Global Financial Modeling Guidelines

Developing best-in-class financial models

pwc

PwC's global modeling network includes over 400 professionals, working as a collaborative team across the globe.

PwC combines commercial, technology, data and finance skills to design, build and review models that provide insights for major decision making and analysis purposes.

These Modeling Guidelines are the result of collaboration between modeling teams in more than twenty countries across the PwC global network.

PwC provides training courses on each component of these Modeling Guidelines.

This is a living document that will be updated from time to time to reflect new developments. To confirm the latest version, or to access a non-English version, please go to www.pwc.com.

This version of the Modeling Guidelines is v3.0 and was issued in January 2020.

If you have any questions, contributions or comments, please contact Toby O'Brien (toby.obrien@pwc.com)

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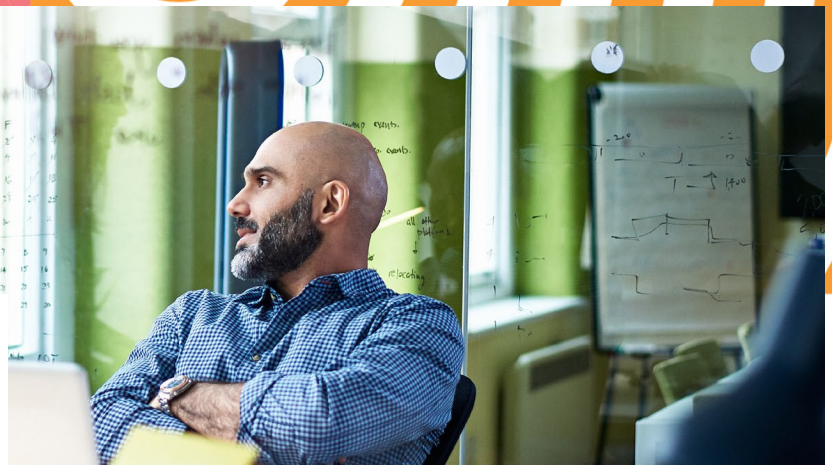
Welcome



The PwC Modeling Guidelines are designed to help us build high quality, user-friendly models that minimize the risk of errors and assist in making better business decisions.

Application of the Guidelines

The Guidelines are comprised of:

- 5 Core Principles
- 10 Design Practices
- 16 Areas of High Risk elements
- 74 Modeling Guidelines
- 39 Modeling Considerations

The 5 Core Principles are the key criteria that govern the content and future development of the Modeling Rules and Guidelines.

Modeling Guidelines serve to build upon the Modeling Rules and should be applied when practical.

Benefits

Following the Modeling Guidelines will:

- Improve vital first impressions of the model(s)
- Provide a framework in which complicated messages can be easily conveyed to stakeholders
- Enables users to easily answer their questions
- Reduce model risk
- Enable more efficient model review
- Ensure a basis of consistency for which all users can understand and replicate.

Controls and policy vs individual skills

The vast majority of financial modeling risk can be mitigated if the developer and the user of the model are sufficiently skilled and the model is independently reviewed. As such, PwC has developed a suite of training courses to upskill developers, users and reviewers of financial models.

As the future users and developers of any financial model are unknown when first designed, PwC's Modeling Guidelines have been developed on the premise that each model could be used by multiple users with a range of experience, and it's not possible to rely solely on the skills of advanced developers.

Technologies and the future

These Modeling Guidelines specifically refer to Microsoft Excel given the number of financial models built in Excel; however, these principles can be applied across any financial modeling exercise. As the financial modeling industry evolves to being technology agnostic, PwC has developed new methodologies so it can deliver and review models in many technologies.

Financial modeling is a dynamic and ever changing discipline. While these Modeling Guidelines have been developed in consideration of future developments, they will continue to evolve as Excel and other technologies change the financial modeling landscape.

Core Principles

Models built using Microsoft Excel can be powerful analytical tools. However, Excel's flexible platform introduces challenges and risks that the PwC Modeling Guidelines aim to address and manage. The five Core Principles below are the key criteria that govern the content and future development of the Modeling Rules and Modeling Guidelines.

1 Maximize simplicity, consistency and transparency

2 Minimize risk of errors, misinterpretations or incorrect use

3 Minimize the scope for queries or issues from a model review or audit

4 Provide universal applicability for any time series models

5 Provide a framework for building models that are user-friendly and fit for purpose

Design Best Practices

Developed over many years, the following 10 Design Best Practices are practical tips you should apply when developing any financial model. These 10 Design Best Practices are a simplified and practical subset of the most important Modeling Guidelines.

1 Keep it simple and transparent

- Make the calculations and logic easy to understand.
- Break formula down into simple, logical, easy-to-follow calculations.
- Avoid hiding any rows, columns or sheets.

2 Identify and separate inputs, calculations and outputs

- Separate input cells and format them so they are clearly identifiable.
- Locate inputs in their own cells and do not include constants hardwired within a formula.
- Keep inputs, calculations and outputs separate from each other.
- Treat any links to external workbooks as inputs and identify them with consistent formatting.

3 Format in a clear and consistent manner

- Introduce consistent cell and sheet formatting to improve user comprehension.
- Include a format key to explain formats to model users.
- Apply formatting consistently throughout the model.

4 Use structured and descriptive labeling and units

- Ensure every row has an accurate and useful label.
- Name each sheet clearly and consistently.
- Clearly identify the units of every line item.

5 Keep the flow natural: left to right, top to bottom

- Ensure sheet calculations flow intuitively, from left to right and top to bottom.
- Organize model content into logical groupings of sheets and sections.

6 Use consistent column headings throughout the model

- Assign each column a clear purpose.
- Each time series should use the same column in every worksheet.
- Do not mix different periodicities in a single worksheet and always use the same column for the first period of each, irrespective of periodicity.

7 Use one unique formula per row that is copied across

- Ensure logic is always in the one consistent place in each row.
  - Prevents copying over mid-row formula changes.
  - Make reviewing / testing future maintenance easier and safer.
- Use the same formula for Actuals and Forecast periods in the same row.

8 Make extensive use of error checks

- Use error checks frequently throughout the model to check that it is internally consistent and produces logical outputs.
- Link all error checks to a central location that instantly alerts the model user on every sheet if an error occurs.

9 Include table of contents, user instructions and explanations

- Include a description setting out the model purpose, functionality and limitations.
- Make user instructions clear and simple.
- Summarize the content of the model in a table of contents.

