The Ultimate Guide to Financial Modeling Best Practices

Introduction

Like many computer programmers, people who build financial models can get quite opinionated about the "right way" to do it.

In fact, there is surprisingly little consistency across Wall Street around the structure of financial models. One reason is that models can vary widely in purpose. For example, if your task was to build a discounted cash flow (DCF) model to be used in a preliminary pitch book as a valuation for one of 5 potential acquisition targets, it would likely be a waste of time to build a highly complex and feature-rich model. The time required to build a super complex DCF model isn't justified given the model's purpose.

On the other hand, a leveraged finance model used to make thousands of loan approval decisions for a variety of loan types under a variety of scenarios necessitates a great deal of complexity.

Understanding the purpose of the model is key to determining its optimal structure. There are two primary determinants of a model's ideal structure: **granularity** and **flexibility**. Let's consider the following 5 common financial models:

Model	Purpose	Granularity	Flexibility
One page DCF	Used in a buy side pitch book to provide a valuation range for one of several potential acquisition targets.	Low. Ball-park valuation range is sufficient) / Small. Entire analysis can fit on one worksheet < 300 rows)	Low. Not reusable without structural modifications. Will be used in a specific pitch and circulated between just 1-3 deal team members.
Fully integrated DCF	Used to value target company in a fairness opinion presented to the acquiring company board of directors	Medium	Low. Not reusable without structural modifications. Will be tailored for use in the fairness opinion and circulated between deal time members.
Comps model template	Used as the standard model by the entire industrials team at a bulge bracket bank	Medium	High. Reusable without structural modifications. A template to be used for a variety of pitches and deals by many analysts and associates, possibly other stakeholders. Will be used by people with varying levels of Excel skill.
Restructuring model	Built specifically for a multinational corporation to stress test the impact of selling 1 or more businesses as part of a restructuring advisory engagement	High	Medium. Some re-usability but not quite a template. Will be used by both the deal team and counterparts at the client firm.
Leveraged finance model	Used in the loan approval process to analyze loan performance under various operating scenarios and credit events	High	High. Reusable without structural modifications. A template to be used group wide.

Financial model granularity

A critical determinant of the model's structure is **granularity**. Granularity refers to how detailed a model needs to be. For example, imagine you are tasked with performing an LBO analysis for Disney. If the purpose is to provide a back-of-the-envelope floor valuation range to be used in a preliminary pitch book, it might be perfectly appropriate to perform a "high level" LBO analysis, using consolidated data and making very simple assumptions for financing.

If, however, your model is a key decision making tool for financing requirements in a potential recapitalization of Disney, a far higher degree of accuracy is incredibly important. The differences in these two examples might involve things like:

- Forecasting revenue and cost of goods segment by segment and using price-per-unit and #-units-sold drivers instead of aggregate forecasts

- Forecasting financials across different business units as opposed to looking only at consolidated financials

- Analyzing assets and liabilities in more detail (i.e. leases, pensions, PP&E, etc.)

- Breaking out financing into various tranches with more realistic pricing

- Looking at quarterly or monthly results instead of annual results

Practically speaking, the more granular a model, the longer and more difficult it will be to understand. In addition, the likelihood of errors grows exponentially by virtue of having more data. Therefore, thinking about the model's **structure** — from the layout of the worksheets to the layout of individual sections, formulas, rows and columns — is critical for granular models. In addition, integrating formal error and "integrity" checks can mitigate errors.

Financial model flexibility

The other main determinant for how to structure a model is its required **flexibility**. A model's flexibility stems from how often it will be used, by how many *users*, and for how many different *uses*. A model designed for a specific transaction or for a particular company requires far less flexibility than one designed for heavy reuse (often called a template).

As you can imagine, a template must be far more flexible than a company specific or "transaction specific model. For example, say that you are tasked with building a merger model. If the purpose of the model is to analyze the potential acquisition of Disney by Apple, you would build in far less functionality than if its purpose was to build a merger model that can handle any two companies. Specifically, a merger model template might require the following items that are not required in the deal-specific model:

1. Adjustments to acquirer currency

2. Dynamic calendarization (to set target's financials to acquirer's fiscal year)

3. Placeholders for a variety of income statement, balance sheet and cash flow statement line items that don't appear on Disney or Apple financials

4. Net operating loss analysis (neither Disney or Apple have NOLs)

Together, granularity and flexibility largely determine the structural requirements of a model. Structural requirements for models with low granularity and a limited user base are quite low. Remember, **there is a trade-off** to building a highly structured model: time. If you don't need to build in bells and whistles, don't. As you add granularity and flexibility, structure and error proofing becomes critical.

Granularity and flexibility determine model's structure
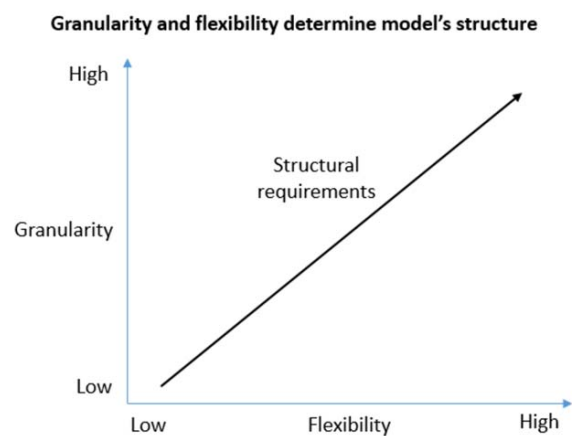
The table below shows the granularity/flexibility levels of common investment banking models.

	High flexibility	**Low flexibility**
High granularity	• Leveraged finance credit model	• Integrated LBO model

	• Merger model template "one size fits all"	• Integrated DCF model
		• Integrated Merger Model
		• Integrated operating model
Low granularity	• Trading comps template • Transaction comps template	• "Back of the envelope" accretion/dilution model • DCF "one pager" • LBO "one pager" • Simple operating model

Financial model present-ability

Regardless of granularity and flexibility, a financial model is a tool designed to aid decision making. Therefore, all models must have clearly presented outputs and conclusions. Since virtually all financial models will aid in decision-making within a variety of assumptions and forecasts, an effective model will allow users to easily modify and sensitize a variety of scenarios and present information in a variety of ways.

Now that we have established a simple framework for structuring models, it's time to discuss specific features of model architecture, error proofing, flexibility and presentation.

Financial model structure

Below, we lay out the key elements of an effectively structured model, most of which will go a long to way to improve the model's **transparency**. As a model becomes more complex (due to higher granularity and flexibility), it naturally becomes less transparent. The best practices below will help to fix this.

Formatting

Color coding

Just about everyone agrees that color coding cells based on whether it holds a hard coded number or a formula is critical. Without color coding, it is extremely difficult to visually distinguish between cells that should be modified and cells that should not (i.e. formulas). Well built models will further distinguish between formulas that link to other worksheets and workbooks as well as cells that link to data services.

