Excel Error Horrors (and How to Avoid Them)

Dr. Liam Bastick FCA FCMA MVP
SumProduct Pty Ltd

1

How many spreadsheets in your business do you think have errors in them?

- 0%
- 25%
- 50%
- 90%
- 100%

2

2

Key risks and considerations

Models contain errors:

- 100% of models contain errors of some kind [Ernst & Young]
- 90% of all Excel spreadsheets with more than 150 rows of Excel formulae contain material errors [KPMG]
- MBA students with over 250 hours of spreadsheet development experience had a 24% chance of introducing spreadsheet errors in to the first worksheet they built [R. Panko, 1998]

Businesses and financiers partially rely on these models:

- Objective of a model validation (not an audit) is to provide assurance that results can be relied upon
- Otherwise, bad decisions can be made
- Intention is to reduce financial risk

There are horror stories…

3

3

Horror stories

Westpac, Nov 2005

- Westpac was forced to halt trading on its shares and deliver its annual profit briefing a day early after it accidentally sent its results by email to research analysts
- Details of the $2.8 billion record profit result for the 12 months to September 30, were embedded in a template of last year's results and were accessible with minor manipulation of the spreadsheet (some reports indicated an employee had thought that a black cell background fill would hide black text)
- CFO Philip Chronican said, "It is not just one error, it is a compounding of two or three errors … We will obviously be conducting a full inquiry to make sure it doesn't happen again"

4

4

Horror stories

Credit Suisse, Jul 2009

- The booking structure relied upon by the UK operations of Credit Suisse for the CDO trading business was complex and overly reliant on large spreadsheets with multiple entries
- This resulted in a lack of transparency and inhibited the effective supervision, risk management and control of the SCG (Structured Credit Group)
- FSA fined Credit Suisse GBP5.6m

5

5

Horror stories

Harvard University, Apr 2013

- Two Harvard University economists wrote a paper in 2010 that heavily influenced international government policymaking by claiming that high levels of government debt is correlated with slow economic growth, particularly past 90% of GDP
- This was reviewed by a post-doc student from University of Massachusetts, which identified a formula error that excluded 5/20 countries from the analysis, as well as concerns with the averaging technique that evenly weighted 20 years of British historical data with 1 year of NZ data
- The difference in post-WW2 growth rates for 'high GDP' countries was -0.1% (Harvard) vs 2.2% p.a. (Massachusetts)

6

6

Horror stories

National Treasury Management Agency - Ireland, Nov 2019

- The National Treasury Management Agency (NTMA) purchased a fund in dollars
- This was recorded as a euro fund in their spreadsheet records
- By the time the error was discovered, the dollar exchange rate had moved against the NTMA and the investment return was down €750,000
- The Public Accounts Committee questioned the NTMA about their “control weakness” and were informed that NTMA had corrected the weakness that had been caused by “human error”

7

7

Horror stories

Public Health England, Oct 2020

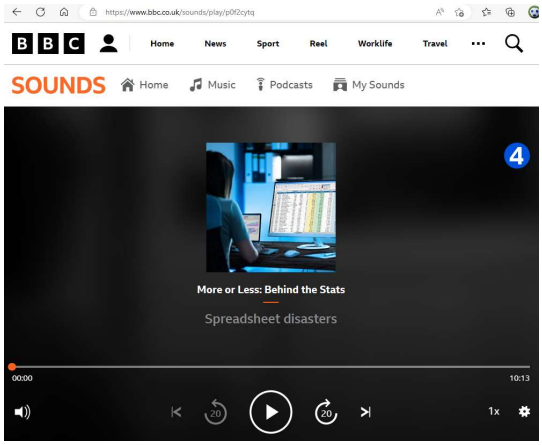
- Public Health England (PHE) were receiving CSV files containing details of coronavirus cases, PHE collated these CSV files into Excel templates, these templates were using the XLS format
- The XLS format (which was superseded by XLSX in 2007) can only contain 65,536 rows of data – PHE did not consider this and any additional rows were simple left off
- This lead to the underreporting of coronavirus cases in England
- Once this issue was discovered, PHE began breaking down the data into smaller batches to try and ensure that no template would hit its cap