10 Avoid high risk functionality or outputs

- Avoid circular references and volatile functions such as INDIRECT & OFFSET as they introduce a high risk of error, are difficult to check, and reduce calculation speed.
- Ensure outputs are free from logic issues and the model does not contain logic errors including #REF!, #DIV/0!, and #NUM!

Our experience suggests that when a model adheres to these Design Best Practices, ***the likelihood of errors within the model is significantly reduced.***

Essence of Spreadsheet Evil

Essence of Spreadsheet Evil exist to warn financial modelers about the risks of using certain elements within Excel. These elements should be avoided unless there are no safer alternatives available.

16 elements of functionality within Excel to avoid

Highest Risk

Very few situations in which they should be used

- Circular references
- OFFSET
- INDIRECT
- Custom formats to change units

Medium Risk

Normally avoid, but some specific exceptions

- VLOOKUP / HLOOKUP
- Complex formula
- {Array functions}
- Nested IF statements
- Pivot tables
- Dynamic named range
- Merged cells

Lower Risk

Can be safely deployed if you understand and mitigate the risks

- XNPV / NPV / IRR
- Avoidable VBA code
- ROUND, ROUNDUP, ROUNDDOWN
- ISERROR, ISERR, IFERROR
- External links

Highest risk

Very few situations in which they should be used

01 Circular references

- There is no guarantee it will iterate to a correct solution, and may reach different solutions depending on the startingpoint.
- Cannot tell if a second circularity is introduced.
- Slow to recalculate.
- Very difficult to troubleshoot if an error is introduced.
- There are alternative methods of calculating materially accurate model inputs.

02 OFFSET

- Volatile functions increase calculation time, increase memory usage will always recalculate, even if all precedents are unchanged.
- 'Trace Dependents' functionality will not identify a volatile function as dependent, thus implying they are redundant cells.
- The 'Trace Precedents' functionality will identify only cells within an OFFSET function and may be different to the actual precedents of the OFFSET function.

03 INDIRECT

- Volatile functions increase calculation time, increase memory usage and will always recalculate, even if all precedents are unchanged.
- 'Trace Dependents' functionality will not identify a volatile function as a dependent, thus implying they are redundant cells.
- The 'Trace Precedents' functionality will identify only the cell(s) within the INDIRECT function and not the actual precedents of the INDIRECT function.

04 Custom formats to change units

- It is reasonable to assume that 'what you see is what youget'.
- If these values are used elsewhere, a user will assume they contain the displayed values.

Essence of Spreadsheet Evil

Medium risk

Normally avoid, but some specific exceptions

05 VLOOKUP / HLOOKUP

- Wrong column / row can be referenced if new columns or rows are inserted.
- Inflexible - cannot look left and cannot be used between sheets.
- Other appropriate alternatives are available.

06 Complex formula

- Difficult for a model user or reviewer to understand and edit.
- Significantly increases the risk that the formula contains an error.

** Note, "complex formula" can take many forms (long formula, poor syntax, complicated functions, etc.). A common rule of thumb is any formula with 3 or more parenthesis should be considered complex.

07 {Array functions}

- They are complex and hard for most model users to understand and amend.
- If formula is edited and Ctrl + Shift + Enter is not used, formula will return the wrong value.
- Multi-cell array functions are difficult to control when making changes to worksheet structure (e.g. insert or delete rows / columns).

08 Nested IF statements

- Very hard for anyone to understand logic.
- Very risky when editing and difficult to check whether all branches of the formula work as intended.

09 Pivot Tables

- Don't refresh automatically so if the source data is updated, they must be updated manually.
- Calculations in Pivot Tables are opaque.
- Significantly increases the file size.

10 Dynamic Named Range

- Not transparent to model users and difficult to understand and amend.
- Difficult to identify (only accessible via the Name Manager).
- A change in model structure can inadvertently create an error.

11 Merged cells

- Introduces risks if used with formulas: may not copy across as expected.
- Makes it more difficult to select individual rows or columns and to cut / copy / paste cells.

Low risk

Can be safely deployed if you understand and mitigate the risks

12 XNPV / NPV / IRR

- All of these functions need to be used very carefully to ensure they get the intended results, as they use simplified and often imprecise assumptions.
- The IRR sometimes produces inaccurate results.
- An approach applying first principles may be more appropriate.

13 Avoidable VBA code

- Greatly reduces transparency and requires specialist skills to maintain the model.
- Very difficult to ensure VBA code will work in all circumstances.
- Difficult for most people to review.

14 ROUND, ROUNDUP, ROUNDDOWN

- May inadvertently hide mistakes particularly when used on error checks.
- If rounding is implemented too early in a string of logic, it could cause the results at the end of the logic string to be inaccurate.

15 ISERROR, ISERR, IFERROR

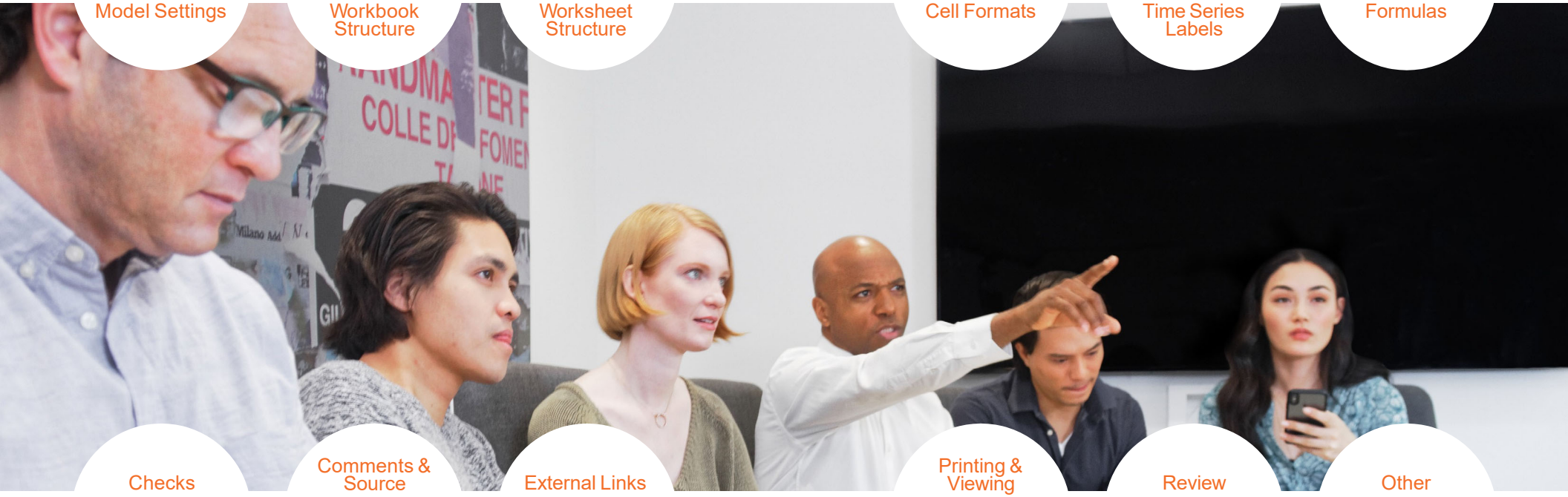
- Excel Error messages are useful and have a purpose – to notify you of errors!
- These functions hide a wide range of error messages, some of which you may need to see in order to know that something has gone wrong.
- Always test for the specific error, e.g., ISNA