While different investment banks have different house styles, blue is typically used to color inputs and black is used for formulas. The table below shows our recommended color coding scheme.

Type of cells	Excel formula	Color
Hard-coded numbers (inputs)	=1234	Blue
Formulas (calculations)	=A1*A2	Black
Links to other worksheets	=Sheet2!A1	Green
Links to other files	=[Book2]Sheet1!$A$1	Red
Links to data providers (i.e. CIQ, Factset)	=CIQ(IQ_TOTAL_REV)	Dark Red

While everyone agrees that color coding is very important, keeping up with it can be a pain in native Excel. It's not easy to format cells based on whether they are inputs or formulas, but it *can* be done. One option is to use Excel's "Go To Special" (covered in our Excel Crash Course, which you can enroll in here). Alternatively, color coding is dramatically simplified with a third party Excel add-in like Macabacus (which is bundled with Wall Street Prep self-study products and boot camp enrollments), Capital IQ or Factset. These tools allow you to "autocolor" an entire worksheet in one click.

Comments

Inserting comments (Shortcut **Shift F2,** see our [Essential Excel Shortcuts List](#)) in cells is critical for footnoting sources and adding clarity to data in a model.

For example, a cell containing an assumption on revenue growth that came from an equity research report should include a comment with a reference to the research report. So how much commenting do you need? **Always err on the side of over commenting**. No managing director will ever complain that a model has too many comments. Additionally, if you're on a conference call and someone asks how you came up with the number in cell AC1238 and you blank, you'll regret not commenting.

Sign convention

The decision on whether to use positive or negative sign conventions must be made before the model is built. Models in practice are all over the place on this one. The modeler should choose from and clearly identify one of the following 3 approaches:

Convention 1		Convention 2		Convention 3	
Revenues	$335.6	Revenues	$335.6	Revenues	$335.6
Cost of goods sold (COGS)	(144.9)	Cost of goods sold (COGS)	144.9	Cost of goods sold (COGS)	144.9
Gross profit	$190.7	**Gross profit**	$190.7	**Gross profit**	$190.7
Operating expenses	(188.6)	Operating expenses	188.6	Operating expenses	188.6
Operating profit (EBIT)	$2.1	**Operating profit (EBIT)**	$2.1	**Operating profit (EBIT)**	$2.1
Interest income	$3.4	Interest (income)	($3.4)	Interest income	$3.4
Interest (expense)	(0.1)	Interest expense	0.1	Interest (expense)	(0.1)
Other (expense) / income, net	0.0	Other expense / (income), net	(0.0)	Other (expense) / income, net	(0.0)
Pretax profit	$5.3	Pretax profit	$5.3	Pretax profit	$5.3
Tax (expense) / benefit	(2.5)	Tax expense / (benefit)	2.5	Tax expense / (benefit)	2.5
Net income	$2.8	**Net income**	$2.8	**Net income**	$2.8

> **Convention 1:** All income positive, all expenses negative.

- Advantage: logical, consistent, makes subtotal calculations less error-prone

- Disadvantage: Doesn't align with conventions used by public filings, % margin calculations appear negative

> **Convention 2:** All expenses positive; non-operating income negative.

- Advantage: Consistent with public filings, % margin calculations appear positive

- Disadvantage: Negative non-operating income is confusing, subtotal calculations are error-prone, proper labeling is critical

> **Convention 3:** All expenses positive except non-operating expenses.

- Advantage: Avoids negative non-operating income presentation; margins evaluate to positive

- Disadvantage: Presentation not internally consistent. Proper labeling is critical.

Our recommendation is Convention 1. The reduced likelihood of error from easier subtotaling alone makes this our clear choice. In addition, one of the most common mistakes in modeling is forgetting to switch the sign from positive to negative or vice versa when linking data across financial statements. Convention 1, by virtue of being the most visibly transparent approach, makes it easier to track down sign-related mistakes.

Formulas

Avoid partial inputs (all models)

Hard coded numbers (constants) should never be embedded into a cell reference. The danger here is that you'll likely forget there is an assumption inside a formula. Inputs must be clearly separated from calculations (see below).
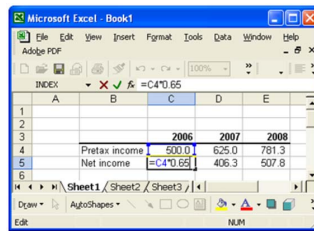
One row, one calculation

Most investment banking models, like the 3-statement model, rely on historical data to drive forecasts. Data should be presented from left to right. The right of the historical columns are the forecast columns. The formulas in the forecast columns should be **consistent across the row**.

A	B	C	D	E	F	G	H	I	J	K
10										
11	INCOME STATEMENT								QUARTERLY RESULTS	
12	Fiscal year	2015A	2015A	2015A	2015A	2016P	2016P	2016P	2016P	2017P
13	Quarter	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1
14	Quarter end date						6/30/16	9/30/16	12/31/16	3/31/17
15										
16	Revenue	37,472	57,594	45,646	37,432	39,329	60,448	47,908	39,287	41,278
17	Cost of sales (enter as -)	(23,601)	(35,748)	(27,699)	(22,697)	(23,598)	(36,269)	(28,745)	(23,572)	(24,767)
18	Gross Profit	13,871	21,846	17,947	14,735	15,732	24,179	19,163	15,715	16,511
19	Research & development (enter as -)	(1,168)	(1,330)	(1,422)	(1,603)	(1,180)	(1,813)	(1,437)	(1,179)	(1,238)
20	Selling, general & administrative (enter as -)	(2,673)	(3,053)	(2,932)	(2,850)	(4,326)	(6,649)	(5,270)	(4,322)	(4,541)
21	Operating profit (EBIT)	10,030	17,463	13,593	10,282	10,226	15,717	12,456	10,215	10,732
22	Interest income	113	246	225	202	205	221	234	236	242

Formulas starting in the forecast period are the same across each row

Use roll-forward ("BASE" or "cork-screw") calculations

Roll-forwards refers to a forecasting approach that connects the current period forecast to the prior period.

	A	B	C	D	E	F	G
19			$ in millions	2018	2019	2020	
20			Property, plant & equipment, beginning	800.0	960.0	1,180.0	
21			Capital expenditures	420.0	450.0	478.0	
22			Depreciation	(210.0)	(230.0)	(250.0)	
23			Sales	(50.0)	0.0	0.0	
24			Property, plant & equipment, ending	960.0	1,180.0	1,408.0	
25							

This approach is very useful in adding transparency to how schedules are constructed. Maintaining strict adherence to the roll-forward approach improves a user's ability to audit the model and reduces the likelihood of linking errors.

Write good (and simple) formulas

There is a temptation when working in Excel to create complicated formulas. While it may feel good to craft a super complex formula, the obvious disadvantage is that no one (including the author after being away from the model for a bit) will understand it. Because transparency should drive structure, complicated formulas should be avoided at all cost. A complicated formula can often be broken down into multiple cells and simplified. Remember, Microsoft doesn't charge you extra for using more cells! So take advantage of that. Below are some common traps to avoid:

1. Simplify IF statements and avoid nested IFs

2. Consider using flags

Simplify IF statements

IF statements, while intuitive and well understood by most Excel users, can become long and difficult to audit. There are several excellent alternatives to IF that top-notch modelers frequently use. They include using Boolean logic along with a variety of reference functions, including MAX, MIN, AND, OR, VLOOKUP, HLOOKUP, OFFSET.

