

# Excel Financial Modeling & Data Analysis

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Excel is a staple of the business professional's toolbox, yet, all too often, features remain undiscovered and underutilized, leading to inefficiencies and errors. Many of these features have been in Excel for a number of years and some are new in Excel 2013. All of them will save you time. In this session, you will learn about key features in Excel and how to put these features to work. Features such as Data Tables, Forecast, Forecast Sheets, XNPV, XIRR and PivotTables. Among the new tools you will learn about are Quick Analysis, Data Models, Flash Fill, PowerPivot, and Power BI.

## Learning Objectives

Upon completing this session, you should be able to:

- Identify and implement three types of automated data analyses in Excel;
- Use Flash Fill to split, combine, and rearrange data quickly and easily without using commands or complicated formulas;
- Utilize Excel's Data Model and identify their impact on PivotTable analysis;
- Obtain insights into data using business intelligence features in Excel.

## Ten Best Practices for Creating Financial Models in Excel

Although the term "best practices" is, in the eyes of many, overused in today's vernacular, it still has meaning when considering how we should build our financial models in Excel. Thus, let us begin this session discussing why the following ten items are considered best practices for creating financial models in Excel.

### Clearly Articulate the Objective of the Model

Define and clearly indicate the nature of your model up-front. A good place for doing so is in the **Properties** section of the Excel workbook. By clearly defining and articulating the objective of the model, you are letting other users know what they should expect from the model, and, at the same time, you are helping to minimize the prospect of "scope creep" affecting your model and causing it to turn into an unwieldy and unmanageable workbook.

### Build the Model Using the Least Complicated Structure and Functions

*Simple is good* should be your mantra when creating Excel-based financial models. You should always strive to create your models using the simplest, most direct techniques. Doing so will allow you to create the models more quickly and help you to reduce the prospect of errors arising in your models. For example, seek to minimize the use of **IF** functions in your formulas and try to avoid nested IF functions altogether. In many cases, using **MAX** or **MIN** functions or the recently added **IFS** function will provide a simpler, more direct approach to creating formulas in your financial models.

### Sufficiently Plan Your Model to Ensure Simplicity and Accuracy

Following on the previous point, a bit of planning can go a long way toward ensuring simplicity and accuracy. Think in advance about what you are trying to accomplish and use this as the basis for creating your workbook. A good rule of thumb here is to start with the desired end result and work backwards

from there. This will help you to identify all the necessary assumptions and calculations up-front and expedite designing your workbook for simplicity and accuracy.

## Clearly Label and Document Assumptions and Perform Adequate Data Validation

To further simplify your workbooks and reduce the opportunity for errors, you should ensure that you clearly identify and document every assumption that is in each of your Excel models. Using Excel's **Comments** feature is a great way to add detailed notes about the source of an assumption. Further, using Excel's **Data Validation** feature facilitates you restricting end-user inputs to values within prescribed norms, thereby preventing someone from entering an interest rate of 0.03% when the correct rate should be 3.00%.

## Ensure the Protection of Calculations and Formulas

In many cases, other team members or perhaps clients will be the end-users of your Excel models. To ensure that these individuals do not change any of your formulas, you should enable Excel's protection tools. Among the ones that you should most likely consider using are those listed below.

- **Encrypt with Password** to ensure that unauthorized users cannot open a workbook or create links from cells in the workbook
- **Add a Digital Signature** to reduce the likelihood of unauthorized changes and provide an alert that potentially unauthorized changes have been recorded
- **Protect Workbook Structure** to ensure that individual worksheets within the workbook are not added, deleted, rearranged, hidden, or unhidden
- **Protect Worksheet** to control whether a single user or a group of users can make edits to a specific worksheet in the model, and, if they can, which cells can be edited and what actions can be taken on those cells

## Create a Beta of the Model to Test against “Known-Good” Results

As you are creating your models, consider building or testing them using historical data. This provides the luxury of comparing the results from the newly created model to “known-good” results and helps to ensure the accuracy of the model. In what would hopefully be very rare cases, it also potentially could be useful in identifying errors in previously generated reports.

## Maintain the Independence of the Workbook Whenever Possible

While you might exercise caution and due diligence when creating your financial models to ensure that they are free from error, can you say the same about others on your team? Because if they do not exercise the same level of care that you do, and you link data from one or more of their models into yours, you would have created an opportunity to corrupt your model with the erroneous data flowing from theirs. Always seek to create independent, self-contained models that do not depend upon linked data from other users' workbooks. If that is not possible, then you should thoroughly examine/audit their model to ensure that it is free from error.

## Understand Your Audience

Know which team members or clients will be using the Excel-based model that you are creating and tailor the design of the workbook and the terminology used therein to their knowledge level, skill sets, and needs. A group of accounts payable specialists will have a decidedly different skill set than a CFO. Ensure that the model that you are creating aligns with the skills and needs of those who will be working with it.

## Project the Life of the Model

Some financial models – perhaps one providing a simple present value calculation used in a capital budgeting project – will have a very short useful life. Others – for example, a business valuation model that is updated quarterly to estimate the value of the stock of a privately held concern – will have a useful life that may extend for decades. While both models are important to their users, in some cases, you may be able to treat the model with the shorter life a bit more “casually” than the model with an extended life. Likewise, if a model is used repeatedly – but with a different set of assumptions each time it is accessed – you should consider saving it as an Excel template file (with an **.XLTX** extension); doing so will make it easier to access, enter new assumptions, and save as an independent Excel file without risking overwriting the templated model.

## Take Advantage of Continuous Improvement in Excel Features

Particularly if you use Excel through an Office 365 subscription, you are in an environment of continuous improvement with new features being added as frequently as each month. Seek out and utilize these new features as they become available to help you build your models with greater speed and ease than might have been possible in the past. For example, the **FORECAST SHEETS** feature added to Excel 2016 (and discussed later in this session) provides a great illustration of a new feature that can save countless hours when building a forecast that needs to reflect seasonality in your data.

# Sensitivity, Trend, and Discounted Cash Flow Analyses

## The Need for Sensitivity, Trend, and Discounted Cash Flow Analyses in Financial Models

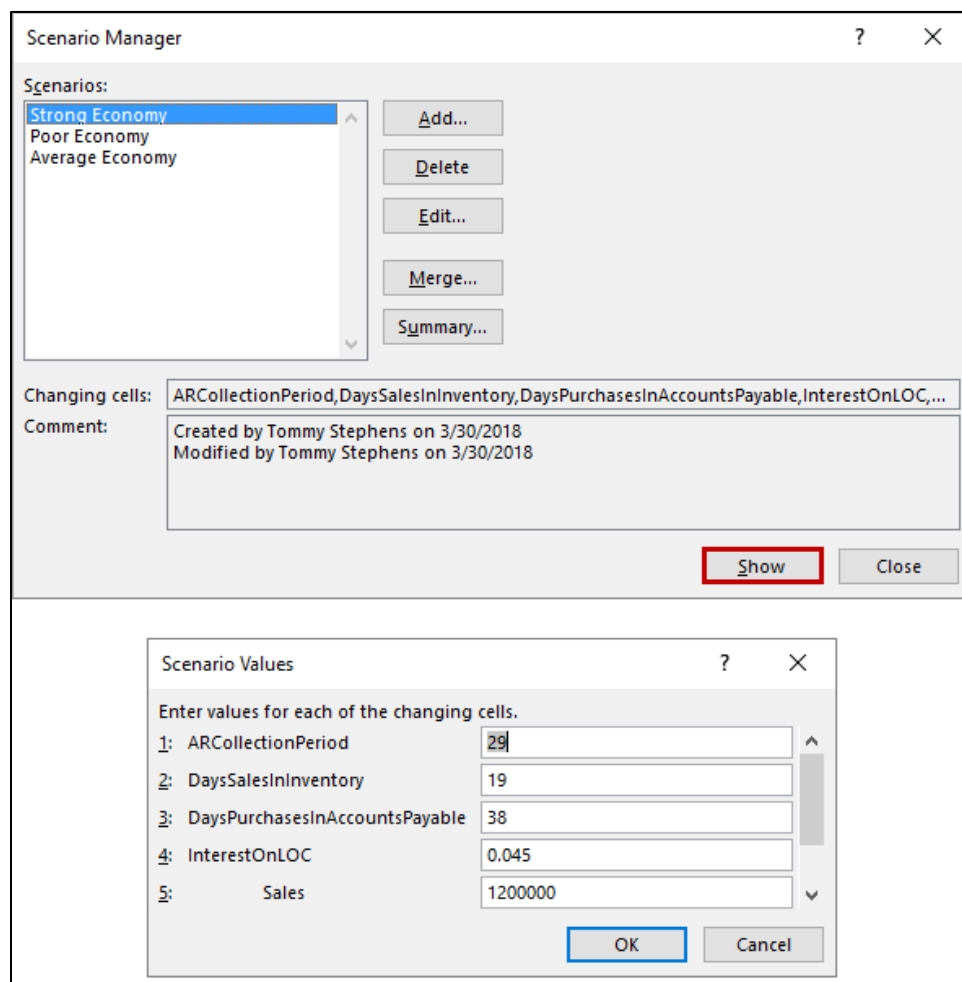
Among the most common needs in Excel-based financial models are sensitivity analysis, trend analysis, and discounted cash flow analysis. In the following section, you will learn about best practices to accommodate each of these needs in Excel-based financial models.

## Performing Sensitivity Analysis with Scenario Manager

Sensitivity analysis simply asks the question “what if” and is often used in budgeting and forecasting models. As an example, team members might change a sales growth percentage from 4% to 5% to see what the impact is on the bottom line. While a simple change such as that one is easily keypunched into an Excel model, challenges arise when attempting to track multiple versions of a workbook, each with a different set of assumptions. To ease this process, consider taking advantage of Excel’s **Scenario Manager** feature. You can use Scenario Manager to manage and save up to thirty-two different variables quickly

and easily on a single worksheet within your model. Further, Scenario Manager can affect multiple worksheets, so you can use it to manage up to thirty-two variables on *Sheet1*, thirty-two variables on *Sheet2*, thirty-two variables on *Sheet3*, etc.

You can access Scenario Manager by clicking **What-if Analysis** on the **Data** tab of the Ribbon and choosing **Scenario Manager**. As shown in **Figure 1**, you can add, delete, edit, and merge all the scenarios for the active worksheet from the **Scenario Manager** dialog box. For each cell that you choose to have Scenario Manager affect, you can store and save your assumptions in the **Scenario Values** dialog box. To recall and insert all the assumptions for a specific scenario quickly, just click the scenario's name and then click the **Show** button near the lower right corner of the Scenario Manager dialog box.



**Figure 1 - Working with Excel's Scenario Manager Tool**

A very useful feature of Scenario Manager is the **Scenario Summary** report. Clicking **Summary** in the **Scenario Manager** dialog box causes Scenario Manager to create a report that shows all the assumptions and all the results for all the scenarios on that worksheet. This can be very useful when attempting to compare various options contained in your financial models. **Figure 2** illustrates a sample Scenario Summary report.

Scenario Summary				
	Current Values:	Strong Economy	Poor Economy	Average Economy
<b>Changing Cells:</b>				
ARCollectionPeriod	29	29	43	37
DaysSalesInInventory	19	19	36	24
DaysPurchasesInAccountsPayable	38	38	45	34
InterestOnLOC	0%	0%	0%	0%
Sales	1,200,000	1,200,000	700,000	800,000
GrossProfitPerCent	0%	0%	0%	0%
Wages	250,000	250,000	225,000	200,000
<b>Result Cells:</b>				
JanuaryNetIncome	142,776	142,776	(52,122)	42,846
JanuaryEndingCash	1,023,104	1,023,104	760,141	866,211
Notes: Current Values column represents values of changing cells at time Scenario Summary Report was created. Changing cells for each scenario are highlighted in gray.				

**Figure 2 - Sample Scenario Summary Report**

## Using Excel Functions and Features for Trend Analysis

Trend analysis is a “go-to” technique when attempting to forecast future values based on historical results and is often used when building sales forecast, budget, and business valuation models in Excel. Numerous options exist for conducting trend analysis in Excel, including formula-based approaches, automated approaches with add-ins, and an alternative automated approach added to Excel 2016. Each of these methods is discussed below.

## Working with Formula-based Approaches for Trend Analysis

Excel provides numerous formula-based options for creating estimates of values in future periods. These functions allow a user to construct simple formulas on observed data for producing equations useful in forecasting future values, such as revenues or expenses.

**FORECAST** is used to calculate or predict a value based on existing values. For example, the formula **=FORECAST(25000,A2:A31,B2:B31)** would predict the monthly sales associated with advertising expenses of \$25,000 one month prior, given the linear relationship between the independent variable in range B2:B31 and the dependent variable in range A2:A31.

**TREND** generates values along a linear trendline and can be used to predict multiple future dependent values based on the relationship between existing dependent and independent variables. Note that TREND formulas are array formulas and must be entered using **SHIFT+CTRL+ENTER**.

**GROWTH** is very similar to TREND except that GROWTH provides an exponential calculation rather than a linear calculation as provided by the TREND function. Like TREND, the GROWTH function must be entered as an array formula.

Other useful functions that can be used in this same context include **LINEST**, **INTERCEPT**, **SLOPE**, and **LOGEST**.

## Creating Regression Analyses with the Analysis ToolPak

The regression analysis tool in the Analysis ToolPak add-in allows estimation of a single dependent variable based on up to sixteen independent variables. In our first example, a sales executive wants to determine if there is a relationship between monthly revenue and advertising expenditures incurred in

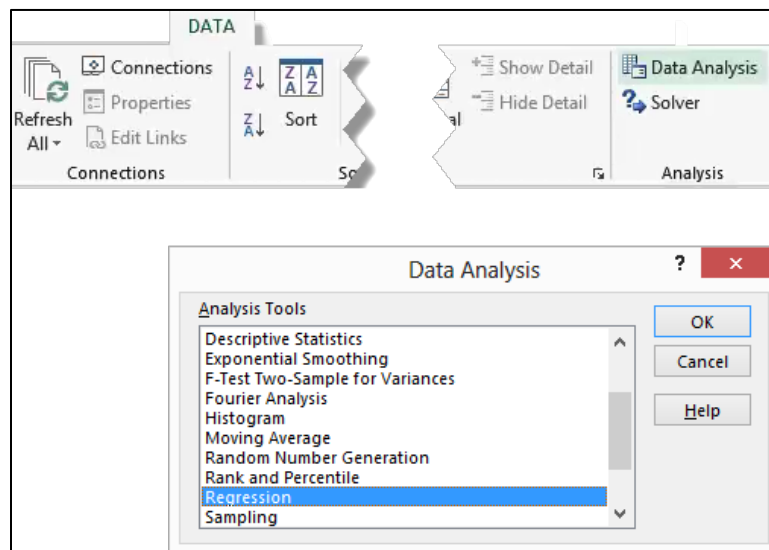
the previous month. Used here, regression analysis will determine the strength of the relationship between these variables and will forecast future sales revenues.

Consider the partial dataset shown in **Figure 3**, which summarizes monthly revenue and advertising expenditures for the past thirty months. Note the general trend in the data. As advertising expenses for the prior month increase, sales revenues for the current month increase.

1	Monthly Sales	Ad Expense 1 Month Prior	Ad Expense 2 Months Prior
2	\$ 1,700,000	\$ 20,000	\$ 20,000
3	1,650,000	19,000	20,000
4	1,725,000	20,000	19,000
29	1,925,000	22,500	22,500
30	1,850,000	21,750	22,500
31	1,900,000	22,000	21,750

**Figure 3 - Regression Analysis Data Set**

To begin the regression estimation process, click **Data Analysis** on the **Data** tab. Then, select **Regression** in the **Analysis Tools** list of the **Data Analysis** dialog box and click **OK** as shown in **Figure 4**.



**Figure 4 - Selecting Regression in the Data Analysis Dialog Box**

In the **Regression** dialog box shown in **Figure 5**, click the **Collapse Dialog** button just to the right of the **Input Y Range** box and select the range of cells that contains the dependent variable. In this case, select the range **A2:A31, Monthly Sales**. Next, click the **Collapse Dialog** button just to the right of the **Input X Range** box and select the range of cells that contains the independent variable. In this case, select the range **B2:B31, Ad Expense 1 Month Prior**. Note that the number of observations in the X and Y ranges must be equal.

**Regression**

**Input**

Input **Y** Range: **\$A\$2:\$A\$31**

Input **X** Range: **\$B\$2:\$B\$31**

☐ Labels ☐ Constant is **Z**ero

☐ Confidence Level: **95** %

**Output options**

☐ Output Range:

☒ New Worksheet **P**ly:

☐ New **W**orkbook

**Residuals**

☐ Residuals ☐ Residual Plots

☐ Standardized Residuals ☐ Line Fit Plots

**Normal Probability**

☐ Normal Probability Plots

OK Cancel Help

**Figure 5 - Specifying the X and Y Ranges in a Simple Linear Regression**

Click **OK** to calculate the regression and display the results on a new worksheet as shown in **Figure 6**.

	A	B	C	D	E	F	G	H	I
1	SUMMARY OUTPUT								
2									
3	<i>Regression Statistics</i>								
4	Multiple R	0.954919307							
5	R Square	0.911870882							
6	Adjusted R Square	0.908723414							
7	Standard Error	21880.19817							
8	Observations	30							
9									
10	<i>ANOVA</i>								
11		<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>			
12	Regression	1	1.38699E+11	1.38699E+11	289.7156508	2.6595E-16			
13	Residual	28	13404806016	478743072					
14	Total	29	1.52104E+11						
15									
16		<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95.0%</i>	<i>Upper 95.0%</i>
17	Intercept	10538.36094	106333.4823	0.099106704	0.921759697	-207275.9036	228352.6255	-207275.9036	228352.6255
18	X Variable 1	85.17872711	5.00432109	17.02103554	2.6595E-16	74.92784005	95.42961417	74.92784005	95.42961417

**Figure 6 - Linear Regression Analysis Based on a Single Independent Variable**

When interpreting the regression results, key components to consider are R Square, the Intercept Coefficient, and the X Variable 1 Coefficient. Recall that R Square is a measure of fit – it measures how well the computed linear equation fits the data. Generally, an R Square value of 0.80 or higher means that there is a strong relationship between the independent variable(s) and the dependent variable. In this example, the R Square is calculated to be 0.9118, which indicates a strong relationship between the variables and that the linear equation fits the data very well.



The Intercept Coefficient and the X Variable 1 Coefficient are used to specify the equation for estimating or predicting new values of the dependent variable based on specified values of the independent variable. In this case, the equation for estimating monthly sales as a function of the advertising expense incurred in the prior month is as follows.

$$\text{Monthly Sales} = \$10,538 + (85.179 * \text{Ad Expense 1 Month Prior})$$

To forecast the sales revenue for a future month based on anticipated advertising expenses of \$25,000 in the prior month, simply substitute the anticipated advertising expenses into the equation and solve for monthly revenue.

$$\text{Monthly Revenue} = \$10,538 + (85.179 * \$25,000)$$

$$\$2,140,013 = \$10,538 + (85.179 * \$25,000)$$

In this case, the regression equation yields estimated sales revenue of \$2,140,013.

### Building Trend Models with the Forecast Sheet Feature

A feature added to the 2016 release of Excel is **Forecast Sheets**. With Forecast Sheets, you can build forecasts into the future that accommodate seasonality in your data. Forecast Sheets examines the dates in your historical data, relates them to the actual values, and then creates a forecast for future values based on any date-oriented trends it identifies. Further, Forecast Sheets provides you with the opportunity to create not only an estimate for each forecast period but also upper and lower confidence intervals based on criteria that you specify.

To create a Forecast Sheet, click anywhere in the data range from which you want to build your forecast, go to the **Data** tab of the Ribbon, and click **Forecast Sheet**. Upon doing so, Excel generates the **Create Forecast Worksheet** dialog box. There, make any necessary adjustments to the options presented and click **Create** to create the Forecast Sheet as a separate worksheet in the workbook as shown in **Figure 7**.

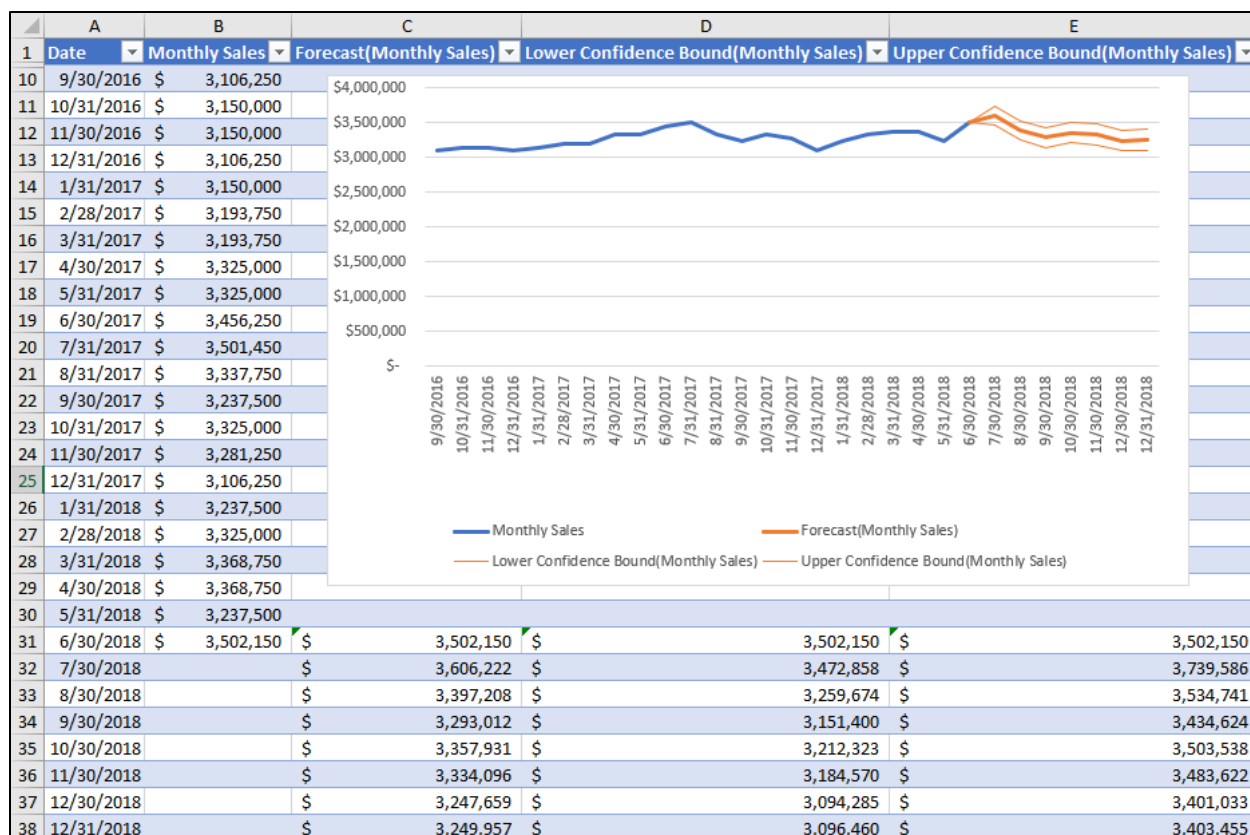


Figure 7 - Sample Forecast Sheet

## Working with Excel's Capital Budgeting Features and Formulas

Many financial models are built to determine the feasibility of capital projects, such as purchasing a new piece of machinery or investing in a new line of business. The decision to make such a capital investment should always be supported by a thorough Discounted Cash Flow (DCF) analysis. A DCF model involves projecting future cash flows and discounting these cash flows back to the present using a discount rate that accounts for the estimated riskiness of these cash flows. Finance professionals are in almost unanimous agreement that using Net Present Value (**NPV**) analysis is the best way of creating a DCF analysis; however, other techniques such as Internal Rate of Return (**IRR**) are often used in lieu of, or in addition to, NPV analysis.

## Calculating the Weighted Average Cost of Capital

When preparing a DCF, you should always discount cash flows using the company's **Weighted Average Cost of Capital** (WACC), not the company's incremental borrowing rate or any other discount rate. WACC provides a risk-adjusted measure of how much of a return an investor would require to loan to or invest in a particular company. Because the cash flows of the entire enterprise would be used to repay these investors, it would be improper to segregate the cash flows of the project under consideration and use only those cash flows when conducting a DCF analysis. Instead, a company's WACC should be used because the WACC measures the perceived riskiness of all the cash flows of the company, not just those related to a specific project.