16 External links

- Easy for error to occur if rows or columns are inserted in either the source or destination file without a corresponding change in the other file.
- Need to ensure that the links are always referring to the right file, particularly if the file name changes or the file moves.

Modeling Guidelines

These Modeling Guidelines exist to ensure a high and consistent level of quality across every model produced. They are considered to be universal for all models. Note exceptions to these Guidelines may be justified in certain circumstances; such as, for output and dashboard sheets where the Modeling Guidelines conflict with the visual requirements of these sheets.



Modeling Guidelines

Model Settings

Include general model settings on an inputs sheet

The following model characteristics provides important context for all users:

General model settings	
Model name	Project ABC
Model owner(s)	Ryan Nicholas
Model status (e.g. draft, final)	Final
Model start date	January 1, 2019
Model end date	December 31, 2028
Number total periods	10
Number of actual periods	2

Display general model settings on the cover sheet

Typically the cover sheet is the first worksheet within the model.

Displaying general model settings reiterates the importance of these settings and helps communicate them clearly.

Workbook Structure

Maintain distinct sheet types

Distinct worksheets assist users orientate through the model; examples of such worksheets include:

- Cover sheet (which may contain model overview, notes and table of contents, navigation)
- Inputs sheet(s)
- Calculations sheet(s)
- Outputs sheet(s)
- Review sheet (contains independent review steps, notes and a sign-off for each section).

Table of contents for each sheet and, potentially, each section provides useful context

A table of contents for workbooks with several sheets outlines the structure and composition of the underlying workbook.

This provides a summary of the model as well as navigation.

Hyperlinks can be applied to table of contents to facilitate easy navigation

Hyperlinks create efficient navigation. Including a hyperlink back to the table of contents ensures any sheet can be accessed within two clicks.

Modeling Guidelines

Workbook Structure *(cont.)*

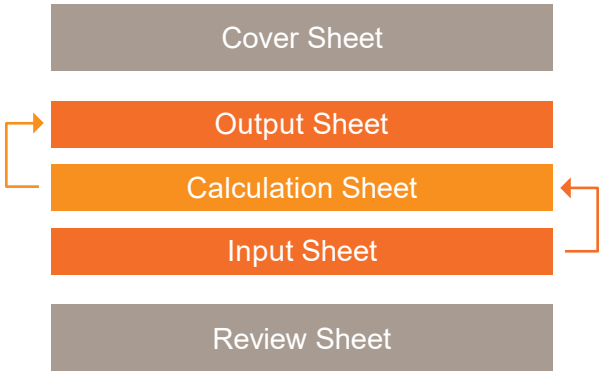
Keep the model content within one workbook whenever possible

Where possible, workbooks should be self-contained with no external links to other workbooks.

If external links must be used, consider Guideline 9.

Avoid hiding a worksheet

Hidden sheets can cause errors or confusion for users.



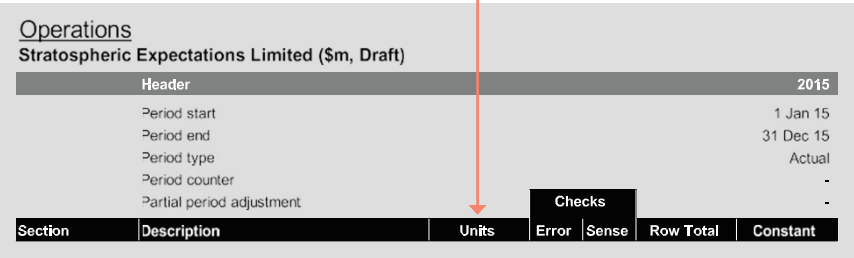
Worksheet Structure

Maintain key items in the same location

Ensuring key information (such as: title, sub-title, navigation, and error checks) is located in the same location provides consistency and aids with comprehension.

Maintain columns with clear and consistent purposes

Examples include columns for the following purposes: headers, descriptions, units, comments, sources, error checks, sense checks, totals and time series.



Maintain consistent column widths and labels for inputs and calculations of the same periodicity

The intent is to maintain column widths and labels consistency across all input, calculation and output sheets where possible.

	2020	2021	2022
Calculation Sheet	1 Jan 20 31 Dec 20	1 Jan 21 31 Dec 21	1 Jan 22 31 Dec 22
	2020	2021	2022
Output Sheet	1 Jan 20 31 Dec 20	1 Jan 21 31 Dec 21	1 Jan 22 31 Dec 22

Modeling Guidelines

Worksheet Structure *(cont.)*

Divide sheets into 'sections' using clearly formatted section headings

Create an organized workbook by using consistent formatting for section headings that are appropriately ordered to clearly distinguish differences.

Section	Description	Units
1) Revenue		
	Product A revenue	$m
	Product B revenue	$m
	Total revenue	$m
2) COGS		
	Product A COGS	$m
	Product B COGS	$m
	Total COGS	$m

Use cell and sheet protection to control access to cells that are to remain consistent

This reduces the likelihood of accidental errors and encourages users to only change input cells.

Each sheet tab should be coloring to differentiate inputs, calculations and outputs

Colors help model users to quickly identify the purpose of each worksheet. Use a consistent color for each sheet type.

Different types of outputs to have different colors.

Cover	Inputs	Operations	Financing	Dashboard	Fin Stats

Cell Formats

Format in accordance with a formatting key

A formatting key helps provide context over different values within the model (as an example, the difference between all links and inputs from external workbooks vs internal sources).