Below is a real-world example of how an IF statement can be simplified. Cell F298 uses any surplus cash generated during the year to pay down the revolver, up until the revolver is fully paid down. However, if deficits are generated during the year, we want the revolver to grow. While an IF statement accomplishes this, a MIN function does it more elegantly:

Revolver formula using IF statement

	B	C	D	E	F	G	H	I	J
291									
292	**MODEL PLUG: REVOLVER & CASH**								
293	*Fiscal year*		2012A	2013A	2014P	2015P	2016P	2017P	2018P
294	Fiscal year end date		9/29/12	9/28/13	9/30/14	9/30/15	9/30/16	9/30/17	9/30/18
295									
296	**Revolver**								
297	Beginning of period				215,945	70,384	63,484	58,190	48,833
298	Increases / (decreases)				=IF(F306>F297,-F297,-F306)		(5,294)	(9,356)	(4,833)
299	End of period		198,467	215,945	70,384	63,484	58,190	48,833	44,000
300									
301	Revolver needs analysis								
302	Beginning of period				146,761	5,000	5,000	5,000	5,000
303	Less: Minimum cash desired				5,000	5,000	5,000	5,000	5,000
304	Equals: Excess cash at BOP				141,761	0	0	0	(0)
305	Plus: Free cash flows generated during period				3,800	6,901	5,294	9,356	4,833
306	Equals: Cash available (needed) to paydown (draw from) revolver				145,561	6,901	5,294	9,356	4,833

Revolver formula using MIN

	B	C	D	E	F	G	H	I	J
291									
292	**MODEL PLUG: REVOLVER & CASH**								
293	*Fiscal year*		2012A	2013A	2014P	2015P	2016P	2017P	2018P
294	Fiscal year end date		9/29/12	9/28/13	9/30/14	9/30/15	9/30/16	9/30/17	9/30/18
295									
296	**Revolver**								
297	Beginning of period				215,945	70,384	63,484	58,190	48,833
298	Increases / (decreases)				=-MIN(F306,F297)		(5,294)	(9,356)	(4,833)
299	End of period		198,467	215,945	70,384	63,484	58,190	48,833	44,000
300									
301	Revolver needs analysis								
302	Beginning of period				146,761	5,000	5,000	5,000	5,000
303	Less: Minimum cash desired				5,000	5,000	5,000	5,000	5,000
304	Equals: Excess cash at BOP				141,761	0	0	0	0
305	Plus: Free cash flows generated during period				3,800	6,901	5,294	9,356	4,833
306	Equals: Cash available (needed) to paydown (draw from) revolver				145,561	6,901	5,294	9,356	4,833

The revolver formula using MIN as an alternative to IF also holds up better when additional complexity is required. Imagine that there's a limit on annual revolver draw of $50,000. Look at how we have to modify both formulas to accommodate this:

Revolver formula using IF statement

	A	B	C	D	E	F	G	H	I	J
291										
292		MODEL PLUG: REVOLVER & CASH								
293		*Fiscal year*			2012A	2013A	2014P	2015P	2016P	2017P	2018P
294		Fiscal year end date			9/29/12	9/28/13	9/30/14	9/30/15	9/30/16	9/30/17	9/30/18
295										
296		**Revolver**								
297		Beginning of period					215,945	70,384	63,484	58,190	48,833
298		Increases / (decreases)					=IF(F306>F297,-F297,IF(F306<-50000,50000,-F306))				(4,833)
299		End of period			198,467	215,945	70,384	63,484	58,190	48,833	44,000
300										
301		Revolver needs analysis								
302		Beginning of period					146,761	5,000	5,000	5,000	5,000
303		Less: Minimum cash desired					5,000	5,000	5,000	5,000	5,000
304		Equals: Excess cash at BOP					141,761	0	(0)	0	(0)
305		Plus: Free cash flows generated during period					3,800	6,901	5,294	9,356	4,833
306		Equals: Cash available (needed) to paydown (draw from) revolver					145,561	6,901	5,294	9,356	4,833

Revolver formula using MIN

	A	B	C	D	E	F	G	H	I	J
291										
292		MODEL PLUG: REVOLVER & CASH								
293		*Fiscal year*			2012A	2013A	2014P	2015P	2016P	2017P	2018P
294		Fiscal year end date			9/29/12	9/28/13	9/30/14	9/30/15	9/30/16	9/30/17	9/30/18
295										
296		**Revolver**								
297		Beginning of period					215,945	265,945	64,526	59,244	49,899
298		Increases / (decreases)					=-MIN(MAX(F306,-50000),F297)			(9,344)	(4,821)
299		End of period			198,467	215,945	265,945	64,526	59,244	49,899	45,078
300										
301		Revolver needs analysis								
302		Beginning of period					146,761	200,063	5,000	5,000	5,000
303		Less: Minimum cash desired					5,000	5,000	5,000	5,000	5,000
304		Equals: Excess cash at BOP					141,761	195,063	0	(0)	(0)
305		Plus: Free cash flows generated during period					3,302	6,356	5,282	9,344	4,821
306		Equals: Cash available (needed) to paydown (draw from) revolver					(145,063)	201,419	5,282	9,344	4,821

While both formulas are challenging to audit, the formula using IF statements is more difficult to audit and is more vulnerable to getting completely out of hand with additional modifications. It uses nested (or embedded) IF statements, which our feeble human brains have a hard time with once there's more than one or two.

Fortunately, Excel has made this a bit easier in 2016 with the introduction of the IFS function, but our preference for relying on more elegant functions remains. We spend a lot of time in our Excel Crash Course going over the many ways "IF alternative" functions can be used to power-charge Excel.

Reduce date-related formula complexity using flags

Flags refer to a modeling technique most useful for modeling transitions across phases of a company, project or transaction over time without violating the "one row/one calculation" consistency rule. Imagine you're building a model for a company that's contemplating bankruptcy. Each phase of the restructuring process has its own distinct borrowing and operating characteristics.

In our example below, the company's revolver "freezes" once it goes into bankruptcy and a new type of borrowing ("DIP") acts as the new revolver until the company emerges from bankruptcy. Additionally, a new "Exit" facility replaces the DIP. We insert 3 "flags" in rows 8-10 to output "TRUE/FALSE" based on the phase we're in. This enables us to build very simple, consistent formulas for each revolver without having to embed IF statements into each calculation.

In cell F16 the formula is =F13*F8. Whenever you apply an operator (like multiplication) on a TRUE, the TRUE is treated like a "1" while a FALSE is treated like a "0." This means that the pre-bankruptcy revolver is the de facto revolver when the pre-bankruptcy flag evaluates to TRUE and becomes 0 once the flag evaluates to FALSE (starting in column I in our example below).

