

“What’s average about that?”

Measuring central tendency, dispersion, and ranking are all common tasks when asked to describe where we stand. Excel has many built in functions to describe these measures.

Imagine a group of 20 staff who have been rated on a scale from 0-100 for a particular skill set and we want to know “what’s average” or what a particular score ranks at. The following table lists Excel functions and the results describing different measures of central tendency, dispersion, or ranking.

A few Statistical Measures In Excel for measuring the center, the dispersion, or rankings.

Category	Measure	Excel Formula	Description	Result	Additional Argument
Central Tendency	Minimum	=MIN(LIST)	Smallest number in list	30	
	Maximum	=MAX(LIST)	Largest number in list	95	
	Average	=AVERAGE(LIST)	Arithmetic mean	68.75	
	Median	=MEDIAN(LIST)	Median	67.5	
	Mode	=MODE(LIST)	Mode	50	
Dispersion	Range	=MAX(LIST)-MIN(LIST)	Constructed from MAX and MIN	65	
	Standard Deviation	=STDEV(LIST)	Standard Deviation	18.20027	
Ranking	Percentile	=PERCENTILE(LIST,percentile)	Returns the value at the selected PERCENTILE	67.5	0.5
	Percent Rank	=PERCENTRANK(LIST,number)	Returns the percentile for the selected NUMBER	52.6%	70
	Large	=LARGE(LIST,X)	Returns the Xth largest number	90	3
	Small	=SMALL(LIST,X)	Returns the Xth smallest number	50	3
	Rank	=RANK(number,LIST,ORDER)	Returns the rank of a selected number	2	90

Order	LIST
1	30
2	45
3	50
4	50
5	50
6	55
7	60
8	65
9	65
10	65
11	70
12	75
13	80
14	80
15	85
16	85
17	90
18	90
19	90
20	95

Understanding Variation with Process Behavior Charts (Control Charts)

There are several different kinds of control charts. The chart that is probably the best for use in local government is known as the Individual Moving Range chart or I-MR or sometimes X-MR. It is actually two separate charts that should be prepared and used together. The charts are meant to examine the process behavior of some data over time to determine if it is predictable process and what amount variation is part of the process. While the chart starts off with the assumption the data is “in control” one of the key purposes of the chart is to determine if that is the case.

Imagine an operation where we are concerned with actual waiting time. The goal is for waiting times to be under five minutes. Twenty-four consecutive data points were collected and are shown at the right. The I-MR chart is constructed with the following steps.

1. Calculate the range which is the absolute value of the difference between the current point and the previous point.
2. Find the average of the ranges.
3. Create an upper limit for the ranges by multiplying the average range by 3.268 and add to the average range.
4. Plot the range chart.
5. Find the average for the actual data.
6. Calculate upper and lower control limits for the actual data with the formula $\text{DataAverage} \pm 2.66 * \text{AverageRange}$
7. Plot the data chart with the data line and the upper and lower control limits.

