PF2 SECURITIES EVALUATIONS, INC.

Public Sector Credit Framework

Introducing the Public Sector Credit Framework: An Open Source Solution for Evaluating Sovereign and Municipal Bond Issuers

Marc Joffe
415-578-0558
marc.joffe@pf2se.com

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Government Credit Ratings Lack Transparency

[N]o one, including some of the analysts involved, with whom we have spoken, with whom others that we know have spoken at very great length indeed, are quite sure what a rating is based upon. The criteria are foggy. The rating services maintain a sort of an aloofness and are not too willing to discuss with the representatives in municipal offices of cities what it is about the city that occasions the upward or downward move in a rating.

- ***Roy Goodman, Director of Finance, New York City, In Congressional Testimony, Dec. 5, 1967 (but could have been said yesterday)***

… and Are Subject to Accusations of Bias

All three credit rating agencies systematically and intentionally gave lower credit ratings to bonds issued by states, municipalities and other public entities as compared to corporate and other forms of debt with similar or even worse rates of default, Blumenthal alleges.

As a result of these deceptive and unfairly low ratings, Connecticut's cities, towns, school districts, and sewer and water districts have been forced to spend millions of taxpayer dollars to purchase bond insurance to improve their credit rating, or pay higher interest costs on their lower rated bonds.

"We are holding the credit rating agencies accountable for a secret Wall Street tax on Main Street -- millions of dollars illegally exacted from Connecticut taxpayers," Blumenthal said. "Connecticut's cities and school districts have been forced to spend millions of dollars, unconscionably and unnecessarily, on bond insurance premiums and higher interest rates as a result of deceptive and deflated credit ratings. Their debt was rated much lower than corporate debt despite their much lower risk of default and higher credit worthiness.

- ***Connecticut Attorney General's Office Press Release, July 30, 2008***

Our Research into US Muni Bonds Finds . . .

- Municipal bond ratings performed poorly during the Depression, with a 10% default rate among Aaa issuers – far worse than the rate for Aaa corporate issuers.
- Rating agencies (over)-reacted by severely grading municipalities for the next 70 years, creating the so-called dual ratings scale.
- Low municipal ratings gave rise to the monoline bond insurance industry, which received billions of taxpayer dollars and then blew itself up by using proceeds to insure toxic assets.

What Investors Need

Investors need sovereign and municipal bond assessments that:

- Are based on thorough research of historic credit performance and issuer-specific financial conditions rather than conjectures and/or generalizations
- Rely primarily or exclusively on quantitative approaches (given the large number of issuers together with the expense and subjectivity of analytical talent)
- Are transparent, well communicated and thus clearly understood by participants on both the buy and sell sides
- Use one overall approach that addresses both sovereign and general obligation municipal bonds, since these two asset classes share relevant characteristics

The Solution: PSCF

- PF2's Public Sector Credit Framework is:
  - Quantitative
    - to decrease the likelihood that unconscious biases will affect the analysis
    - to take advantage of the computer's ability to rapidly perform large numbers of calculations.
  - Transparent – So that other analysts can examine and update assumptions.
  - Open Source – To enable a community of developers to enhance the tool.
- The open source release provides a framework. Users or vendors have to build their own issuer-specific models. We are supplying two fully developed sample models to kick-start this process.

Solution Overview

Quantitative methodology based on:

- Multi-Year Budget Projections for Each Public Sector Issuer
  - Can rely in part on estimates published by the government itself
- Monte Carlo Simulation of economic variables such as GDP growth, inflation and interest rates
  - Forecasts and historical data are available from a number of vendors
- Default point stated in terms of a fiscal ratio
  - Debt to GDP
  - Interest Expense to Revenue
  - Debt to Assessed Valuation
  - Others?
- Annual default probabilities calculated as the percentage of simulation trials resulting in ratios exceeding the specified threshold; DPs can be mapped to ratings within the framework