To calculate WACC, first identify the company's cost of debt. Because the tax deductibility of interest expense provides a benefit to the company, the cost of debt should be multiplied by a factor of 1 minus the company's marginal tax rate to calculate the after-tax cost of debt. To illustrate, if a company's cost of debt is 6%, and its marginal tax rate is 27%, then its after-tax cost of debt would be 4.38%, calculated as follows.

$$6\% * (1 - 27\%) = 4.38\%$$

Once you have calculated the company's after-tax cost of debt, then you should calculate the required rate of return of the company's shareholders. This is often done by using the **Capital Asset Pricing Model (CAPM)**, which estimates the required rate of return on a company's stock as being equal to the expected risk-free rate of return plus a measure known as "beta" multiplied by the overall expected rate of return of the stock market minus the risk-free rate of return. Beta is a measure of the volatility of a company's share price relative to the volatility of the stock market taken as a whole; the share price of a company with a beta of 1.0 would move in lockstep with the market, whereas the share price of a company with a beta of 2.0 would be twice as volatile as the market. Assuming a company has a beta of 1.2, the current risk-free rate is 3%, and the expected rate of return on the stock market is 10%, the calculated cost of a company's equity would be 11.4%, calculated as follows.

$$3\% + 1.2 * (10\% - 3\%) = 11.4\%$$

Knowing both the cost of equity and cost of debt, you are now ready to calculate WACC. To do so, simply determine the weighted average of these two components, using the total market value of the company's equity and the total market value of its debt as the basis for calculating the weighted average. In other words, if the total market value of the company's debt is \$2,100,000<sup>1</sup>, and the total market value of the company's equity is \$4,800,000, the WACC is 9.26%, calculated as follows.

Market Value of Debt	\$ 2,100,000	30.43%	4.38%	1.33%
Market Value of Equity	<u>4,800,000</u>	<u>69.57%</u>	11.40%	7.93%
	<u>\$ 6,900,000</u>	<u>100.00%</u>		<u>9.26%</u>

### Simple NPV Analyses Using WACC

With the WACC now estimated, you can begin performing your DCF using Excel's PV, NPV, or other appropriate functions. However, you should be aware that obtaining accurate results when using the NPV function can be a little trickier than many believe. To illustrate how to utilize NPV, consider the following circumstances. Carlisle Manufacturing is considering investing in a new piece of equipment that will cost \$110,000. It projects the cash flows resulting from this piece of machinery to be \$18,000 at the end of Year 1, \$22,000 at the end of Year 2, \$31,000 at the end of Year 3, \$37,000 at the end of Year 4, and

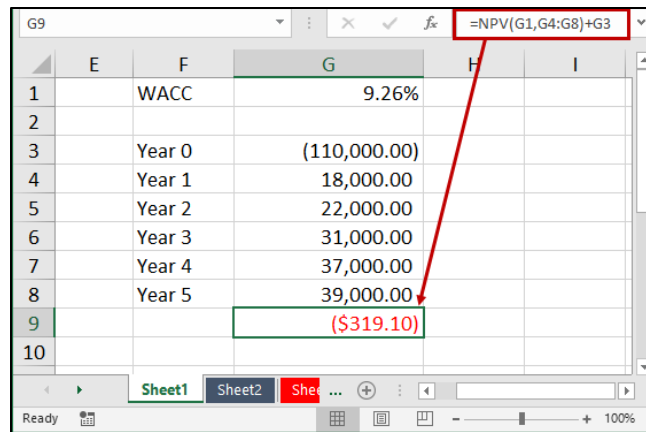
<sup>1</sup> Experienced financial professionals understand that the market value of a company's debt can fluctuate just as the market value of its equity can fluctuate. When estimating the WACC, market values should always be used for both debt and equity.

\$39,000 at the end of Year 5, at which point Carlisle will retire the machine; the company expects to receive no salvage value. The Company's CFO generates the NPV analysis pictured in **Figure 8** and concludes that Carlisle should not make the investment because the NPV of the project is negative. However, the CFO fails to realize that the NPV calculation is *incorrect*, jeopardizing the quality of her decision. Excel's NPV function calculates the sum of the present value of a series of cash flows and, in doing so, it assumes that all cash flows occur one year into the future beyond their actual date of occurrence. In the example presented, Excel's NPV function incorrectly assumes that the initial \$110,000 outflow occurs one year into the future, the \$18,000 cash inflow occurs two years into the future, etc. This means that all cash flows receive an extra year of discounting and leads to an incorrect calculation.

	C	D	E
1	WACC	9.26%	
2			
3	Year 0	(110,000.00)	
4	Year 1	18,000.00	
5	Year 2	22,000.00	
6	Year 3	31,000.00	
7	Year 4	37,000.00	
8	Year 5	39,000.00	
9		(\$292.06)	
10			

**Figure 8 - Incorrect Version of NPV Analysis**

If you are going to perform an NPV analysis, you can solve the problem outlined in Figure 8 by simply moving the reference to the "Time Period 0" cash flow so that it is not part of the NPV function. This is demonstrated in **Figure 9**. With the reference to cell C3 stated outside the NPV function, it is not being discounted at all, and each of the other cash flows referenced by the NPV function are now being discounted for the appropriate number of periods. While in this case, the decision made by the CFO was still correct because the correct NPV was negative, you can clearly see that it would be relatively easy to create an NPV model that leads to an improper decision, thereby destroying organizational value.



**Figure 9 - Corrected NPV Calculation**

Perhaps a better choice when generating NPV analyses would be to utilize Excel's **XNPV** function instead of the NPV function. With XNPV, you can state the actual dates of when cash flows are expected to materialize. Not only is this perhaps a clearer and more discrete way of creating your models, but it also facilitates including cash flows that do not occur at symmetrical intervals, such as yearly, quarterly, or monthly. To illustrate the usefulness of the XNPV function, consider the model pictured in **Figure 10** (with some of the rows hidden for presentation purposes). In this example, numerous inflows and outflows are occurring over a two-year period at uneven intervals. With XNPV, we can accommodate these irregular intervals by explicitly stating the expected cash flow dates in column B and including a reference to that column in the formula that includes the XNPV function.<sup>2</sup>

<sup>2</sup> You should be aware that Excel also provides an XIRR function to calculate the Internal Rate of Return when a project's cash flows occur at irregular intervals.

	B	C	D
1			
2	WACC	9.26%	
3			
4	Date	Cash Flow	Description
5	1/4/2019	(50,000.00)	Down Payment
6	1/31/2019	(50,000.00)	Second Payment
7	2/28/2019	4,000.00	Operating Revenue
8	3/15/2019	(50,000.00)	Final Payment
9	3/31/2019	6,000.00	Operating Revenue
10	4/30/2019	7,000.00	Operating Revenue
11	5/31/2019	7,500.00	Operating Revenue
29	11/30/2020	9,500.00	Operating Revenue
30	12/31/2020	9,500.00	Operating Revenue
31	12/31/2020	(35,000.00)	Royalties
32	Calculated NPV Using XNPV	\$ 183.65	
33			
34			
35			

**Figure 10 - Using Excel's XNPV Function to Handle Cash Flows at Irregular Time Intervals**

### Business Valuation Models Using DCF Analysis

The previous examples of using DCF focused on single projects and determining whether an organization should undertake these projects. Let us now consider the idea of using DCF analysis to estimate the value of an entire organization. At the risk of oversimplifying, this process boils down to five steps.

1. Estimate the organization's WACC.
2. Estimate Cash Flows for the near term (*typically five to seven years*).
3. Estimate Cash Flows into Perpetuity.
4. Discount All Cash Flows using the Weighted Average Cost of Capital.
5. Sum the Discounted Cash Flows to Arrive at the Gross Value of the Organization.

For purposes of this demonstration, we will continue using the WACC calculated in the example discussed beginning on page 10 and proceed directly to the topic of estimating cash flows for the near term. As pictured in **Figure 11**, this process generally involves estimating four items: 1) revenue; 2) earnings before interest, taxes, depreciation, and amortization; 3) earnings before interest and taxes; and 4) depreciation and amortization.

Operational Data								
	2016	2017	2018	2019	2020	2021	2022	2023
	actual	actual	actual	forecasted	forecasted	forecasted	forecasted	forecasted
Period				1	2	3	4	5
Revenue	3,200.0	3,350.0	3,500.0	3,710.0	3,933.0	4,090.0	4,172.0	4,339.0
Revenue Growth Rate		4.7%	4.5%	6.0%	6.0%	4.0%	2.0%	4.0%
EBITDA	1,300.0	1,400.0	1,500.0	1,372.7	1,455.2	1,513.3	1,543.6	1,562.0
EBITDA Margin	41%	42%	43%	37.0%	37.0%	37.0%	37.0%	36.0%
EBIT	950.0	1,000.0	1,050.0	1,113.0	1,179.9	1,227.0	1,251.6	1,301.7
EBIT Margin	29.7%	29.9%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%
Depreciation & Amortization	250	300	350	259.70	275.30	286.30	292.00	260.30
As a % of Revenue	7.8%	9.0%	10.0%	7.0%	7.0%	7.0%	7.0%	6.0%

**Figure 11 - Estimating Selected Operational Data in the Near Term**

Once you have estimated the items indicated above, you will need to make similar estimates for balance sheet data, such as accounts receivable, inventory, and capital expenditures. **Figure 12** presents an example of how these estimates might appear.

Selected Balance Sheet and Related Data								
	2016	2017	2018	2019	2020	2021	2022	2023
	actual	actual	actual	forecasted	forecasted	forecasted	forecasted	forecasted
Period				1	2	3	4	5
Cash	60.0	80.0	85.0					
Accounts Receivable	130.0	145.0	275.0	302.5	335.8	376.1	425.0	480.3
Inventory	10.0	12.0	12.0	12.2	12.8	13.6	14.7	16.0
Prepaid Assets	25.0	31.5	37.5	44.6	52.6	61.5	70.1	81.3
Accounts Payable	465.0	480.0	500.0	515.0	545.9	578.7	619.2	662.5
Accrued Expenses	45.0	44.0	46.5	51.2	56.3	62.5	69.4	75.6
Debt	1150.0	2375.0	2100.0					
Capital Expenditures	400.0	425.0	450.0	495.0	549.5	615.4	707.7	764.3
Accounts Receivable Growth (%)				10.0%	11.0%	12.0%	13.0%	13.0%
Inventories Growth (%)				2.0%	5.0%	6.0%	8.0%	9.0%
Prepaid Expenses Growth (%)				19.0%	18.0%	17.0%	14.0%	16.0%
Accounts Payable Growth (%)				3.0%	6.0%	6.0%	7.0%	7.0%
Accrued Expenses Growth (%)				10.0%	10.0%	11.0%	11.0%	9.0%
Capital Expenditures Growth (%)				10.0%	11.0%	12.0%	15.0%	8.0%

**Figure 12 - Estimating Selected Balance Sheet Data in the Near Term**

With the estimated operational and balance sheet data available, you can proceed with estimating the free cash flow build up that is expected to occur over the near-term planning period. You can do this by building a model like the one pictured in **Figure 13**. This model takes the estimated operational data along with the estimated changes in selected balance sheet components and combines them to generate an estimate of after-tax free cash flows. These cash flows are then discounted using the WACC, and those results are summed to generate a total of the present values of the free cash flows during the near term.

Free Cash Flow Build Up								
	2016	2017	2018	2019	2020	2021	2022	2023
	actual	actual	actual	forecasted	forecasted	forecasted	forecasted	forecasted
Period				1	2	3	4	5
Revenues	3,200.0	3,350.0	3,500.0	3,710.0	3,933.0	4,090.0	4,172.0	4,339.0
EBITDA	1,300.0	1,400.0	1,500.0	1,372.7	1,455.2	1,513.3	1,543.6	1,562.0
EBIT	950.0	1,000.0	1,050.0	1,113.0	1,179.9	1,227.0	1,251.6	1,301.7
Tax Rate			27%	27%	27%	27%	27%	27%
EBIAT			766.50	812.49	861.33	895.71	913.67	950.24
Depreciation & Amortization			350.00	259.70	275.30	286.30	292.00	260.30
Accounts Receivable				(27.50)	(33.30)	(40.30)	(48.90)	(55.30)
Inventory				(0.20)	(0.60)	(0.80)	(1.10)	(1.30)
Prepaid Assets				(7.10)	(8.00)	(8.90)	(8.60)	(11.20)
Accounts Payable				15.00	30.90	32.80	40.50	43.30
Accrued Expenses				4.70	5.10	6.20	6.90	6.20
Capital Expenditures				(45.00)	(54.50)	(65.90)	(92.30)	(56.60)
Unlevered Free Cash Flows				1,012.09	1,076.23	1,105.11	1,102.17	1,135.64
Weighted Average Cost of Capital				9.26%	9.26%	9.26%	9.26%	9.26%
Present Value of Free Cash Flows				<u>\$ 926.31</u>	<u>\$ 901.54</u>	<u>\$ 847.27</u>	<u>\$ 773.40</u>	<u>\$ 729.35</u>
Sum of Present Values of Free Cash Flows	\$	4,177.87						

**Figure 13 - Estimating the Present Value of Free Cash Flows during the Near Term**

Of course, cash flows will materialize after the forecast period also, and these are typically referred to as the *terminal value*. As with near-term cash flows, you will need to estimate the terminal value and calculate the present value of the terminal value. To do so, first estimate a long-term sustainable growth rate for unlevered free cash flow occurring beginning in the year after your near-term forecast ends. In this example, we will assume a long-term sustainable growth rate of 3% beginning in year 2024. Then, multiply that rate plus one by the unlevered free cash flow of the last year in your near-term forecast. In this case, that would yield \$1,169.71 as calculated below.

$$\$1,135.64 * (1 + 3\%) = \$1,169.71$$

Next, calculate the undiscounted terminal value by dividing the amount calculated above by the WACC minus the long-term growth rate. In this case, that yield \$18,685.46 as calculated below.

$$\$1,169.71 / (9.26\% - 3\%) = \$18,685.46$$

Finally, calculate the present value of the terminal value by discounting it at the WACC but keep in mind that this calculation should occur as of the end of the near-term forecast period. Therefore, the formula to calculate the present value of the terminal value would be the following.

$$\$18,685.46 / (1.0926)^5 = \$12,000.46$$

Knowing that the present value of the near-term cash flows is \$4,177.87, and the present value of the terminal cash flows is \$12,000.46, you can simply add these two values together to arrive at the estimated gross value of the organization, which in this case would be \$16,178.33. From this amount, subtract the net amount of debt (which is calculated as debt minus cash), and you will arrive at an estimate for the total value of the company's equity. In this case, the net debt is \$2,015.0, which yields an equity valuation



of \$14,163.33. Assuming there are 600 shares of common stock outstanding, each share should be worth approximately \$23.61 based on this valuation.

### One Final Thought on DCF Analysis

One of the biggest challenges when creating a DCF analysis is to ensure that the proper basis of cash flows – real or nominal – is used consistently and without exception throughout the model. In fact, it does not matter which basis is used, because if the same basis is used consistently throughout the model, you will get the same result as if you had used the other basis. Thus, the focus on the basis should be consistency. One way of checking to see if you have used a basis consistently is to build your model using real cash flows and discount rates and then rebuild it using nominal cash flows and discount rates. If you have used these bases consistently throughout both models, you will get the same result.

## Excel has three Tables

Excel now contains three tables that can be of great benefit to accountants. Two tables were added to Excel 5.0 in 1993. The third table was added to Excel in Office 2007. The first two, Data Tables and PivotTables, were actually part of Lotus 1-2-3. Microsoft followed, enhanced both, and added the third Excel Tables to Office 2007.

Excel's three tables:

1. Data Tables
2. PivotTables
3. Excel Tables

Each table has its own distinct value. Don't let the title, "Tables", fool you; they are not similar in any fashion.

Despite being part of Lotus 1-2-3 and the early versions of Excel, Data Tables and PivotTables were very unique and very misunderstood for years. PivotTables are now becoming popular while Data Tables are still hardly ever used correctly. The third table, Excel Tables, is new enough that users do not think that they are anything more than formatting, but they are wrong. By the end of this session, you will understand how to use each of these three tables in an appropriate fashion.

The primary function of each table is as follows:

- |                |                               |
|----------------|-------------------------------|
| • Data Tables  | One or two variable analysis  |
| • PivotTables  | Summarize and categorize data |
| • Excel Tables | Control a block of data       |

## Using Data Tables for Sensitivity Analysis

One-variable and two-variable data tables have been a major spreadsheet analytical tool since Lotus 1-2-3, but for many accountants, data tables have become a lost art. Data tables are an excellent method of conducting sensitivity or what-if analysis. In a simple one-variable data table, one variable is manipulated in calculating a result. In a two-variable data table, two variables are manipulated in calculating a result.

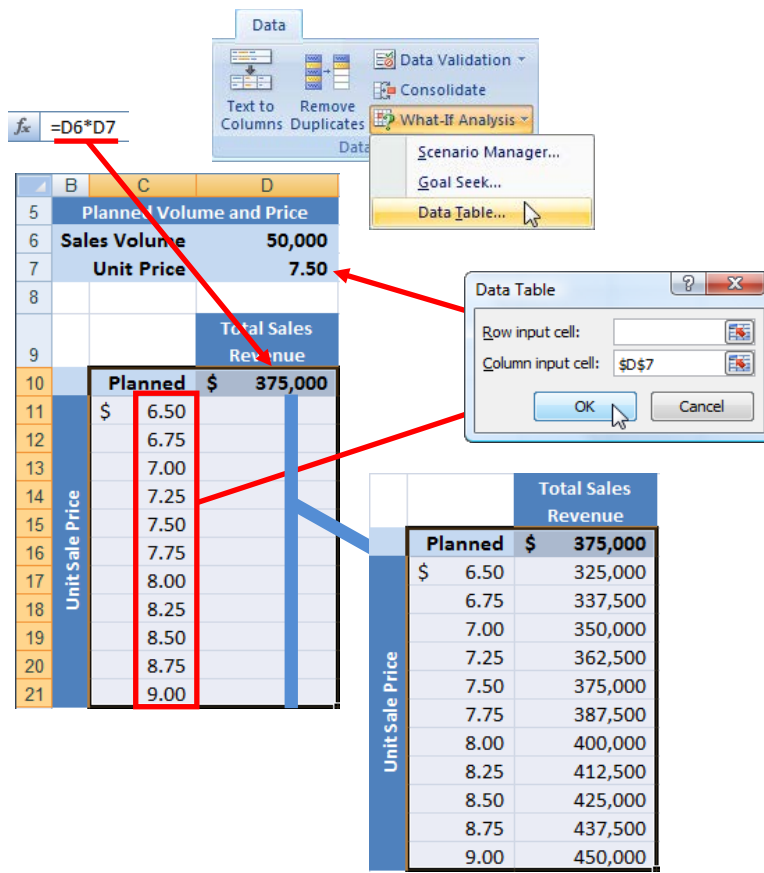
Many users only use Data Tables to replicate formulas. This type of use is not all that beneficial. Accountants who understand Data Tables know they can use them in analyzing large models to provide summaries of complex calculations based on one or two variable changes. The value of the Data Table analysis is directly related to the size or complexity of the calculations used in the tables.

For example, changing COGS based on a lookup function of values that is driven by activity. There is no way to simply create a formula for all the possible effects of activity without a Data Table summary.

### Simple Formulas

In our first example, Debbie Nelson, the CFO of a small manufacturing company, is trying to understand the impact of a change in unit sales price on the total sales revenue expected from a new product to be introduced in the coming year. Her analysis can be done quickly and easily with a simple one-way data table. In the example table, the planned sales volume and unit sales price are known. However, Nelson would like to calculate the sales revenue generated by unit prices ranging from \$6.50 to \$9.00 per unit in twenty-five cent increments. First, create a workbook with a layout similar to the one displayed at the left in **Figure 14**. Put the alternative prices in a single column, in this case in cells **C11** through **C21**. Build a formula in cell **D7** to calculate the estimated sales revenue from the planned sales volume and unit price. In a one-way data table, the formula at the top of each column of the data table area is recalculated for each of the values in a single variable, in this case unit sales price. Multiple columns can be recalculated but only on one variable.

To create the data table, highlight the range **C10:D21** and select **What-If Analysis, Data Table** from the **Data** tab of the Ribbon. In the **Data Table** dialog box, click in the box for the **Column input cell** and then click on cell **D7**. This process indicates to Excel where it is to substitute the values \$6.50 through \$9.00 in recalculating the total sales revenue. Click **OK** to produce the data table shown in the lower right of **Figure 14**.



**Figure 14 - Creating a One-Way Data Table to Calculate Sales Revenue from Multiple Prices**

### Multiple Answers in a Column (Row) Data Table

You can use as many available rows as you have in your worksheet for changes in the variable and as many available columns as answers. If you create a Data Table with a row of variables, then the above rules flip and you can use as many available columns for the variable and as many rows for the answer. This option becomes very powerful. We can change the interest rate and find out three answers: Payment, total loan interest, and total payments on loan.

Given Excel 2007 or Excel 2010, Data Tables can become a very powerful tool because you now have over sixteen thousand columns and over one million rows. See table of features below:

Feature	Excel 2003 & Prior	Excel 2007
Rows	65,536	1,048,576
Columns	256	16,384
Cells per Worksheet	16,777,216	17,179,869,184
Worksheets in Workbook	2 GB	All RAM
Characters in Cell	1,024	32,768
Multi-level Undo	16	256
Sort Keys	3	64
Conditional Formats Per Cell	3	Unlimited
Colors in Workbook	56	4.3 Billion

## A Greater Value

A greater value can be found by using Data Tables in combination with complex calculations that cannot be done in a single cell. For example, you can easily create a simple formula to calculate a loan payment.  $\text{=PMT}(\text{rate}, \text{nper}, \text{pv})$ . Using a Data Table when you can easily create a partially absolute formula is not all that helpful.

Using the loan amortization analogy, you would need a Data Table to compare total loan interest with different rates as the variable. Without the Data Table, you cannot easily compare a column of rates and the total loan interest which requires the body of the amortization in the worksheet which calculates this answer. Hence, the more complex the answer, the more valuable the Data Table analysis. Companies with large financial models can reap great insight from using Data Tables with key variables on large calculations.

## Analysis of Interest

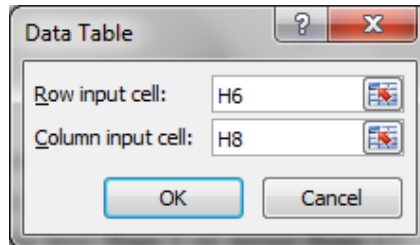
To create the two-variable data table, begin by creating the outline of the data table as shown in **Figure 15**. Note that in the outline shown, cell Q3 contains the formula **=PAYMENT**.

	Q	R	S	T	U	V	W	X
1	<b>Data Table (Row &amp; Column) Analysis Total Loan Interest</b>							
2	Interest Rate			Years (Periods)				
3	=pay	5	7	10	15	20	25	30
4	PAYMENT							
5	2.75%							
6	3.00%							
7	3.25%							
8	3.50%							
9	3.75%							
10	4.00%							
11	4.25%							
12	4.50%							
13	4.75%							

**Figure 15 - Outline of Two-Variable Data Table**

Once the outline of the two-variable data table is complete, select the range from cell Q3 through cell X13. Then, from the Data tab of the Ribbon, select **What-If Analysis** and **Data Table** to open the **Data Table** dialog box shown in **Figure 16**. In the Data Table dialog box, enter cell **H7** as the **Row input cell** and cell **H8** as the **Column input cell** and click **OK**.

This instructs the data table to substitute the contents of the first row of the data table into cell H6 and the contents of the left-most column of the data table into cell H8 and to recalculate the formula in the cells.

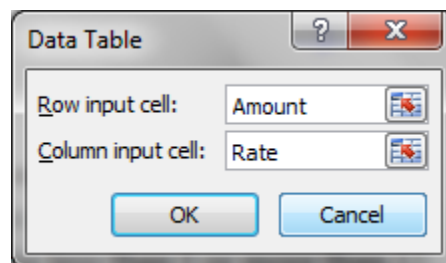


**Figure 16 - Data Table Dialog Box**

	E	F	G	H
2	<b>K2 Enterprises</b>			
3	<b>VS VER.(4/10/11)</b>			
4				
5	Payment Date		10/15/10	
6	Loan Amount		\$ 20,000.00	
7	Term Of Loan (Years)			5
8	Initial Annual Interest Rate			5.00%
9	Initial Payment			\$ 377.42

## Named Cells

A more useful approach when creating Data Tables is to name the cells of key variables so that during Data Table construction you can reference the named cell and not worry about specific cell addresses.



## Excel Tables

The **table** features in Excel 2007 and Excel 2010 are designed to ease and enhance the way users sort, filter, format, and analyze information in tables. Here are some of the built-in features for managing and manipulating tables.

- **Auto Expansion** – Tables expand automatically to include new data entered in adjacent rows or columns. All styles, calculations, data validation, and conditional formats are applied to extensions.
- **Sorting** – Users can sort on unlimited columns and on font or fill colors. Sorts can be made case-sensitive.
- **Filtering** – Users can filter on single or multiple criteria, icon sets, and on dynamic dates, such as last week or last month.
- **Formula Replication** – Any formula created in an adjacent column to make calculations on table data is automatically replicated across all rows.
- **Duplicate Data** – Users can highlight or remove duplicate rows with a few simple commands.
- **Table Styles** – A large gallery of table styles is available for automatically formatting tables. Styles with banded rows auto-adjust the color bands for record additions, deletions, sorting, and filtering. Styles interact with Themes to provide greater flexibility in formatting tables.
- **Structured Referencing** – Formulas that reference elements of a table can use row and column tags rather than cell references in the formula for clarity and ease of use.

Think of a table as a two-dimensional Excel database with special functionality. The data should be properly laid out with columns as fields and rows as records. The first row should contain the names of each field. If the first row does not contain field names, Excel will create generic field names automatically.

## Creating a Table

To create a table in Excel using the default style, place the cursor inside of the data range and press **CTRL + T**. In the **Create Table** dialog box, confirm the table range and check **My table has headers** as shown in **Figure 17**.

