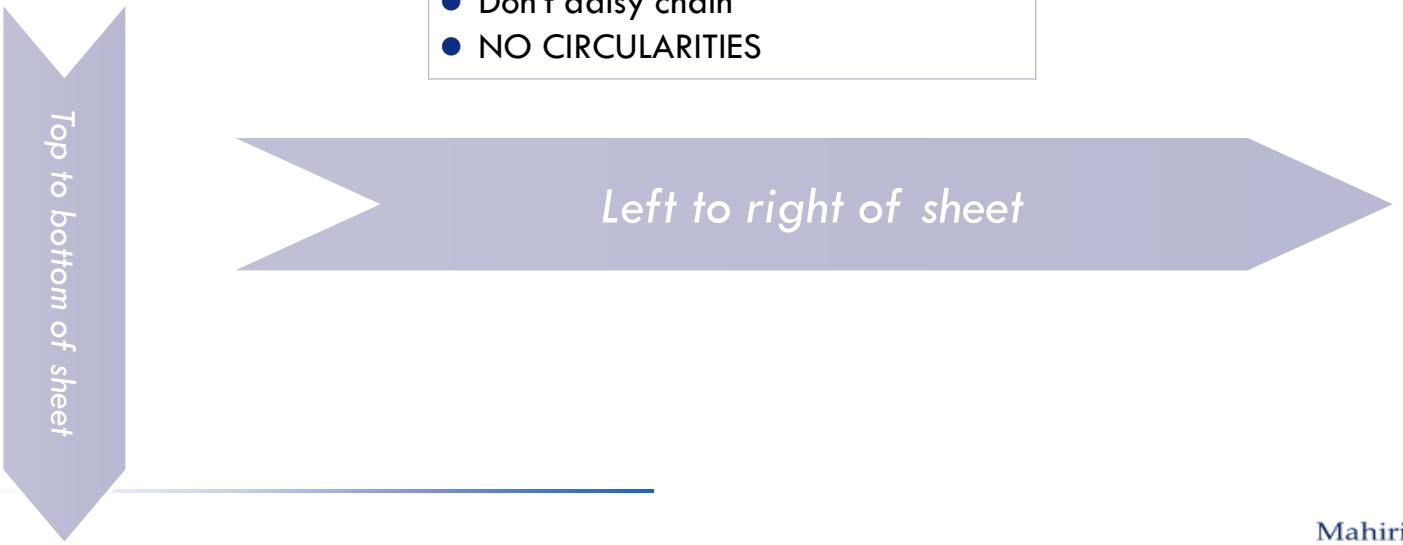
BEST PRACTICE PRINCIPLES	
INTEGRITY	• work book is free from Mathematical Errors • Correct relationships between inputs and variables • Integrity is safeguarded through error checks, protection etc • The balance sheet should ALWAYS balance with the movements in P&L and cash flow – No cheating; no fudges
SEPARATION	• Separate formulas into simple logical steps • Separate inputs, calculation and outputs – Never mix inputs with calculations
CONSISTENCY	• With each sheet – have ONE consistent formula across one row • Across sheets – ALWAYS have the same time period in the same column on every sheet
SIMPLICITY	• Keep formulas simple – If you struggle to understand the logic, someone less familiar with the work book will definitely struggle – The more people understand the logic in a work book, the more they will believe in the correctness of the answers
LINEARITY	• Calculations across time flow from left to right • No circular references
MODULARITY	• Group related calculations (operations, fixed assets, finance, tax) together in separate modules, which could be on separate sheets

Characteristics

CHARACTERISTICS OF A GOOD WORK BOOK	
INSIGHTFULNESS	• Delivers outputs and outcomes to support decision making
TRANSPARENT LAYOUT	• Uses colour coding to make the structure of the work book and formulas clear – Clear layout helps other users understand the work book and buy into the results • Has a logic flow that is easy to follow, and contains a diagram that shows the flow of data through the work book – If you can't visualise this, its time to restructure the work book
FLEXIBILITY	• Is able to cope with changing requirements while maintaining clarity and accuracy – Inputs are easy to change – work book can easily be developed further
CHECKS	• Has totals wherever possible, to ensure consistency and accuracy throughout – Checking a balancing balance sheet is the bare minimum
DOCUMENTATION	• Has a contents table that explains each sheet • Contains an assumption sheet/data book that lists all the key assumptions in the work book

Linear modelling

INPUTS	CALCULATION	OUTPUTS
• Constant and time based • Appropriate shading • Inputs collected together	• Separate worksheets for different time series • No inputs • Formula discipline → simple and easy to follow; break down to constituent parts • Worksheet discipline → follow western reading style • No counter flows • Don't daisy chain • NO CIRCULARITIES	• Financial statements • Ratio and cash flow analysis • Graphs



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