Technology Overview

- User interface implemented as an Excel add-in
- User enters simulation data parameters in 2-4 tabs of an Excel workbook and then runs the simulation from a control panel callable from Excel and written in Visual Basic for Applications (VBA)
- Excel inputs are converted to a C-language program, the program is compiled and then it is executed. Results are written to text file(s) and loaded into new Excel tab(s)
- Generated C-language simulation programs are compiled with the GNU C++ compiler and are thus compatible with Linux and other operating systems. GNU compiler is installed with the framework.
- We also install the Boost C++ library which we use for random number generation
- C-language translation and compiling are used in order to maximize speed, enabling the user to run complex simulations and large numbers of trials

Walkthrough Part 1: Model Sheet

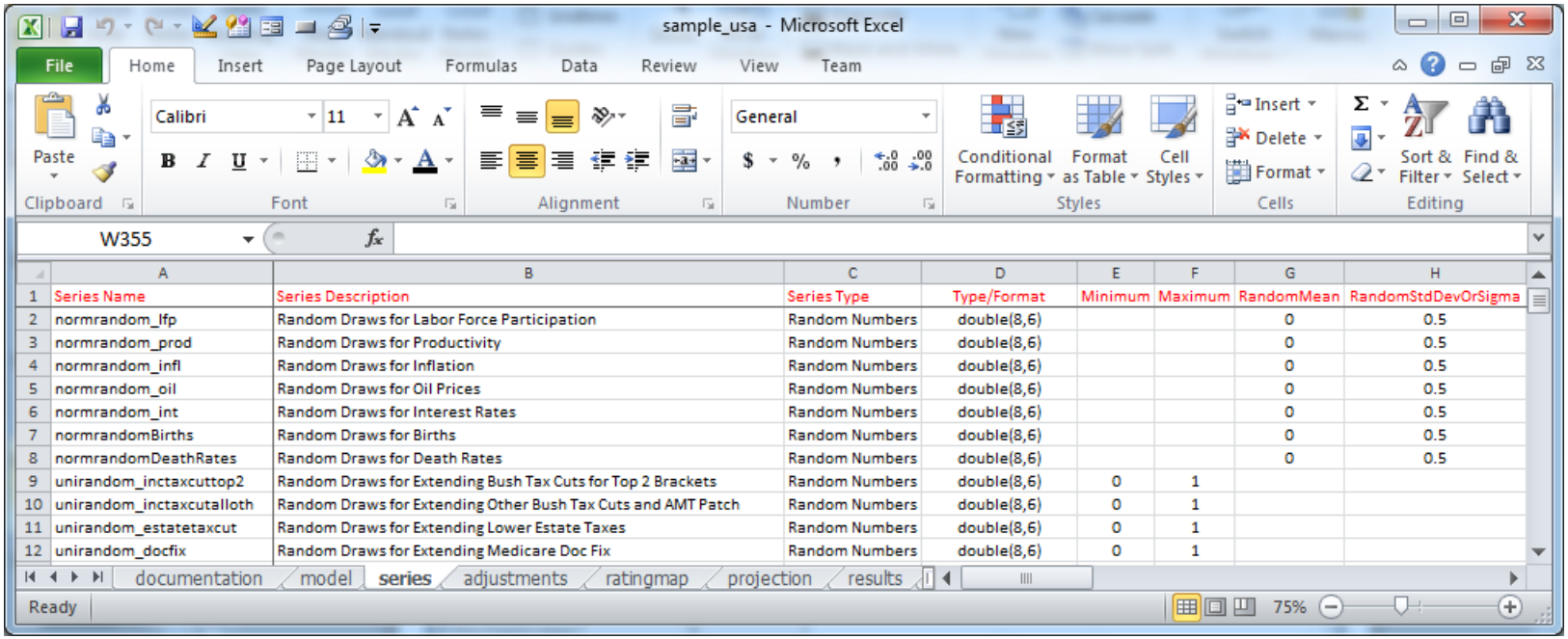
sample_usa - Microsoft Excel

	A	B	C	D	E
1	Parameter Name	Parameter Value			
2	Government Entity	United States			
3	Model Description	US Federal Budget Sample			
4	Currency	USD			
5	Initial Year	2012			
6	Projection Years	30			
7	Number of Trials	10			
8	Threshold Label	Default			
9	Show Projection Details	Y			
10					
11		Description	Expression	Threshold Level	Relation to Threshold Signifying Default
12	Metric 1	Interest Expense/Total Revenue	netinterest[y]/totrev[y]	0.3	>
13	Metric 2	Debt/GDP	debt[y]/GDP[y]		
14	Metric 3	Debt/Total Revenue	debt[y]/totrev[y]		
15	Metric 4	Absolute Increase in Debt	debt[y]-debt[y-1]		
16	Metric 5	Total Rev / Total Exp	totrev[y]/totexp[y]		
17					
18		Default Probability Code			
19					
20					
21		PSCF Control Panel			
22					
23					
24					