8

8

Hot off the press…

https://www.bbc.co.uk/sounds/play/p0f2cytq



9

9

Common areas where errors are induced

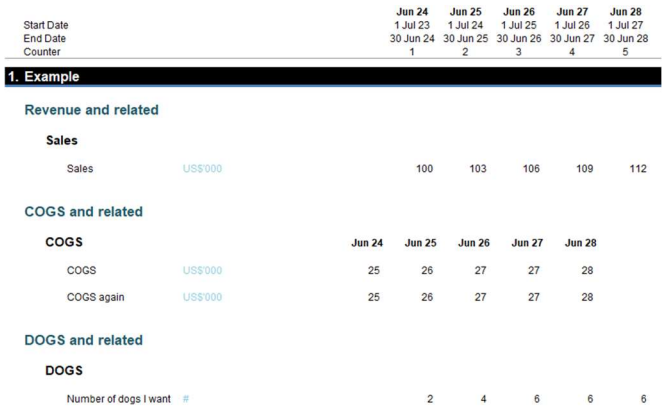
- Creating an input worksheet
- Hard coding values
- Priding yourself on your VLOOKUP workmanship
- Becoming frustrated when PivotTables refuse to sum values automatically
- Copying worksheets
- Merging cells
- Generating charts with populated data coming from another worksheet
- Becoming confused with absolute, semi-absolute, and relative referencing
- Working with dynamic arrays
- Linking files

10

10

Input worksheets

- Ensure dates and numbers line up
- Don't repeat inputs
- Don't include unreferenced inputs
- Don't include irrelevant inputs
- Use formatting



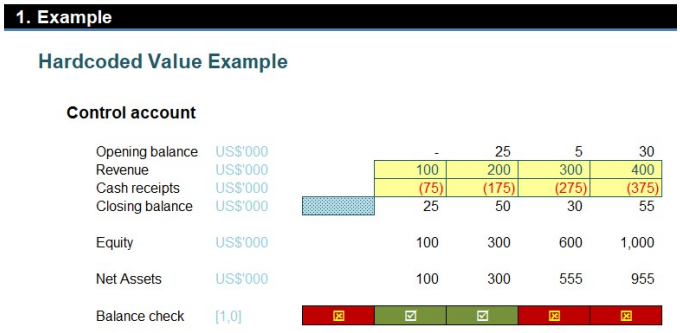
		Jun 24	Jun 25	Jun 26	Jun 27	Jun 28
Start Date		1 Jul 23	1 Jul 24	1 Jul 25	1 Jul 26	1 Jul 27
End Date		30 Jun 24	30 Jun 25	30 Jun 26	30 Jun 27	30 Jun 28
Counter		1	2	3	4	5
1. Example						
Revenue and related						
Sales						
Sales	US$'000		100	103	106	109	112
COGS and related						
COGS		Jun 24	Jun 25	Jun 26	Jun 27	Jun 28
COGS	US$'000	25	26	27	27	28
COGS again	US$'000	25	26	27	27	28
DOGS and related						
DOGS						
Number of dogs I want	#		2	4	6	6	6

11

11

Hard coded values

- Unless your workbook is properly protected, formulae can be overwritten
- One hardcoded value can cause errors in all further calculations



1. Example

Hardcoded Value Example

Control account

Opening balance	US$'000	-	25	5	30
Revenue	US$'000	100	200	300	400
Cash receipts	US$'000	(75)	(175)	(275)	(375)
Closing balance	US$'000	25	50	30	55
Equity	US$'000	100	300	600	1,000
Net Assets	US$'000	100	300	555	955
Balance check	[1,0]	☒	☑	☑	☒	☒

12

12

The VLOOKUP function

- So what does that all mean?