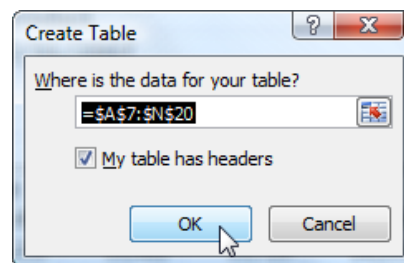


Figure 17 - Create Table Dialog Box

Click **OK** to create the table as shown in **Figure 18**. Instantly, the table is created with the default style. In this case, the default style bands adjacent rows with different colors for readability. Drop-down filter arrows are visible at the top of each column. The arrows are for setting filters and sorting and are not visible on printouts. Any fields that do not have a name at the top of the column will be named **Column1**, **Column2**, etc. These fields can be renamed by typing over the labels.

Item	Description	Jan	Feb	Mar	Apr	May	Jun
1	Creme, Aloe Vera Hand, 9 oz	8,388	9,087	8,039	8,388	10,485	12,582
2	Creme, Extra Moisturizing Hand, 9 oz	8,988	9,737	8,614	8,988	11,235	13,482
3	Creme, Hand and Body, 16 oz	15,588	16,887	14,939	15,588	19,485	23,382
4	Lotion, Organic Body, 9 oz	9,588	10,387	9,189	9,588	11,985	14,382
5	Lotion, Organic Body, 16 oz	17,988	19,487	17,239	17,988	22,485	26,982
6	Lotion, Organic Body, 24 oz	26,388	28,587	25,289	26,388	32,985	39,582
7	Lotion, Extra Moisturizing Body, 9 oz	8,388	9,087	8,039	8,388	10,485	12,582
8	Lotion, Organic Hand and Body, 9 oz	10,188	11,037	9,764	10,188	12,735	15,282
9	Lotion, Organic Hand and Body, 16 oz	19,188	20,787	18,389	19,188	23,985	28,782
10	Mask, Organic Facial, 9 oz	16,788	18,187	16,089	16,788	20,985	25,182
11	Mask, Wrinkle Reducing Facial, 9 oz	22,788	24,687	21,839	22,788	28,485	34,182
12	Mask, Wrinkle Reducing Facial, 16 oz	5,399	4,679	4,139	4,319	5,399	6,478
13	Mask, Wrinkle Reducing Facial, 24 oz	8,099	7,019	6,209	6,479	8,099	9,718

**Figure 18 - Creating a Table Instantly with CTRL+T**

Alternatively, the table could have been created from the Ribbon. Again, position the cursor inside the data range. From the Ribbon, select **Format as Table** from the **Home** tab of the Ribbon. Select a style from the gallery and then confirm the table range in the **Create Table** dialog box. Click **OK** to create the table.

Using CTRL + T is a faster and easier process to create a table, but it always creates a table in the default table style. To change the default table style, click on **Format as Table** on the **Home** tab of the Ribbon, right-click on a style, and choose **Set As Default**.



Styles interact with Themes. Themes contain attributes for fonts, line and fill effects, and the color palette. By changing the Theme, the colors and formats of a Table Style will be affected. To see the impact, select **Themes** from the **Page Layout** tab. Then, roll your mouse over the various themes and watch the table formats change. Themes give users even greater flexibility in formatting their tables.

## Using Table Names

Excel names each table with a generic name and displays it in the **Properties** group of **Table Tools, Design**. The table name is part of structured referencing, which will be discussed later. Naming tables with a representative name, such as Sales or Invoices, will make building formulas with structured referencing easier and more intuitive, especially if multiple tables are present in a single workbook.

## Turning a Table into a Range

Some accounting professionals will just want to format their lists with a few clicks. They don't need filtering, sorting, or any of the other advanced features, and they certainly don't want the filter arrows at the top of each column. Here's the trick. Create a table from the data selecting the desired style in the process. Then, change the table back into an ordinary range from the Ribbon by selecting **Convert to Range** on the **Table Tools, Design** tab. Click **OK** in the confirmation dialog box, and the table will become a range again. Note that the table formatting remains! To turn off the filter arrows in a working table, position the cursor inside the table and click **Filter** on the **Data** tab or click **Sort & Filter, Filter** on the **Home** tab of the Ribbon. The same process can be used to turn on filtering again whenever it's needed.



When a table is turned into a range, the style formatting becomes cell formatting which may cause unexpected results if the range is later turned back into a table. If the table formatting is inconsistent, it may be repaired. Click inside the table. From the Ribbon, select **Home, Format as Table**. Right-click on the desired style in the gallery and choose **Apply and Clear Formatting**.

## Working with Tables

Let's review the sample table. It consists of monthly sales data for thirteen products over the past six months. First, use the check boxes in **Table Style Options** to explore how styles can be adjusted to meet specific needs. **Figure 19** shows the results of our efforts.

☒ Header Row
 ☐ First Column
 ☐ Total Row
 ☐ Last Column
 ☐ Banded Rows
 ☒ Banded Columns

Table Style Options

Lotion, Organic Body, 9 oz	8,388	9,087	8,039
Lotion, Organic Body, 16 oz	8,988	9,737	8,614
Lotion, Organic Body, 24 oz	15,588	16,887	14,939
Lotion, Extra Moisturizing Body, 9 oz	9,588	10,387	9,189
Lotion, Organic Hand and Body, 9 oz	17,988	19,487	17,239
Lotion, Organic Hand and Body, 16 oz	26,388	28,587	25,289

Figure 19 - Using Table Style Options to Adjust Table Formatting



Altering the options in **Table Style Options** changes the styles presented in the Style Gallery. Formatting tables with styles may be more effective if options are set *before* styles are applied.



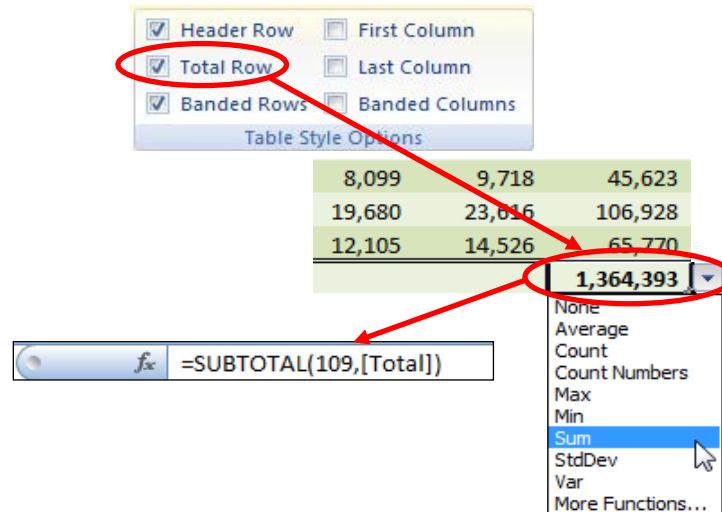


Figure 20 - Adding Totals to a Table

Each column in the table can be totaled independently of every other column. In other words, one column can be summed while another can be averaged or counted. Copy the total formula to the bottom of all sales columns by grabbing the auto-fill box in the lower right-hand corner of the cell containing the grand total and dragging the fill box across the row to the January sales column.

### Quick-Add Column, Row

Excel Tables will also help with the mundane work, such as, adding columns and rows, including formulas. The trick to this is inserting the column or row within the table range. If you create a formula in the new column or row, the table will automatically copy the formula to the rest of the column or row. When dealing with a substantial amount of data, this can be a huge time saver.

Nov-201	Dec-201	New Caclulation	Dec-201	New Caclulation
289,000	305,000	=sum(Table2[@[Sep-2012]:[	305,000	1,128,000
135,000	140,000	1R x 4C	140,000	530,000
154,000	165,000		165,000	598,000
68,000	73,000		73,000	261,000
68,000	73,000		73,000	261,000
8,000	8,000		8,000	32,000
144,000	154,000		154,000	554,000
10,000	11,000		11,000	44,000

Figure 21 – Quick-Add

### Freeze Column and Row

Column and row titles will freeze in place, automatically, as long as you are working in the table. When you click off the table, the column and row headings go back to their original state.

	B25			$f_x$	Northeast
	Date	Region	Product Line	Amount	
19	7/14/2007	South	Lotions	679.35	
20	7/14/2007	South	Cremes	529.89	
21	7/14/2007	South	Masks	237.77	
22	7/14/2007	Midwest	Lotions	698.76	
23	7/14/2007	Midwest	Cremes	545.03	
24	7/14/2007	Midwest	Masks	244.57	
25	7/21/2007	Northeast	Lotions	782.30	
26	7/21/2007	Northeast	Cremes	610.19	

Figure 22 – Freeze Column and Row within a Table

## Filtering and Sorting

The sales manager for Nature's Softness would like to have monthly sales totals for one of the product groups. Click the drop-down filter button at the top of the **Description** column. Clear the **Select All** button in the record list at the bottom of the filter dialog. Next, select all of the **Cream** products. Click **OK** to apply the filter. The table should resemble the one in **Figure 23**. Note that the total row calculates the total sales for only the records displayed. Also, note the icon on the filter button of the Description column indicating that a filter is active.

Item	Description	Jan	Feb	Mar	Apr	May	Jun	Total
1	Creme, Aloe Vera Hand, 9 oz	8,388	9,087	8,039	8,388	10,485	12,582	56,969
2	Creme, Extra Moisturizing Hand, 9 oz	8,988	9,737	8,614	8,988	11,235	13,482	61,044
3	Creme, Hand and Body, 16 oz	15,588	16,887	14,939	15,588	19,485	23,582	105,869
Total		32,964	35,711	31,592	32,964	41,205	49,446	223,882

Figure 23 - Table with Simple Filter Applied

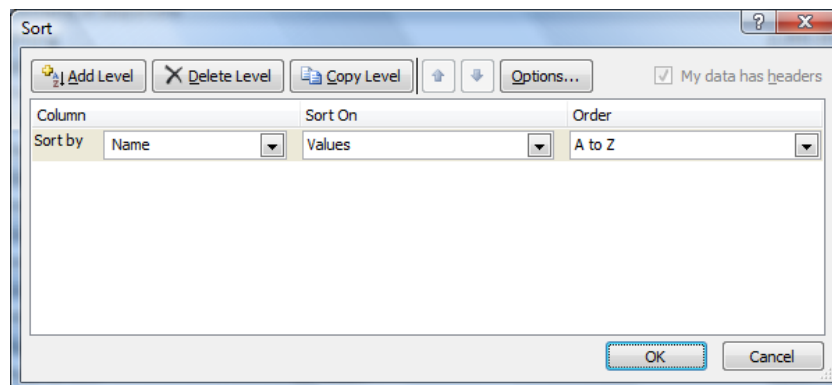


Figure 24 - The Custom Sort Dialog Box

## Structured Referencing

Scrolling up to set filters and then down to see totals in a large table is not effective practice. Let's put our totals at the top of the table, so that as we set filters, the results will be plainly visible. In the process, we will investigate another innovation called structured referencing. Position the cursor in cell E4. Type in the label **Total** and format the label with boldface, right justification, and accounting format. Move right to cell F4 and type in the following formula:

**=SUBTOTAL(109,Checks[Amount])**

The formula sums all checks displayed in the **Amount** column of the **Checks** table. As the filters are reset, the total displayed will change to reflect the sum of just those records displayed. If filters are cleared, then the formula will reflect the sum of all checks written.



As a table is filtered, Excel hides from the user the rows that are not of interest. The **SUBTOTAL** function uses function numbers to determine whether the summary calculation includes hidden rows. Hidden rows are normally included in summary totals when using function numbers 1-11 except when the rows are hidden by active filters, in which case the hidden rows are not included in the totals. Hence, it is not necessary to use SUBTOTAL function 109 to sum filtered tables so that only displayed rows are included in the totals.

Copy cells E4 and F4 to cells E3 and F3. Change the label in cell E3 to read **Mean** and change the formula in cell F3 to read as shown below.

**=SUBTOTAL(101,Checks[Amount])**

Manipulate the filters, by any means, so that the number of displayed rows varies in length. Note that the mean and total formulas displayed at the top of the table change accordingly as shown in **Figure 25**.

	A	B	C	D	E	F
1	<b>Hesson Flooring Company</b>					
2	Check Payments Data					
3	For the Years 2009 and 2010				<b>Mean</b>	2,756.05
4					<b>Total</b>	135,046.69
5						
6	Type	Date	Num	Name	Memo	Amount
31	Bill Pmt -Check	01/03/2010	126	Sergeant Insurance	786-35	4,050.00
40	Bill Pmt -Check	02/14/2010	136	Timberloft Lumber	1890-76	1,358.00
48	Bill Pmt -Check	03/28/2010	144	East Bayshore Tool & Supply		1,476.23
53	Bill Pmt -Check	04/04/2010	150	Timberloft Lumber	1890-76	1,610.00

**Figure 25 - Creating Totals at the Top of a Table**

Structured references are a means of working with table data, both inside the table and outside the table. Formulas built on structured referencing are self-documenting because they specify data elements within a table rather than cell references. There are a number of reserved item specifiers. For example, **[#Totals]** refers to the total row, and **@** refers to data elements in other columns but on the same row. A total row

exists in the sample table shown in Figure 25. To create a formula in the worksheet to refer to the total displayed at the bottom of the **Amount** column as its value and position changes, use this formula.

**=Checks[#Totals], [Amount]]**

As the formula is entered from the keyboard, **Formula AutoComplete** will display the tables and fields for selection, just as with functions and range names. To learn more about this innovation, search for "structured references" in the Excel help system.

## Removing Duplicate Records

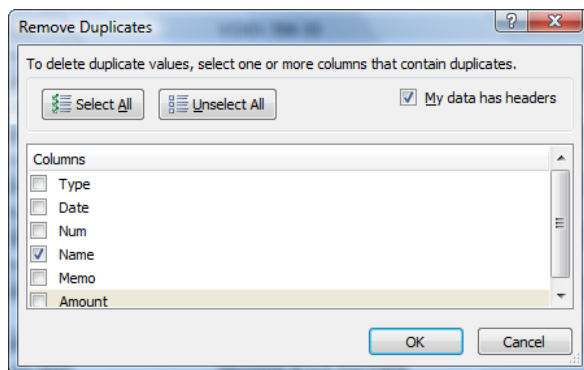
One of the best features of the two latest versions of Excel is their ability to easily identify or remove duplicate values in a range or table.



Using the **Remove Duplicates** command is destructive. The rows in a range or table identified as duplicates will be deleted from the data. Make sure that you save a copy of the workbook with a different file name before executing the command.

Continuing with our example, Rod Hesson would like to have a sorted list of all payees who received a check in 2009 or 2010. To produce the list he needs, simply remove all duplicate records in the Name column.

First, keeping in mind that removing duplicate records is a destructive process, save the workbook with a different file name. Then, clear all of the filters and sorts in the sample table. To remove the duplicate payees, position the cursor in the table and select **Data, Remove Duplicates**. Uncheck all columns except **Name** in the **Remove Duplicates** dialog box as shown in **Figure 26**. Click **OK** and then **OK** again to confirm the removal. Sort the **Name** column in ascending order to complete the task.

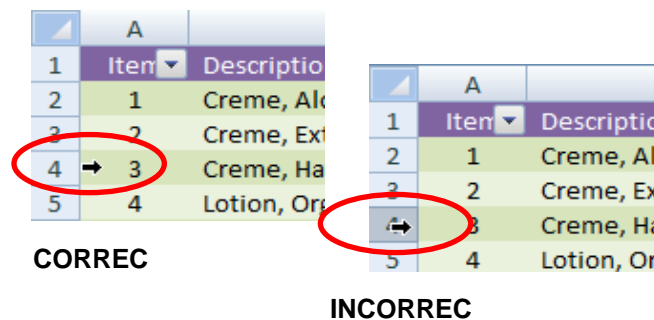


**Figure 26 - Selecting Columns from Which to Remove Duplicates**

Alternatively, an advanced filter could have been applied to the **Name** field. Using an advanced filter is not destructive, and the filtered list can be copied to another range in the worksheet as part of the filter command. Before discussing advanced filters, let's take a few minutes to discuss the process of selecting a range in a table.

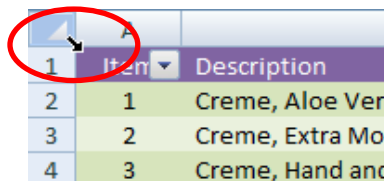
## Selecting Table Rows or Columns

A table is a single unitary object within a worksheet. Think of a table as a *worksheet within a worksheet*. In other words, users can insert, delete, or move rows and columns within a table without disturbing the surrounding worksheet. Moreover, users can select rows and columns in a table without selecting entire rows and columns in the surrounding worksheet. To select a row, position the cursor just inside the left-hand margin of the row. The cursor will change to a small dark arrow pointing to the right or inside of the table. Click to select the row. Right-click and select **Insert, Table Rows Above** to insert a row in the table but *not* in the surrounding worksheet. If the cursor is positioned too far to the left, in the worksheet row reference, the entire row in the worksheet will be selected. The correct and incorrect cursor positions are shown in **Figure 27**.



**Figure 27 - Positioning Cursor Properly to Insert Row in Table**

The data in a table or an entire table can be selected by positioning the cursor just at the upper left-hand corner of the table. The cursor will change to a small dark arrow pointing down and to the right inside the table. Click once to select the data and twice to select the entire table, including the headings and total row. The correct cursor position for selecting an entire table is shown in **Figure 28**.



**Figure 28 - Positioning Cursor to Select Entire Table**

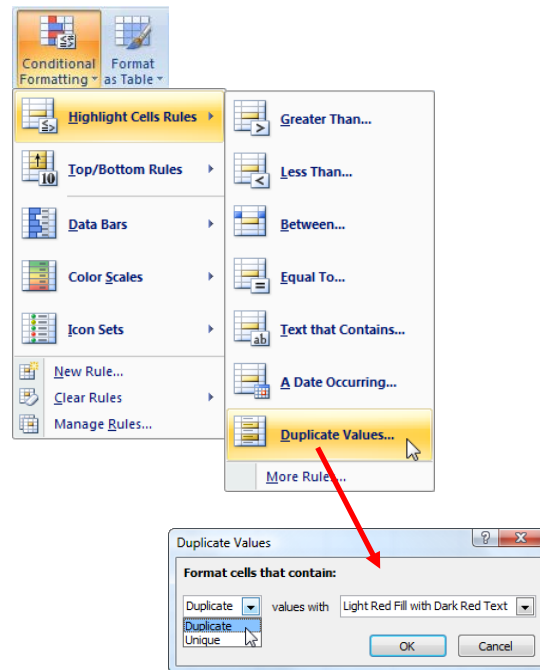
Note the similarity of working with rows and columns in Word tables. If you have ever worked with tables in Word, then you will recognize the process immediately.

## Filtering Duplicate Records

The last example of working with duplicate records involves using conditional formatting to highlight duplicate records and then filtering by color to find the duplicates. For example, users may want to identify checks issued with duplicate check numbers.

Using the QuickBooks check data, clear all active sorts and filters. Sort the **Date** column in ascending date order. Select the data in the **Num** column by any means. Then, select **Conditional Formatting, Highlight**

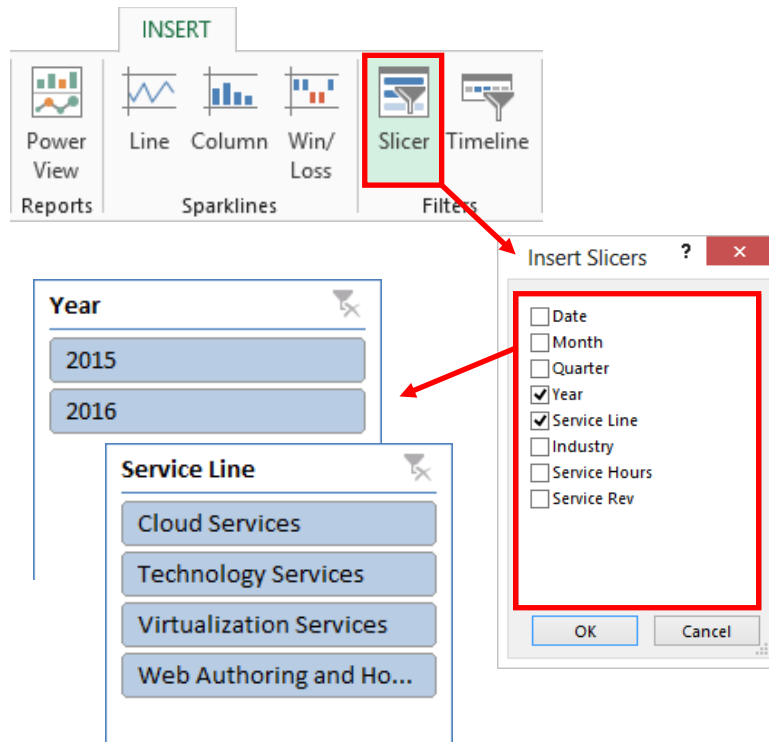
**Cells Rules, Duplicate Values** from the **Home** tab of the Ribbon. In the **Duplicate Values** dialog box, select **Duplicates** and accept the default color scheme as shown in **Figure 29**. Click **OK** to apply the conditional formatting.



**Figure 29 - Formatting Duplicate Values**

## Slicers for Tables

Think of Slicers as end-user filters. Slicers have been available to filter PivotTables and PivotCharts since Excel 2010. Now they are available for filtering Excel Tables, and can even be used to filter Tables connected to external data sources. To apply a Slicer to a Table, place the cursor in the data and then select **Insert, Slicer** on the ribbon. In the **Insert Slicers** dialog box, check the fields that you desire to filter in the Table and click **OK** to create the Slicers, as shown in **Figure 30**. Arrange, format, and apply styles to Slicers on the **Slicer Tools, Options** contextual tab.



**Figure 30 – Applying Slicers to a Table**

## Introduction to PivotTables

PivotTables are the most powerful feature of Excel, yet few accountants use them in their day-to-day activities. For some, PivotTables are too intimidating; for others, PivotTables are unknown. PivotTables may be challenging at first, but with a little instruction and guidance, they will become part of your regular repertoire for analysis and reporting. reports in the PivotTable task pane, grouping and custom grouping, ungrouping, data summaries, creating calculated items and using advanced summarization techniques.

## What is a PivotTable?

A PivotTable report is an interactive table that automatically extracts, organizes, and summarizes data. In just a few clicks, users can go from raw data to a completed report, as shown in **Figure 31**. A PivotTable report can be used to analyze data — for example, to make comparisons, to detect patterns and relationships, or to uncover trends. PivotTables are extremely useful for summarizing and analyzing large amounts of data efficiently and effectively. For example, a CFO may need to summarize fifty thousand sales transactions to produce quarterly totals by product line within sales region. Alternatively, a public practitioner evaluating audit risk may need to summarize all of a client's bill payment checks by vendor and by quarter. In both examples, users would like to be able to drill on the summarized totals in the report to see the detailed transactions that underlie the totals. PivotTables can provide all of this functionality and more, quickly and with computational accuracy.

Month	Region	Product	Amount			
1/31/2013	New England	Astringent, Organic, 16 oz	8,376			
1/31/2013	Southeast	Astringent, Organic, 16 oz	10,615			
1/31/2013	Midwest	Astringent, Organic, 16 oz	9,532			
1/31/2013	West	Astringent, Organic, 16 oz	8,284			
1/31/2013	New England	Astringent, Organic, 24 oz	16,185			
1/31/2013	Southeast	Astringent, Organic, 24 oz	19,962			
1/31/2013	Annual Comparative Product Sales					
1/31/2013		2013	2014	2015	Grand Total	
1/31/2013	☐ Lotion, Organic Body, 9 oz		663,216	703,012	633,845	2,000,073
1/31/2013	New England		155,568	164,619	147,417	467,604
	Southeast		191,601	203,277	183,760	578,638
	Midwest		167,694	177,921	160,685	506,300
	West		148,353	157,195	141,983	447,531
	☐ Lotion, Organic Body, 16 oz		1,266,688	1,342,084	1,207,893	3,816,665
	New England		288,344	305,247	276,567	870,158
	Southeast		362,758	384,803	344,832	1,092,393
	Midwest		332,305	351,728	318,052	1,002,085
	West		283,281	300,306	268,442	852,029

**Figure 31 – From Raw Data to PivotTable Report in a Few Clicks**

Excel uses specific terms to identify the elements of a PivotTable report. The main elements, shown in **Figure 32**, are row fields, column fields, report filters, values fields, items, and the data area.



	A	B	C	D	E
1	Years	(All)			
2					
3	Sum of Sales		Quarter		
4	Region	Product	Qtr1	Qtr2	Qtr3
5	East	Pipe, 1/2-inch, Galv	13,950	9,220	4,470
6		Pipe, 1/2-inch, Sch 40	48,070	44,280	40,490
7		Pipe, 1-inch, Galv	15,400	17,300	19,190
8		Pipe, 3/4-inch, Galv	35,940	31,860	36,960
9		Pipe, 3/4-inch, Sch 40	50,520	54,310	58,100
10		Tubing, 1/2-inch, Type L	7,570	9,460	11,370
11		Tubing, 1-inch, Type L	44,150	53,620	63,110
12		Tubing, 3/4-inch, Type L	43,020	39,220	35,430
13	East Total		258,620	259,270	269,120
14	West	Pipe, 1/2-inch, Galv	18,420	10,730	5,930
15		Pipe, 1/2-inch, Sch 40	63,350	51,480	53,350

Figure 32 - Parts of a PivotTable

- |   |                |   |            |
|---|----------------|---|------------|
| 1 | Report Filters | 4 | Items      |
| 2 | Values Fields  | 5 | Row Fields |
| 3 | Column Fields  | 6 | Data Area  |

**Row Fields** are fields from the source data that are assigned to a row layout in a PivotTable. Region and Product are row fields in Figure 32.