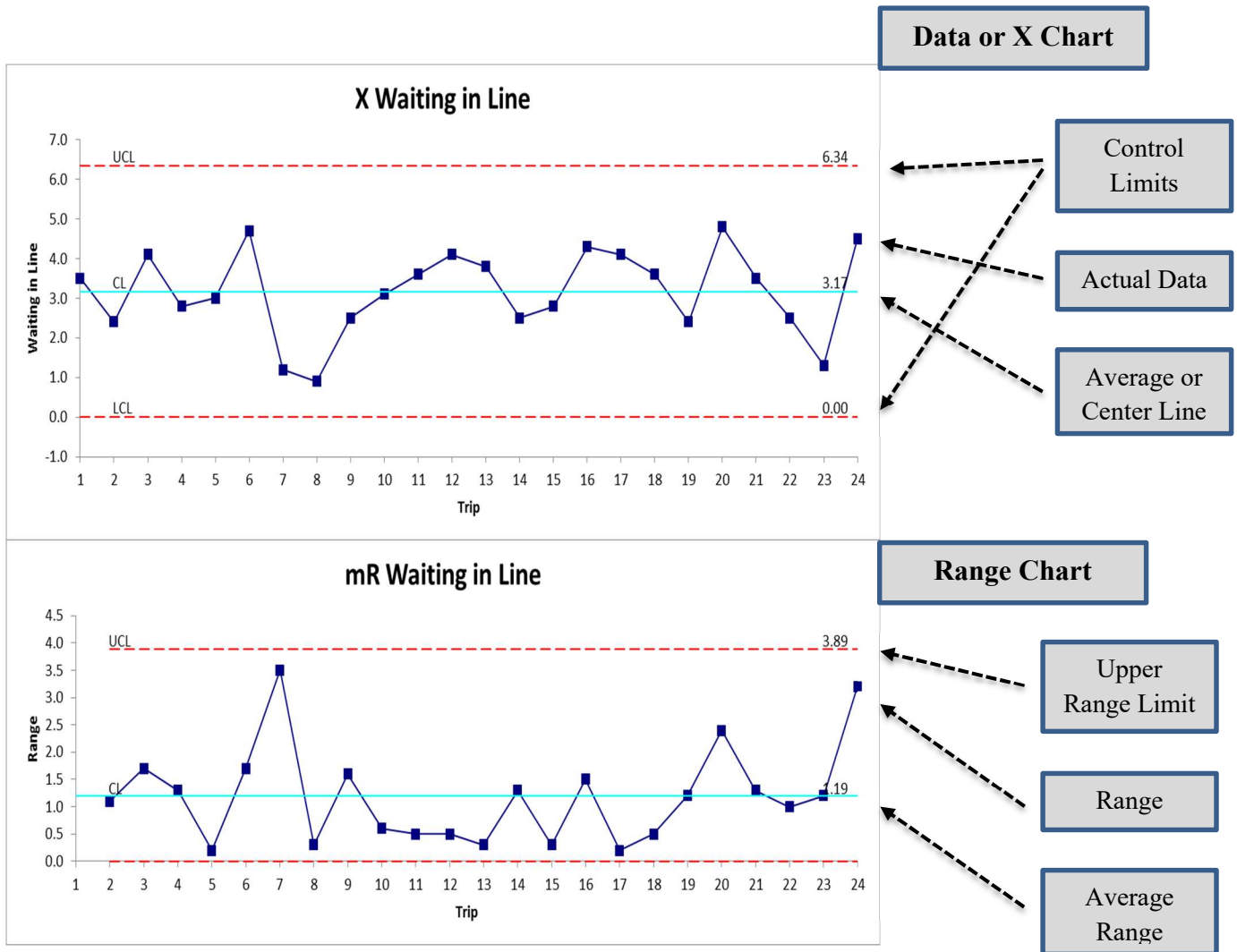
Trip	Waiting in Line	Range
1	3.5	
2	2.4	1.1
3	4.1	1.7
4	2.8	1.3
5	3	0.2
6	4.7	1.7
7	1.2	3.5
8	0.9	0.3
9	2.5	1.6
10	3.1	0.6
11	3.6	0.5
12	4.1	0.5
13	3.8	0.3
14	2.5	1.3
15	2.8	0.3
16	4.3	1.5
17	4.1	0.2
18	3.6	0.5
19	2.4	1.2
20	4.8	2.4
21	3.5	1.3
22	2.5	1
23	1.3	1.2
24	4.5	3.2
Average	3.17	1.19

The resulting Range and Data chart are shown on the next page. Interpreting the charts.

1. The range chart tells us the average movement from period to period is 1.19 minutes and the maximum change in waiting time from one period to the next we should see, assuming a predictable process, is 3.89 minutes.
2. No points on the range chart are past the 3.89 control limit so there are no points of concern on that range chart. The changes from one period to the next are predictable.
3. On the waiting time data chart, we see that the times while varying all lie within the control limits. We would conclude this is a stable and predictable process.
4. The average waiting time is 3.17 minutes and the maximum that would be expected is 6.34 minutes and we might see instances of zero waiting time.

Practical Analytic Techniques Using Excel

5. Unless changes take place, we can use this for making predictions going forward and checking when we have problems.



Control charts can be calculated with a little work in Excel. The template included with class will do a basic first cut I-MR chart. Several companies sell add-ins for Excel which help you make the process of creating controls very easy. Possible vendors include:

1. www.Qimacros.com
2. www.spcforexcel.com
3. www.sigmaxl.com/
4. www.sigmazone.com
5. http://www.pipproducts.com/qi_charts.html