The main benefit is that with the use of just an extra 3 rows, we've avoided having to insert any sort of conditional tests within the calculations. The same applies to the formulas in rows 20 and 204 — the flags have prevented a lot of extra code.

		C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
3	Bankruptcy date	31-Dec-17																
4	Post bankruptcy date	30-Sep-19																
6				31-Dec-16	31-Mar-17	30-Jun-17	30-Sep-17	31-Dec-17	31-Mar-18	30-Jun-18	30-Sep-18	31-Dec-18	31-Mar-19	30-Jun-19	30-Sep-19	31-Dec-19	31-Mar-20	30-Jun-20
7	Flags ("Counters")																	
8	Pre bankruptcy			TRUE	TRUE	TRUE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
9	Bankruptcy			=AND(E6>=$C$3,E6<=$C$4)	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE	FALSE	FALSE
10	Post bankruptcy			FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	TRUE	TRUE
12	Calculations																	
13	Cash surplus / (deficit)			(983)	5,534	4,210	(6,668)	8,766	(165)	(4,099)	(2,460)	(757)	894	(1,127)	1,249	2,554	3,106	3,406
15	Prebankrputcy revolver - BOP			5,421	4,438	9,972	14,182	7,514	7,514	7,514	7,514	7,514	7,514	7,514	7,514	7,514	7,514	7,514
16	Net additions/(Subtractions)			(983)	5,534	4,210	(6,668)	0	0	0	0	0	0	0	0	0	0	0
17	Prebankrputcy revolver - EOP	5,421		4,438	9,972	14,182	7,514	7,514	7,514	7,514	7,514	7,514	7,514	7,514	7,514	7,514	7,514	7,514
19	DIP Revolver - BOP			0	0	0	0	0	8,766	8,601	4,502	2,042	1,285	2,179	1,052	2,301	2,301	2,301
20	Net additions/(Subtractions)			0	0	0	0	8,766	(165)	(4,099)	(2,460)	(757)	894	(1,127)	1,249	0	0	0
21	DIP Revolver - EOP	0		0	0	0	0	8,766	8,601	4,502	2,042	1,285	2,179	1,052	2,301	2,301	2,301	2,301
23	Exit Revolver - BOP			0	0	0	0	0	0	0	0	0	0	0	0	0	2,554	5,660
24	Net additions/(Subtractions)			0	0	0	0	0	0	0	0	0	0	0	0	2,554	3,106	3,406
25	Exit Revolver - EOP	0		0	0	0	0	0	0	0	0	0	0	0	0	2,554	5,660	9,066

Names and named ranges

Another way many modelers reduce formula complexity is by using names and named ranges. **We strongly caution against using names and named ranges**. As you're probably beginning to sense, there is always some kind of tradeoff with Excel. In the case of names, the tradeoff is that when you name a cell, you no longer know exactly where it is without going to the name manager. In addition, unless you are proactively deleting names (you aren't), Excel will retain these names even when you delete the named cell. The result is that a file you're using today to build a DCF contains dozens of phantom names from prior versions of the model, leading to warning messages and confusion.

Don't calculate on the balance sheet — link from supporting schedules.
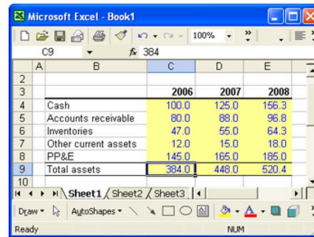
In investment banking, your financial models will frequently involve financial statements. Ideally, your calculations are done in schedules separate from the output you're working towards. For example, it's preferable that you don't perform any calculations on the model's balance sheet. Instead, balance sheet forecasts should be determined in separate schedules and linked into the balance sheet as illustrated below. This consistency helps in the transparency and auditing of a model.

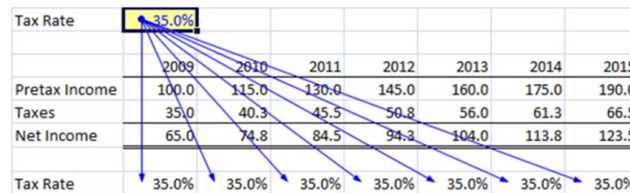|	A / B	C	D	E	F	G	H	I	J
51	BALANCE SHEET								
52	Fiscal year	2015A	2015A	2015A	2015A	2016A	2016A	2016A	2016A
53	Quarter end date	3/31/15	6/30/15	9/30/15	12/31/15	3/31/16	6/30/16	9/30/16	12/31/16
54	Cash & equivalents ST & LT market. securities	146,761	158,842	150,589	164,490	169,608	189,699	191,148	193,342
55	Accounts receivable	13,102	14,200	9,700	10,788	11,323	11,884	12,473	13,091
56	Inventory	1,764	2,122	1,829	1,594	1,657	2,547	2,019	1,655
57	Deferred tax assets	3,453	3,742	4,014	3,884	3,884	3,884	3,884	3,884
58	Other current assets	14,421	19,572	13,648	13,878	13,878	13,878	13,878	13,878
59	Property, plant & equipment	16,597	15,488	15,120	17,585	18,039	=H145	19,289	19,743
60	Acquired intangible assets	4,179	4,105	3,928	3,767	3,767	3,767	3,767	3,767
61	Goodwill	1,577	2,022	2,055	2,374	2,374	2,374	2,374	2,374
62	Other assets	5,146	5,091	5,106	4,160	4,160	4,160	4,160	4,160
63	Total assets	207,000	225,184	205,989	222,520	228,690	250,929	252,992	255,894
137									
138	PROPERTY, PLANT & EQUIPMENT								
139	Fiscal year		2015A	2015A	2015A	2016P	2016P	2016P	2016P
140	Quarter end date		6/30/15	9/30/15	12/31/15	3/31/16	6/30/16	9/30/16	12/31/16
141									
142	Beginning of period					17,585	18,039	18,737	19,289
143	Plus: Capital expenditures					2,499	3,840	3,044	2,496
144	Less: Depreciation					(2,045)	(3,143)	(2,491)	(2,042)
145	End of period		16,597	15,488	15,120	17,585	18,039	18,737	19,289	19,743

How to reference cells

Never re-enter the same input in different places

For example, if you've inputted a company name in the first worksheet of the model, reference that worksheet name — don't re-type it into the other worksheets. The same goes for years and dates entered into a column header or a discount rate assumption used in a variety of different places in the model. A more subtle example of this is hard coding subtotals or EPS when you can calculate it. In other words, calculate whenever possible.