1. VLOOKUP Illustration

Example

Table

Lookup Value	Column 2	Column 3	Column 4	Column 5	Column 6	INSERTED	Column 7	Result Column
1	94	82	36	58	99		32	84
2	40	77	75	28	96		48	47
3	92	55	96	57	50		81	80
4	61	47	45	51	27		39	35
5	11	52	67	86	96		11	66
6	76	96	29	84	45		26	44

VLOOKUP

Value	2
Result	48

13

13

PivotTables

- Count vs. Sum

1. Example

PivotTable

Sales

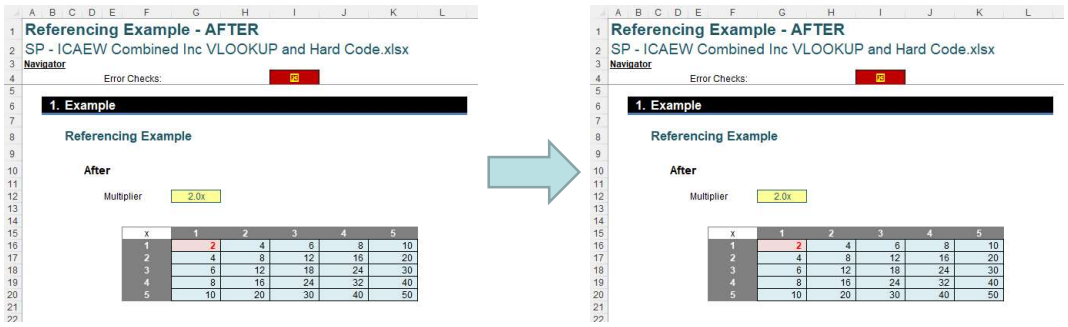
Business Unit	(All)

Row Labels	Count of Amount
Q1	5
Q2	3
Q3	2
Q4	4
Grand Total	**14**

14

14

Copying worksheets



x	1	2	3	4	5
1	2	4	6	8	10
2	4	8	12	16	20
3	6	12	18	24	30
4	8	16	24	32	40
5	10	20	30	40	50

15

15

Merging cells

- Merged cells can cause you to lose data
- They can also cause formulae to pick up the wrong references

1. Example

Data

Sales

	Q1	Q2	Q3	Q4
	104	135	334	152
	159	308	378	154
	226	135	175	153
	308	207	251	379
	197		311	239
	309	279	347	370
	328	224	222	338
	329	252	260	326
	176	354	136	234
Total	**2,136**	**4,309**	**965**	**2,344**

16

16

Charts

17

17

Anchoring cells

- It is important to know the difference between absolute, semi-absolute, and relative referencing

1. Example

Referencing Example

After

Multiplier 2.0x

x	1	2	3	4	5
1	2	4	6	8	10
2	4	8	12	16	20
3	6	12	18	24	30
4	8	16	24	32	40
5	10	20	30	40	50

18

18

Dynamic arrays

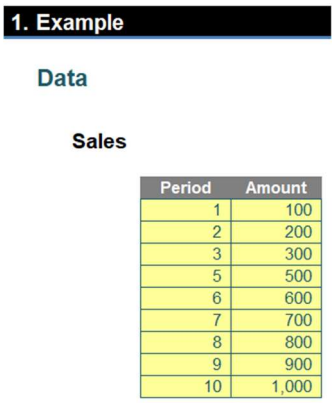
- Avoid volatility in dynamic arrays
- Plan accordingly for the maximum size of an array
- Avoid unintentionally coercing an array

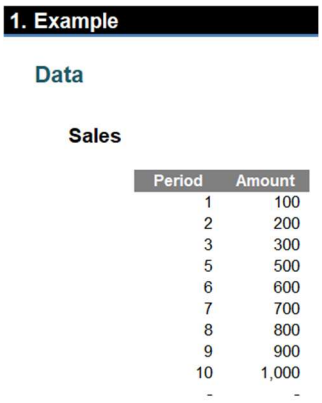
19

19

Linking files

- Take care when linking files together
- Consider creating hidden Input/Output sheets that can't be changed





20

20

Which of the following types of review procedures do you follow in your spreadsheets?

- Independent spot check by a colleague
- Independent review by a colleague
- Independent review by an external auditor
- Specific time allocated for self-review
- Built-in checks and error messages in formulae
- Manager / information user reviews outputs
- No material checks and balances

21

21

Importance of auditing / validating a model

What can go wrong?