An example of format key is as follows. Note changes and additions to these defined formats may be required to meet client or model demands.

Format key
= User input
= Link in from external workbook / source
= Notification
= Formula (100% formula)
= Text (100% text and text that includes formula)
= Link in from different worksheet
= Hyperlink (navigation)
= Work in progress / incomplete
= Error Check

Display the format key prominently in the model

Display the format key in a prominent location (such as cover sheet) to make it easier for users.

Enter inputs once (on an inputs sheet) in the model

Having the same input entered more than once necessitates that multiple edits are required as assumptions change. Rather, use a link to the source input cell. Try not to daisy-chain (i.e. link to other links, rather than linking to the source).

Modeling Guidelines

Cell Formats *(cont.)*

Enter a heading or name (hardcoded text) in the model once

Repeated headings or names can be linked to one source.

Limited choice or binary inputs should use in cell list boxes (data validation and list)

Allows for binary, limited or multiple choices without cell links.

Maintain 'List' inputs in a dedicated 'lists' section on an inputs sheet

A named range can be utilized to ensure 'Lists' are consistent in the naming convention and description.

Ensuring 'Lists' are maintained can assist ensure all unique combinations are captured.

Bracket negative numbers

Bracketing negative numbers easily differentiates between 'inflows' and 'outflows'.

Negative numbers	$m	50	50	(50)	50

Format zeros as dashes

This allows 0s to be visually distinct from 1s in flags.

Formatting zeros	1 / -	1	-	1	1

Formatted numbers appropriately (e.g. %, x) and have a units column

Applying consistent number formatting ensures uniformity and helps avoid and identify calculation issues.

Consistently align all numbers across rows and down columns

Alignment assists with analysis and checking as anomalies (such as large vs small, positive vs negative values, etc.) stand out more readily when aligned and are easily comparable. Different alignment may be applied to numerical values (e.g. percentages, currency, units) vs text.

Not all formatting guidelines are applicable on output sheets

Output sheets must visually meet stakeholder requirements and can deviate from the formatting in the rest of the model in order to tell the story.

Modeling Guidelines

Time Series Labels

Maintain consistent time series labels in the same location for sheets with similar time series content

Maintaining consistent labels (such as header, period start date, period end date, period type (e.g. actual, forecast) and period number) in the same location ensures uniformity.

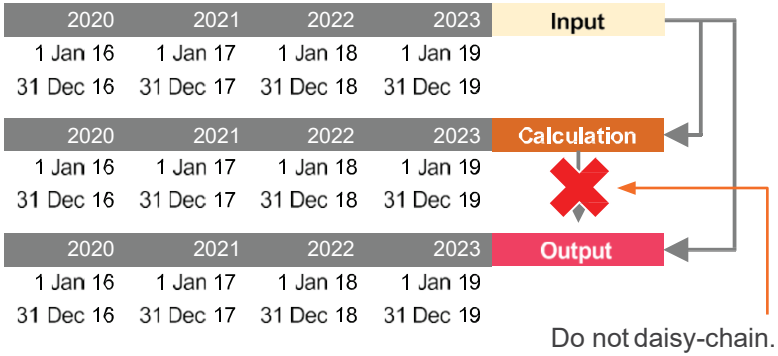
Link time series as a calculation to the labels on the relevant inputs sheet

Labels on all other sheets are direct links to the inputs sheet.

Utilizing 'named ranges' may be effective in applying consistent time series information and cell location.

Calculate time series labels on the inputs sheet using general model settings

Once initially calculated, all instances of that same time series throughout the model should be pulled from that initial calculation, time series calculations flow throughout the model.



Calculate time series flags or counters in one place in the model where practical

Timing flags serve multiple purposes: indication for the timing of events, toggling cells on / off, and dynamic updating without introducing complex formulas.

Adopt an approach of a single periodicity per worksheet (e.g. do not mix quarterly and annual on a single sheet)

This avoids the risk and complexity of multiple periodicities.

Create separate 'input', 'output' and / or 'calculation' worksheets if more than one periodicity is used.

Summary columns to the left of the main time series are permitted.

Use consistent calculations for all cells when summarizing Monthly / Quarterly to Annual

This assists with error identification as inconsistent values are easier to spot.

Subtotals, as opposed to SUMIF on the subtotal, can be more robust.

Use checks to compare Annual subtotals to Monthly / Quarterly subtotals.

Modeling Guidelines

Formulas

Construct formulas so they are consistent across columns

All formulas should be able to be copied across all columns.

= E17 + $E18	= F17 + $E18	= G17 + $E18	= H17 + $E18	= I17 + $E18

Calculate formulas which are constant across time periods in the constants column

To distinguish constant values (i.e. those that do not change over a time series from those that do), maintain a column for constant values.

This visually distinguishes constant calculations from time series calculations.

Avoid cells that contain both a link to a different worksheet and a calculation

Instead, use conversion factors and flags with inter-sheet links or named ranges.

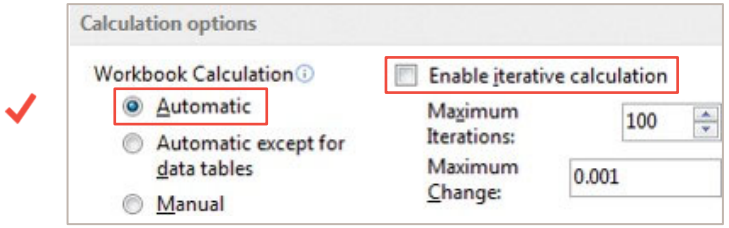
✗	Revenue$	m	300	*= Inputs'!K240 * Inputs'!K241*
	Price$		3.00	*= Inputs'!K240*
	Quantity	millions	100	*= Inputs'!K241*
✓	Revenue$	m	300	*= K99 * K100*
✓	Revenue$	m	300	*= Price * Quantity*

Avoid repeating identical calculations in separate cells

Instead, link subsequent identical calculations to the original formula.

As a default, set workbooks to calculate 'automatically' (not 'manually') and not enable iterative calculations

This is a workbook level setting based on the first workbook open.



Avoid circular references

Circular references introduce risk into the model which could result in multiple possible outputs.

Circular references are used to calculate inputs, but are often assumed to be necessary parts of the model's calculations.

There is almost no commercial situation where a circular reference is required.

Modeling Guidelines

Formulas *(cont.)*

Avoid hardwired inputs

Separate and label inputs on the inputs sheets and then link to other formulas.