First metric used to establish the default point

Additional metrics can be calculated and viewed in Projection Details

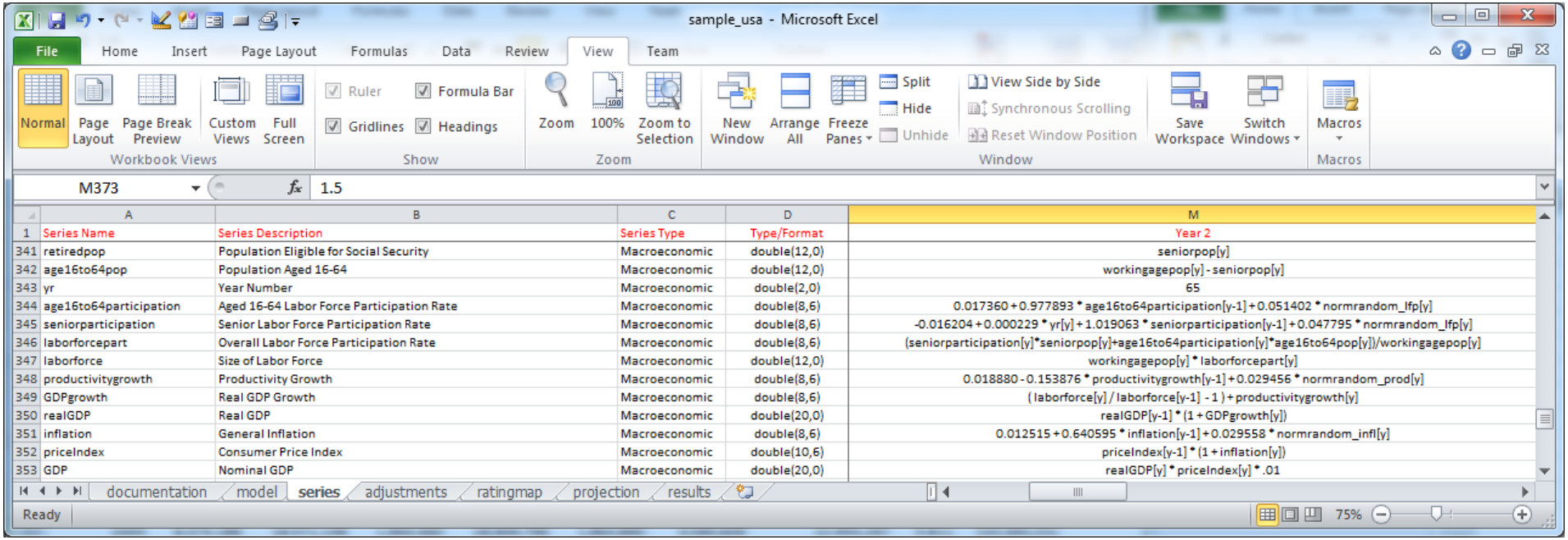
Part 2: Series Sheet / Random Numbers



	A	B	C	D	E	F	G	H
1	Series Name	Series Description	Series Type	Type/Format	Minimum	Maximum	RandomMean	RandomStdDevOrSigma
2	normrandom_lfp	Random Draws for Labor Force Participation	Random Numbers	double(8,6)			0	0.5
3	normrandom_prod	Random Draws for Productivity	Random Numbers	double(8,6)			0	0.5
4	normrandom_infl	Random Draws for Inflation	Random Numbers	double(8,6)			0	0.5
5	normrandom_oil	Random Draws for Oil Prices	Random Numbers	double(8,6)			0	0.5
6	normrandom_int	Random Draws for Interest Rates	Random Numbers	double(8,6)			0	0.5
7	normrandomBirths	Random Draws for Births	Random Numbers	double(8,6)			0	0.5