**Column Fields** are fields from the source data that are assigned to a column layout. Quarter is a column field in Figure 32.

**Report Filters** are fields from the source data that act as filters in a PivotTable report. Years is a report field in Figure 32. The Years field could be used to display data from a single year, such as 2014, or multiple years, such as 2013 and 2014, etc.

**Items** are the elements within a row, column, or report filter. In this example, the Region field contains these items: East and West. The Product field contains these items: Pipe, 1/2-inch, Galv; and Pipe, 1/2-inch, Sch 40, etc.

**Values Fields** are fields from the source data that contain values to be summarized. Sales is a values field in Figure 1. For numeric data, users can choose how to summarize the data (sum, average, count, etc.). For text data, users can count the number of times a specific text entry, such as Yes or No, appears in a field.

The **Data Area** is the range of cells in a PivotTable report that contains summarized data. For example, the value in cell C5 summarizes sales for the product Pipe, 1/2-inch, Galv, for the East region in the first quarter of 2012. In other words, cell C5 provides a summary of the sales figures for every row in the source data that contains the items Pipe, 1/2-inch, Galv, East, Qtr1, and 2012.

## Simple PivotTables

A large portion of the productivity and information analysis benefits of using PivotTables is gained with the simplest of PivotTables. In other words, you need not be a PivotTable expert or know how to apply the advanced features of PivotTables in order to take advantage of their power and functionality. The Law of Diminishing Returns applies! As our PivotTables become more complex, the amount of learning required to take advantage of their more complex functionality increases. For most analyses, a simple PivotTable that auto-summarizes or auto-tabulates our data will be very effective and will provide all of the power that we need.

The table of data in **Figure 33** contains sales data extracted from a general ledger. It will serve as the data source for our initial PivotTable examples. Each record represents the total sales by month for a specific product. There are three columns of data – Month, Product, and Sales. The sales figures could be in units, thousands of units, dollars, or thousands of dollars, etc. In this case, we will assume that sales are reported in dollars.

In our sample data set, there are nearly one hundred rows of data, although many data sets may have thousands of rows. The latest version of Excel supports over one million rows in the worksheet grid. PowerPivot in Excel 2013 supports data sets up to ninety-nine billion records. As you can see, PivotTables can be used to summarize very large data sets. While there are no practical limits on the amount of data that can be used in a PivotTable, the more data there is to summarize or analyze, the greater the power of PivotTables.

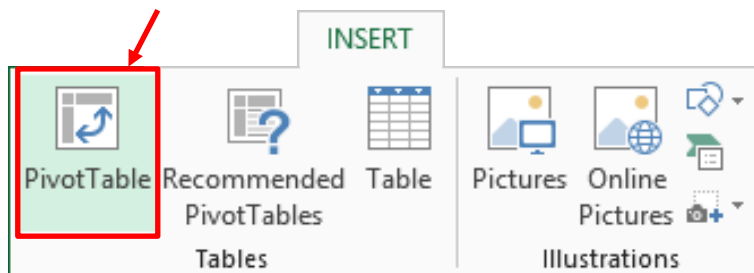
	A	B	C
1	Month	Product	Sales
2	Jan-2015	Pipe, Galv, 1-inch	4,040
3	Jan-2015	Pipe, Galv, 2-inch	4,230
4	Jan-2015	Pipe, Galv, 3-inch	13,460
5	Jan-2015	Pipe, Sch 40, 1-inch	12,110
6	Jan-2015	Pipe, Sch 40, 2-inch	12,350
7	Jan-2015	Pipe, Sch 40, 3-inch	13,460
8	Jan-2015	Tubing, Type L, 1-inch	11,210
9	Jan-2015	Tubing, Type L, 2-inch	1,900
10	Jan-2015	Tubing, Type L, 3-inch	12,080
11	Feb-2015	Pipe, Galv, 1-inch	2,920
12	Feb-2015	Pipe, Galv, 2-inch	2,640
13	Feb-2015	Pipe, Galv, 3-inch	7,170
14	Feb-2015	Pipe, Sch 40, 1-inch	8,600
15	Feb-2015	Pipe, Sch 40, 2-inch	9,090
16	Feb-2015	Pipe, Sch 40, 3-inch	9,560

**Figure 33 - Data for Simple PivotTable Examples**

In our first example, we would like to tabulate the sales figures by Product and by Month of sale. Our completed PivotTable will have rows for the Product and Months for the columns.

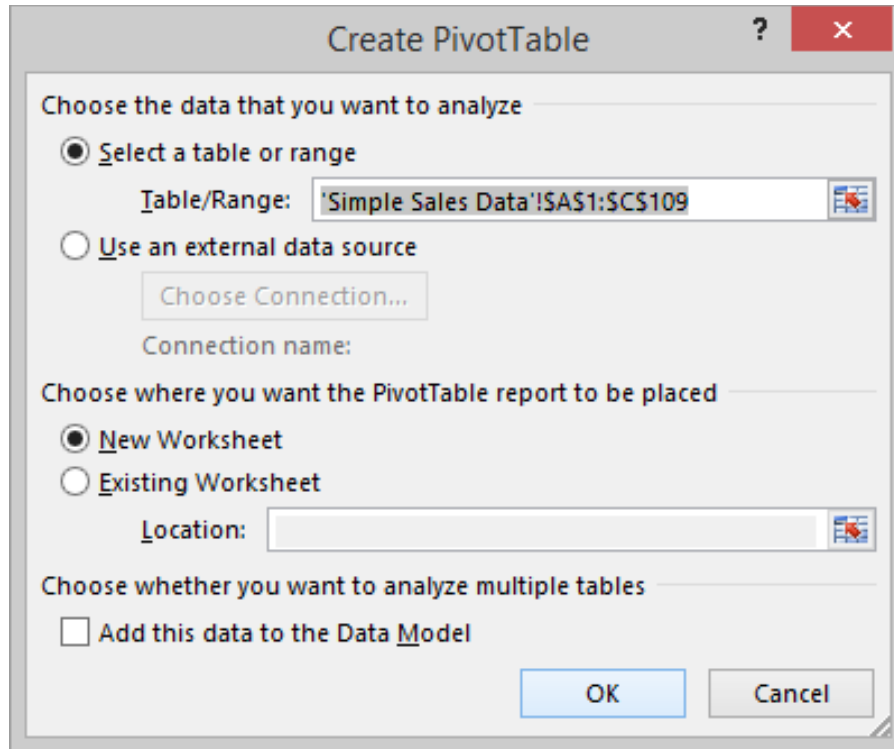
To create a simple PivotTable from our data, do the following.

1. Place the cursor in the data and click **PivotTable** on the **Insert** tab, as shown in **Figure 34**, to open the **Create PivotTable** dialog box.



**Figure 34 - Select PivotTable from the Insert Tab**

2. In the **Create PivotTable** dialog box, shown in **Figure 35**, the data range should already be defined. If not, click the **Collapse Dialog** button and highlight the data range. Make sure that the entire data range is selected, including the field names at the top of the data columns. Select **New Worksheet** and then click **OK**. Note that a Table can serve as a dynamic data range for a PivotTable in Excel 2007/2010/2013.

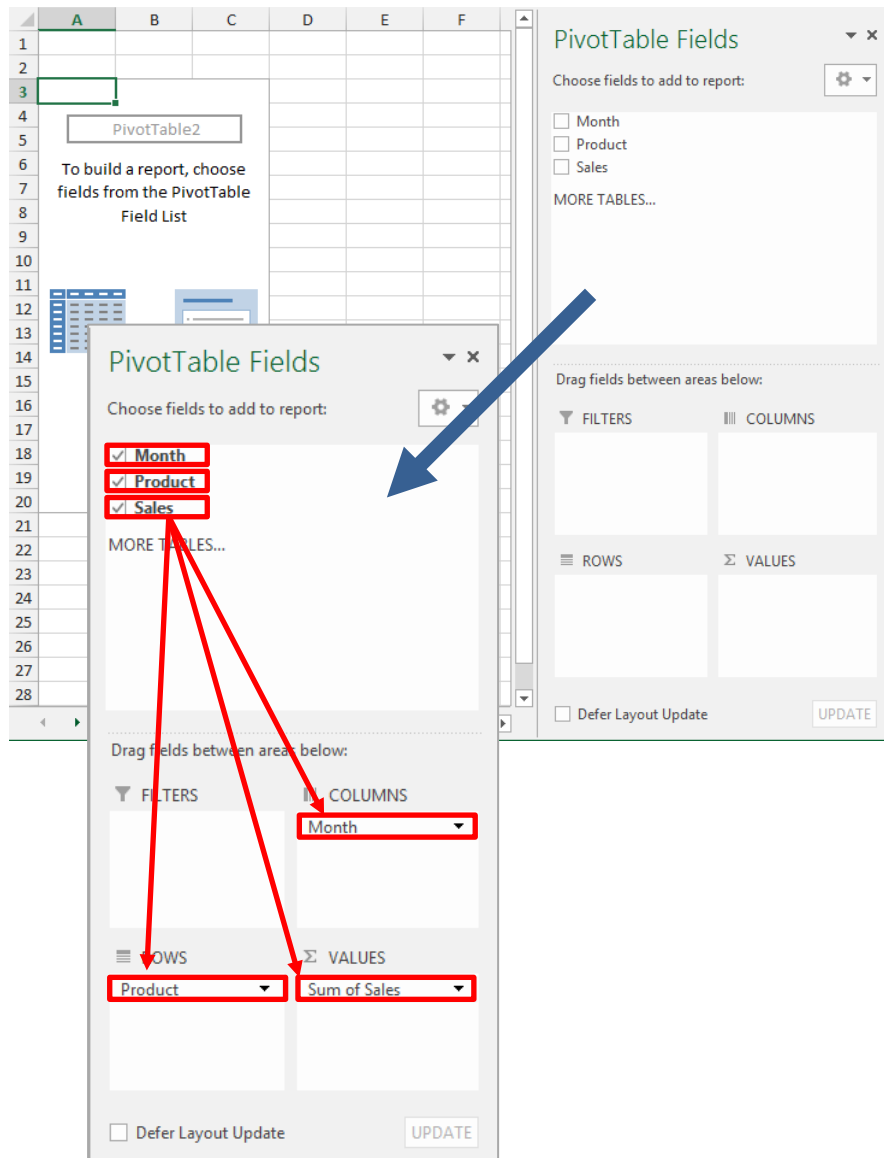


**Figure 35 - Highlight the Data Range and Select New Worksheet**

3. A new worksheet, like the one shown in **Figure 36**, will be inserted in the workbook. On the left side of the worksheet is a placeholder for the PivotTable report to be created. On the right side is the **PivotTable Task Pane**. The layout of the task pane can be customized to a user's needs by clicking the drop-down button in the top right corner of the task pane just below the title bar.
4. The task pane contains the **PivotTable Field List** at the top and four drop areas into which fields can be dragged from the list to create the PivotTable. The drop areas correspond to the four areas of a PivotTable report: Report Filters, Column Labels (column fields), Row Labels (row fields), and Values (data area).



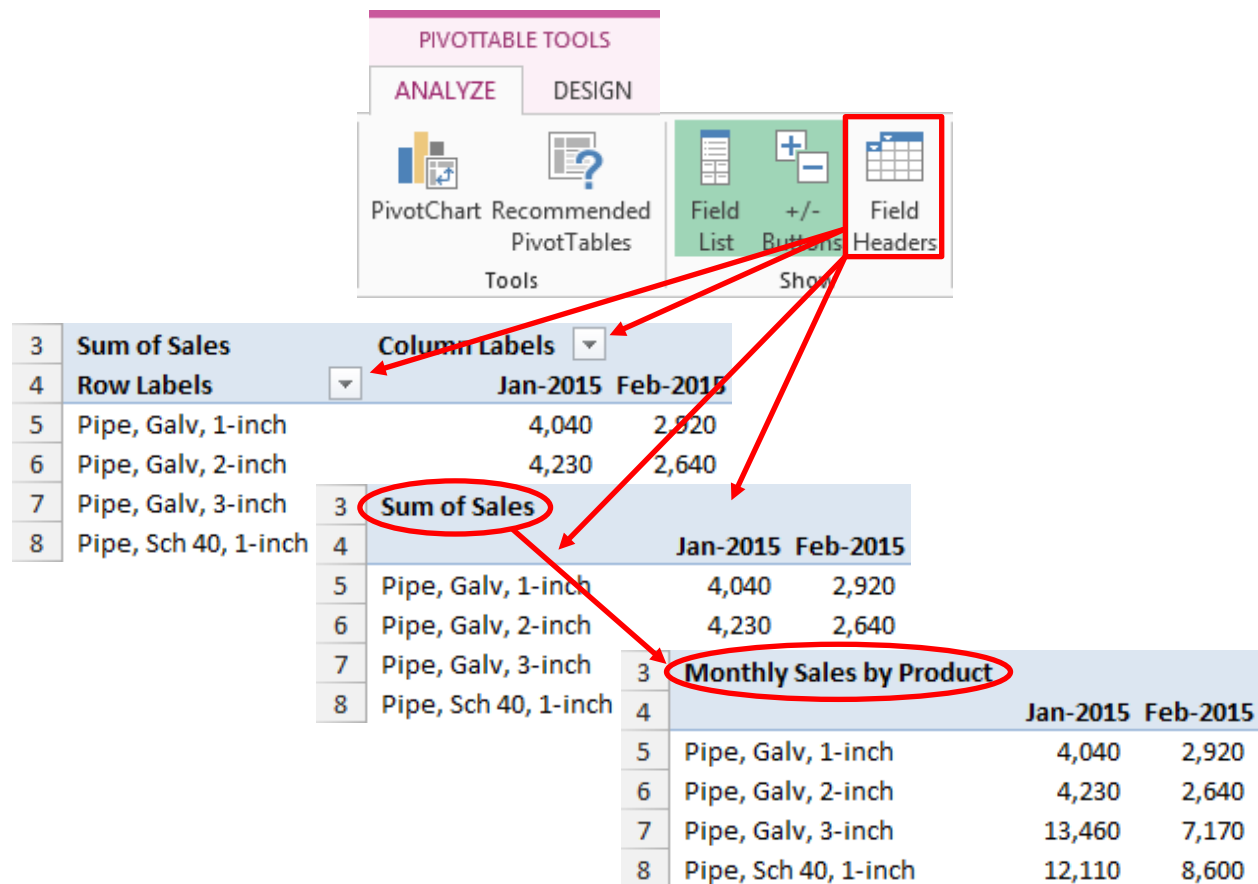
Experienced PivotTable users will recognize Report Filters as Page Fields in earlier versions of Excel. Report Filters are just a new, more descriptive, name for existing functionality. Report Filters serve the same function and work exactly as Page Fields.



**Figure 36 - Creating a PivotTable by Dragging Fields to the Drop Areas**

5. Now, drag each of the fields, in turn, from the field list at the top of the **PivotTable Task Pane** to the drop areas at the bottom, as shown in **Figure 36**.
6. Click on the **Month** field, hold down your left mouse button and drag and point to the **Column Labels** drop area, and then release your left mouse button.
7. Click on the **Product** field, hold down your left mouse button and drag and point to the **Row Labels** drop area, and again release your left mouse button.
8. Click on the **Sales** field, hold down your left mouse button and drag and point to the **Values** drop area, and then release your left mouse button.

Turn off the field headers in the report for presentation. Click **Field Headers** on the **PivotTable Tools, Analyze** tab, to turn off the headers, as shown in **Figure 37**. Next, rename the Sum of Sales label by typing the desired label into the cell. Simply click in the cell containing the label **Sum of Sales** and enter **Monthly Sales by Product**.



**Figure 37 - Hiding the Field Headers and Entering a Descriptive Label for Presentation**

Cells in a PivotTable can be formatted for printing and display just as with any other cell or range of cells. In our example PivotTable, the sales values in the report need to be formatted in the Accounting format with zero decimals and without dollar signs. The first and total rows of the sales values need to be formatted with dollar signs for presentation.

Excel also has a large number of built-in visual styles with which to format PivotTables automatically. These styles, available in the **PivotTables Styles** gallery on the **PivotTable Tools, Design** contextual tab, contain a wide variety of colors and formatting for the table, table headers, and total and subtotal rows. **Figure 38** shows our PivotTable report with the values formatted as dollars and one of the built-in styles applied.

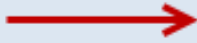
	A	B	C	N
1				
2				
3	<b>Expenditures</b> 			
4		<b>Jan</b>	<b>Feb</b>	<b>Grand Total</b>
5	Beverages	\$ 5,099	\$ 4,448	\$ 60,435
6	Food	25,563	23,221	288,391
7	Insurance	427	427	5,726
8	Payroll Expense	13,658	32,601	347,431
9	Rent	2,400	2,400	28,800
10	Supplies	1,511	1,632	21,736
11	Utility Expense	1,542	2,157	25,506
12	<b>Grand Total</b>	<b>\$ 50,200</b>	<b>\$ 66,887</b>	<b>\$ 778,025</b>

Figure 38 - PivotTable with Accounting Format and Style Applied

### Grouping and Ungrouping Data

Now, let's examine some of the power of PivotTables. To calculate and display quarterly sales totals for each of the products, simply group the months into quarters. Position the cursor in a cell containing one of the monthly column headings, such as **Jan-2015**. Right-click, and choose **Group** to open the **Grouping** dialog box. In the **By** box, click **Quarters**, so that Months and Quarters are highlighted, as shown in **Figure 39**. Click **OK** to complete the task.

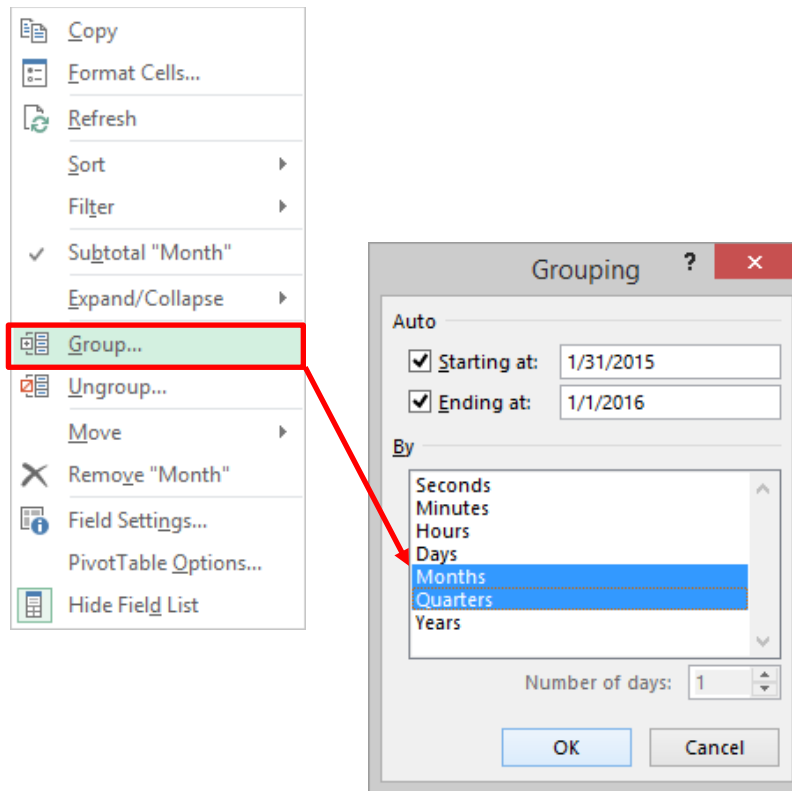


Figure 39 - Grouping Months into Quarters

Turn off the field headers for presentation. On the **PivotTable Tools, Analyze** contextual tab, click on **Field Headers**. Next, position the cursor in a cell containing one of the quarterly column headings, such as **Qtr1**. Right-click on the cell and from the context-sensitive menu, select **Subtotal "Quarters"** to add a quarterly subtotal for each quarter. The initial results are shown in **Figure 40**. Some of the columns have been removed for presentation.

Monthly Sales by Product				
	Qtr1			Qtr1 Total
	Jan	Feb	Mar	
Pipe, Galv, 1-inch	\$ 4,040	\$ 2,920	\$ 3,620	\$ 10,580
Pipe, Galv, 2-inch	4,230	2,640	2,780	9,650
Pipe, Galv, 3-inch	13,460	7,170	4,280	24,910
Pipe, Sch 40, 1-inch	12,110	8,600	10,520	31,230
Pipe, Sch 40, 2-inch	12,350	9,090	10,550	31,990
Pipe, Sch 40, 3-inch	13,460	9,560	11,690	34,710
Tubing, Type L, 1-inch	11,210	8,370	10,690	30,270
Tubing, Type L, 2-inch	1,900	1,440	1,850	5,190
Tubing, Type L, 3-inch	12,080	8,130	9,410	29,620
<b>Grand Total</b>	<b>\$ 84,840</b>	<b>\$ 57,920</b>	<b>\$ 65,390</b>	<b>\$ 208,150</b>

Figure 40 - Results of Grouping Months into Quarters



Again, position the cursor in a cell containing one of the quarterly column headings, such as **Qtr1**. Right-click on the cell and from the context-sensitive menu, select **Expand/Collapse, Collapse Entire Field**. Months are collapsed into Quarters, and all of the totals now reflect quarterly totals as shown in **Figure 41**. Detail can be shown or hidden for a single group or an entire field from the context-sensitive menu.

Monthly Sales by Product					
	⊕ Qtr1	⊕ Qtr2	⊕ Qtr3	⊕ Qtr4	Grand Total
Pipe, Galv, 1-inch	\$ 10,580	\$ 10,630	\$ 13,180	\$ 12,970	\$ 47,360
Pipe, Galv, 2-inch	9,650	5,700	3,130	840	19,320
Pipe, Galv, 3-inch	24,910	18,420	24,450	9,290	77,070
Pipe, Sch 40, 1-inch	31,230	30,050	35,940	34,260	131,480
Pipe, Sch 40, 2-inch	31,990	27,260	27,880	22,590	109,720
Pipe, Sch 40, 3-inch	34,710	33,390	39,930	38,060	146,090
Tubing, Type L, 1-inch	30,270	32,960	43,310	44,620	151,160
Tubing, Type L, 2-inch	5,190	5,820	7,790	8,140	26,940
Tubing, Type L, 3-inch	29,620	24,150	24,410	19,490	97,670
<b>Grand Total</b>	<b>\$ 208,150</b>	<b>\$ 188,380</b>	<b>\$ 220,020</b>	<b>\$ 190,260</b>	<b>\$ 806,810</b>

**Figure 41 - Monthly Data Grouped into Quarters**

To see the detail observations that underlie any of the cells, just double-click on the cell of interest. Excel will insert a new sheet containing the detail observations that created the cell contents. For example, if a user double-clicked on 34,260 (Qtr4 sales for 1-inch Sch 40 Pipe) in our sample PivotTable, Excel would display the underlying detail as shown in **Figure 42**. Note that the data is presented in *Table* form and format, which makes it easy to filter and analyze. In this case, a Total Row was added to the table, thereby providing a supporting schedule for the summarized value.

Month ▼	Product ▼	Sales ▼
10/31/2015	Pipe, Sch 40, 1-inch	9,740
11/30/2015	Pipe, Sch 40, 1-inch	16,140
12/31/2015	Pipe, Sch 40, 1-inch	8,380
<b>Total</b>		<b>34,260</b>

**Figure 42 - Drilling to Detail from a PivotTable**

## Custom Groups

In the example PivotTable, data items were summarized using built-in groups, such as when months were grouped into quarters. However, Excel allows data to be grouped with user-defined groups. To accomplish this task, first highlight the items to be grouped together. Then, right-click and select **Group** from the context-sensitive menu.

In the example PivotTable, we would like to group the products into one of three product lines – Iron, Plastic, and Copper. The galvanized pipe products make up the Iron group, the schedule 40 products make up the Plastic group, and the tubing products make up the Copper group. Click on product **Pipe, Galv, 1-inch**, hold down the **CTRL** key and then select **Pipe, Galv, 2-inch** and **Pipe, Galv, 3-inch**. Next, right-click and choose **Group** from the context sensitive menu. This combines the first three products into a single group. Rename the **Group1** label to **Iron** to complete the first group, as shown in **Figure 43**.