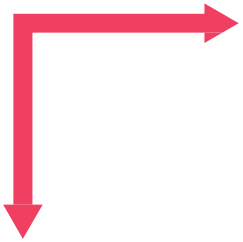
Some exceptions are: 1, 0, -1 (and occasionally 12 and 4).

Break down complex formula into separate cells / rows

When formulas are complex, either break the formulas down into simpler formulas in separate cells / rows or incorporate logic diagrams of the formulas.

= $R8 * (S$2 >= $R9) * (S$2 <= $R10)
= R17 * (1 + $R16)
= S17 * $R21
= S11 * S22

Flow calculations from left to right across columns and across sheets in the workbook. However, summary sections may be placed at the top of a sheet



This formatting style ensures consistency and efficiency in the calculations.

Avoid any references to blank cells

Use the 'notification' format and insert zeros to ensure this criteria is met.

For example, when referring to opening balances in t = -1 (i.e. opening balance for the first period).

Clearly define each row with a descriptive label

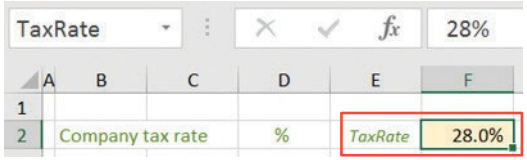
Ensure that all labels adequately describe the row content.

Summary			
Revenue - Product A	$m	Cost of goods sold - Product A	$m
Revenue - Product B	$m	Cost of goods sold - Product B	$m
Revenue - total	$m	Cost of goods sold - total	$m

Include a text label beside a named range

This ensures that all named ranges are easily identifiable.

A common best practice is to differentiate with different formatting (such as smaller font size & italics).



Modeling Guidelines

Checks

Include a column in each worksheet to sum up error checks in every applicable row

It's best practice to include error checks wherever possible. This allows quick identification of the source of any issue triggered.

Each error check row can be summarized in a designated column.

Header			2016	2017	2018
Period start			1 Jan 16	1 Jan 17	1 Jan 18
Period end			31 Dec 16	31 Dec 17	31 Dec 18
Period counter	Checks		1	2	3
Description	Error	Sense			
Check - change in net working capital	2		-	1	1

Include a cell in the freeze panes across each worksheet that summarizes the error checks in the worksheet

Maintain a total error check in the same location of every worksheet.

Model users may decide to show: the number of distinct errors; a binary indication whether there is an error or not in the worksheet; or the actual magnitude (differences) in error.

Maintain a dedicated section in the workbook to summarize all error checks

The error checks section consolidates all error checks from every worksheet in the model.

Error checks are for logical / mathematical issues that must be errors (e.g. the balance sheet not balancing).

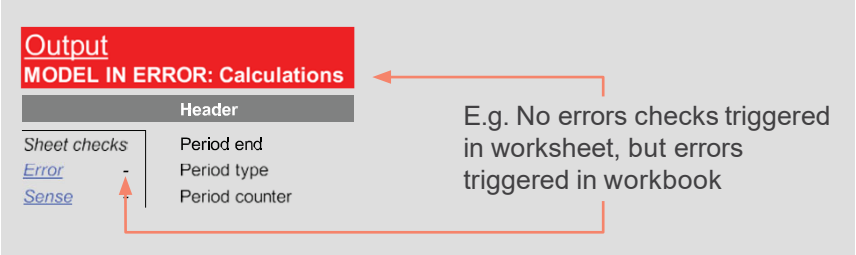
Include a dedicated section in each workbook for sense checks

The sense checks section consolidates all sense checks from every sheet in the model.

Sense checks are for 'rules of thumb' that indicate model values are outside normal parameters (e.g. revenue growth is above X%) or financial / contractual checks that don't necessarily indicate model error (e.g. covenant tests and negative cash balances).

Link overall error and sense check results to the sheet sub-title on every sheet

Link the sheet sub-title and to display the result of any error checks.



Use conditional formatting to show when error & sense checks are triggered

Conditional formatting serves as an alarm for the builder(s) and user(s). Use a distinct cell color to indicate triggered error checks and sense checks.

	Checks				
Description	Error	Sense			
Error check - revenue	1		-	1	-
Sense check - revenue growth		2	1	-	1

Modeling Guidelines

Checks *(cont.)*

Format header sheets to change when an error is triggered

Use a distinct cell color to indicate triggered error checks and sense checks.

Calculations
[XYZ Limited] ($m, Draft)
Calculations
MODEL IN ERROR: Calculations

E.g. Formatting changes when error check is triggered.

Make use of the ABS function for error checks

This function simplifies the error check by converting negative to positive values.

Ensures check is positive

= -- (ABS(1 - SUM(T57:T58)) > ErrorTolerance)

Changes TRUE/FALSE to 1/0

Named Range: Allows for Excel calculation engine inaccuracy

Comments & Sources

Allow for Comments | Sources | Responsibility columns in input sheets

The location of these columns may vary depending upon specific model requirements.

Comments	Sources	Responsibility
1-month forward LIBOR curve	Bloomberg (15-January 2020, 12:00EST)	Ryan Nicholas
Sourced from term sheet	Project ABC - senior secured note.pdf	Jane Smith

Comments | Source | Responsibility columns on the inputs sheet should explain all input sources

Input source comments could include a hyperlink to the source.

Include notes describing the workbook and its overall content in a cover sheet

The notes should describe the purpose of the model, the intended users, any assumed knowledge and highlight any unusual or complex sections.

Modeling Guidelines

External Links

Separate links external to workbooks through the use of a dedicated inputs section / sheet

In order to reduce the risk inherent in the model, it is important to centralize and identify all external workbook links.

If there are many links to multiple external workbooks, centralize their location (such as dedicated input sheet(s)

Organize links to an external workbook with a consistent layout.

Where external workbook links are used, recalculate the subtotals and use error checks to ensure that the source and destination locations remain consistent

Error checks ensure that any changes to the source file are picked up.

Section	Description	Error	Sense			
5) External Workbook 1 inputs						
	Quantity - Product A			100	50	100
	Quantity - Product B			100	100	200
	Total Quantity (calc)			**200**	**150**	**300**
	Total Quantity (source)			200	50	100
	check - external source data	2		-	*1*	*1*

Ensure that time series labels are consistent with labels in any linked external workbook

This ensures consistency between workbooks.