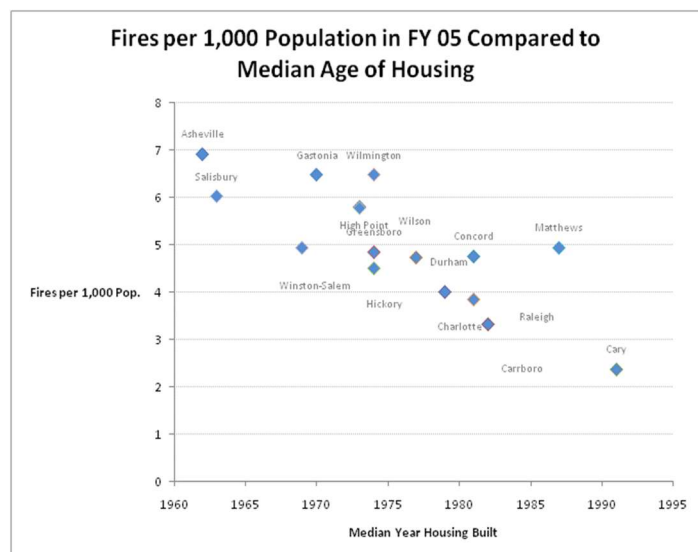
Analyzing Differences in Performance with Scatterplots

When trying to compare performance, we frequently find large differences which leads us to ask why. Using scatterplots can help us test whether possible explanations may account for differences.

The table to the right shows the number of actual fires per 1,000 population for a group of North Carolina cities in Fiscal Year 2005. While the average is 4.98 fires per 1,000 population, the range of fire rates stretches from 2.37 to 6.91 or a 192% difference. What might explain such variation? Graphing the data by itself doesn't tell us but by graphing one set of data against another in a scatterplot in Excel, we can determine if some relationship might exist which explains this variation.

A variety of possibilities might suggest themselves but age of houses could be one possibility. Older homes have heating systems with higher risks such as wood fires and were built at a time when fire and building codes were not as stringent. To test whether this makes a difference, we simply graph the fire rate data against age of housing stock in a scatterplot. As can be seen in the plot, there is a strong relationship that in communities with newer homes, the rate of fires is indeed less. By examining different variables, we can visually test whether a given explanation shows a relationship with some performance indicator.

City	Fires per 1,000 Population in FY 2005
Asheville	6.91
Carrboro	3.32
Cary	2.37
Charlotte	3.99
Concord	4.75
Durham	4.72
Gastonia	6.47
Greensboro	4.84
Hickory	4.50
High Point	5.79
Matthews	4.94
Raleigh	3.84
Salisbury	6.02
Wilmington	6.47
Wilson	5.78
Winston-Salem	4.93
Average	4.98