8	normrandomDeathRates	Random Draws for Death Rates	Random Numbers	double(8,6)			0	0.5
9	unirandom_inctaxcuttop2	Random Draws for Extending Bush Tax Cuts for Top 2 Brackets	Random Numbers	double(8,6)	0	1		
10	unirandom_inctaxcutalloth	Random Draws for Extending Other Bush Tax Cuts and AMT Patch	Random Numbers	double(8,6)	0	1		
11	unirandom_estatetaxcut	Random Draws for Extending Lower Estate Taxes	Random Numbers	double(8,6)	0	1		
12	unirandom_docfix	Random Draws for Extending Medicare Doc Fix	Random Numbers	double(8,6)	0	1		

- Create any number of random series.
- One random number generated per series per trial.
- Three random number distributions currently supported:
  - Uniform / Normal / Cauchy (allowing fat tails)
- User can impose maxima and minima on generated numbers

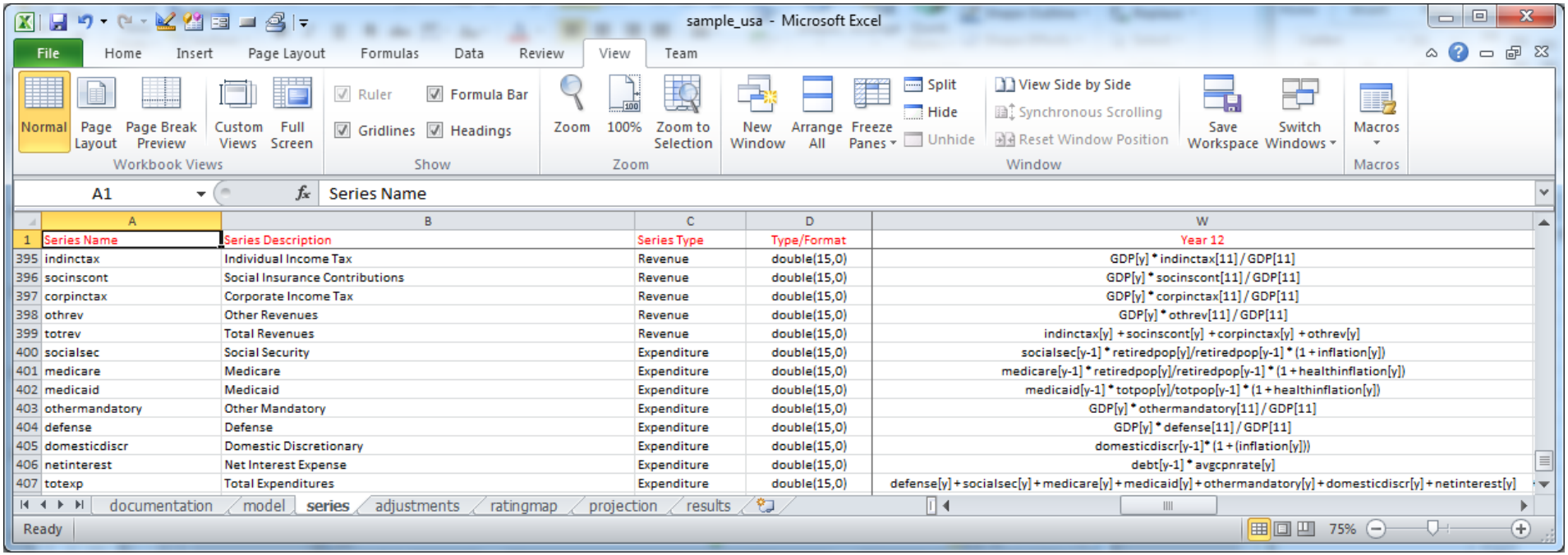
Part 3: Series Sheet / Macroeconomic Variables