Printing & Viewing

Maintain the same print zoom percentage for every sheet

As a general rule, an 85% page view (zoom) may be appropriate.

Set worksheets view to Normal not Page Break Preview.

Cell A1 can serve as the active cell of each sheet before finalizing the workbook

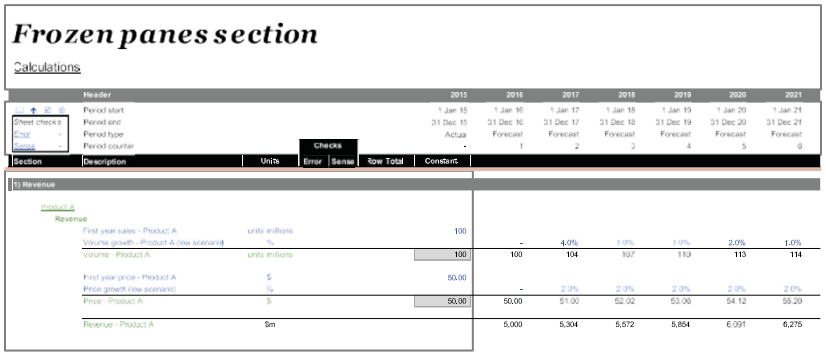
The cell that is active when the workbook is saved is what the users will first see when they open the workbook. Consider saving accordingly (e.g. the cover sheet, instruction sheet, inputs / assumptions, disclaimer, etc).

Use 'freeze panes' to keep the titles and times series labels in view

Utilize freeze panes to keep important labels in constant view including row headers, titles, column descriptions and checks.

Apply freeze panes to worksheets where a time series label is applied.

Model builders may also utilize 'split' view, however this is only suggested if multiple view panes with separate sections are going to be utilized.



Modeling Guidelines

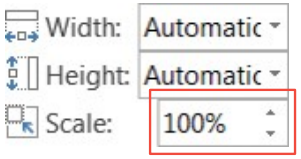
Printing & Viewing *(cont.)*

Set and scale the print view appropriately

This ensures the sheets will print as intended.

The print scaling should generally be set to the same percentage for every sheet

This ensures that print scaling is consistent across worksheets with the same time series.



Use Rows and Columns to repeat (where practical) to print titles and time series labels on every page

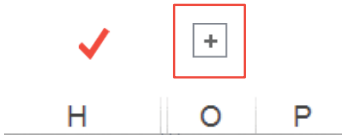
This ensures that titles and time series labels are printed on every page.

Footers can include important information (such as: file name, date printed and page numbers)

This ensures that printed copies can be related to a file and time.

Avoid hiding rows or columns. If necessary, Group and collapse.

This ensures that hidden rows or columns are identifiable.



Review

Complete a review before finalizing

Document the review process.

Document review steps for every section and sheet in the workbook

Be systematic and consistent in review procedures.

Include a mixture of review processes to review inputs, formulas and outputs in the workbook

As part of review steps, examine adherence to Modeling Guidelines.

Conduct review steps with a qualified individual who is not the model builder

Model builders cannot always find their own errors. Model builders should not build the model and be the sole reviewer of the model.

Modeling Guidelines

Other

Only include VBA Macros within a workbook that are absolutely necessary

If included in the workbook, VBA Macros should be clearly notated and tested.

Avoid the use of VBA Macros created solely by using the 'macro recorder'

The macro recorder introduces risk into the model because it does not produce reliable macros.

Separate sensitivity analysis inputs (if any) from the inputs

Separate sensitivity analysis inputs from the original inputs.

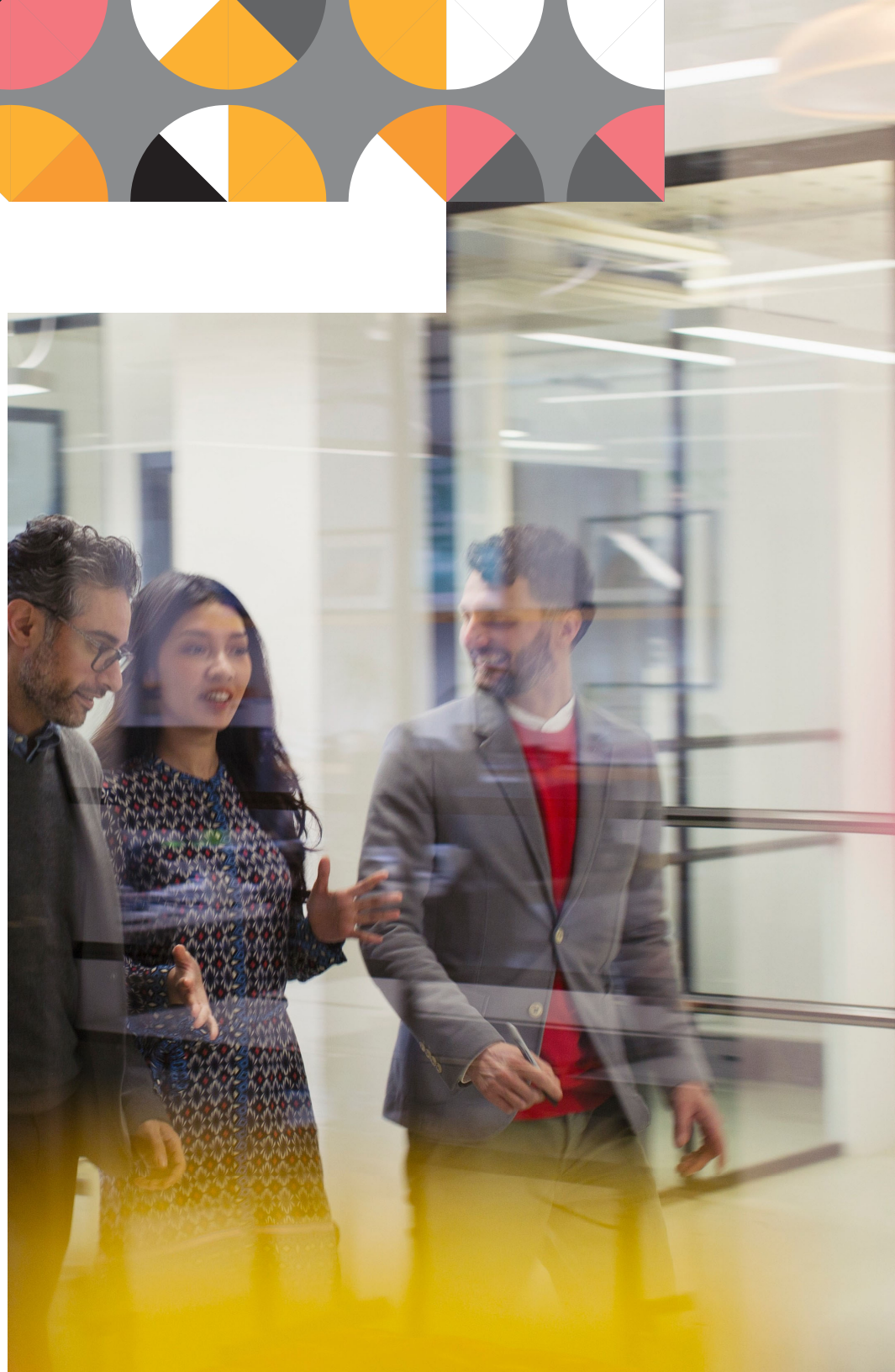
Apply a consistent file naming convention allowing for identification, status and version