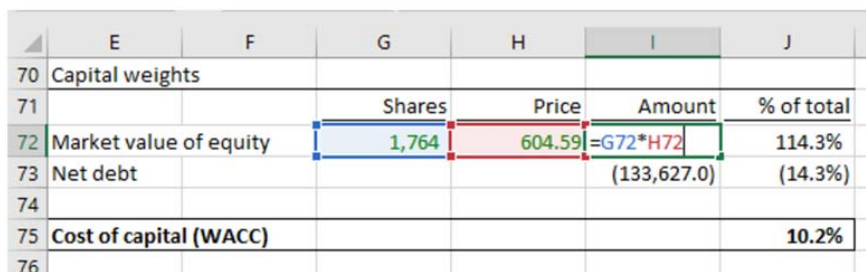## Always link directly to a source cell as it is more difficult to audit "daisy chained" data
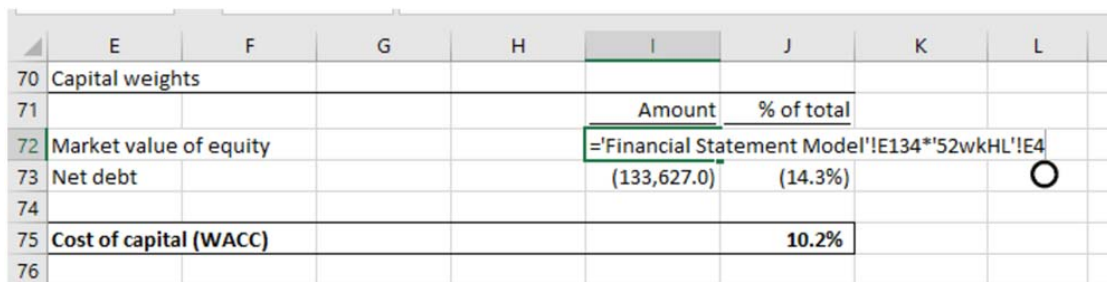
The one major exception to this is when **"straight-lining" base period assumptions**. For this, go ahead and daisy chain. The reason is that straight-lining base period assumptions is an implicit assumption, which can change, thus making it possible for certain years in the forecast to ultimately end of with different assumptions than other years.

Avoid formulas that contain references to multiple worksheets

Compare the two images below. It is more difficult to audit the formula in the first image because you'll need to bounce around to different worksheets to view the precedent cells. Whenever possible, bring the data from other worksheets into the active worksheet where the calculation is made.

Link assumptions into standalone cells in the calculation and output sheets

If you're working with larger models and you have assumptions that need to be referenced from a separate worksheet, consider linking assumptions directly into the worksheet where you're using them, and color code them as a distinct worksheet reference link. In other words, don't have an input reference embedded into a calculation (i.e. =D13*input!C7). Instead, use a clean reference =input!C7 and a separate cell for the calculation. While this creates a redundant cell reference, it preserves the visual audit-ability of the model tab and reduces the likelihood of error.

Avoid linking files

Excel allows you to link to other Excel files, but others might not have access to the linked-to files, or these files may get inadvertently moved. Therefore, avoid linking to other files whenever possible. If linking to other files is a must, be vigilant about color coding all cell references to other files.

Worksheets

One long sheet beats many short sheets

A long worksheet means a lot of scrolling and less visual compartmentalizing of sections. On the other hand, multiple worksheets significantly increases the likelihood of linking errors. There's no hard and fast rule about this, but the general bias should be toward a longer sheet over multiple, shorter worksheets. The dangers of mis-linking across worksheets is quite real and hard to mitigate, while the issues of cumbersome scrolling and lack of compartmentalization associated with long worksheets can be drastically mitigated with Excel's split screen functionality, clear headers and links from a cover sheet or table of contents.

Don't 'hide' rows — 'group' them (and do it sparingly)

A model often has rows with data and calculations that you do not want to show when the model is printed or when you paste the data into a presentation. In this situation, it's often tempting to hide rows and columns for a "cleaner" presentation of results. The danger is that when the model is passed around, it is very easy to miss (and potentially paste over) the hidden data.
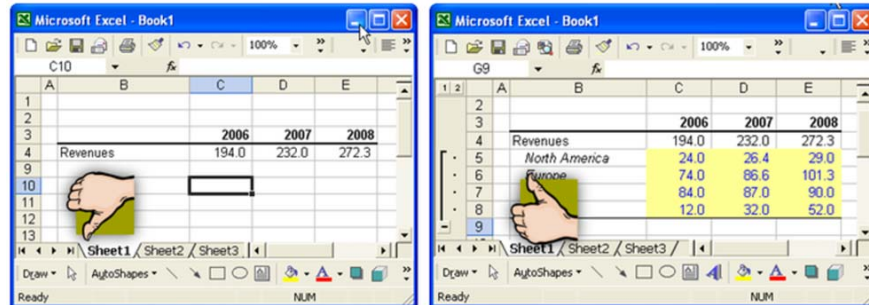
Keeping inputs (assumptions) together (for high-granularity models)

Nearly every financial modeling expert recommends a standard that isolates all of the model's hard-coded assumptions (things like revenue growth, WACC, operating margin, interest rates, etc…) in one clearly defined section of a model — typically on a dedicated tab called 'inputs.' These should never be commingled with the model's calculations (i.e. balance sheet schedules, the financial statements) or outputs (i.e. credit and financial ratios, charts and summary tables). In other words, think of a model as comprised of three clearly identified and physically separated components:

- **Assumptions → Calculations → Output**

    Advantages:

- **Consistent, reliable architecture:** Once a model is built, the user has *only one place they need to go* to change any assumptions. This creates a consistent distinction between areas in the model that *the user* works in vs. areas *the computer* works in.

- **Error mitigation:** Storing all assumptions in one place makes it far less likely that you'll forget to remove old assumptions from a prior analysis and inadvertently bring them into a new analysis.

Yet despite these advantages, this practice has never been widely adopted in investment banking.

One reason is simply **poor practice.** Some models would clearly benefit from an input/calculation/output separation, but are often built with no forethought given to structure. Imagine building a house without any pre-planning. Sure, you'll avoid the pain of all that planning, but you'll encounter unforeseen problems and end up redoing work or adding complexity by working around what's already been done. This problem is rampant in investment banking models.

Another reason is that many investment banking models **are simply not granular enough** to merit the additional audit trail and legwork. The analyses bankers perform are often broader than they are deep. For example, a pitch book might present a valuation using 4 different valuation models, but

none of them will be overly granular. Common investment banking analyses like accretion dilution models, LBO models, operating models and DCF models usually don't delve into detail beyond the limits of public filings and basic forecasting. In this case, moving back and forth from input to calculation to output tabs is unnecessarily cumbersome. As long as you're diligent about color coding, placing assumptions on the same sheet and right below calculations is preferable in smaller models because your assumptions are visually right next to the output, making it easy to see what's driving what.

The other consideration is the number of a model's users. The advantages of the "inputs together" approach grow with the number of a model's intended users. When you have many users, your model will inevitably be used by people with a wide range of modeling proficiency. In this case, a consistent and reliable structure that prevents users from getting into the guts of the model will reduce error. In addition, it will also reduce the amount of time a user has to spend in the model — a user can simply locate the area for inputs, fill them in, and the model (in theory) will work. That said, despite attempts by IB teams to standardize models, many investment banking models are essentially "one-offs" that get materially modified for each new use. Aside from comps models which lend themselves to becoming templates, most models are used primarily by their original authors (usually an analyst and associate) who understand the model well.