	A	B	C	D	M
1	Series Name	Series Description	Series Type	Type/Format	Year 2
341	retiredpop	Population Eligible for Social Security	Macroeconomic	double(12,0)	seniorpop[y]
342	age16to64pop	Population Aged 16-64	Macroeconomic	double(12,0)	workingagepop[y] - seniorpop[y]
343	yr	Year Number	Macroeconomic	double(2,0)	65
344	age16to64participation	Aged 16-64 Labor Force Participation Rate	Macroeconomic	double(8,6)	0.017360 + 0.977893 * age16to64participation[y-1] + 0.051402 * normrandom_lfp[y]
345	seniorparticipation	Senior Labor Force Participation Rate	Macroeconomic	double(8,6)	-0.016204 + 0.000229 * yr[y] + 1.019063 * seniorparticipation[y-1] + 0.047795 * normrandom_lfp[y]
346	laborforcepart	Overall Labor Force Participation Rate	Macroeconomic	double(8,6)	(seniorparticipation[y]*seniorpop[y]+age16to64participation[y]*age16to64pop[y])/workingagepop[y]
347	laborforce	Size of Labor Force	Macroeconomic	double(12,0)	workingagepop[y] * laborforcepart[y]
348	productivitygrowth	Productivity Growth	Macroeconomic	double(8,6)	0.018880 - 0.153876 * productivitygrowth[y-1] + 0.029456 * normrandom_prod[y]
349	GDPgrowth	Real GDP Growth	Macroeconomic	double(8,6)	(laborforce[y] / laborforce[y-1] - 1) + productivitygrowth[y]
350	realGDP	Real GDP	Macroeconomic	double(20,0)	realGDP[y-1] * (1 + GDPgrowth[y])
351	inflation	General Inflation	Macroeconomic	double(8,6)	0.012515 + 0.640595 * inflation[y-1] + 0.029558 * normrandom_infl[y]
352	priceIndex	Consumer Price Index	Macroeconomic	double(10,6)	priceIndex[y-1] * (1 + inflation[y])
353	GDP	Nominal GDP	Macroeconomic	double(20,0)	realGDP[y] * priceIndex[y] * .01

- Inflation, GDP and interest rates can be modeled using any combination of constants, functions of random numbers and functions of other variables or prior year values
- Any C-compliant expression may be used
- Minima and maxima also supported
- Can apply different formulas at different stages of the forecast