**Monthly Sales by Product**

	Qtr1	Qtr2	Qtr3	Qtr4	Grand Total
Pipe, Galv, 1-inch	\$ 10,580	\$ 10,630	\$ 12,400	\$ 12,970	\$ 47,360
Pipe, Galv, 2-inch	9,650	5,700	3,130	840	19,320
Pipe, Galv, 3-inch					77,070
Pipe, Sch 40, 1-inch					131,480
Pipe, Sch 40, 2-inch					109,720
Pipe, Sch 40, 3-inch					146,090
Tubing, Type L, 1-in					151,160
Tubing, Type L, 2-in					26,940
Tubing, Type L, 3-in					97,670
<b>Grand Total</b>	<b>\$190,260</b>	<b>\$ 806,810</b>			

**Monthly Sales by Product**

	Qtr1	Qtr2
<b>Group1</b>		
Pipe, Galv, 1-inch	\$ 10,580	\$ 10,630
Pipe, Galv, 2-inch	9,650	5,700
Pipe, Galv, 3-inch	24,910	18,420
<b>Pipe, Sch 40, 1-inch</b>		
Pipe, Sch 40, 1-inch	31,230	30,050
<b>Pipe, Sch 40, 2-inch</b>		
Pipe, Sch 40, 2-inch	31,990	27,260

**Monthly Sales by Product**

	Qtr1	Qtr2
<b>Iron</b>		
Pipe, Galv, 1-inch	\$ 10,580	\$ 10,630
Pipe, Galv, 2-inch	9,650	5,700
Pipe, Galv, 3-inch	24,910	18,420
<b>Pipe, Sch 40, 1-inch</b>		
Pipe, Sch 40, 1-inch	31,230	30,050
<b>Pipe, Sch 40, 2-inch</b>		
Pipe, Sch 40, 2-inch	31,990	27,260

**Figure 43 - Grouping Products into Product Groups**

Repeat the steps for each of the two remaining groups, Plastic and Copper. To complete the PivotTable, add subtotals for each of the product groups. Position the cursor in a cell containing one of the group row headings, such as **Iron**. Right-click on the cell and from the context-sensitive menu, select **Subtotal "Product2"** to add a subtotal for each product group. The completed report should resemble the one shown in **Figure 44**.

Monthly Sales by Product					
	⊕ Qtr1	⊕ Qtr2	⊕ Qtr3	⊕ Qtr4	Grand Total
⊖ Iron	45,140	34,750	40,760	23,100	143,750
Pipe, Galv, 1-inch	\$ 10,580	\$ 10,630	\$ 13,180	\$ 12,970	\$ 47,360
Pipe, Galv, 2-inch	9,650	5,700	3,130	840	19,320
Pipe, Galv, 3-inch	24,910	18,420	24,450	9,290	77,070
⊖ Plastic	97,930	90,700	103,750	94,910	387,290
Pipe, Sch 40, 1-inch	31,230	30,050	35,940	34,260	131,480
Pipe, Sch 40, 2-inch	31,990	27,260	27,880	22,590	109,720
Pipe, Sch 40, 3-inch	34,710	33,390	39,930	38,060	146,090
⊖ Copper	65,080	62,930	75,510	72,250	275,770
Tubing, Type L, 1-inch	30,270	32,960	43,310	44,620	151,160
Tubing, Type L, 2-inch	5,190	5,820	7,790	8,140	26,940
Tubing, Type L, 3-inch	29,620	24,150	24,410	19,490	97,670
Grand Total	\$ 208,150	\$ 188,380	\$ 220,020	\$ 190,260	\$ 806,810

Figure 44 - PivotTable with Product Groups and Subtotals



Note that the default field name, **Product2**, given by Excel to the product group can be renamed in **Field Settings**. Right-click on any one of the group labels and select **Field Settings** from the context-sensitive menu. In the **Field Settings** dialog box, type in the desired field name, such as Product Line, in the **Custom Name** box and click **OK**.

Note that the default Compact layout puts group subtotals at the top of the group on the same line with the group name. If subtotals are desired at the bottom of each group, select **Subtotals, Show All Subtotals at Bottom of Group** on the **PivotTable Tools, Design** contextual tab. Alternatively, right-click on any one of the group labels and select **Field Settings**. In the **Field Settings** dialog box, on the **Layout & Print** tab, uncheck **Display subtotals at the top of each group**, and click **OK**.

## Pivoting Columns and Rows

The summarized table can be rearranged, or pivoted, to show the data from any perspective. Along with the ability to group or ungroup data, being able to immediately rearrange the table is among the most powerful features of PivotTables. For example, if users wanted to display Products as the columns and Quarterly Totals as the rows, they would simply rearrange the rows and columns by dragging and dropping the fields in the drop areas. Continuing with our example PivotTable, follow along with your instructor as we demonstrate the ease of rearranging a PivotTable report.

1. Position the cursor in the PivotTable report to display the **PivotTable Task Pane**. In the field list at the top of the task pane, uncheck **Month** and **Product Line** to remove them from the report. Click-and-drag **Quarters** to the **Row Labels** drop area below **Product**. This has the effect of reporting Quarters within Products, as shown in **Figure 45**.

The figure illustrates the process of rearranging a PivotTable report by dragging fields between the task pane and the report. The task pane shows the field list with 'Month' and 'Product Line' unchecked, and 'Quarters' moved to the ROWS area. The resulting report shows 'Product' as the column labels and 'Quarters' as the row labels, with 'Sales' as the values.

	Sales
<b>Pipe, Galv, 1-inch</b>	<b>\$ 47,360</b>
Qtr1	10,580
Qtr2	10,630
Qtr3	13,180
Qtr4	12,970
<b>Pipe, Galv, 2-inch</b>	<b>19,320</b>
Qtr1	9,650
Qtr2	5,700
Qtr3	3,130
Qtr4	840
<b>Pipe, Galv, 3-inch</b>	<b>77,070</b>
Qtr1	24,910
Qtr2	18,420
Qtr3	24,450
Qtr4	9,290

**Figure 45 - Dragging Fields in the PivotTable Task Pane to Rearrange a Report**

2. Now, click-and-drag **Quarters** to the **Column Labels** drop area. This rearranges the report so that Products are the columns and Quarters are the rows.

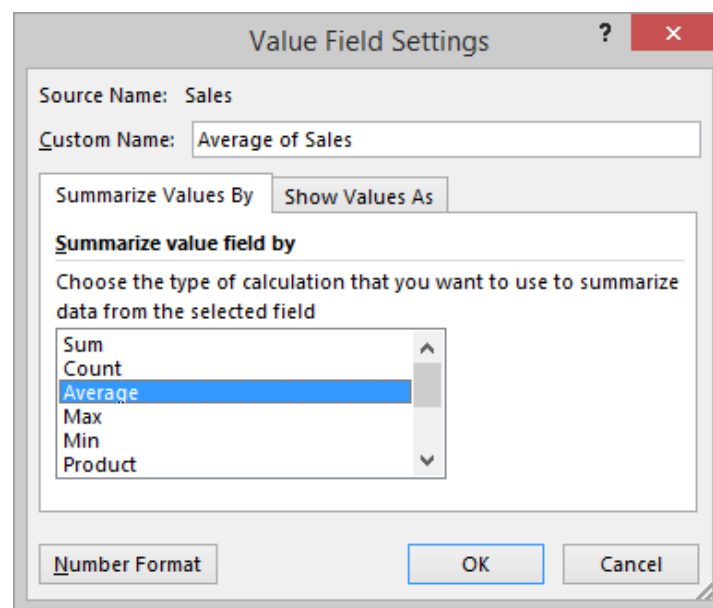
To review, we are simply dragging the field buttons to different drop areas in the PivotTable Task Pane in order to rearrange the report. We can view a report with Month and/or Quarters across the columns and Products as the rows, or Products as the columns and Months and/or Quarters as the rows, Months within Products, or Products within Months, etc. The number of ways that we can view a PivotTable is limited only by the number of fields that we have to display and our imagination.

At first glance, the power of PivotTables to reduce the time and tedium of preparing routine reports is significant. However, the real power of PivotTables is not clerical; it is the added ability they provide to view data from different perspectives. By viewing data from different perspectives, PivotTables increase the probability of uncovering relationships in the data that were previously unknown and of exploiting these relationships on behalf of our company or our clients. Now, that's analytical power!

## Using Field Settings

In our PivotTable examples above, the individual data elements were summed to produce the report. By changing field settings, we can display the average sales in each cell, or the minimum or maximum sales, or the variance or standard deviation of the sales distribution, etc. Field Settings are accessible in any of several ways: 1) Right-click on a field label and select **Field Settings** or **Value Field Settings** from the context-sensitive menu, 2) Position the cursor in a cell containing a field label or value and select **Field Settings** from the **PivotTable Tools, Analyze** contextual tab, or 3) Click the drop-down arrow of any field button in a drop area in the PivotTable Task Pane and select **Field Settings** or **Value Field Settings** from the menu.

To change the summary function for any value field, open the **Value Field Settings** dialog box using any of the described methods. In the **Summarize value field by** box, select the function to use in summarizing the field's values. To summarize the selected field by calculating averages, select **Average**, as shown in **Figure 46**.



**Figure 46 - Changing the Summary Function for a Value Field**

In the next example, a PivotTable report that displays four columns, one each for the total annual sales by product, the average sales by product, and the minimum and maximum sales by product will be created. Since the statistics are calculated on sales data, the sales field must be dragged to the **Values** drop area four times, once for each summary column to be displayed. The Field Settings (field name and

summary function) for each field are then modified, in turn, to reflect the appropriate calculation. **Figure 47** illustrates this process and the finished report. Follow along with your instructor as we explore multi-column reports and field settings.

The image illustrates the process of creating a multi-column PivotTable. On the left, the **PivotTable Fields** task pane shows the **Sales** field checked. Below it, the **VALUES** area shows a list of aggregation functions: Total, Mean, Min, and **Sum of Sales3**. A right-click context menu is open over **Sum of Sales3**, with **Value Field Settings...** highlighted. In the center, the **Value Field Settings** dialog box is shown. The **Source Name** is **Sales**, and the **Custom Name** is **Max**. Under the **Summarize value field by** tab, the **Summarize Values By** list has **Max** selected. A red arrow points from the **Max** selection in the list to the **Custom Name** field. A blue arrow points from the **Max** selection in the list to the **Max** column header in the PivotTable. On the right, the resulting PivotTable report is displayed with columns for **Total**, **Mean**, **Min**, and **Max**.

	Total	Mean	Min	Max
Pipe, Galv, 1-inch	\$ 47,360	\$3,947	\$2,640	\$ 6,110
Pipe, Galv, 2-inch	19,320	1,610	230	4,230
Pipe, Galv, 3-inch	77,070	6,423	310	13,460
Pipe, Sch 40, 1-inch	131,480	10,957	7,370	16,140
Pipe, Sch 40, 2-inch	109,720	9,143	5,220	12,810
Pipe, Sch 40, 3-inch	146,090	12,174	8,190	17,930
Tubing, Type L, 1-inch	151,160	12,597	8,370	21,050
Tubing, Type L, 2-inch	26,940	2,245	1,440	3,840
Tubing, Type L, 3-inch	97,670	8,139	4,470	12,080
<b>Grand Total</b>	<b>\$ 806,810</b>	<b>\$ 7,470</b>	<b>\$ 230</b>	<b>\$ 21,050</b>

**Figure 47 - Creating a Multi-Column PivotTable to Display Sales Statistics**

Let's add another column to our report. In this final example, the CFO would like to have a column that displays the sales of each product as a percentage of total sales. Since the column will summarize sales data, the **Sales** field must be dragged to the **VALUES** drop area once again. Right-click on its column heading and select **Value Field Settings**. Click on the **Show values as** tab and in the **Show values as** drop-down list, select **% of column** and click **OK**. Type in **Percent** as the new column heading, drag the new Percent column just to the left and adjacent to the Totals column, and then adjust the column widths to complete the PivotTable report, as shown in **Figure 48**.

The image shows the configuration of a PivotTable in Excel. At the top, a PivotTable displays sales data categorized by product type (Pipe and Tubing) and size (1-inch, 2-inch, 3-inch). The columns are Total, Percent, Mean, Min, and Max. The 'Percent' column shows values as a percentage of the total sales for each category.

The PivotTable Fields task pane on the right shows the 'Sales' field selected. The 'Show values as' section in the Value Field Settings dialog box is set to '% of Column Total'.

	Total	Percent	Mean	Min	Max
Pipe, Galv, 1-inch	\$ 47,360	5.87%	\$3,947	\$2,640	\$ 6,110
Pipe, Galv, 2-inch	19,320	2.39%	1,610	230	4,230
Pipe, Galv, 3-inch	77,070	9.55%			
Pipe, Sch 40, 1-inch	131,480	16.30%			
Pipe, Sch 40, 2-inch	109,720	13.60%			
Pipe, Sch 40, 3-inch	146,090	18.11%			
Tubing, Type L, 1-inch	151,160	18.74%			
Tubing, Type L, 2-inch	26,940	3.34%			
Tubing, Type L, 3-inch	97,670	12.11%			
<b>Grand Total</b>	<b>\$ 806,810</b>	<b>100.00%</b>			

**PivotTable Fields**

Choose fields to add to report:

- ☐ Month
- ☒ Product
- ☒ Sales
- ☐ Quarters
- ☐ Product Line

MORE TABLES...

Drag fields between areas below:

**FILTERS**

**COLUMNS**

**ROWS**

**VALUES**

Product

Total

Percent

Mean

Min

Max

Defer Layout Update

UPDATE

**Value Field Settings**

Source Name: Sales

Custom Name: Percent

Summarize Values By

Show Values As

Show values as

- % of Column Total
- No Calculation
- % of Grand Total
- % of Row Total
- % Of
- % of Parent Row Total

Product Line

Number Format

OK

Cancel

Figure 48 - Using Percentage of Column to Display Sales as a Percentage of Total Sales

## Sorting and Filtering Fields

The latest versions of Excel provide enhanced context-sensitive sorting and filtering of PivotTable fields. All of the sorting and filtering capabilities are easily accessible in the **Field List** at the top of the **PivotTable Task Pane**. Click the drop-down arrow of any field button and select the appropriate sort or filter options, as shown in **Figure 49**.

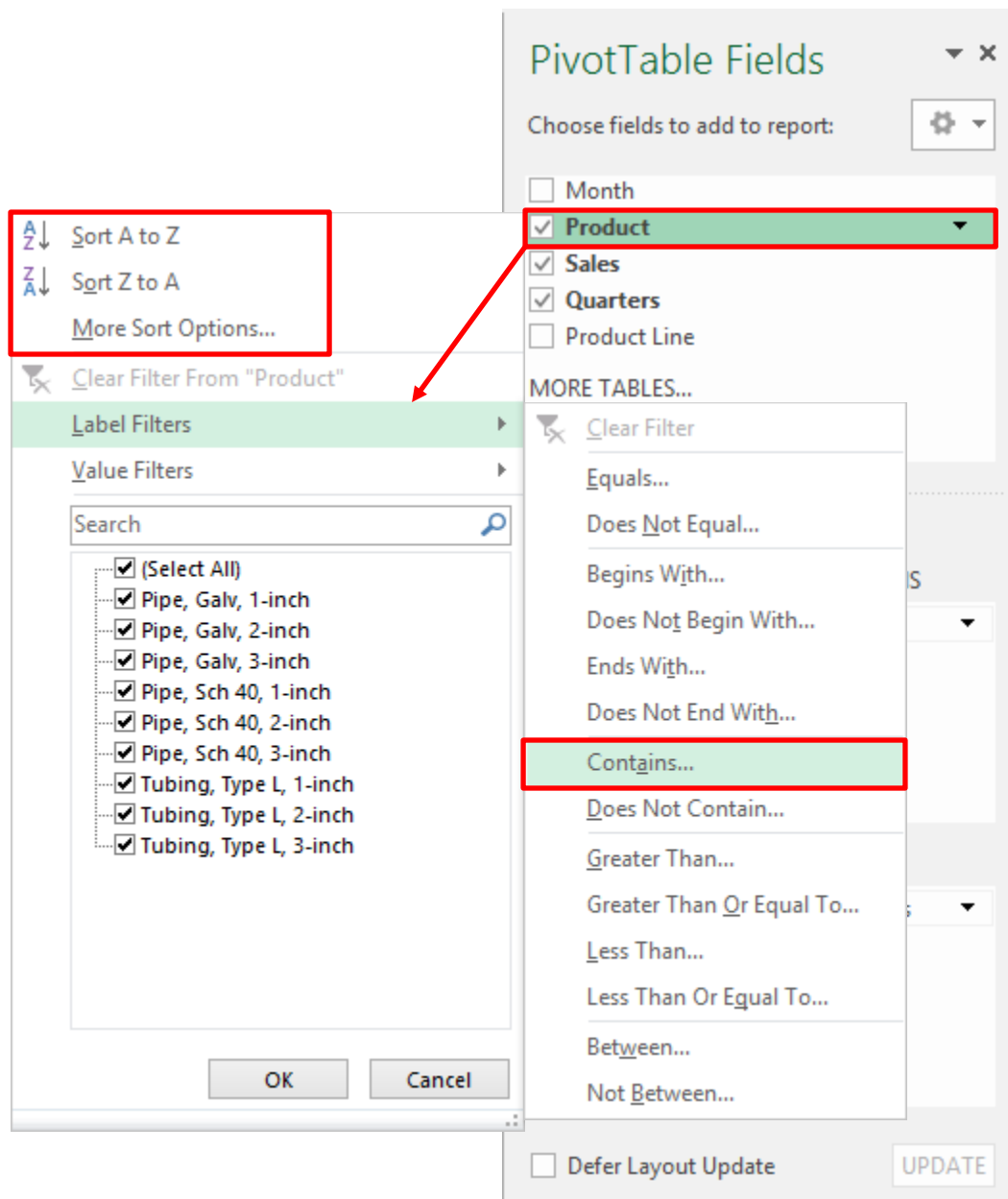


Figure 49 - Sorting or Filtering PivotTable Fields

## Updating the Underlying Data

Whenever data is changed, updated, or added to the underlying data set, a user must refresh the PivotTable to see the changes reflected in the report. Position the cursor anywhere in the PivotTable report, and then right-click and choose **Refresh** from the context-sensitive menu. Alternatively, click the **Refresh** button on the **PivotTable Tools, Analyze** contextual tab. Note that it is best practice to refresh a PivotTable after re-arranging a complex report.

If data is added or removed from the data range and the size of the range changes, then users *may* have to modify the data range. If the data range is an Excel *table*, no action is necessary. A table is a dynamic



range that re-adjusts its dimensions automatically as data is added or removed. Similarly, if the data range is a named dynamic range, no action is necessary. However, if the data range is an ordinary range specified using cell references, the data range must be adjusted. To adjust the data range, position the cursor in the PivotTable report. On the **PivotTable Tools, Analyze** contextual tab, click **Change Data Source**. In the **Change PivotTable Data Source** dialog box, re-specify the data range and click **OK**. The existing PivotTable will be updated to reflect the new data.

## Recommended PivotTables in Excel 2013

Excel 2013 attempts to ease the burden of learning how to use PivotTables with Recommended PivotTables. Excel produces a gallery or pre-configured PivotTables, from which a user need only make a selection.

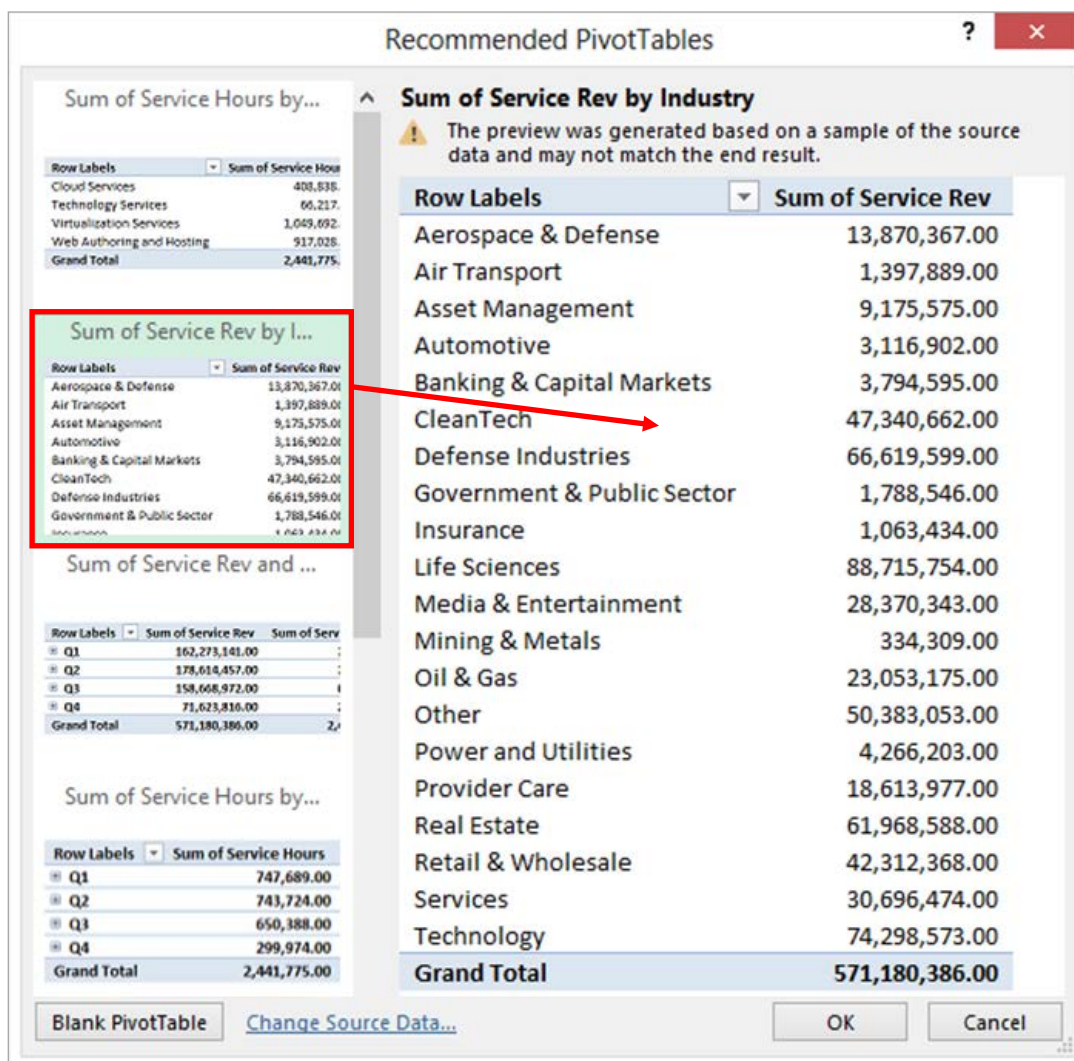


Figure 50 - Creating a PivotTable with Recommended PivotTables

While the PivotTables produced by this functionality are the simplest of reports, they can serve as the foundation for more sophisticated analysis. In this context, Recommended PivotTables can save many steps in the report creation process, thereby saving time and delivering greater staff productivity.

Producing a recommended PivotTable takes just a few clicks. Highlight the data, including the field names, or use a Table for the data, and then click **Recommended PivotTables** on the **Insert** tab. From the gallery of PivotTables, select the one that best summarizes the data and click **OK**, as shown in **Figure 50**. The PivotTable may then be customized and formatted to meet a user's needs. Note that recommended PivotTables can also be created from the **Tables** tab of the **Quick Analysis** lens.

## PivotTables on External Data Sources

Most users build PivotTables on data stored in the workbook where the PivotTable is being built. Under these circumstances, the creation and update of a report will require the extraction of data from the application where the data is stored and maintained, which is usually the general ledger or other business application. Alternatively, we could use the Open DataBase Connectivity (ODBC) capabilities of Excel to extract the data from the general ledger. Once we connect a PivotTable to our general ledger using ODBC, Excel becomes an extraordinarily effective *ad hoc* reporting engine.

### What is ODBC?

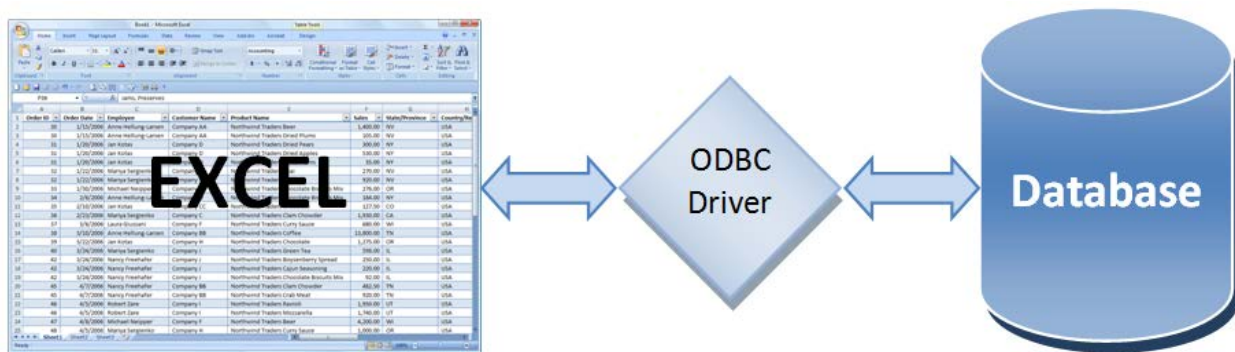
ODBC is a standard database access method developed by the SQL Access group in 1992. With ODBC, it is possible to access data stored in any ODBC-compliant database from within any ODBC-compliant application. ODBC manages this by inserting a middle layer, called an ODBC driver, between the application and the database management system (DBMS) that translates the application's data queries into commands that the DBMS understands. ODBC can be used to provide two-way integration between Excel and the general ledger, although generally ODBC is used only to extract data.