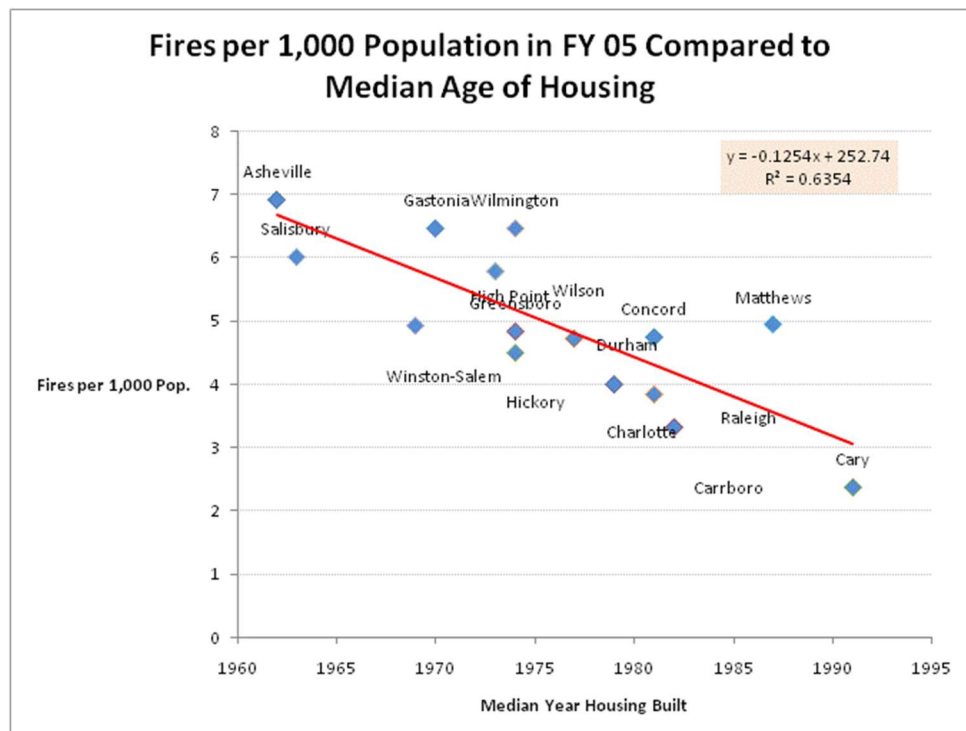


Analyzing Differences in Performance with Regression

Examining differences in data with scatterplots is useful but using regression in Excel we can push this analysis further. Regression is a statistical technique for estimating whether relationships exist between one or more “independent” variables with a single “dependent” variable. If there is a relationship, the regression results will show us the strength and size of those relationships.

Excel supports regression analysis in several ways. The simplest is simply to create a simple scatterplot graph and then insert a trendline. This is done by right clicking the data series in the scatterplot and selecting “add trendline”. The default trendline type is linear which is a regular regression line. When selecting this, the user can also have Excel display the regression line and the R^2 which measures how strong the fit is. R^2 can range from 0 to 1 with 1 indicating a perfect fit and 0 indicating no relationship. The regression equation will show what a one unit change in the independent variable (the x-axis) will do to the dependent variable (the y-axis). The graph on the right shows the fire rate date as the dependent variable and the median year housing was built as the independent

variable. The R^2 of 0.6354 confirms a strong relationship. The $-0.1254x$ part of the regression equation indicates that each year later for the median age of housing is associated with a drop in the fire rate per 1,000 population of 0.1254.



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Regression analysis can also be done in Excel using the Data Analysis add-in. This add-in has to be installed first to be accessible. The user selects the Data Analysis toolpak from the Data tab in Excel 2007 and later (for older versions of Excel 2003 or earlier, the Data Analysis option is in the Tools menu). From the Data Analysis pop-up box select Regression from the list of choices. In the Regression pop-up box, enter the range of the data for the dependent variable (this is the variable you are trying to explain) and separately the range of data for the one or more independent variables. You can choose to have the output come out on the same page or on a new worksheet. The resulting output will produce the key regression data. For display purposes, the R² and the coefficient for the independent variable have been highlighted and can be seen to match the results from the previous graphic display. For users wishing to make full use of the tool a basic understanding of regression is needed and can be obtained in most statistics books. The highlighted "P-value" shows the probability that the coefficient is due to chance. In this case, there is only a 0.02% chance the result is by chance so we can be quite confident the association is valid.

SUMMARY OUTPUT	
Regression Statistics	
Multiple R	0.797136893
R Square	0.635427226
Adjusted R Square	0.609386313
Standard Error	0.769943868
Observations	16

ANOVA					
	df	SS	MS	F	Significance F
Regression	1	14.46531017	14.46531	24.40111	0.000218
Residual	14	8.299389834	0.592814		
Total	15	22.7647			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	252.7388108	50.15703753	5.03895	0.000181	145.1627	360.315	145.1627	360.315
Median Year Housi	-0.125409079	0.025387747	-4.93975	0.000218	-0.17986	-0.07096	-0.17986	-0.07096

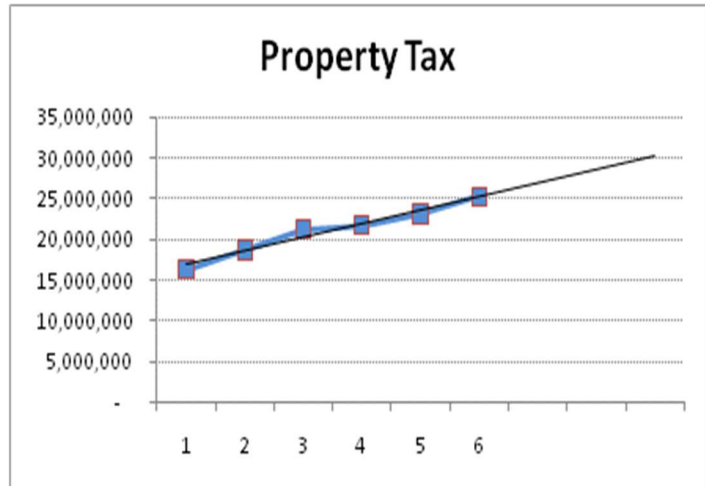
Time Series Forecasting – Gazing into the Future

What will happen tomorrow is uncertain, but we can use simple trend projection with time series data to forecast what might happen. Forecasting the future is essential in budgeting but also many other functions. Using trend forecasting in Excel we can project one or more periods forward.