The bottom line on keeping inputs all together

Unfortunately, there's no established benchmark for when it makes sense to separate out assumptions. The ideal approach depends on the scope and goal of the model. For a simple 1-page discounted cash flow analysis not intended for frequent reuse, it is preferable to embed inputs throughout the page. However, for a large fully-integrated LBO model with many debt tranches to be used a group-wide template, the benefits of keeping all inputs together will outweigh the costs.

No spacer columns between data

	INCOME STATEMENT							QUARTERLY RESULTS						
	Fiscal year	2015A	2015A	2015A	2015A	2016P	2016P	2016P	2016P	2017P	2017P	2017P
	Quarter	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3
	Quarter end date	3/31/15	6/30/15	9/30/15	12/31/15	3/31/16	6/30/16	9/30/16	12/31/16	3/31/17	6/30/17	9/30/17
	Revenue	37,472	57,594	45,646	37,432	39,329	60,448	47,908	39,287	41,278	63,444	50,283
	Cost of sales (enter as -)	(23,601)	(35,748)	(27,699)	(22,697)	(23,598)	(36,269)	(28,745)	(23,572)	(24,767)	(38,067)	(30,170)
	Gross Profit	13,871	21,846	17,947	14,735	15,732	24,179	19,163	15,715	16,511	25,378	20,113
	Research & development (enter as -)	(1,168)	(1,330)	(1,422)	(1,603)	(1,180)	(1,813)	(1,437)	(1,179)	(1,238)	(1,903)	(1,508)
	Selling, general & administrative (enter as -)	(2,673)	(3,053)	(2,932)	(2,850)	(4,326)	(6,649)	(5,270)	(4,322)	(4,541)	(6,979)	(5,531)
	Operating profit (EBIT)	10,030	17,463	13,593	10,282	10,226	15,717	12,456	10,215	10,732	16,496	13,074
	Interest income	113	246	225	202	205	221	234	236	242	260	274
	Interest expense (enter as -)	0	0	0	0	(75)	(75)	(75)	(75)	(75)	(75)	(75)
	Equity income from affiliates (enter as +)	0	0	0	0	0	0	0	0	0	0	0
	Other expense (enter as -)	0	0	0	0	0	0	0	0	0	0	0

Elevator jumps

In long worksheets, dedicating the leftmost column for placing an "x" or another character at the start of schedules will make it easy to quickly navigate from section to section.

	A	B	C
43		EBITDA reconciliation	
44		Depreciation & amortization	1,814
45		Stock based compensation	1,168
46		EBITDA	36,772
47			
48	x	SEGMENTS	
49		Fiscal year	2011A
50		Fiscal year end date	9/24/11
51		Product	
52		iPhone	45,998
53		iPad	19,168
54		Mac	21,783
55		iPod	7,453
56		iTunes / Software / Services	9,373
57		Accessories	4,474
58		Total	108,249
59		% growth	

Annual vs quarterly data (periodicity)

Most investment banking models are either quarterly or annual. For example, a U.S. equity research earnings model will always be a quarterly model because one of its key purposes is to forecast upcoming earnings, which are reported by firms quarterly. Similarly, a restructuring model is usually a quarterly model (or even a monthly or weekly model) because a key purpose of this model is to understand the cash flow impact of operational and financing changes over the next 1-2 years. On the other hand, a DCF valuation is a long term analysis, with at least 4-5 years of explicit forecasts required. In this case, an annual model is appropriate.

There are also models for which both quarterly and annual periods are useful. For example, a merger model usually needs a quarterly period because a key goal is to understand the impact of the acquisition on the acquirer's financial statements over the next 2 years. However, attaching a DCF valuation to the combined merged companies may also be desired. In this case, a possible solution is to roll up the quarters into an annual model and extend those annual forecasts further out.

When determining a model's periodicity, keep in mind the following:

1. The model **must be set up with the smallest unit of time desired**, with longer time periods being aggregated (rolled up) from those shorter time periods. If you're building an integrated financial statement model in which you want to see quarterly and annual data, forecast the quarterly data first.

2. Keep the quarterly and annual data in separate worksheets. It is easier to audit what's going on when periods aren't commingled. Additionally, commingling quarterly and annual data in one worksheet will either A) force you to violate the one row/one formula consistency best practice or B) you will have to jump through some crazy hoops to maintain the consistency.

Circularity

Circularity refers to a cell referring to itself (directly or indirectly). Usually, this is an unintentional mistake. In the simple example below, the user has accidentally included the sum total (D5) in the sum formula. Notice how Excel becomes confused:

	A	B	C	D	E	
1						
2			Segment 1	50		
3			Segment 2	20		
4			Segment 3	12		
5			Sum	16400	=SUM(D2:D5)	

But sometimes a circularity is intentional. For example, if a model calculates a company's interest expense based on a cell that calculates the company's revolving debt balance, but that revolving debt balance is itself determined by (among other things) the company's expenses (including interest expense), then we have a circularity:

	A	B	C	D	E	F
7			Cash Revenue	100.0		
8			Interest Expense	5.1	=D15*D13	
9			Cash Profit	94.9	=D7-D8	
10						
11			Beginning Debt	150.0		
12			Ending Debt	55.1	=D11-D9	
13			Average Debt	102.6	=AVERAGE(D11:D12)	
14						
15			% interest	5%		
16						

The logic of such a calculation is sound: A company's borrowing needs should take into account the interest expense. As such, many investment banking models contain intentional circularities like these.