ODBC is an open, vendor-neutral interface for database connectivity that provides access to a variety of PC, RISC, and mainframe database systems. The ODBC programming interface permits a developer to build an application without targeting a specific DBMS. Users can add drivers that link their applications to a database management system and then can access their data using conventional SQL query commands. Most accounting software applications support ODBC. If your accounting software supports ODBC, then Excel can access historical data directly in the general ledger without re-keying any data or going through the typical import-export process used by most management accountants.

All of the Microsoft Office applications are ODBC compliant. Office comes with ODBC drivers for Access, Excel, dBase, and text files. Windows 7 and Windows 8 broaden the ODBC capabilities of Windows applications by adding drivers for SQL Server, Visual FoxPro, Oracle, and Paradox. The Windows ODBC drivers are part of Microsoft Data Access Components (MDAC), the latest version of which can be downloaded from the Microsoft web site.

## Extracting Data from an External Database

Using ODBC, Excel can easily connect to an external database and extract any necessary data. **Figure 51** depicts a graphical representation of the data access process. Direct extraction may not solve all of our problems. In earlier versions of Excel, it was not uncommon for a data extraction to exceed the row or column capacity of Excel. Users were forced to use an intermediary database, such as Access, to store the data temporarily. However, if users extract data directly into a PivotTable and thereby summarize the data in a limited number of rows or columns, the row and column limits of Excel are not exceeded even if the data itself exceeds the limitations.

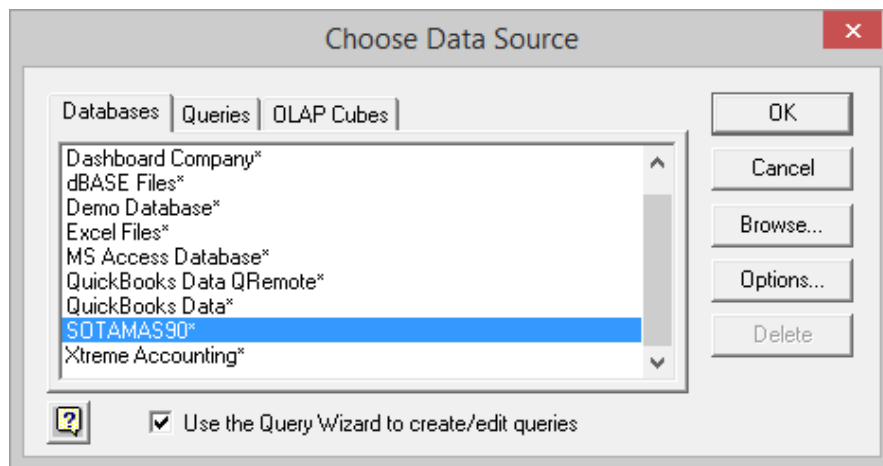


**Figure 51 - Accessing Data in Excel Using ODBC**

The process of creating a PivotTable from an external database is the same as for any other PivotTable except that users must specify a source database and the database fields that contain the data of interest. If the data source has already been defined in Excel, the PivotTable creation process is simplified. On the **Insert** tab, select **PivotTable, PivotTable**. In the **Create PivotTable** dialog box, select **Use an external data source** and click **Choose Connection**. Select an existing data source in the **Existing Connection** dialog box and click **Open**. Then, continue the process to create the desired PivotTable.

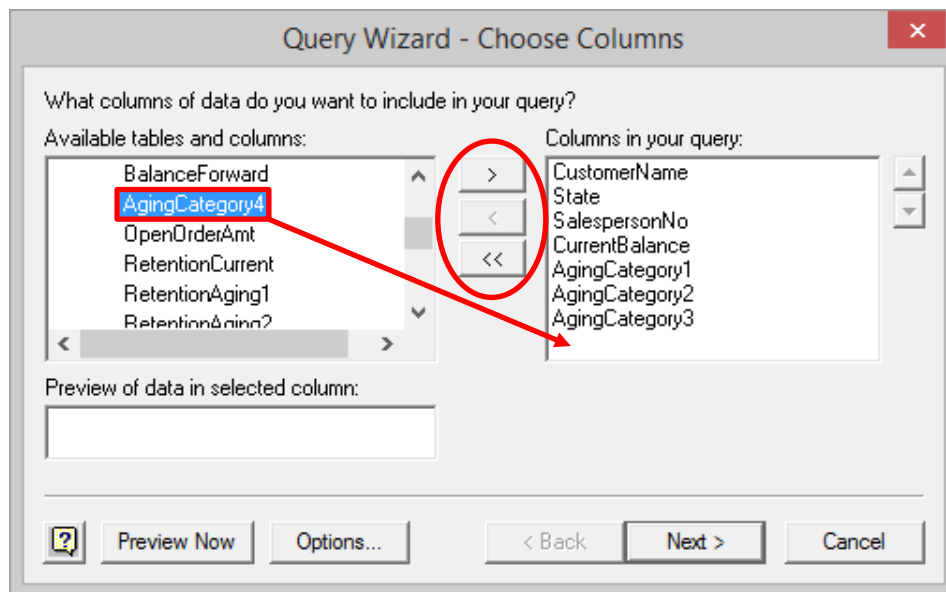
If the data source has not been defined, begin the PivotTable creation process on the **Data** tab. Click **From Other Sources, From Microsoft Query** to open the **Choose Data Source** dialog box. Select the appropriate ODBC data source, and click **OK**, as shown in **Figure 52**. In the resulting dialog box, select the desired tables and/or fields from the table list.

In this example, we will be using MAS 90 data from the ABC sample company file. After selecting the data source in the dialog box shown in Figure 52, choose a company file and authenticate to MAS 90, if necessary, by entering a username and password. The ODBC driver for MAS 90 requires authentication for each use if ODBC security is enabled. ODBC security can be set from within MAS 90 to restrict access to the general ledger data on a user by user basis. When users authenticate themselves to a company file, the users will only have access to the data for which they have been granted specific rights and permissions. Only a MAS 90 administrator can alter the data access rights and permissions of an individual user.



**Figure 52 - Selecting the External Data Source**

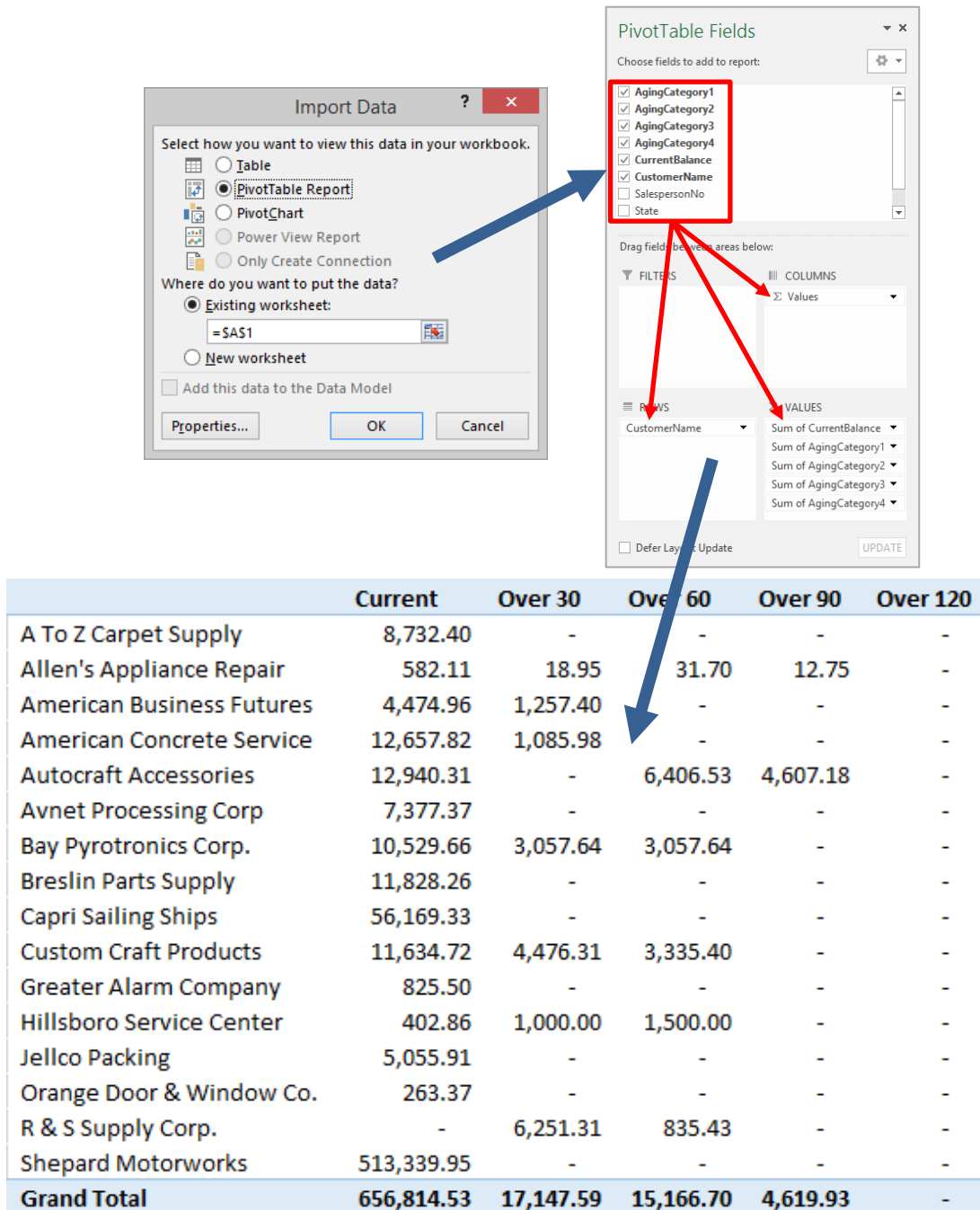
Next, choose the desired fields from a single table, in this case the customer master file, **AR\_Customers**. Expand the field list by clicking on the plus (+) sign to the left of the table name in the left-hand pane. Then, choose the fields that are to be displayed in the report and click on the (>) button to move them to the right hand pane, as shown below in **Figure 53**. Select the following fields: **CustomerNo**, **State**, **SalespersonNo**, **CurrentBalance**, **AgingCategory1**, **AgingCategory2**, **AgingCategory3**, and **Aging Category4**.



**Figure 53 - Select the Fields for the Report**

After the required fields are selected, click **Next** several times. In the **Query Wizard - Finish** pane, select **Return Data to Microsoft Office Excel** and click **Finish**. In the **Import Data** dialog box, select **PivotTable Report**, specify the location for the report, and then click **OK**. Next, drag and drop the fields to the

appropriate report drop areas in the **PivotTable Task Pane**, rename and format the column labels, choose a number format for the data, and complete the PivotTable just as with any other. The major difference is that this PivotTable is dynamically linked to the underlying data in the General Ledger. If users need the same report next week or next month, all they need to do is retrieve the workbook, refresh the PivotTable, and print the updated report. The process to update and print the report takes seconds to complete. **Figure 54** illustrates the creation of the initial PivotTable.

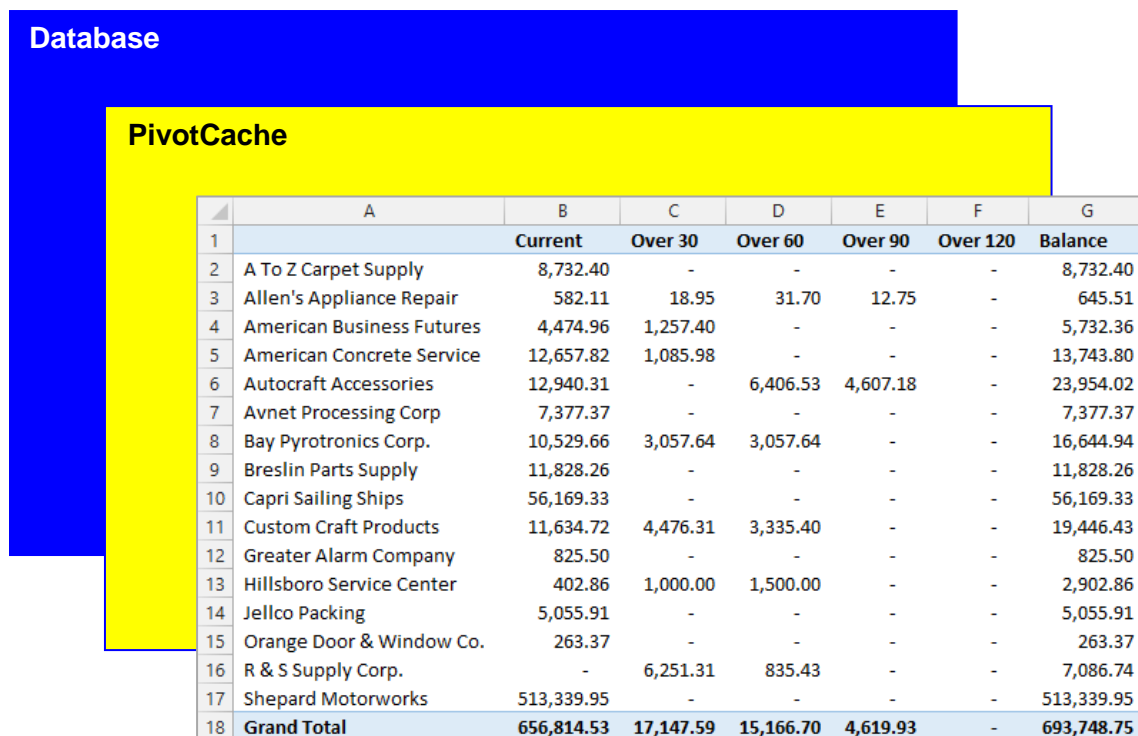


**Figure 54 - Creating a PivotTable Connected to an External Data Source**

## The PivotCache – A Temporary Data Store

Would users be able to send this report by e-mail to their managing partner in another office? After all, the PivotTable gets its data from MAS 90, and the managing partner doesn't have access to the data. The simple answer is "Yes." When Excel retrieves data from a data source, it puts the data into a work area called the PivotCache. The PivotTable is actually built on the data residing in the cache, not directly on the data in the external database. The reason for this is to speed up the data manipulation process – the dragging and dropping, the grouping, the renaming, and the rearranging – that goes on when we use PivotTables. **Figure 55** illustrates the PivotTable data model.

The PivotCache becomes part of the workbook and is always in the background, unseen and inaccessible except through the PivotTable. Whenever a user sends a PivotTable by e-mail or direct file transfer, the PivotCache accompanies the PivotTable as part of the workbook, so that the recipient can view the report and drill down to the underlying details as if she were connected to the MAS 90 database.



	A	B	C	D	E	F	G
1		Current	Over 30	Over 60	Over 90	Over 120	Balance
2	A To Z Carpet Supply	8,732.40	-	-	-	-	8,732.40
3	Allen's Appliance Repair	582.11	18.95	31.70	12.75	-	645.51
4	American Business Futures	4,474.96	1,257.40	-	-	-	5,732.36
5	American Concrete Service	12,657.82	1,085.98	-	-	-	13,743.80
6	Autocraft Accessories	12,940.31	-	6,406.53	4,607.18	-	23,954.02
7	Avnet Processing Corp	7,377.37	-	-	-	-	7,377.37
8	Bay Pyrotronics Corp.	10,529.66	3,057.64	3,057.64	-	-	16,644.94
9	Breslin Parts Supply	11,828.26	-	-	-	-	11,828.26
10	Capri Sailing Ships	56,169.33	-	-	-	-	56,169.33
11	Custom Craft Products	11,634.72	4,476.31	3,335.40	-	-	19,446.43
12	Greater Alarm Company	825.50	-	-	-	-	825.50
13	Hillsboro Service Center	402.86	1,000.00	1,500.00	-	-	2,902.86
14	Jellco Packing	5,055.91	-	-	-	-	5,055.91
15	Orange Door & Window Co.	263.37	-	-	-	-	263.37
16	R & S Supply Corp.	-	6,251.31	835.43	-	-	7,086.74
17	Shepard Motorworks	513,339.95	-	-	-	-	513,339.95
18	<b>Grand Total</b>	<b>656,814.53</b>	<b>17,147.59</b>	<b>15,166.70</b>	<b>4,619.93</b>	<b>-</b>	<b>693,748.75</b>

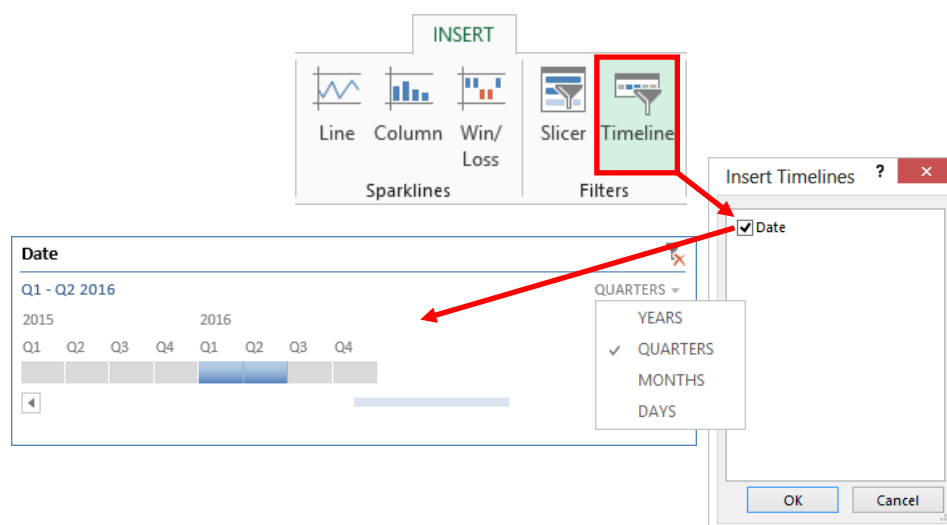
**Figure 55 - PivotTable Data Model**

## Timeline Filters

Timeline filters in Excel 2013 are similar to slicers, but are used to filter date fields in PivotTables. If you are using PivotTables to analyze transactional data, every record in your data set will have a date associated with it. Usually, dates are grouped into months, quarters, or years for reporting and analysis. Date grouping adds another layer of complexity that makes it more difficult for less knowledgeable users to create and manipulate PivotTables. That's where Timelines come in to play. Simply click in a PivotTable and select **Timeline** from the **Insert** tab to produce a Timeline filter as displayed in **Figure 56**. To change how the data is grouped (months, quarters, or years), click the drop-down in the upper right hand corner



of the Timeline control. To filter the PivotTable, click on a period button, such as **Q1**, **Q2**, etc., or drag your mouse across the Timeline to select multiple periods. The selected period is displayed in the upper left hand corner of the control.



**Figure 56 – Using a Timeline to Filter Dates in a PivotTable**

## Flash Fill

Flash Fill is a new data manipulation feature that allows users to split, combine, or rearrange data quickly and easily without using commands or complicated formulas. Whether it's rearranging customer contact names, inserting parentheses and hyphens in telephone numbers, or separating account numbers and account names in a QuickBooks trial balance, Flash Fill can get the job done, as shown in **Figure 57**.

Contact	Phone	Account No and Account	
Abercrombie, Kristy	4155556579	10100 · Checking	
Allard, Robert	6505553422	10300 · Savings	
Contact Name	Phone	Account No	Account
Baker, Chris	(415) 555-6579	10400 · Petty Cash	10100 Checking
Balak, Mike	(650) 055-3422	11000 · Accounts Receivable	10300 Savings
Barley, Renee	(415) 555-2253	12000 · Undeposited Funds	10400 Petty Cash
Bauman, Mark	(415) 555-6636	12100 · Inventory Asset	11000 Accounts Receivable
Bolinski, Rafal	(415) 555-7262	12800 · Employee Advances	12000 Undeposited Funds
Bristol, Sonya	(415) 555-8669	13100 · Pre-paid Insurance	12100 Inventory Asset
Burch, Jason	(415) 555-3262	13400 · Retainage Receivable	12800 Employee Advances
	(415) 555-5239	15000 · Furniture and Equipment	13100 Pre-paid Insurance
	(415) 555-2351		13400 Retainage Receivable
			15000 Furniture and Equipment

**Figure 57 – Use Flash Fill to Manipulate Data**

There are multiple ways to apply Flash Fill. In default, Excel displays Flash Fill suggestions as you work. As shown in **Figure 58**, a user has modified the first record and has moved to the second record. As the user begins modifying the second record, Excel automatically displays a suggested flash fill for the column. At that point, the user can press **ENTER** to accept the suggested flash fill or press **ESC** to cancel the suggested

fill. Alternatively, select **Data, Flash Fill** from the ribbon or press **CTRL + E** to execute Flash Fill from the keyboard.

To reformat a list of telephone numbers, type one number as it is to appear with parentheses and a hyphen, press **ENTER**, and then press **CTRL + E**. If Excel is unsure of what is to be done for any record, it will skip the record. Move the cursor to a skipped record and "correct" it, and then press **CTRL + E** to fill similar records. Continue this process until the entire column has been updated.

Contact	Phone	Contact Name	Phone
Abercrombie, Kristy	4155556579	Kristy Abercrombie	(415) 555-6579
Allard, Robert	6505553422	Robert Allard	(650) 055-3422
Baker, Chris		Chris Baker	(415) 555-2253
Balak, Mike		Mike Balak	(415) 555-6636
Barley, Renee		Renee Barley	(415) 555-7262
Bauman, Mark		Mark Bauman	(415) 555-8669
Bolinski, Rafal	4155553262	Rafal Bolinski	(415) 555-3262
Bristol, Sonya	4155555239	Sonya Bristol	(415) 555-5239
Burch, Jason	4155552351	Jason Burch	(415) 555-2351

**Figure 58 – Excel Automatically Displays a Suggested Flash Fill**

Here's a few tips for using Flash Fill effectively:

- Flash Fill does not create formulas related to the original records, so the original data column can be deleted without impact on the fill column.
- The fill column need not be adjacent to the column that contains the data to be manipulated, but make sure that there are no blank columns between the original data and the intended fill column.
- Flash Fill cannot be used to transform numbers. For example, Flash Fill cannot be used to divide a column of numbers by five. Use formulas instead.
- A column can be filled from any record in the column. If the first record contains ambiguous data, use another record to demonstrate how the data is to be manipulated and then press **CTRL + E** to force the execution of Flash Fill.
- Flash Fill is a pattern recognition engine, not a logic engine. Flash Fill cannot be used to convert state names to state abbreviations because it does not recognize that UT and LA are the abbreviations for Utah and Louisiana, respectively. Use Custom Lists or a VLOOKUP table instead.

## The Excel Data Model

All versions of Excel 2013 include the Excel Data Model, a core in-memory OLAP data engine. The Data Model provides users with additional PivotTable functionality, but it also removes some functionality with which many users are familiar and are accustomed to using. In order to use the newest and most powerful functionality associated with the Data Model, users must give up some tried and true functionality.

The Excel data model provides PivotTables with new and powerful functionality.



- PivotTables can be built from multiple related tables. The ability to establish relationships between tables eliminates the need to build VLOOKUP formulas to cross-reference information stored in different tables. Relationships between tables can be defined before or during the PivotTable building process.
- PivotCharts without an accompanying PivotTable (Standalone Pivot Charts) are available in Excel 2013 when the data is stored in the Excel Data Model.
- Quick Explore, a revolutionary way to drill to detail, allows users to drill up, down, and around a PivotTable to examine and explore a report's underlying data more easily. In order to use Quick Explore, a PivotTable must be built on the Excel Data Model.
- Since the Excel Data Model is an OLAP data engine, this allows users to convert PivotTables to formulas using the OLAP Tools available in Excel 2013. This converts a PivotTable from a single unitary object into individual cells connected to the underlying data, which allows users to insert rows or columns, to create subtotals as required, or to move connected cells to produce entirely different reports. All this can be done without breaking the links to the underlying data or impairing the ability to refresh a report after the data has been updated.

Notwithstanding the powerful advantages of building PivotTables on the Excel Data Model, there are several significant disadvantages.

- Grouping of items is not available in a PivotTable built on the Data Model. Neither built-in date grouping nor custom item grouping is available. Calculated fields can be created in the source data to work around this limitation.
- Calculated fields and items are not supported. Calculated fields can be created in the source data as a workaround. PowerPivot users can create calculated fields in PivotTables built on the Excel Data Model from within PowerPivot.
- In default, drilling to detail only displays the first 1000 records that underlie a summarized cell. With the introduction of Office 2013 SP1, Data Model drill-through can be configured to return as many records as desired, up to the maximum number of rows available in Excel.
- Excel 2013 workbooks that use the Data Model are not backward compatible to earlier versions of Excel. For workbooks that must be shared with users of earlier versions of Excel, ordinary PivotTables – those not based on the Excel Data Model – may be used.