The Town of Blue Heaven has property tax collection data for the last six years. Assuming no changes in tax rates and the local economy continues to grow in the same way, how much property tax would be forecasted? This forecast can be done graphically and with the TREND function in Excel.

Year	Property Tax
1	\$16,342,318
2	\$18,690,329
3	\$21,276,968
4	\$21,713,205
5	\$23,081,521
6	\$25,267,247

To do this graphically, the user simply creates a basic line chart in Excel with the property tax data. Then you right click on the data series and select “add trendline”. The default trendline is a simple linear regression line which is usually the best choice. The user should also select the forecast forward button and enter a whole number 1 or higher for the number of periods (years in this case) to forecast forward. The graphic display will change to show the existing data but also a new trendline which will forecast where the property tax will be in the future. If the data being forecast is relatively stable, time series forecasts tend to be very accurate.



However, if the data series being forecast is erratic or is changing direction, the simple linear forecast is will not be as accurate. In this case the property tax growth over time has been relatively stable. So barring dramatic changes, the forecast is likely to be fairly accurate.

The user can also use the TREND function in Excel to forecast future numbers. The TREND function asks for the known Y data range (in this case revenues), the known X data range (in this case the years), and the forecasted X data (in this case years 7, 8, and 9). The result will show the forecasted amount for each year.

“Random” does not mean haphazard

If you can reasonably analyze all of the data available that's great. But sometimes it is not practical. For example imagine if you have several thousand expense items and you want to audit them to check for accuracy and completeness. If you can't afford to do this for all the records, you could alternately draw a sample of records and draw conclusions from those records. There are many types of sampling but simple random sampling is usually the easiest and most appropriate. Drawing a simple random sample in Excel can be done by several methods with the following two being the easiest.

Random Sample Method 1

Take a list of the whole population of data and add a new column with the RAND function in Excel. This function creates a random number between 0 and 1 with a uniform distribution meaning every decimal number between 0 and 1 has an equal chance of being selected. The random number function in Excel is written as =RAND() with nothing between the parentheses. After typing this in the first cell, you simply copy it down so every record in your data now has a random number associated with it. Copy this whole range and paste it back as values. If you don't paste it back as values, the RAND function will create a new random number each time the worksheet recalculates. After you have converted these to numbers rather than the RAND function, you simply sort the database by random numbers and take as many records for your sample as you need (e.g. the first 30 or 50 records). It doesn't matter if the list is sorted in ascending or descending order as the numbers are simply random.

Random Sample Method 2

Take the data list and select the Data Analysis option from the Data menu (for older versions of Excel 2003 or earlier, the Data Analysis option is in the Tools menu). The data analysis add-in has to be enabled first from the add-ins if it has not already been done. From the Data Analysis pop-up box select Sampling from the list of choices. In the Sampling pop-up box, enter the range of the data from which you will sample. Still in the Sampling pop-up box, the default for the Sampling Method is the Random choice. Leave this highlighted and enter the size of the needed random sample in the Number of Samples box. For example entering 30 would get you 30 records selected randomly. Click “OK” and a random sample of the desired size will appear based on where you selected either the default of another sheet or on the existing sheet or in another workbook. The Sampling will only return data from the column selected, so you may have to use a lookup function to retrieve other variables if needed for your analysis

Football or Futball in Blue Heaven?

Optimization Example 1

The Town's Recreation Department has to decide how to allocate available space for the youth football and soccer leagues this fall. Based on some surveys and prior years' experience there is more than enough demand to have at least 80 soccer teams and 70 football teams but the Town does not have the space. The Town's major park can accommodate up to 30 fields (soccer or football) during the time for youth leagues. Adults willing and able to be referees are also limited. There are 80 referees available to work the games. The good news is that all of the referees are quite talented and can work soccer or football games. It takes two referees to work a soccer game while a football game requires four referees. The soccer games have twenty players on each team or forty players per game. The football teams are larger to give the kids a breather from the physical contact with thirty players per team. The Town Council has indicated their priority is to have the most kids playing regardless of which sport they participate in.

1. What allocation of field space between soccer and football games would you advise the Recreation Director to make?
2. What factors most constrain the result?