Examples include: [Model Name] - [STATUS] - [vYYYY-MM-DD HHMM] [initials], [Model Name] – vX.XXX (where 'vX' signifies iteration of external release, and '.XXX' represents edits between external release), etc.

Project Gold - DRAFT - v2016-09-10 1230 TOB.xlsb

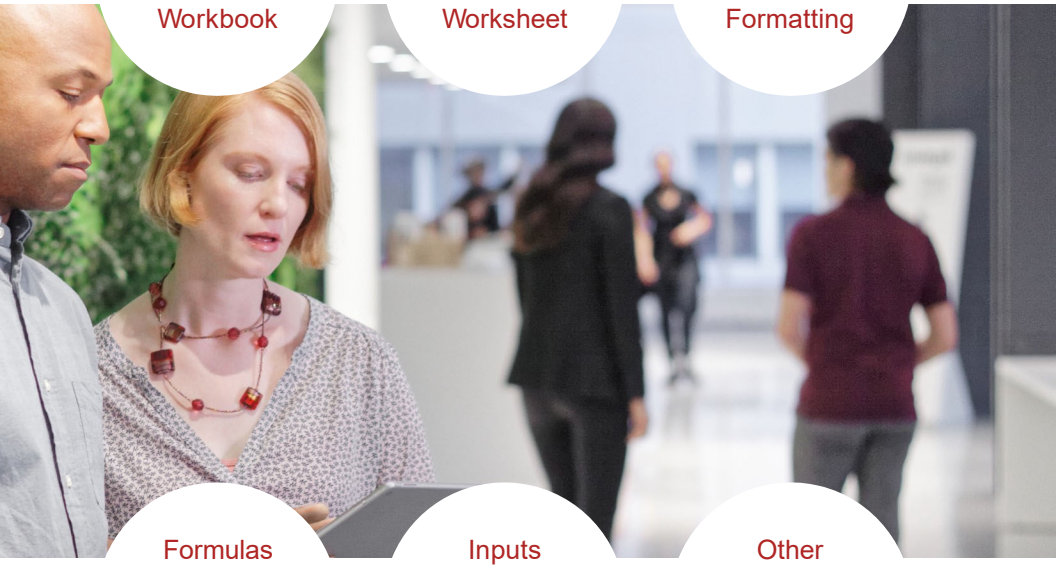
Apply freeze panes so that row and column headings and labels are visible on every sheet

Heading and label visibility is set individually for each she



Modeling Considerations

These Modeling Guidelines serve to build upon the Modeling Rules. The following 39 Considerations may be applied (where practical) in conjunction with the Modeling Guidelines to improve the design of financial models.



Workbook

Include a description of every sheet (and section where relevant) in the workbook

This provides a written summary of the Workbook.

1) Tabular table of contents

Sheet name	*Description*
Model sheets	
Disclaimer	Terms and conditions
Cover	Model information
Checks	Error summary
Review	Review steps
Inputs	
Inputs	All inputs
Calculations	
Operations	Revenue and expenses
PP&E	Capex and depreciation

Avoid the use of chart sheets in a workbook (place charts on worksheets)

Chart sheets are unnecessary and reduce overall sheet consistency.

Avoid the use of chart sheets in a workbook (place charts on worksheets)

Chart data should be centralized and clearly labeled.

Complete workbook 'properties' before finalizing

Workbook properties are attached to each workbook file.

Properties

Related People

Author — Toby O'Brien

Last Modified By — Ani Dino

Identify, label and separate real versus nominal numbers (if relevant)

This increases clarity and reduces scope for interpretation errors.

Modeling Considerations

Worksheet

Group and hide blank columns at the right of the sheet content

Leave one blank column after the time series. This blank column may contain named range labels.

This can be done on every sheet before finalizing a workbook.

Grouped rows should be noted

This applies to input and calculation sheets.

Avoid mixing numbers with different units in the same row

This avoids the risk of denomination errors and ensures consistency.

Apply named ranges for list inputs

Use a consistent list prefix for named lists.

List 1 - Yes/No
Yes
No
List.YesNo

List 2 - Actual/Forecast
Actual
Forecast
List.ActualForecast

Where the cell link of a hyperlink is not cell A1 of a worksheet, apply Named Ranges for their destinations.

This reduces the risk of broken hyperlinks.

Give careful consideration before using form controls (use data validation and lists instead)

Form controls float over cells and require link cells. Avoid using Active-X controls where possible.

Modeling Considerations

Formatting

Identify the last row of the content on each sheet

Use a section heading to identify the end of content.

106	
107	
108	End of sheet
109	
110	

Emphasize totals, sub-totals or other key outputs using consistent formats

Format using borders, bold font and italics. Use only a few formats and keep them consistent throughout in order to maintain an easily legible workbook.

Assets		
Current assets		
Cash balance	$m	502
Accounts receivable$	m3	10
Inventory$	m4	07
Current assets	$m	1,219
Non-current assets		
Plant and equipment	$m	988
Tax asset$	m7	3
Non-current assets$	m1	,061
Total assets	**$m**	**2,280**

Ensure cell content is in view

Avoid cell sizes that cause any content to fall out of view. This also encourages the model builder(s) to consider when there is too much content in one cell, column or row.

Limit the use of font type except on output sheets

Changes in font stand out and inadvertently draw attention or cause concern.