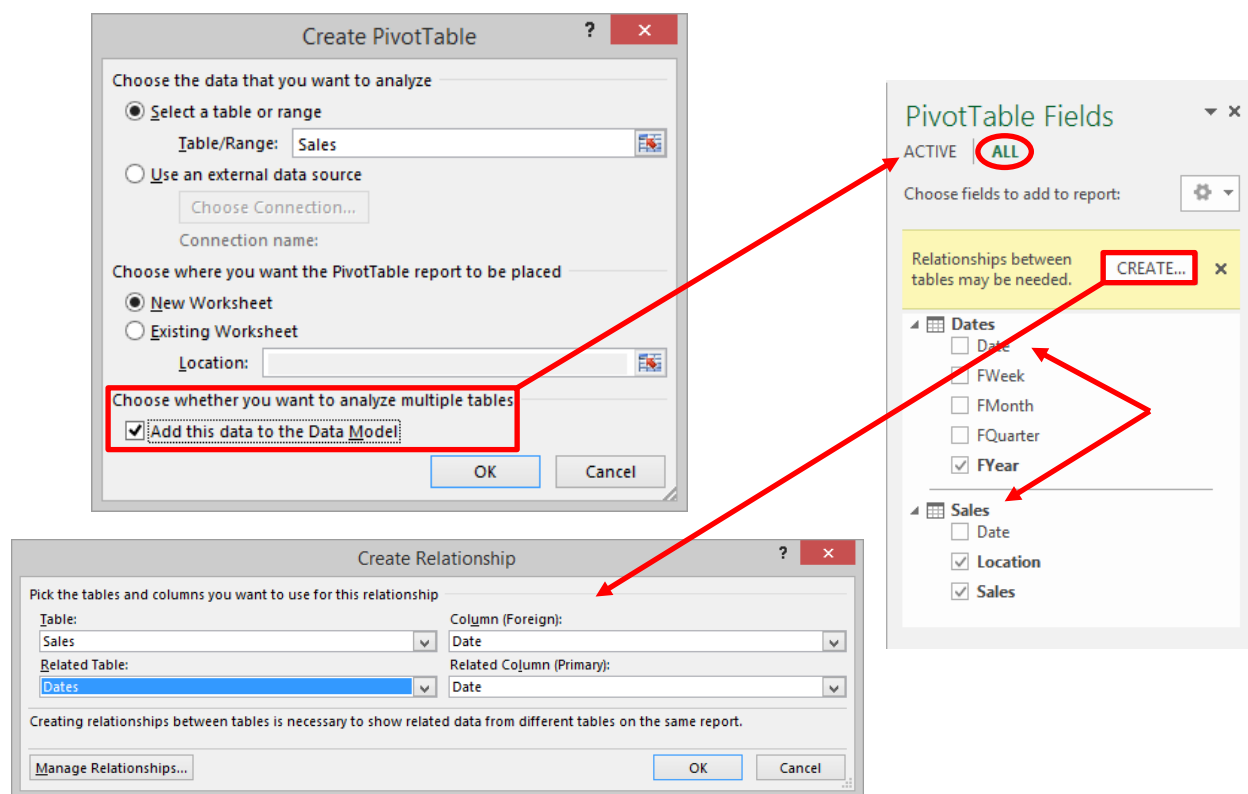
From the outset, users must be keenly aware that the Excel Data Model need not be used when constructing PivotTables in Excel 2013. When the additional features of the Data Model are warranted, users can employ the Data Model. When the features are not needed, or when data sets are small, users still have all of the features of ordinary PivotTables – the ability to create calculated fields and calculated items, group data items, drill through to display all supporting data, and backward compatibility. Those using Excel 2013 Professional Plus or the standalone version of Excel 2013 (acquired not as part of a

Microsoft Office license) have yet a third type of PivotTable, those built with PowerPivot. PowerPivot uses the Excel Data Model, but it can connect to multiple external data sources, handle billions of records, and provide users with additional functionality not available to those using just the Excel Data Model.

#### 4-4-5 Reporting with Related Tables

Earlier in this session, we used VLOOKUP to retrieve reporting period information from a table into the transaction summary to build a PivotTable report. With the Excel Data Model, we can simply relate the **Sales** transaction summary table to the **Dates** table, thereby avoiding the complexity of building VLOOKUP formulas to perform this task. The only requirement is that the Dates table contain a record for each date, rather than just the beginning date for each period, as required to use VLOOKUP. Similarly, we could use related tables instead of VLOOKUP in transforming coded data into an understandable format.

Begin the PivotTable creation process by selecting **Insert, PivotTable** to open the **Create PivotTable** dialog box. Enter the name of the first table and make sure to check **Add this data to the Data Model** as shown in **Figure 59**. Click **OK** to display the PivotTable placeholder and Field List.



**Figure 59 – Creating a PivotTable Using the Excel Data Model**

When a table is added to the Data Model, the PivotTable Field List can display all fields from all tables in a workbook. If the tables are not related, relationships can be created on a common field directly from the Field List as shown in Figure 59. With the Excel Data Model, end users can create PivotTables from multiple related tables, even if the tables themselves are from multiple external data sources.

## Relationships

In the previous example, establishing relationships between tables was accomplished through a link in the PivotTable Field List. A more sophisticated approach to establishing and maintaining data relationships between tables is available through the ribbon. Select **Data, Relationships** to access this functionality as shown in **Figure 60**.

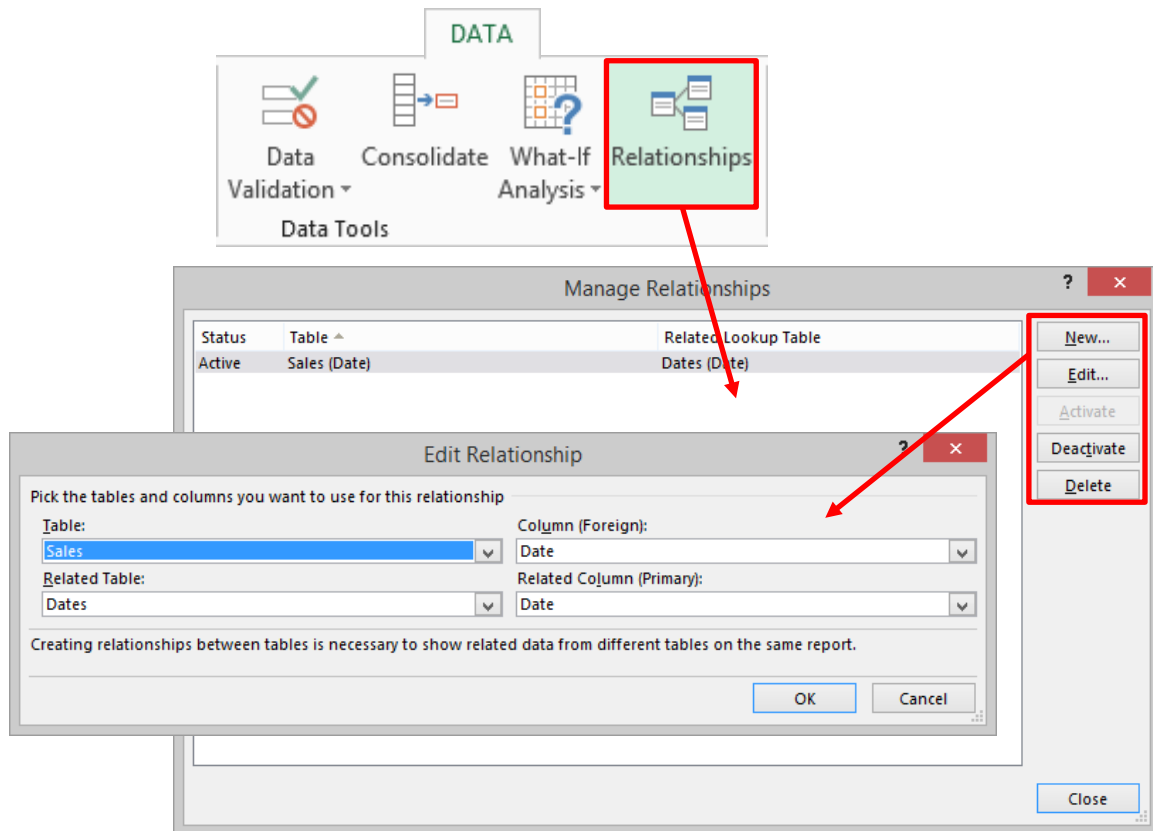


Figure 60 – Creating and Maintaining Data Relationships

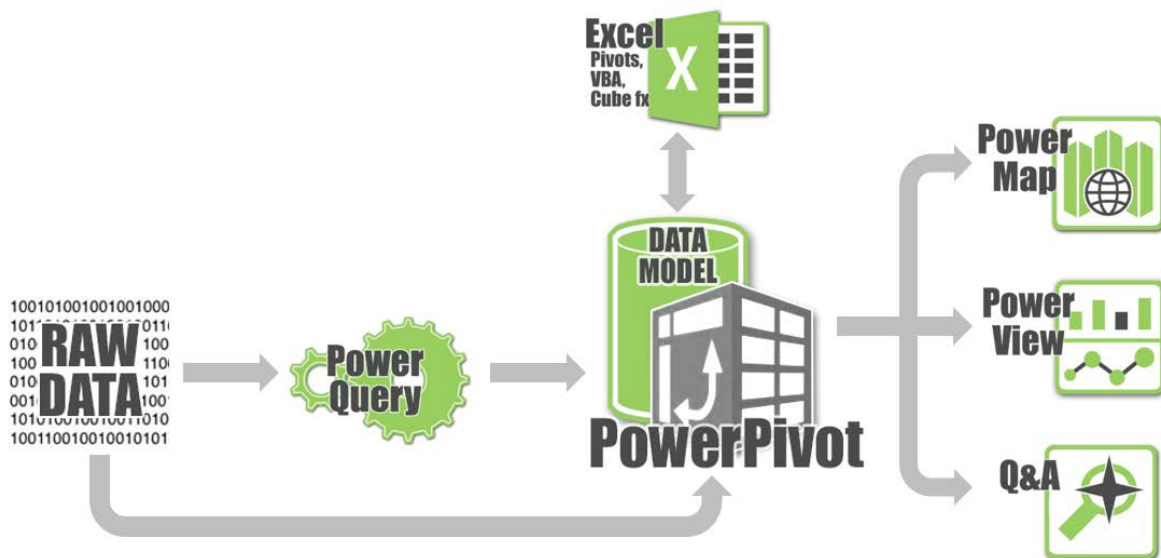
## 10 Rules of Pivot Tables

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1. You must have data that is clean and can be pivoted with no blanks or weird characters in the data.
2. Perform a “Save As” as often as you can. Save versions of your work because sooner or later you will have a mess to recover from.
3. There are five ways to deal with a variable data source:
  - a. Go back into the table settings and change the data range
  - b. Use a Defined Name on the source range
  - c. Use a Dynamic Defined Name on the source Range
  - d. Highlight all in the column
  - e. Use an Excel Table as the source
4. When highlighting the data range, you must include the column headings in the first row which will become the data titles for the pivot table.
5. If you happen to include any empty cells or text in your data range the pivot table command will automatically default back to count as the field setting instead of sum. To fix change the field setting back to sum.
6. To re-activate the field list box and pivot table toolbar you need to click back in the pivot table range or right-click and select show field list box then issue a View, Pivot Table Toolbar command.
7. If you want 4 different elements of a data item such as sales in your table you must drag and drop four instances of that data item into the data range of the pivot table.
8. To group on dates you must have real dates and not text dates. Convert the text dates to real dates using Data, Text to Columns command and then group.
9. Never name a calculated item or field with the same title you want to use in the actual pivot table summary. You cannot duplicate names of items, fields, or calculations.
10. By default, any grouped item will not have a subtotal on that item. You will need to add those manually if desired. Fix this in the field

## The Excel Data Model

The Data Model in Excel 2013/2016 is the key to better data analysis. This in-memory, multidimensional, relational data engine allows users to combine data from multiple sources and handle data sets that contain billions of records without performance degradation. In fact, the Data Model can handle up to 99 billion records, although no field can contain more than 1.99 billion *unique* records. Power Pivot functions as the user interface to the Data Model as shown in **Figure 61**. Many users may not have access to Power Pivot, but users do not have to use Power Pivot to take advantage of the Data Model.<sup>3</sup> Note that each Excel workbook contains only one data model, but that single model can serve as the data source for multiple data analysis objects in the workbook. As with most innovative technologies, there are both advantages and disadvantages of using the Data Model.



**Figure 61 – The Data Model Serves as the Data Source for the Power BI Tools in the Excel Environment**

## Advantages of the Data Model

The key advantages of using the Data Model as a data source for PivotTables are identified in the following list.

- The Data Model allows users to build PivotTables from multiple related Tables and from a wide variety of common external data sources, while maintaining links to the data so that PivotTable reports may be refreshed over time.
- PivotTables built on the Data Model can be converted to cube formulas with a single click on the ribbon. Converting a PivotTable to formulas allows users to insert rows or columns across the report to create needed subtotals or other ancillary calculations without impairing the ability to refresh the report as the data is updated.

<sup>3</sup> Power Pivot is available in Office 2013 and 2016 Professional Plus, Office 365 ProPlus, E3, and E5 subscriptions, and the standalone versions of Excel 2013 and 2016.

- Cube functions can be used to prepare formal reports directly from the Data Model without creating a PivotTable to summarize the data because the Data Model contains an intelligent OLAP cube populated from the data tables stored in the model. Think of the cube as a multidimensional PivotTable that contains pre-calculated measures at each intersection of the cube.
- PivotTables built on the Data Model support drill down and around with Quick Explore, a new feature available in Excel 2013/2016. Quick Explore provides functionality far beyond mere drill-to-detail of summarized values that appear in ordinary PivotTables. Quick Explore allows less-sophisticated users to rearrange a PivotTable in an automated process so that they may view the data from other perspectives without having the requisite knowledge or skill to rearrange the PivotTable manually.

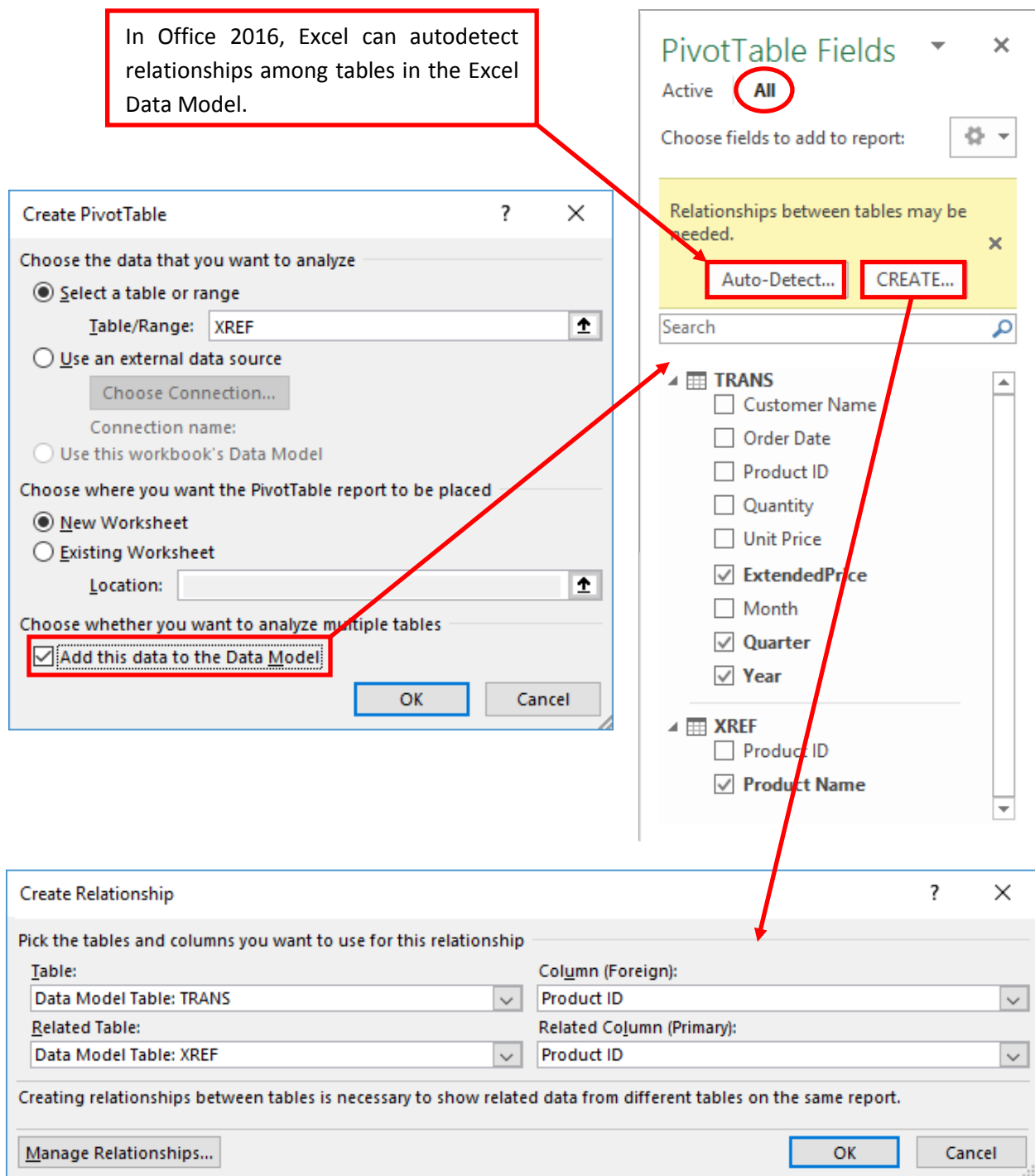
## Disadvantages of the Data Model

While there are significant advantages to using the Data Model, there are also disadvantages. The key disadvantages of using the Data Model as a data source for PivotTables are identified in the following list.

- Calculated fields and items are not supported. In Excel 2013, calculated fields (measures) can be created with DAX functions using Power Pivot. As a workaround, calculated columns can be created in the source data. Dragging a calculated column to the **Values** area in the **PivotTable Field List** will create an *implicit* measure automatically. In Excel 2016, users can create calculated *measures* with DAX functions using Power Pivot or directly from the PivotTable Field List as a workaround. Right-click on a table name in the **Field List** and select **Add Measure** from the context-sensitive menu.
- Grouping of items is not available in a PivotTable built on the Data Model. Neither date grouping nor custom item grouping is available in Excel 2013, but date grouping returns in Excel 2016. Calculated columns to produce the required groupings can be created in the source data to work around this limitation.
- In default, drilling to detail only displays the first 1000 records that underlie a summarized cell. Drill-through can be set to a larger record count in Connection Properties.
- Excel 2013/2016 workbooks that use the Data Model are not backwardly compatible with earlier versions of Excel.

## Using the Data Model

To use the power of the Data Model on data that exists in an Excel workbook, the data to be analyzed must be stored in tables, not ordinary data ranges. Keep in mind that tables can be connected to external data sources, such as the accounting system, to automate the process of updating the data. Once the data sets are in tables, start the PivotTable creation process by selecting **Insert, PivotTable** to open the **Create PivotTable** dialog box. Enter the name of the first table and make sure to check **Add this data to the Data Model** as shown in **Figure 59**. Click **OK** to display the PivotTable placeholder and Field List.



**Figure 62 – Relating Tables in a PivotTable Based on the Excel Data Model**

When tables are added to the Data Model, the PivotTable Field List displays all fields from all tables in a workbook. If the tables are not related, relationships can be created on a common field directly from the Field List as shown in Figure 59. In Excel 2016, relationships between tables can be detected automatically. With the Data Model, end-users can create PivotTables from multiple related tables, even if the tables themselves are connected to external data sources. This makes it easy for users to combine data from

multiple files or systems to create needed reports or analyses. While there are powerful advantages to building PivotTables on the Data Model, there are significant disadvantages as outlined previously, especially for experienced PivotTable users.

## Relating Multiple Tables

In the previous example, establishing relationships between tables was accomplished through a link in the PivotTable Field List. In this example, four tables – Transactions, Service, Industry, and Dates – will be related to transform the data before beginning the process of building a PivotTable report.

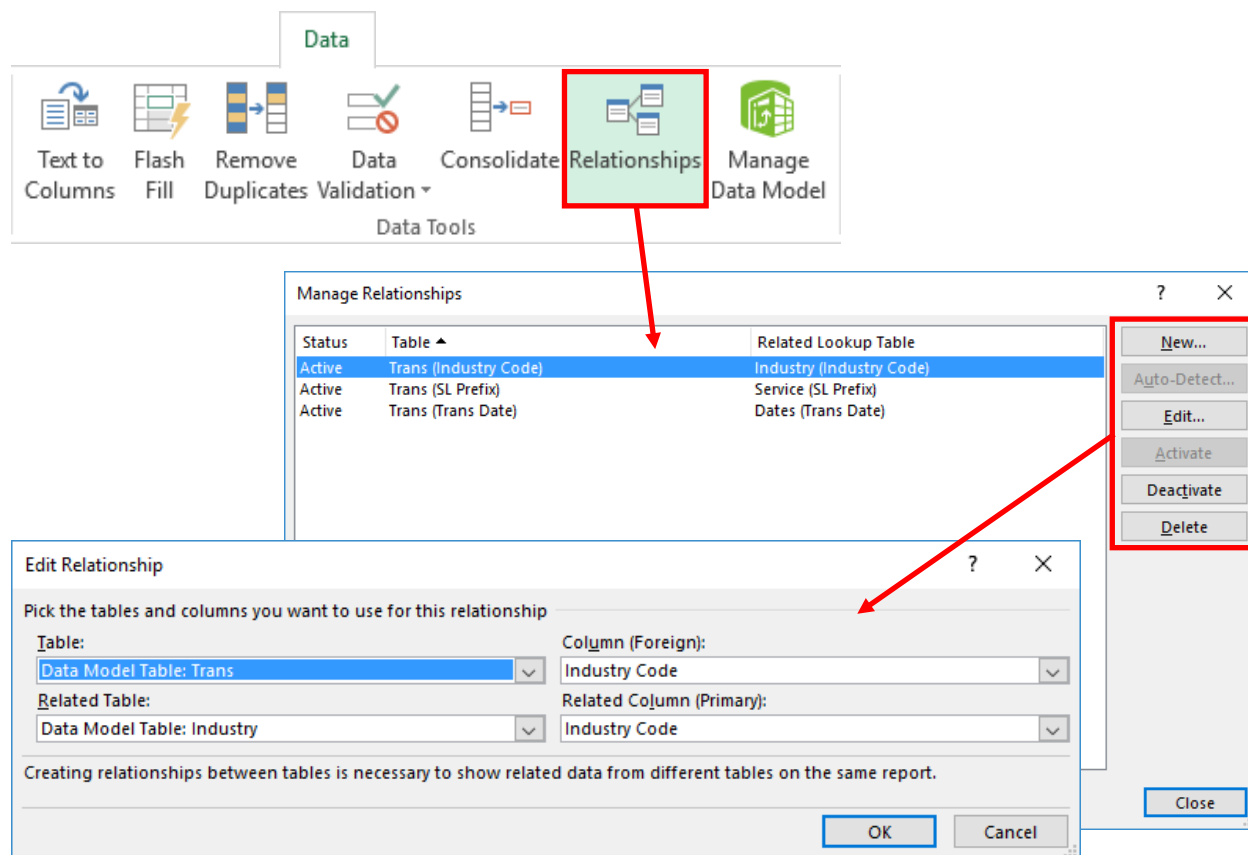


Figure 63 – Creating and Maintaining Data Relationships

Creating and maintaining data relationships between tables is available through the ribbon. Select **Data, Relationships** to access this functionality as shown in **Figure 60**. Excel 2016 introduces auto-relationships to relate tables, thereby easing the burden of creating numerous relationships across many tables in a Data Model.

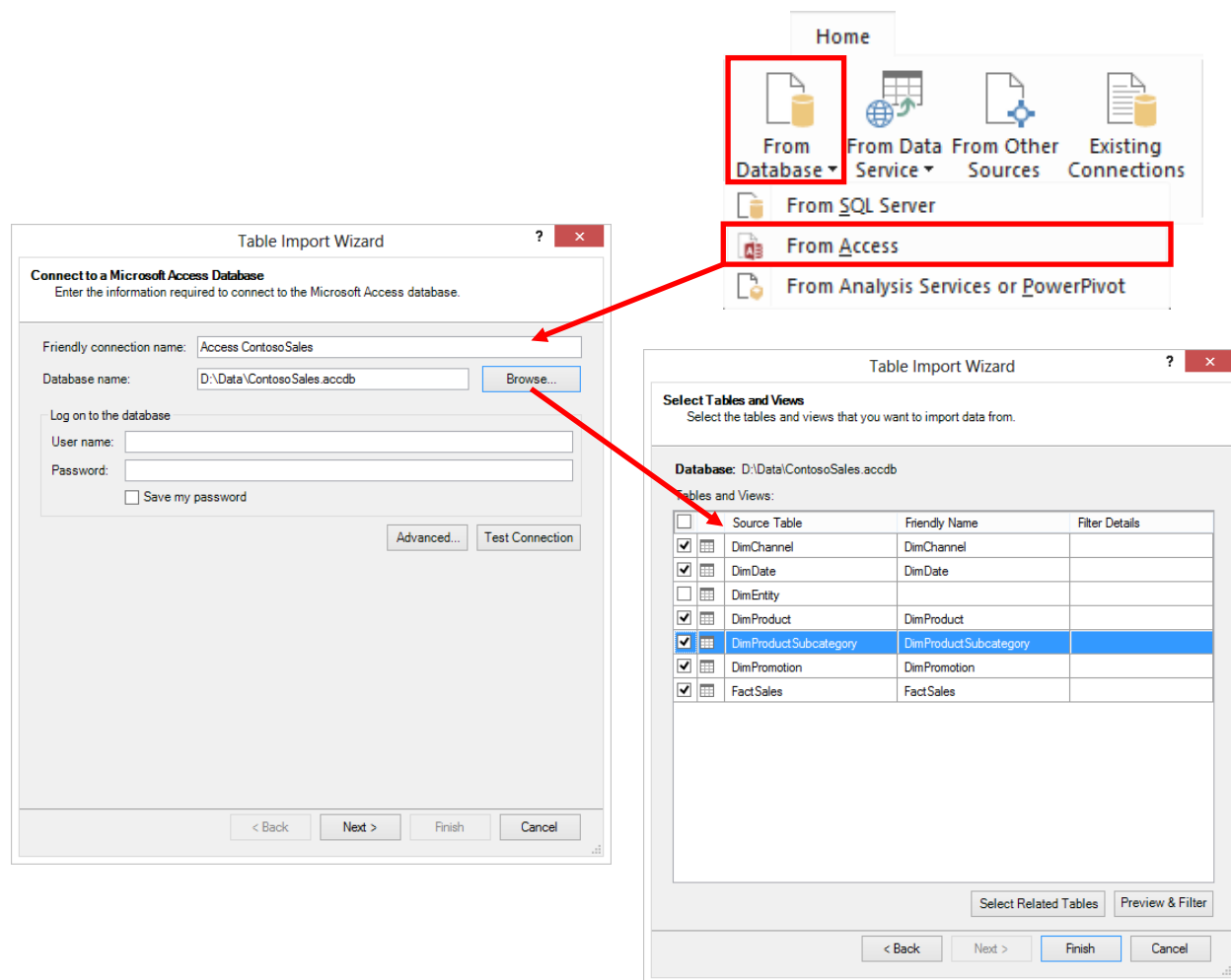
## Building Data Models to Feed into Power Pivot

Power Pivot, the interface to the Excel Data Model, provides additional functionality for building reports and analyses – PivotTables, Pivot Charts, Power View dashboards, and interactive 3D Maps – using the Excel business intelligence add-ins. More importantly, Power Pivot allows users to create Data Models



from multiple external data sources. The extracted data can be refreshed on demand from within Power Pivot or Excel.