Practical Analytic Techniques Using Excel

Recreational Field Allocation Problem

	Fields	REFEREES		KIDS	
		Refs per Game	Refs Needed	Kids per Game	Kids Playing
Soccer	10	2	20	40	400
Football	10	4	40	60	600
Combined	20		60		1000
Limit	30		80		

maximize	$40s + 60f$
such that	$2s + 4f \leq 80$
	$s + f \leq 30$

Yellow Squares are the inputs to manipulate

Blue Squares are the key assumptions

The Orange Square is the outcome we wish to maximize

The number of fields used and referees required will turn bright red if they exceed the limit

The number of fields used and referees required will turn light red if they use less than the limit

Searching for the Best Solutions - Optimization with Excel Solver

Excel “Solver” is an optimization add-in tool which may help you find “best” solutions rather than just acceptable choices. Optimization is a mathematical process where given a defined decision model, the “Solver” program looks for the choice which best maximizes or minimizes some outcome of interest given various constraints and assumptions. If a solution can be found, you have the “best” or optimal outcome.

The “Solver” add-in comes standard with Excel. However, it is typically not part of the standard installation. If you have not already installed it, you will need to go to the add-ins menu and load it up on your computer. This may require the original Microsoft Office disk. Installation takes only a few seconds. Once installed, Solver is activated from the “Data” menu in Excel 2007 to 2013 or the “Tools” menu in Excel 2003 or MAC Excel.

A basic optimization model requires:

1. Data Cell(s) – These are defined numbers that shape the target outcome. In our case these are numbers such as how many kids play on each team and the number of referees per game.
2. Decision Cell(s) – These are the cells we want Solver to change. In our case, we want to know how many football fields and how many soccer fields to use.
3. Constraint Cell(s) (optional but usually these are included) – these are possible limits or constraints to the range of possibilities. For our case constraints include that we only have 30 fields and we only have 80 referees.
4. Output or Target Cell – this is the outcome we want to optimize. For our case the target is we want to maximize the number of kids who get to play.

Optimization models are used widely in business to help determine the best choices for many types of complex decisions such as how to schedule employees, what product mix produces the most profits, and what shipping network produces the lowest cost. Optimization models are sometimes used in government such as determining the best routing for trash trucks, locating public facilities to minimize response time for emergency services, and scheduling staff.

For more information on optimization, there are many texts and practical guides available. Searching for “management science” should produce the most helpful leads. The website www.solver.com is the official website of the company that makes the Solver add-in for Excel. In addition to selling more advanced versions, they have free on-line tutorials and downloadable Excel examples showing a variety of optimization model examples such as scheduling or financing.

Capital Budgeting Optimized

The Town of Blue Heaven has identified a set of 20 capital projects to fund. In total these projects would cost \$44 million. But a tight budget won't permit all these projects to be funded at this time. To help identify priorities, the community has gone through a rating process giving a score to all 20 projects assessing their importance and value to the community with 100 being most favored and 0 being least. The town wants to get the most value for its money and still live within its budget limit.

- The council has also said they would like to fund at least two projects in each of their four major goal areas.
- Due to the tight budgets, the town council has decided to limit the new capital budget to \$10M.

- 1) Which projects should be chosen?
- 2) Does the requirement to require two projects in each goal area limit the potential?

Practical Analytic Techniques Using Excel

Capital Budgeting Example for Binary Problems

The Town of Blue Heaven has identified a set of 20 capital projects to fund. The tight budget situation has led the board to say only a portion of these projects can be funded. Each project has gone through a rating process with 100 being most favored and 0 being least. The town would like to select the projects which produce the highest combined rating score.

--The council has also said they would like to fund at least two projects in each of their four major goal areas.

--Due to the tight budgets, the town council has decided to limit the capital budget to \$10M.

Which projects should be selected?