Since unintentional circularity is a mistake to avoid, the usage of intentional circularity in financial models is controversial. The problem with intentional circularity is that a special setting must be selected within 'Excel Options' to prevent Excel from misbehaving when a circularity exists:
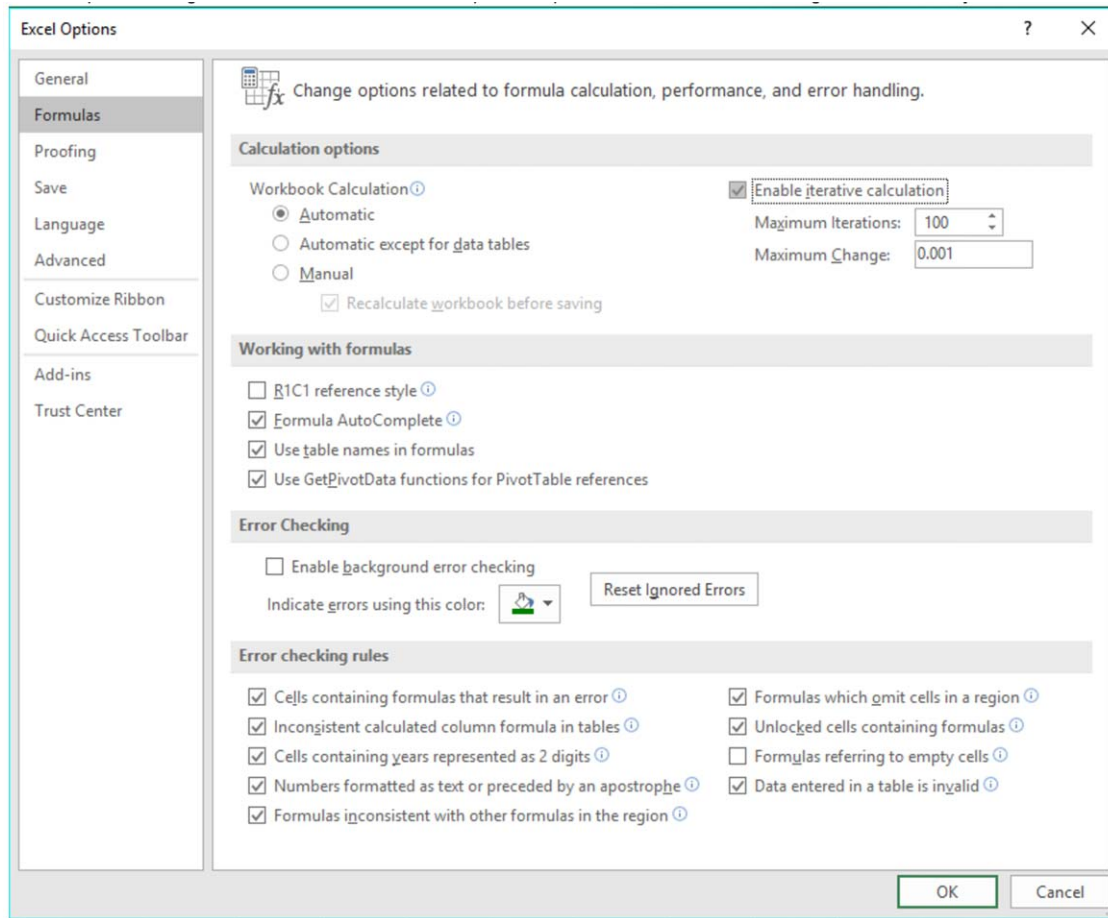
Even with these settings selected, Excel can become unstable when handling circularity and often leads to a model "blowing up" (i.e. the model short-circuits and populates the spreadsheet with errors), requiring manual intervention to zero out the cells containing the source of circularity:

While the underlying logic for wanting to incorporate a circularity into a model may be valid, circularity problems can lead to minutes, if not hours, of wasted auditing time trying to locate the source(s) of circularity to zero them out. There are several things modelers can do to better cope with circularity, most notably the creation of a simple circuit breaker, which creates a central place in the model that "resets" any cell containing a circularity or wrapping an error-trap formula (IFERROR) around the formula that is the source of the circularity.

Circuit breaker or an IFERROR error-trap

When building an intentional circularity, you MUST build a circuit breaker and clearly identify all the circularities in your model. In our simple example, we placed a circuit breaker in D17 and altered the formula in D8 so the circularity is zeroed out when the user switches the breaker to "ON":

Approach 1: Adding a circuit breaker toggle

	A	B	C	D	E	F	G	H
7			Cash revenue	100.0				
8			Interest expense	5.1	=IF(D17=1,D15*D13,0)			
9			Cash profit	94.9	=D7-D8			
10								
11			Beginning debt	150.0				
12			Ending debt	55.1	=D11-D9			
13			Average debt	102.6	=AVERAGE(D11:D12)			
14								
15			% interest	5%				
16								
17			Circuit breaker (1=OFF, 0=ON)	1				
18								

An alternative approach is to simply wrap an IFERROR function around the source of the circuilarity. When the model short circuits, the IFERROR function evaluates to the FALSE condition and populates the model with 0s automatically. The primary downside to this approach is that they make finding unintentional circularities harder. That's because you can never explicitly turn the breaker on or off – the IFERROR does it automatically. That said, as long as all circs are handled with an IFERROR function, the model will never blow up.

Approach 2: Adding an error trap using the IFERROR function

	A	B	C	D	E	F	G
7			Cash revenue	100.0			
8			Interest expense	5.1	=IFERROR(D15*D13,0)		
9			Cash profit	94.9	=D7-D8		
10							
11			Beginning debt	150.0			
12			Ending debt	55.1	=D11-D9		
13			Average debt	102.6	=AVERAGE(D11:D12)		
14							
15			% interest	5%			
16							
17							

Bottom line: To circ or not to circ?

Despite the circuit breaker and error trap solutions, many believe it is preferable to simply outlaw all circularity from financial models. For example, the way to altogether avoid the intentional circularity in the example above is to calculate interest expense using beginning debt balance. For quarterly and monthly models with minor debt fluctuations, this is desirable, but for an annual model with a large forecasted change in debt, the "fix" can lead to a materially different result. Therefore, we do not believe in a blanket "ban." Instead, we provide the following simple guideline:

A circularity is only OK if all the following conditions are met.

1. **It is intentional:** At risk of stating the obvious, you must understand exactly why, where, and how the circularity exists. The example described above is the most common source of circularity in financial models.

2. **You have "enable iterative calculation" selected in your Excel settings:** This tells Excel the circularity is intentional and ensures Excel doesn't throw up an error and populate the entire model with random zeros everywhere.

3. **You have a circuit breaker or error trap formula:** A circuit breaker or error trap formula ensures that if the file gets unstable and #DIV/0!s start populating the model, there is an easy and clear way to fix it.

4. **The model will not be shared with Excel novices:** Circularities, even with a circuit breaker, can create confusion for Excel users not familiar with it. If the model you are building will be shared with clients (or a managing director) that like to get into the model but are generally unfamiliar with Excel, avoid the circularity and save yourself the headache.

Don't use macros

Keep macros to an absolute minimum. Very few people know how macros work, and some users cannot open files that use macros. Every additional macro is a step closer to making your model a "black box." In investment banking, this is never a good thing. The only macros regularly tolerated in banking models are print macros.

Error checking

Excel is an amazing tool. Unlike software specifically designed to perform a particular set of tasks (i.e. real estate investment software, bookkeeping software), Excel is a blank canvas, which makes it easy to perform extremely complicated analyses and quickly develop invaluable tools to help in financial decision making. The downside here is that Excel analyses are only as good as the model builder (i.e. "Garbage in = garbage"). Model error is absolutely rampant and has serious consequences. Let's break up the most common modeling errors:

1. **Bad assumptions:** If your assumptions are faulty, the model's output will be incorrect regardless of how well it is structured.

2. **Bad structure:** Even if your model's assumptions are great, mistakes in calculations and structure will lead to incorrect conclusions.

The key to mitigating #1 is to present results with clearly defined ranges of assumptions (scenarios and sensitivities) and make the assumptions clearly defined and transparent. Breaking models out into **inputs→calculation→output** helps others quickly identify and challenge your assumptions (Addressed in detail in the "Presentation" section above). The far more pernicious modeling error is #2 because it's much more difficult to find. As you might imagine, the problem grows exponentially as the model's granularity increases. This is why building error checks into your model is a critical part of model building.