- Model doesn't actually do what it's meant to do
- Logic may not work in all situations
- Model attempts too much, gets too complex
- Assumptions may not be used / input incorrectly
- Value drivers in model don't reflect actual business drivers

22

22

Importance of auditing / validating a model

Why does it matter?

- Management decisions are based on the model's outputs
- These decisions may therefore be based on inaccurate information
- The wrong decisions may be made
- Expensive
- Reputational risk for modeller, bank and client
- Financial risk for bank and client

23

23

Understanding the different processes

Need to understand the difference between:

- Model Audit
- Self Review
- Checking

and between:

- Validation
- Verification

24

24

Model Audit

- Process of conducting due diligence on a financial model in order to eliminate errors in the spreadsheet
- Concerned with model structure
- Undertaken by independent reviewer
- Should not be undertaken at the last minute

25

25

Model Audit

Errors are formally dissected:

- actual errors
- potential errors
- queries / undocumented assumptions
- Best Practice design issues

26

26

Third party audit

- Rigorous analysis of a model including one or both of
  - Line-by-line (detailed) review
  - Analytical review
- After careful analysis, auditors will provide recipients with a report containing the reports categorised by severity. Here at SumProduct, we use the following:
  - **Category 1**: Affects the calculations in versions of the model within the scope of the review
  - **Category 2**: May affect the calculations under assumptions outside the scope of the current review
  - **Category 3**: Unclear or bad practice. This may affect the end user's interpretation of the results, but does not necessarily affect the calculations
  - **Queries**: Questions asked to increase understanding of the calculations with the express intention of identifying errors

27

Auditing firm responsibilities

- Auditing firms will generally not be responsible for any of the following tasks:
  - Commenting on the completeness or reasonableness of the assumptions, including accounting, tax and regulatory-related assumptions
  - Commenting on the probability of the projections being achieved
  - Considering the cash flows or other balances from the perspective of specific shareholders and lenders, other than to the extent that they are explicitly represented in the model
  - Reviewing links to files outside the model
  - Assessing whether the financial statements are presented in a format suitable for public financial or tax reporting
  - Reviewing commentary embedded within cell notes
  - Commenting on the model's compliance with generally accepted accounting principles or tax legislation

28

Self review

- Process of stepping back from model build to see if the model constructed “makes sense”
- Reviewer is not independent (can get a colleague to assist)
- Usually areas are reviewed on a selective basis
- Reviewer does not need to get “up to speed with model”
- Reviewer won’t necessarily spot errors in modelling logic
- Can be a “cheap and cheerful” option
- Far less documentation
- Not an insurance policy

29

29

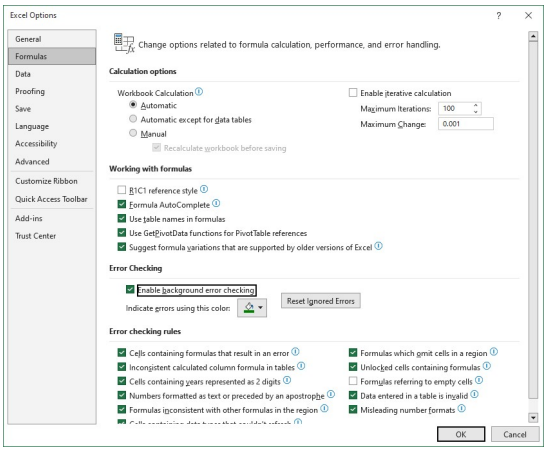
Self-review checklist

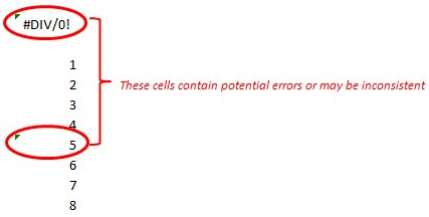
- Checks to perform on your own spreadsheets
- Not an exhaustive list, but a good starting point