Capital Projects		Category				Community Rating	Build	Cost in Millions
		Public Safety	Environmental	Infrastructure	Recreation			
Police Substations	Project 1	1				24	0	\$1.1
New Fire Station	Project 2	1				70	0	\$3.8
New Ladder Truck	Project 3	1				21	0	\$1.2
Upgrade 911 Communications	Project 4	1				32	0	\$1.5
New Police Cars	Project 5	1				17	0	\$0.8
Build Stormwater Detention	Project 6		1	1		85	0	\$4.1
Energy Efficiency Building Retrofit	Project 7		1	1		61	0	\$1.8
Low Energy Streetlights	Project 8		1	1		39	0	\$1.3
Stream Improvement and Trail	Project 9		1		1	79	0	\$2.6
New Automated Trash Trucks	Project 10			1		76	0	\$3.6
New Public Works Garage	Project 11			1		31	0	\$1.5
Water Treatment Upgrade	Project 12			1		93	0	\$4.8
New Farmers Market	Project 13			1		29	0	\$0.8
Street Resurfacing	Project 14			1		78	0	\$2.7
New Sidewalks	Project 15			1		51	0	\$1.4
Sidewalk Repair	Project 16			1		42	0	\$0.8
New Recreation Center	Project 17				1	81	0	\$3.1
New Pool	Project 18				1	88	0	\$5.1
Park Upgrades	Project 19				1	18	0	\$0.5
New Park	Project 20				1	26	0	\$1.5
Projects Selected		0	0	0	0		0	\$0.0 Total Cost
Projects Needed		>=	>=	>=	>=			<=
		2	2	2	2			\$10.0 Budget Cap
Total Community Rating						0		

“A dollar doesn’t buy what it used to”

Inflation makes comparing dollars over time more difficult since the inflation (or deflation) makes dollars have different value from one year to the next. To make comparisons of revenues and expenditures over time more meaningful, we need to adjust for the effects of inflation using price indexes.

The best known price index is the Consumer Price Index or CPI put out by the federal government’s Bureau of Labor Statistics. However, this index is based on what a typical consumer spends her money on. While it is widely known and used for a variety of purposes, it doesn’t reflect what a local government spends money on. There are two general price indexes which are probably better indexes for local government: the Implicit Price Deflator for state and local government put out by the federal government’s Bureau of Economic Analysis or the Municipal Cost Index put out by *American City and County* magazine. These two local government price indexes may run higher or lower than the Consumer Price Index. In the early 2000s these two government oriented indexes both reported higher rates of inflation than the CPI but the differences have been minimal for the last five years. Whichever index is used the method for adjusting for inflation is the same.

$$\begin{array}{ccccc} \text{Current dollar} & & \text{Base year index} & & \text{Current revenue or} \\ \text{revenues or} & & \text{Current year} & & \text{expenditures in base} \\ \text{expenditures} & \times & \text{index} & = & \text{year dollars} \end{array}$$

The base year selected can be of the analyst’s choosing. For example if we use the most current year as the base year, then this year’s number will remain unchanged and earlier numbers will “inflate”. Conversely, if an earlier year is chosen as the base year, that will become the fixed point and numbers before it will inflate, while numbers after it will “deflate” to account for the effects of inflation. Note that if prices begin to go down or deflate, these adjustments will be different.

So if expenditures were \$18,000 in 2003 and the State and Local Implicit Price Deflator was at 81.719 and we wanted to adjust this to 2014 dollars when the price deflator was at 112.287, the calculated expenditures for 2004 in 2014 dollars would be \$24,733.

$$\begin{array}{ccccc} \$18,000 & \times & \frac{112.287}{81.719} & = & \$24,733 \end{array}$$

As further example the table below shows inflation adjustment using the two price indexes. Even while actual expenditure dollars were going up each year, the inflation adjusted expenditures leveled off between 2005 and 2019 essentially just keeping pace with inflation.

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	Actual Expenditures	State and Local Implicit Price Deflator Index 2009=100	State and Local Inflation Adjusted Expenditures- 2019 Dollars	Consumer Price Index Average Annual	CPI Inflation Adjusted Expenditures- 2019 Dollars
2000	\$10,000	66.032	\$17,411	172.2	\$14,847
2001	\$12,000	68.281	\$20,205	177.1	\$17,323
2002	\$14,000	69.815	\$23,055	179.9	\$19,895
2003	\$15,000	72.05	\$23,935	184	\$20,842
2004	\$18,000	75.369	\$27,457	188.9	\$24,361
2005	\$20,000	79.609	\$28,883	195.3	\$26,181
2006	\$21,000	83.617	\$28,874	201.6	\$26,631
2007	\$22,000	88.133	\$28,699	207.342	\$27,126
2008	\$23,000	92.558	\$28,569	215.303	\$27,311
2009	\$23,000	92.048	\$28,727	214.537	\$27,408
2010	\$24,000	94.669	\$29,146	218.056	\$28,138
2011	\$24,500	97.739	\$28,819	224.939	\$27,846
2012	\$24,800	100	\$28,512	229.594	\$27,615
2013	\$25,500	103.279	\$28,386	232.957	\$27,985
2014	\$26,200	105.645	\$28,512	236.736	\$28,294
2015	\$26,400	105.598	\$28,743	237.017	\$28,476
2016	\$26,800	105.77	\$29,131	240.007	\$28,548
2017	\$27,000	108.45	\$28,623	245.12	\$28,161
2018	\$28,000	112.775	\$28,545	251.107	\$28,507
2019	\$28,500	114.969	\$28,500	255.657	\$28,500