Build in error checks

The most common error check in a financial model is the balance check — a formula testing that **assets = liabilities + equity**:

A	B	C	D	E	F	G	H
83							
84 x	**BALANCE SHEET**						
85	*Fiscal year*		2012A	2013A	2014A	2015A	2016A
86	Fiscal year end date		9/29/12	9/28/13	9/30/14	9/30/15	9/30/16
87	Cash & equivalents ST & LT market. securities		121,251	146,761	152,456	161,000	167,912
88	Accounts receivable		10,930	13,102	13,454	14,318	14,959
89	Inventory		791	1,764	1,805	1,887	1,971
90	Deferred tax assets		2,583	3,453	3,453	3,453	3,453
91	Other current assets (inc. non-trade receivables)		14,220	14,421	14,421	14,421	14,421
92	Property, plant & equipment		15,452	16,597	19,467	23,655	28,031
93	Acquired intangible assets (inc. Goodwill)		5,359	5,756	4,706	3,721	2,888
94	Other assets		5,478	5,146	5,146	5,146	5,146
95	**Total assets**		176,064	207,000	214,908	227,600	238,781
96							
97	Accounts payable		21,175	22,367	22,905	24,412	25,506
98	Accrued expenses & def rev. (current & non-current)		20,015	23,916	23,858	23,925	23,816
99	Revolver		0	0	0	0	0
100	Long term debt		0	16,960	16,960	16,960	14,460
101	Other non-current liabilities		16,664	20,208	23,208	26,208	29,208
102	**Total liabilities**		57,854	83,451	86,930	91,505	92,990
103							
104	Common stock / additional paid in capital		16,422	19,764	21,978	24,191	26,616
105	Treasury stock		0	0	(23,968)	(47,936)	(71,904)
106	Retained earnings / accumulated deficit		101,289	104,256	130,439	160,311	191,549
107	Other comprehensive income / (loss)		499	(471)	(471)	(471)	(471)
108	**Total equity**		118,210	123,549	127,978	136,095	145,791
109							
110	*Balance check*		0	0	0	=ROUND(G95-G102-G108,3)	

Anyone who has built an integrated financial statement model knows it is quite easy to make a simple mistake that prevents the model from balancing. The balance check clearly identifies to the user that a mistake has been made and further investigation is required. However, there are many other areas of models that are prone to error and thus could merit error checks. While every model will need its own checks, some of the more common ones include:

- Ensuring sources of funds = uses of funds

- Ensuring the quarterly results add up to annual results

- Total forecast depreciation expense does not exceed PP&E

- Debt pay-down does not exceed outstanding principal

Favor direct calculations over "plugs"

Below we show two common ways that users set up a sources & uses of funds table in financial models. In both approaches, the user accidentally references intangible assets. In approach 1, the incorrect data is linked into D37. The model notices that sources do not equal uses and throws an error message in D41. The second (and equally common) approach structurally sets D52 equal to D47 and uses D49 as a plug to ensure sources and uses always equal. Which approach do you think is preferable? If you guessed the first approach, you are correct. The problem the second ("plug") approach is that because of the mis-linking in D50, the model incorrectly calculates the amount of secured loans required for the transaction, **and no error is identified**.

	C	D	E	F	G
25					
26	Intangible Assets	13,000			
27	Excess Cash	7,500			
28					
29	**Approach 1: Directly modeling sources & uses**				
30					
31	Stock to Target	50,000			
32	Cash to Target	20,000			
33	Fees	2,500			
34	**Total Uses**	72,500	=SUM(D31:D33)		
35					
36	Secured Loan	15,000			
37	Excess Cash	13,000	=$D$26		
38	Stock Issuance	50,000			
39	**Total Sources**	78,000	=SUM(D36:D38)		
40					
41	Do sources equal uses?	No	=IF(D34-D39=0,"Yes","No")		
42					
43	**Approach 2: Using a plug**				
44	Stock to Target	50,000			
45	Cash to Target	20,000			
46	Fees	2,500			
47	**Total Uses**	72,500	=SUM(D44:D46)		
48					
49	Secured Loan	9,500	=D47-SUM(D50:D51)		
50	Excess Cash	13,000	=$D$26		
51	Stock Issuance	50,000			
52	**Total Sources**	72,500	=D47		
53					
54	Do sources equal uses?	Yes	=IF(D47-D52=0,"Yes","No")		

Whenever a direct calculation is possible, use it, along with an error check (i.e. "do sources equal uses?") instead of building plugs.

Aggregate error checks into one area

Place error checks close to where the relevant calculation is taking place, but aggregate all error checks into a central easy to see "error dashboard" that clearly show any errors in the model.

Error trapping

Models that require a lot of flexibility (templates) often contain areas that a user may not need now, but will need down the road. This includes extra line items, extra functionality, etc. This creates room for error because Excel is dealing with blank values. Formulas like IFERROR (and ISERROR), ISNUMBER, ISTEXT, ISBLANK are all useful functions for trapping errors, especially in templates.

Present-ability

Cover Page and TOC

When a model is designed for use by more than just the model builder, include a cover page. Cover page should include:

1. Company and/or project name

2. Description of the model

3. Modeler and team contact information

Include a table of contents when the model is sufficiently large to merit it (a good rule of thumb is more than 5 worksheets).

Worksheet design

Label worksheets by the nature of the analysis (i.e. DCF, LBO, FinStatements, etc…). Tabs should flow logically from left to right. When following the inputs→calculations→output approach, color the worksheet tabs based on this division:

1. Include the company name on top left of every sheet

2. Include the sheet purpose, scenario selected (when relevant), scale and currency prominently below the company name on each sheet

3. Page setup for printing: When a sheet is too long to fit in one page, the top rows containing company name, purpose of the page, currency and scale should be displayed on top of each page (select "rows to repeat at top" (Page Layout>Page Setup>Sheet)

4. Include file path, page number and date in footer

Scenarios and sensitivities

The purpose of building a model is to provide actionable insight that wasn't otherwise readily visible. Financial models shed light on variety of critical business decisions:

- How does an acquisition change the financial statements of an acquirer (accretion/dilution)?

- What is a company's intrinsic value?

- How much should an investor contribute to a project given specified return requirements and risk tolerances?

Virtually all investment banking models rely on forecasting and assumptions to arrive at the outputs presented to clients. Because assumptions are by definition uncertain, presenting the financial model's output in ranges and based on a variety of different scenarios and sensitivities is critical. In this post about scenario analysis and this post about using data tables for sensitivity analysis, we address the two most effective ways to present financial outputs in financial models.

Conclusion and further reading

We wrote this guide to provide a framework applicable to investment banking models. For those that want to dive deeper into building specific investment banking models, consider enrolling in our flagship financial modeling program. For those that want to get into the weeds of modeling theory, I recommend the following texts:

- Building Financial Models by John Tjia

- Financial Modeling by Simon Benninga