Maintain the same font size for the numbers in the model except on output sheets

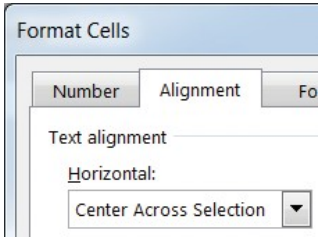
Changes in font and font size stand out and inadvertently draw attention or cause concern.

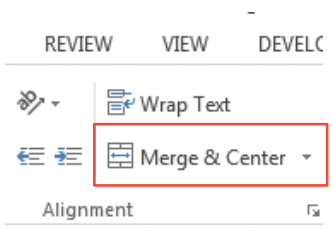
Note and highlight anything unusual or complex in a model

Use the Comments | Sources column to note these complexities.

Avoid merge cells in a workbook (unless required for chart formatting)

Merged cells can increase the risk of errors. Center Across Selection is an excellent alternative.





Modeling Considerations

Formulas

Use spaces in formula construction to make formulas easier to read (particularly longer or more complex formulas)

This increases the clarity of formulas and increases user friendliness.

✓ = (S34 * (A$27 + B$25)) / $C$28

Do not overuse brackets in formula

Excessive brackets make a formula more difficult to understand.

But do use them to make algebra clearer e.g. = a – (b – c)

Adopt an approach where formulas can be easily explained (should take less than 30 seconds)

If formulas are difficult to explain, break complex formulas into separate components (cells).

✗ =('General Inputs'!$J$72+INDEX('Generall nputs'!$E$62:$E$87, MATCH('Flat f ile'!D380,'General Inputs'!$B$62:$B$87,FALSE)) +INDEX('General Inputs'!$J$62:$J$69,MA TCH('Flat f ile'!E380, 'General Inputs'!$I$62:$I$69,FALSE)))*(1-INDEX('General Inputs'!$K$62:$K$69,MATCH('Flat file'!E380,'Inputs'!$I$62:$ I$69,0)))

Avoid the use of array formulas (unless no alternative)

Array formulas are overly complex and cause efficiency problems.

They are also difficult to review.

Use Go To > Special > Current array to identify the size of an array in order to edit it.

Ensure sign switches are conspicuous and clear to any model users

Use "= 0 – " which is easier for the user to see than "=-".

✓	✗
= 0 -A1	= -A1

Row anchor all links to a different sheet

This creates links that are capable of being copied elsewhere on the sheet.

= Inputs'!E$44	= Inputs'!F$44	= Inputs'!G$44	= Inputs'!H$44

Avoid including current worksheet references in formulas

This is unnecessary and confusing for model users.

✓	= E$44	=F$44	+ G$44	= H$44
✗	= Tax'!E$44	= Tax'!F$44	+ Tax'!G$44	= Tax'!H$44

Avoid creating strings of links to links (daisy-chaining)

Link to original sources, the first formula.

Modeling Considerations

Formulas *(cont.)*

Resolve formula errors in outputs cell (even when inputs are varied)

Formula errors flow through to dependent formulas.

Error cells severely negatively impact on a user's perception of a model.

#VALUE!	#DIV0!	#NAME?	#REF!

Build formula (or formula blocks) such that they can be copied where identical logic is applied

Consistent formula blocks reduce risk and increase efficiency.

Used for repeating items such as: business units, debt tranches, revenue and categories.

Use and separate timing flags and indexation factors

Separate the 'what' from the 'when' to avoid complexity. See below as an example, the different periods (the 'when') have been distinguished from the timeline (the 'what').

Flag Actual	1	-	-
Flag.Forecast	-	1	1

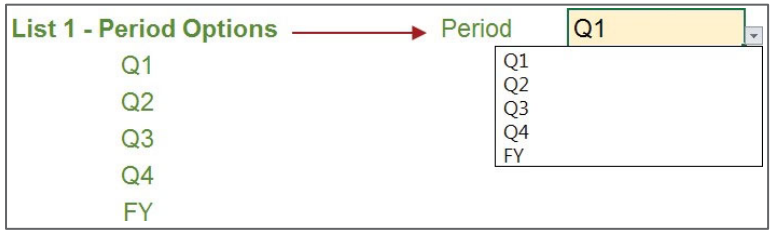
Input

Avoid input cells in output sheets, unless they relate to output controls

For example, inputs for chart display or time period choices might be included on an output sheet (e.g. dashboard).

Data validation can be used on relevant input cells to provide guidance and / or limit inputs

Data Validation allows for comprehensive control over input cells.



Hyperlinks and symbols can be linked to a 'show | hide' choice on the inputs sheet

This allows for hiding hyperlinks for printing and viewing.

Show Hyperlinks?	list	*Model.Navigation.View*	Yes

Adopt a consistent convention for inputting values (and label accordingly)

Adopt a consistent approach for adding inputs (such as: all inputs made as a positive, all credits positive & all debits negative, etc.) to avoid any confusion.

Enter data from external sources as static input values (where possible)

This removes the risk and complexity of external links.

Modeling Considerations

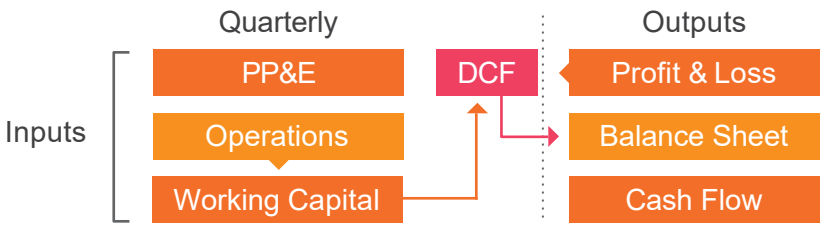
Other

Accompany a model with a 'user guide' or instructions that explains how to use the model

User guides should be as comprehensive and informative as possible.

Provide a model structure diagram with hyperlinks within the model to give greater context

This aids user understanding of the model and navigation.



Ensure non-trivial models whose outputs are relied upon, are subject to an independent integrity review and often a professional model audit

This is an independent sign-off that the workbook content is correct.

Where possible, review steps should include reconciliation of key outputs to other sources

This should occur whenever there is another information source.

Avoid workbooks that require add-ins or additional software to operate or modify

Workbooks should assume that users only have Microsoft Excel.

More Information

The best financial models take a complex problem and break it down into a simple, logical, easy to follow framework.

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Global PwC Modeling

We design and build best practice models that are low risk, flexible, user friendly and fit for purpose and leverage them to create insightful analytics to support making better decisions.

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