30

Use Excel's background error checking

- Instigate during development

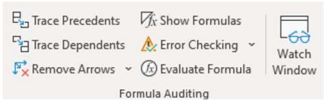




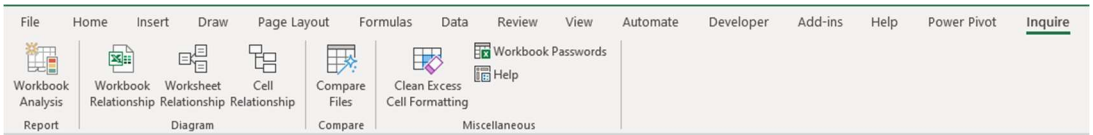
31

Use Excel's formula auditing tools

- In the 'Formulas' tab of the Ribbon, within the 'Formula Auditing' section



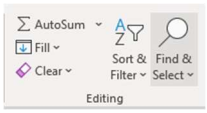
- 'Error Checking' is particularly useful
- Where available, Spreadsheet Inquire adds to this functionality



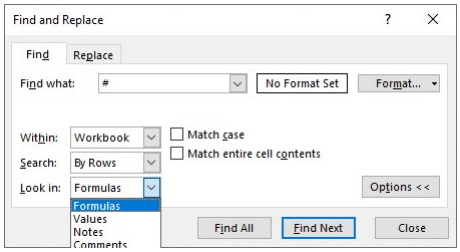
32

Find prima facie errors

- Use the Find functionality (CTRL + F)



- Find '#' in formulas, values, notes, and comments



33

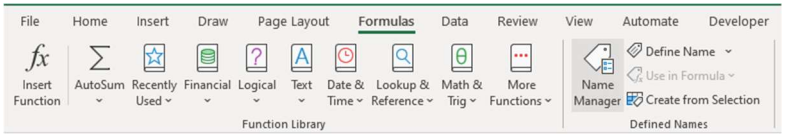
Review inconsistencies in formulae

- Use CTRL + \

34

Look for errors in unintentional links in range names

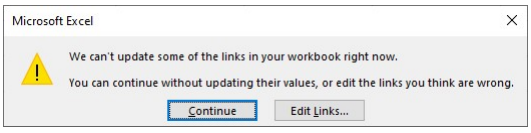
- Name Manager (CTRL + F3) can be used

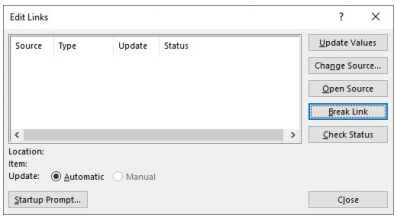


35

Locate unintentional links

- 'Phantom links' should be located and eradicated
- Link manager
- Keep all links in one sheet





36

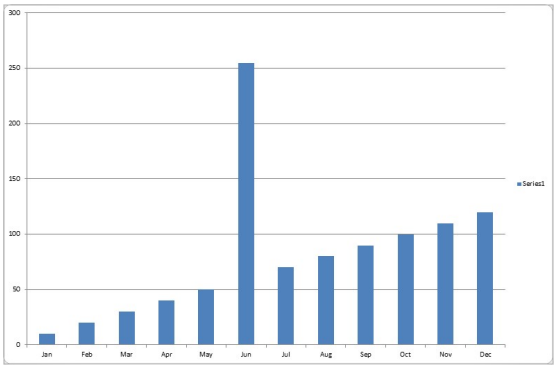
Perform high level analysis

- Varies with purpose and scope
- Create a list of items to review

37

Create ‘quick’ charts

- Key outputs can be graphed momentarily
- F11 or ALT + F1



38

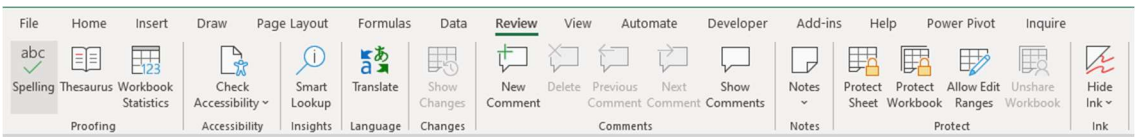
Close and re-open

- E-mail the file to yourself
- Are there unexpected errors?