Sources of Price Indexes for Local Government

Municipal County Price Index

<http://americancityandcounty.com/mciarchive/>

State and Local Government Price Deflator

<http://www.bea.gov/national/nipaweb/index.asp>

Consumer Price Index

<ftp://ftp.bls.gov/pub/special.requests/cpi/cpi.ai.txt>

Death and Tax Rates in Blue Heaven

“What If Analysis”

It is time to balance the budget in the Town of Blue Heaven.

- This year's expenditures were \$10 million and are expected to grow 5% a year for the next five years.
- The current assessed property tax base is \$2.5 billion, the town collects 97% of the assessed property taxes and the current tax rate is 41.3 cents per \$100 of valuation. The property tax base is expected to grow 3% a year for the next five years.
- There are no other revenue sources.
- The town collected \$10,015,250 this year so it has a small surplus equal to less than one-sixth of one percent.

Given these assumptions, how would you go about deciding:

1. What property tax rate is needed to:
 - a. Balance the budget in Year 1?
 - b. Balance the cumulative budget over Years 1-5 assuming you have to keep the same tax rate?
2. What would the effect be of different constant revenue growth rates ranging from 0% to 6%?
3. What would be the effects of different revenue growth rates ranging from 0% to 6% and different expenditure growth rates ranging from 4% to 10%?

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What If Spreadsheet Example

	Current	Year 1	Year 2	Year 3	Year 4	Year 5	5 year Budget
Assessed Property	\$2,500,000,000	\$2,575,000,000	\$2,652,250,000	\$2,731,817,500	\$2,813,772,025	\$2,898,185,186	\$13,671,024,711
Growth		3%	3%	3%	3%	3%	
Tax Rate per \$100	\$ 0.4130	\$ 0.4130	\$ 0.4130	\$ 0.4130	\$ 0.4130	\$ 0.4130	
Collection Rate	97.0%	97.0%	97.0%	97.0%	97.0%	97.0%	
Revenues	\$10,015,250	\$10,315,708	\$10,625,179	\$10,943,934	\$11,272,252	\$11,610,420	\$54,767,492
Expenses	\$10,000,000	\$10,500,000	\$11,025,000	\$11,576,250	\$12,155,063	\$12,762,816	\$58,019,128
Growth		5%	5%	5%	5%	5%	
Balance	\$15,250	-\$184,293	-\$399,821	-\$632,316	-\$882,810	-\$1,152,396	-\$3,251,636
Pct of Expenses	0.2%	-1.8%	-3.8%	-5.8%	-7.8%	-9.9%	-5.9%

“What If” Analysis with Excel

TOOL	What it does	Example	What you need
GOAL SEEK	Goal Seek allows you to work backwards and find the necessary number to produce a final answer you want.	“What does the tax rate need to be to balance the budget”	• A target or goal cell (must be a formula) • A changing cell that affects the target cell indirectly or directly (must be an actual number)
DATA TABLES	Allows you to test multiple values for 1 or 2 variables all at once to answer “what if” questions.	“What effect does varying growth in expenditures from 3% to 10% have on the budget?”	• One or two changing cells (must be actual numbers) • One or more outcome cells to show the effect of varying the changing cells (should be formula)
SCENARIOS	Scenarios allow you to save different versions of your spreadsheet so you can put together sets of assumptions and save them so that you can easily move between scenarios as well as see the effect of different scenarios in one table.	“How do my different budget scenarios compare?”	• Changing cells that you may substitute with different values • Results cells that show particular outcomes you want to see.

Where to find these tools:

In Excel 2007 to 2016 – Under “DATA”, “Data Tool”, “What If Analysis”

In Excel 2003 or MAC Excel – Under “Tools”, “Goal Seek”, “Data Table”, or “Scenarios”