In this example, a PivotTable report will be constructed from a Microsoft Access database and two Excel files. In the Power Pivot window, click **Home, From Other Sources, Microsoft Access** to open the **Table Import Wizard** as shown in **Figure 64**.

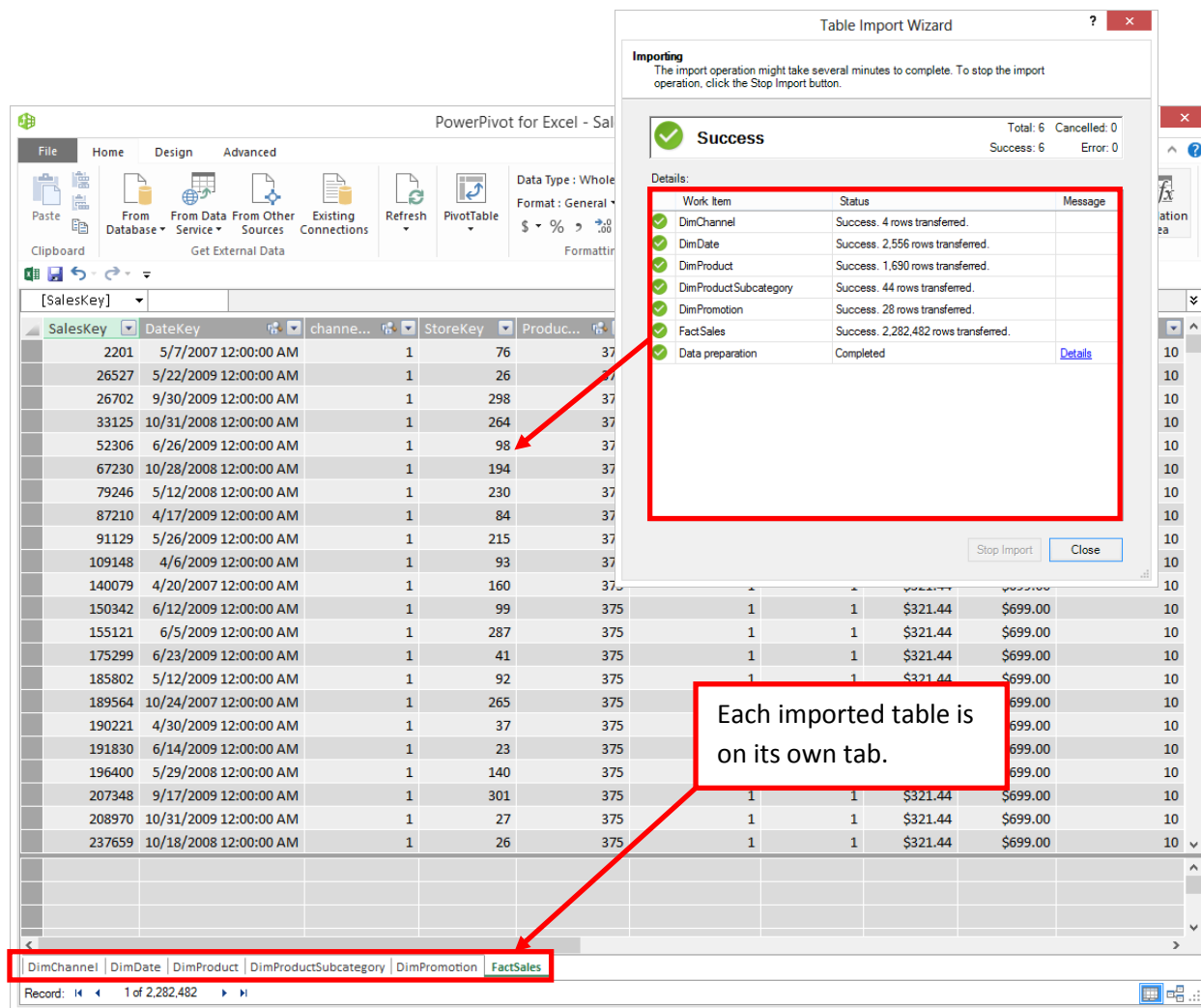


**Figure 64 – Importing Data from an Access Database**

In the first pane of the wizard, click **Browse** and then select the desired database, in this case, **ContosoSales**. Click **Next** to open the second pane of the wizard. Choose **Select from a list of tables and views to choose the data to import** and click **Next**. Select the following tables: **DimChannel**, **DimDate**, **DimProduct**, **DimProductSubcategory**, **DimPromotion**, and **FactSales**.

If you are unsure which tables contain the data elements that you need, click **Preview & Filter**, which will allow you to see the data within each table. The Preview & Filter pane also allows users to filter the data to include just the required records. If you are unsure as to whether you may need data stored in tables related to those selected, click **Select Related Tables**, and Power Pivot will select the related tables

automatically. Click **Finished** to open the final pane of the wizard – the **Import Status** dialog box – and begin the data import. When the data is imported successfully, click **Close** to display the tables in the Power Pivot window as shown in **Figure 65**. Each table will be displayed on a single tab. Note that the FactSales table contains nearly 2.3 million records.



**Figure 65 – Populating the Power Pivot Window with Imported Data**

Continue by importing data from two Excel workbooks – **DimStores** and **DimGeography** – that contain information about the stores and geographical locations in which sales revenue is earned. In the Power Pivot window, click **Home, From Other Sources, Excel File** to open the **Table Import Wizard**. Browse to the location of **DimStores**, select the file, and then click **Open**. Make sure to check **Use first row as column headers**. Click **Next**, **Finish**, and **Close** to complete the process. Repeat the process to import **DimGeography**.

## Defining Relationships Using Diagram View

If multiple tables are imported from the same database, and those tables are related in the source database, Power Pivot recognizes and maintains those relationships. If, however, data is imported from separate data files – for instance, multiple Excel workbooks, multiple databases, or multiple Power Queries – or data imported from a database is not already related, relationships must be established between the tables in Power Pivot prior to building reports or dashboards. Users can employ a simple, click-and-drag process in Diagram View, shown in **Figure 66**, to build the necessary relationships.

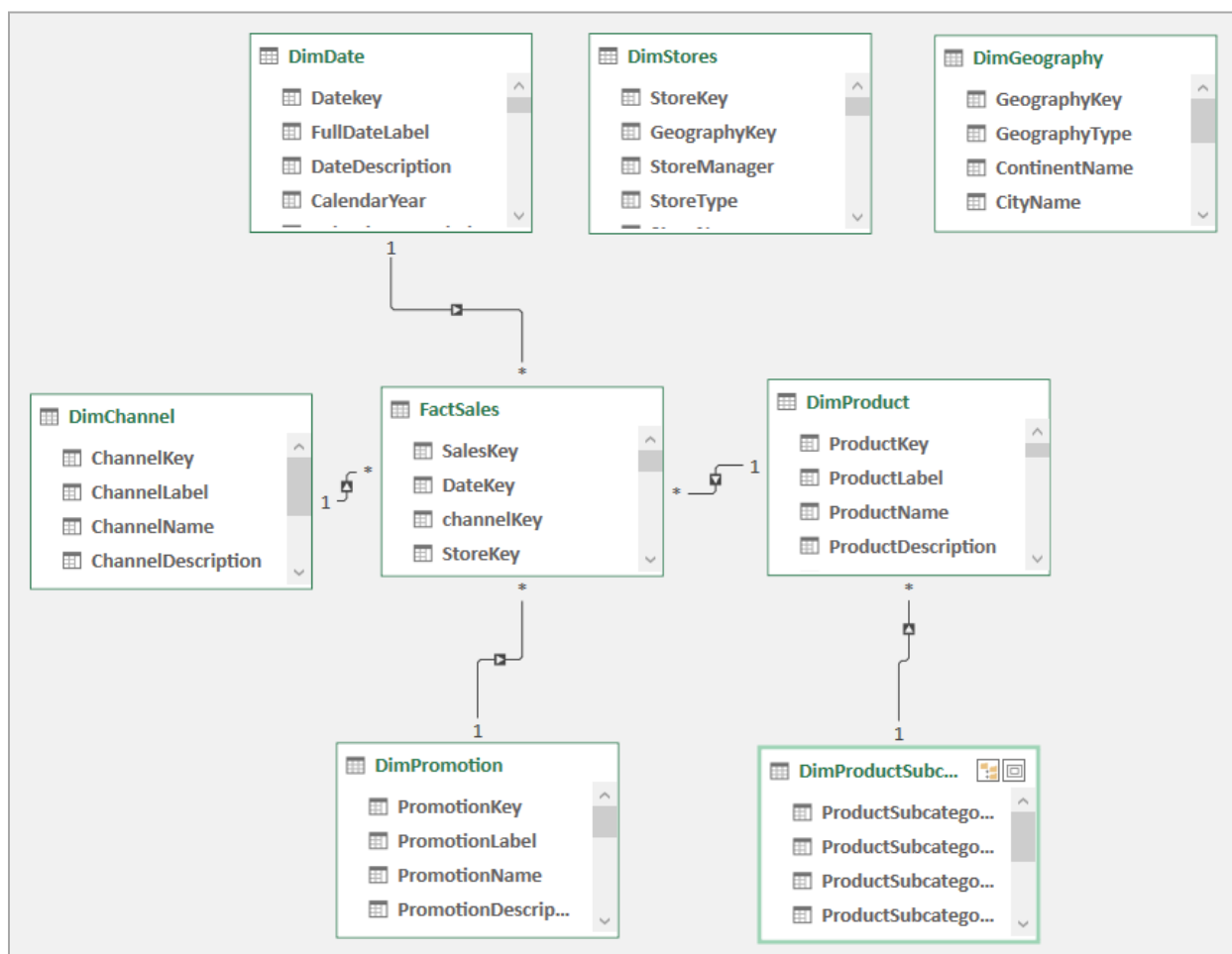


Figure 66 – Diagram View Displays the Relationships among Tables

As its name implies, Diagram View displays the tables visually like the way tables are displayed and related in the Microsoft Query Wizard or Microsoft Access. To open Diagram View, simply click **Diagram View** on the **Home** tab of the Power Pivot ribbon. In the Diagram View shown in Figure 66, six of the eight tables are related because Power Pivot recognized and maintained the relationships on import. The two Excel tables imported separately need to be related if the data in those tables are to be used in any reports or dashboards based on this Data Model.

To create relationships in Diagram View, simply click-and-drag a common field from an unrelated table and drop it on the common field in the table with which you want to create the relationship. In this case,

drag **StoreKey** from the **DimStores** table and drop it on **StoreKey** in the **FactSales** table and then drag **GeographyKey** from the **DimGeography** table and drop it on **GeographyKey** in the **DimStores** table. Once the relationships are established, click a join line to examine or delete the relationship. Note that the process creates an *inner join* between the related tables. To create other types of joins, use Power Query to specify the join type – inner, left outer, right outer, or self, etc. This process can be repeated as often as necessary to relate all the tables in a Data Model.

## Creating PivotTable Reports with Power Pivot

Now that the data has been imported and the tables related, it's time to create a PivotTable report. The process for creating PivotTables and Pivot Charts using Power Pivot is identical to creating ordinary PivotTables and Pivot Charts in Excel. To begin the process, click **PivotTable** on the **Home** tab in the Power Pivot add-in and then select the type of PivotTable or PivotChart to create. **Figure 67** shows a simple PivotTable report produced from the Power Pivot data model.

Sum of SalesAmount				
	FY 2017	FY 2018	FY 2019	Grand Total
[-] Asia	\$502,105,290.31	\$602,630,924.24	\$680,626,667.32	\$1,785,362,881.86
Contoso Ashgabat No.2 Store	\$7,832,371.46	\$8,487,774.60	\$9,444,449.58	\$25,764,595.65
Contoso Ashgabat No.1 Store	\$7,374,074.43	\$8,733,429.42	\$9,664,197.70	\$25,771,701.55
Contoso Asia Online Store	\$156,883,859.58	\$188,427,344.54	\$212,850,715.76	\$558,161,919.88
Contoso Asia Reseller	\$114,185,396.49	\$122,563,956.44	\$125,585,967.89	\$362,335,320.82
Contoso Bangkok No.1 Store	\$786,515.33	\$1,508,081.39	\$8,118,519.53	\$10,413,116.25
Contoso Yerevan Store	\$7,940,032.42	\$8,662,141.74	\$9,482,761.09	\$26,084,935.24
Contoso Yokohama Store	\$7,392,821.19	\$8,702,845.70	\$9,216,056.74	\$25,311,723.62
[+] Europe	\$657,901,509.58	\$489,949,580.45	\$475,716,377.42	\$1,623,567,467.45
[+] North America	\$1,984,386,492.24	\$1,549,832,712.34	\$1,398,074,810.94	\$4,932,294,015.52
Grand Total	\$3,144,393,292.13	\$2,642,413,217.03	\$2,554,417,855.67	\$8,341,224,364.83

Figure 67 – PivotTable Report Built on 2.3 Million Records Using Power Pivot

In the PivotTable displayed in Figure 67, the **SalesAmount** field in the **FactSales** table was added to the **Values** area of the **PivotTable Field List**. This created an *implicit measure* in the Data Model named **Sum of SalesAmount**. To see the measure, click **Manage** on the **Power Pivot** tab to open the Data Model. Click the **FactSales** tab and then click **Advanced, Show Implicit Measures**. Scroll to the right in the **FactSales** table until the **SalesAmount** column is visible. If the **Calculation Area** is not visible at the bottom of the table, click **Home, Calculation Area** in the **View** group. Click on the cell that contains the measure to see the formula, **Sum of SalesAmount:=SUM('FactSales'[SalesAmount])**, in the **Formula Bar** just below the ribbon. Note that the formula simply sums all sales in the table, not the individual amounts that are reported in the PivotTable. The amounts seen in the PivotTable result from *filter context*, which is provided by the row and column names in the report. In more sophisticated Data Models, measures are calculated *explicitly* using DAX formulas.

## Converting PivotTables to Cube Formulas

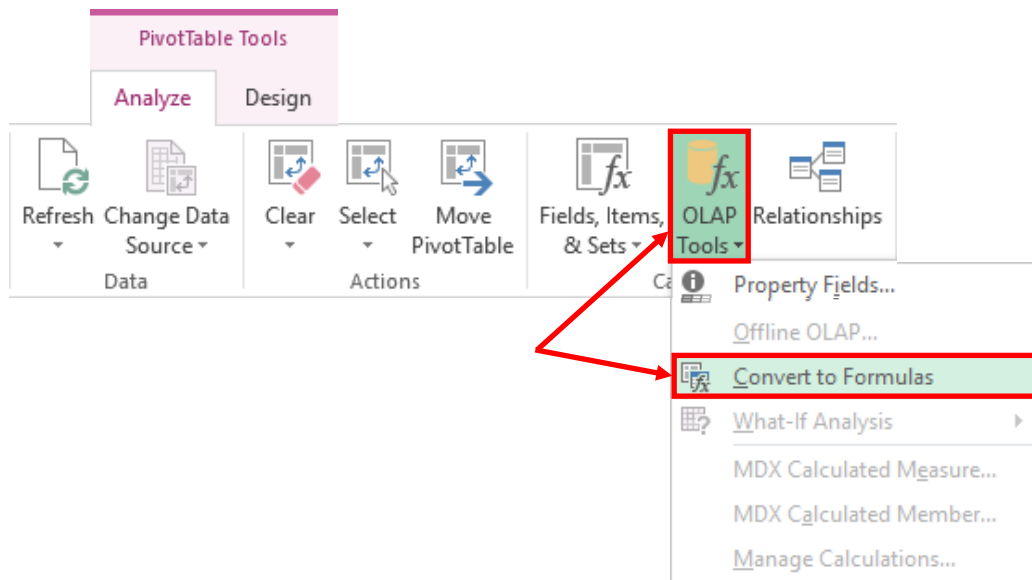
The ability to build formal reports with cube functions is one of the significant advantages of using the Data Model as a data source. Cube functions were introduced in Excel 2007 to create reports from data summarized in SQL Server Analysis Services. Since the Excel Data Model, introduced in Excel 2013, is an OLAP cube, these functions are more relevant now than ever.

An OLAP cube, like the Data Model, contains two types of information – dimensions and measures. Dimensions refer to dimensional categories, such as the date or time of sale, the item or type of product sold, or the store or region in which the sale was made. Dimensions are composed of hierarchies (parent/child levels) with each level containing individual elements or members. Measures refer to numeric information that can be summarized or totaled, such as the sales price of an item, the cost of an item, or how many were sold. Dimensions give meaning to measures. In other words, it's not enough to know total sales if users need sales by store, by item, or by item category. Dimensions provide these categorical breakdowns.

Excel has seven cube functions for creating reports, each identified in the following table.

Function	Description
CUBEKPIMEMBER	Returns a key performance indicator (KPI) property
CUBEMEMBER	Returns a member from the cube
CUBEMEMBERPROPERTY	Returns the value of a member property from the cube
CUBERANKEDMEMBER	Returns the nth, or ranked, member in a set
CUBESET	Defines a calculated set of members in a cube
CUBESETCOUNT	Returns the number of items in a set
CUBEVALUE	Returns an aggregated value from the cube

To begin the exploration of cube functions, first create a simple PivotTable on the Excel Data Model. In this example, the Data Model is built on four related tables – Transactions, Industry, Service, and Dates. A simple PivotTable is used to reduce the complexity of the example. Convert the PivotTable to formulas by selecting **OLAP Tools, Convert to Formulas** in the **PivotTable Tools, Analyze** tab as shown in **Figure 68**.



**Figure 68 – Converting a PivotTable to Cube Formulas**

This process converts a PivotTable built on the Excel Data Model into a report using cube functions to display specified intersections in the Data Model without impairing the ability of a user to refresh the report. Refreshing a report updates the values for any changes that have been made in the underlying data. For example, a sales revenue report could be refreshed monthly to display updated sales revenue amounts given the transactions that have occurred in the intervening period.

Make sure to arrange the PivotTable to display the level of detail required before converting it to formulas. Note that after conversion, the limitations imposed on PivotTables are removed. For example, users can insert rows or columns across the report for summary calculations. This is not possible in a PivotTable. **Figure 69** displays the report with summarizing calculations for Total Eastern US sales. As the underlying data changes over time, the report based on cube formulas can be refreshed just as if it were a PivotTable.

	2017	2018	Grand Total
New England	105,701,086.00	125,060,733.00	230,761,819.00
Seaboard	82,704,061.00	90,512,900.00	173,216,961.00
South	96,880,027.00	124,298,100.00	221,178,127.00
Midwest	91,742,355.00	90,903,271.00	182,645,626.00
<b>Total Eastern US</b>	<b>377,027,529.00</b>	<b>430,775,103.00</b>	<b>807,802,632.00</b>
Mountain	103,898,713.00	92,579,385.00	196,478,098.00
West Coast	117,107,006.00	111,167,273.00	228,274,279.00
<b>Grand Total</b>	<b>598,033,248.00</b>	<b>634,521,761.00</b>	<b>1,232,555,009.00</b>

Rows inserted with formulas to calculate Total Eastern US sales.

**Figure 69 – Reports Based on Cube Formulas Remove PivotTable Limitations**

Report authors with access to Power Pivot can create reports directly from the Data Model without first creating a PivotTable because they can create *explicit* measures in Power Pivot. Those without access to Power Pivot must use a PivotTable to create *implicit* measures before creating cube formula reports. For example, a Power Pivot user can use a DAX formula (**TotalSales:=SUM([Service Rev])**) to calculate total sales revenue explicitly.

## Introducing Power BI

Power BI is a set of cloud-based Microsoft tools used in tandem with Microsoft Office Excel to provide end users with the ability to summarize large volumes of data quickly, create visualizations of the results, drill down on data to see the supporting detail, and share the data in dashboards. You can use the capabilities of Power BI to analyze all types of data, including financial, sales, manufacturing, human resources, and more. The flexibility of Power BI allows you to create Key Performance Indicators (KPIs) that you can easily update and filter to spot trends over time, regions, budgets, or goals.

Additionally, you can extend the capabilities of Power BI with **Power Map** and **Power View**, two tools for creating powerful and interactive visualizations. Using these tools allows you to analyze data in real time, giving you the ability to explore data, design interactive reports, and share this information in dashboards.

Wrangler Sales				
Schedule of Sales and Expenses				
For the Years Ended 2012 through 2015				
As Of : Tuesday, November 17, 2015				
	Sales	COS	Overhead	Profit
2012	\$ 3,457,689	\$ 53,421	\$ 477,265	\$ 2,927,003
2013	1,919,057	420,102	462,583	1,036,372
2014	2,041,016	551,172	467,298	1,022,546
2015	1,326,315	890,564	530,000	(94,249)
	\$ 8,744,077	\$ 1,915,259	\$ 1,937,146	\$ 4,891,672

## What Are the Components of Power BI?

The relationship between Power BI and a desktop installation of Excel with related add-ins can be complex and difficult to understand. As mentioned previously, Power BI works with Microsoft Office Excel – more specifically, Excel provisioned through **Office 365 ProPlus** or **Office 2013 Professional Plus**. With these versions of Excel, you also have access to four tools that are related to Power BI, but which are not technically components of Power BI: **Power Pivot**, **Power View**, **Power Maps**, and **Power Query**. *Each of these four tools is available without subscribing to Power BI.* However, subscribing to Power BI adds functionality that is not otherwise available with Excel and related add-ins, including BI Sites to share and view reports and dashboards, access to BI reports and dashboards on mobile devices, and the ability to create natural language queries.

**Table 1**, adapted from information published on Microsoft's website, summarizes the business intelligence capabilities of Power BI and related components.

Feature	Capability	Office 365 ProPlus or Office 2013 Professional Plus	Power BI for Office 365
<b>Power Pivot</b>	Create data models	•	
<b>Power View</b>	Authoring	•	
	Excel Client viewing	•	
	Excel Web Client viewing	<10 MB File Size	<250MB File Size
<b>Power Maps</b>	Authoring	•	
	Excel Client viewing	•	
	Excel Web Client viewing	N/A	N/A
<b>Power Query</b>	Public data catalog access	•	
	Corporate data catalog access	•	•
<b>BI Sites</b>	Access to BI sites to share/view reports and dashboards		•
<b>Scheduled Data Refresh</b>	Scheduled refresh of on-premises data		•
<b>Data Stewardship</b>	Manage and share data queries		•
<b>Mobile BI Service</b>	HTML5 and Mobile App access		•
<b>Natural Language Query</b>	Search based data visualizations		•

Table 1 – Power BI Components and Capabilities

## How Do I Acquire Power BI?

The best method of acquiring Power BI will depend on the tools to which you already have access.<sup>4</sup>

- If you currently subscribe to either Office 365 E3 or E4, you can acquire Power BI by subscribing to the **Power BI Add-on**. The Power BI Add-on costs \$9.99 per month, per user.
- If you subscribe to Office 365 ProPlus or own Office 2013 Professional Plus, but you do not have an Office 365 E3 or E4 subscription, you can purchase the **Power BI Standalone** subscription for \$17.99 per month, per user.
- If neither of the above applies to you, then you should probably subscribe to an Office 365 E3 or E4 plan and choose the Power BI Add-on. The total cost would be \$29.99 per month, per user for the E3/Power BI combination or \$31.99 per month, per user for the E4/Power BI combination.