39

Spell check

- No excuse for not spell checking a model
- Review tab or F7



40

Printing and viewing

- Not strictly speaking an error
- Set up print margins and include headers and footers
- Consider layout
- Reset pages
- Save it on the front page

41

Protection

- Prevent formulae getting overwritten
- Protect cells, worksheets and the workbook as required

42

Checking

- Can be performed manually or automatically
- Tests must be objective and repeatable
- Aim is to detect and / or alert users to the state of particular outputs or the occurrence of particular events

43

43

Checking

- Checks Classification
  - Error Checks
  - Sensitivity Checks
  - Alert Checks
- Dedicated Checks Worksheets
  - Errors
  - Sensitivities
  - Alerts
- Check Indicator Flags
- Check Cell Formatting

44

44

Validation

- Concerned with **model assumptions**:
  - scope is extended to verify input data back to original documentation
  - tax and accounting treatments are often verified
  - performed in addition to **Model Auditing**
- Key objective is to confirm the numbers used by tracing back to documentation and assumptions
- May need subject matter experts

45

45

Verification

- Concerned with model assumptions also
- Key objective is to confirm that the numbers used in the model are the ones end users intended to be used in the model
- Do not necessarily require subject matter experts

46

46

Assumption entry interfaces

- Model developers should utilise various methods of controlling data entry such that only appropriate values may be entered into the spreadsheet
- Reduces the risk of inappropriate data entries and flow-on errors
- Can be pro-active or reactive

47

47

Proactive assumption entry methods

- The following can be used to prevent model users from entering unacceptable or erroneous assumptions:
  - Controls
  - Data validation
  - Sheet protection

48

48

Retrospective assumption entry methods

- The following can be used to warn model users after an unacceptable or erroneous assumption has been entered:
  - Data validation
  - Error checking
  - Conditional formatting

49

49

The Audit Process

Key techniques in the process:

- Line by line review
- Re-performance
- Analytical review:
  - Ratio analysis
  - Charting
  - Trend analysis
- Sampling
- Sensitivity (key driver) analysis
- Simulations analysis

50

50

The Audit Process

- To decide which technique to use, the review should be planned:
  - What are the key outputs?
  - What are the key drivers / assumptions? Are we sure?
  - What are the key constraints?

51

51

Line by line review

- **All** unique formulae are identified
  - May require third party software or else a very patient auditor!
- Each unique formula is individually reviewed:
  - Does the calculation work as intended?
  - Are all references correct?
  - Will it work in other scenarios?
  - Will it copy to other cells correctly?
  - Is the labelling appropriate and correct?
  - Has anything been double-counted / excluded?
  - Analysis of precedents and dependents

52

52

Line by line review

- Typically, line by line reviews take between 24 and 200+ hours on first review, depending on:
  - Size of model
  - Number of unique calculations and their complexity
  - Workbook structure
- Can take several iterations to get the model correct

53

53

Line by line review

Errors are categorised typically as follows:

- Actual errors
  - Model has calculated a value incorrectly or cell(s) contain prima facie errors, e.g. #DIV/0!, #N/A!
- Potential errors
  - Model works in base case but will fall over in alternative scenarios that are within scope of the audit
- Queries / undocumented assumptions
  - Audit cannot be completed as aspects of the model are not fully understood; clarification is sought
- Best Practice design issues
  - Model is not consistent / transparent / flexible / robust

54

54

Re-performance

- Sometimes a formula / formulae is / are just too complex to review
- It may be better to confirm outputs for an agreed set of scenarios with an alternative calculation, e.g.

=IF(ISERROR(IF(INDEX('TI"S & LC"s'!$K$31:$BN$31,MATCH('USP (BS)'!R$8,'TI"S & LC"s'!$K$8:$BN$8))<0,0,INDEX('TI"S & LC"s'!$K$31:$BN$31,MATCH('USP (BS)'!R$8,'TI"S & LC"s'!$K$8:$BN$8)))=TRUE),0,IF(INDEX('TI"S & LC"s'!$K$31:$BN$31,MATCH('USP (BS)'!R$8,'TI"S & LC"s'!$K$8:$BN$8))<0,0,INDEX('TI"S & LC"s'!$K$31:$BN$31,MATCH('USP (BS)'!R$8,'TI"S & LC"s'!$K$8:$BN$8))))

=MAX('USP (BS)'!R$8, 0)

55

55

Analytical review

- High level overview: an overall sense check on the key outputs
  - Hence, need to be clear what the key outputs are
- Do the results appear reasonable under the base case?
- Flex inputs to ensure that the outputs change as expected
  - e.g. if Sales Volume is increased by 20%, what happens to Costs Of Goods Sold (and Sales)?

56

56

Analytical review

- Attempt to break the model (this will not always be an error)
- Chart key items to examine the patterns:
  - Increasing / decreasing trend
  - “Blips”
  - Time lags or leading indicators

57

57

Some analytical review examples

- Is the company insolvent?
- Do Non-Current Assets over depreciate?
- What happens to the outputs if all inputs are deleted?
  - Tests for hard code in formulae
  - Tests for ‘plugs’
  - Tests for #DIV/0! errors

58

58

Some analytical review examples

- Chart key items such as EBITDA, debt waterfalls, ratios
- Create control accounts
- Is interest being treated correctly: rolled up vs. capitalised, etc.
- Ratios:
  - Ensure they relate to key outputs
  - Confirm definitions
  - Enter some extreme numbers and review corresponding outputs

59

59

Model familiarisation

- Identify and confirm the purpose of the model
  - e.g. Acquisition, Valuation, Scenario Planning, Budgeting and Forecasting, Project Finance, Consolidations
- Identify the key outputs
  - e.g. NPV, IRR, ROE, Valuations, Consolidation, DSCRs, Cash Flows, Data Tables
- Talk to the model builder / seek technical guidance
- Model structure – inputs, calculations and outputs

60

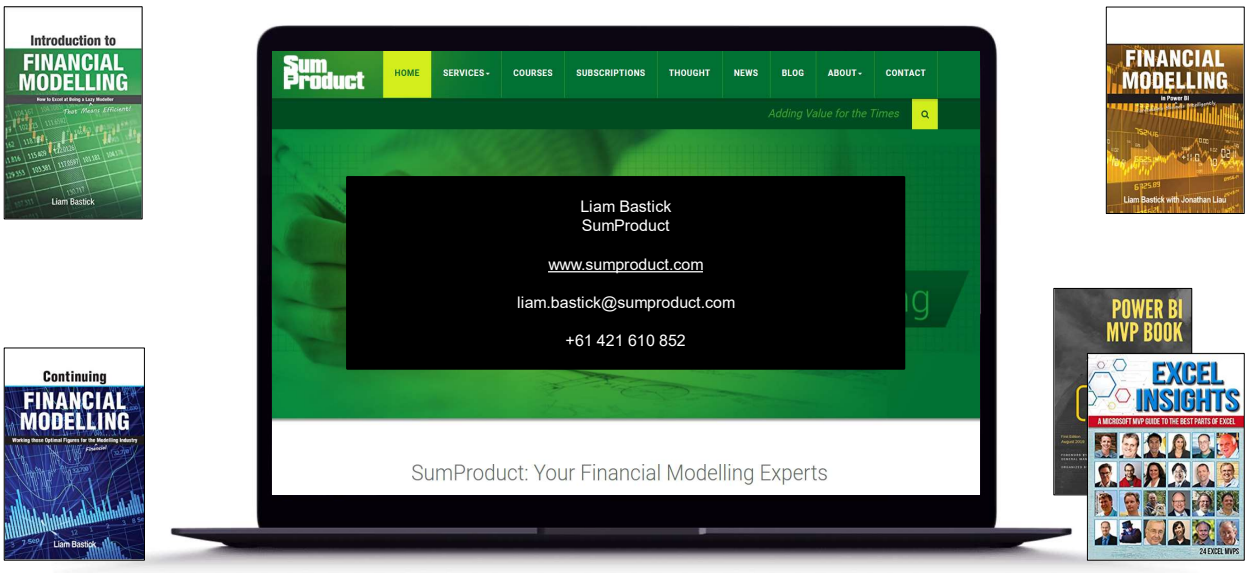
60

Tools available

- Auditing Toolbar
  - Trace Dependents
  - Trace Precedents
- Go To
  - F5 / Ctrl G – Go To
  - Double Click

61

61



62