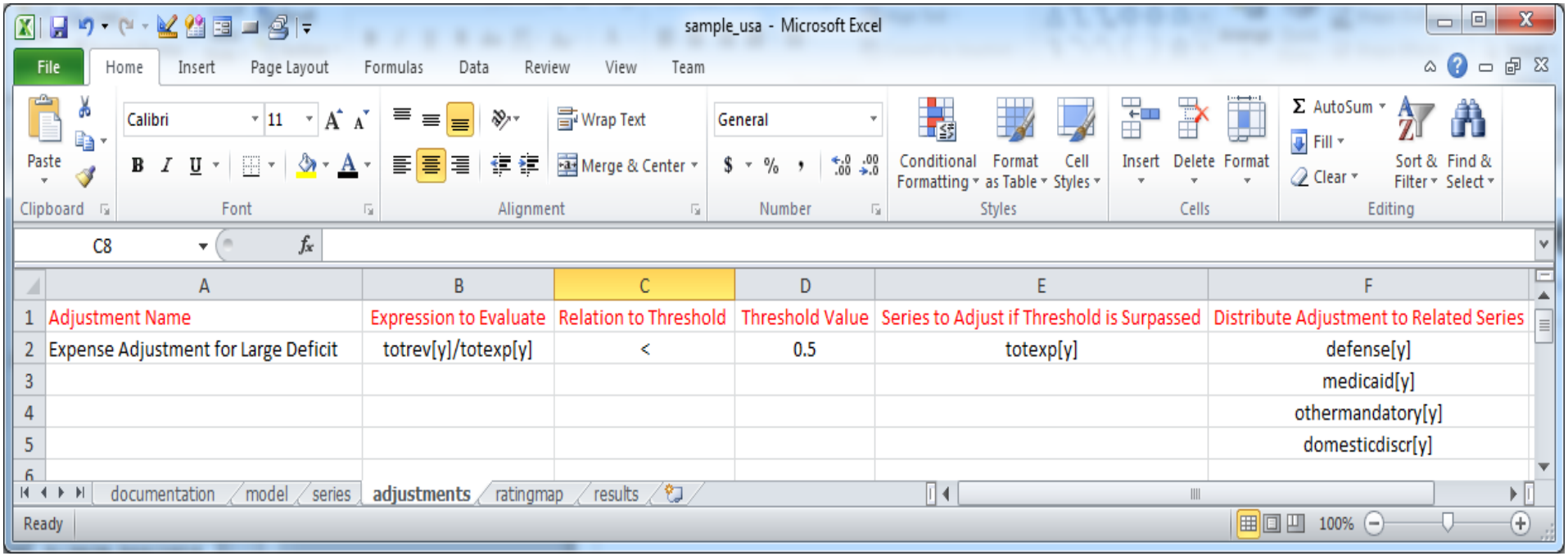
Part 4: Series Sheet / Revenues & Expenditures



	A	B	C	D	W
1	Series Name	Series Description	Series Type	Type/Format	Year 12
395	indinctax	Individual Income Tax	Revenue	double(15,0)	GDP[y] * indinctax[11] / GDP[11]
396	socinscont	Social Insurance Contributions	Revenue	double(15,0)	GDP[y] * socinscont[11] / GDP[11]
397	corpinctax	Corporate Income Tax	Revenue	double(15,0)	GDP[y] * corpinctax[11] / GDP[11]
398	othrev	Other Revenues	Revenue	double(15,0)	GDP[y] * othrev[11] / GDP[11]
399	totrev	Total Revenues	Revenue	double(15,0)	indinctax[y] + socinscont[y] + corpinctax[y] + othrev[y]
400	socialsec	Social Security	Expenditure	double(15,0)	socialsec[y-1] * retiredpop[y]/retiredpop[y-1] * (1 + inflation[y])
401	medicare	Medicare	Expenditure	double(15,0)	medicare[y-1] * retiredpop[y]/retiredpop[y-1] * (1 + healthinflation[y])
402	medicaid	Medicaid	Expenditure	double(15,0)	medicaid[y-1] * totpop[y]/totpop[y-1] * (1 + healthinflation[y])
403	othermandatory	Other Mandatory	Expenditure	double(15,0)	GDP[y] * othermandatory[11] / GDP[11]
404	defense	Defense	Expenditure	double(15,0)	GDP[y] * defense[11] / GDP[11]
405	domesticdiscr	Domestic Discretionary	Expenditure	double(15,0)	domesticdiscr[y-1] * (1 + (inflation[y]))
406	netinterest	Net Interest Expense	Expenditure	double(15,0)	debt[y-1] * avgcpnrate[y]
407	totexp	Total Expenditures	Expenditure	double(15,0)	defense[y] + socialsec[y] + medicare[y] + medicaid[y] + othermandatory[y] + domesticdiscr[y] + netinterest[y]

- Revenue and expenditure items can also use any valid C expression.
- Items may be linked to macroeconomic variables such as inflation or GDP.
- Annual surpluses or deficits can be computed from the revenue and expenditure series and then added to the previous year's debt.

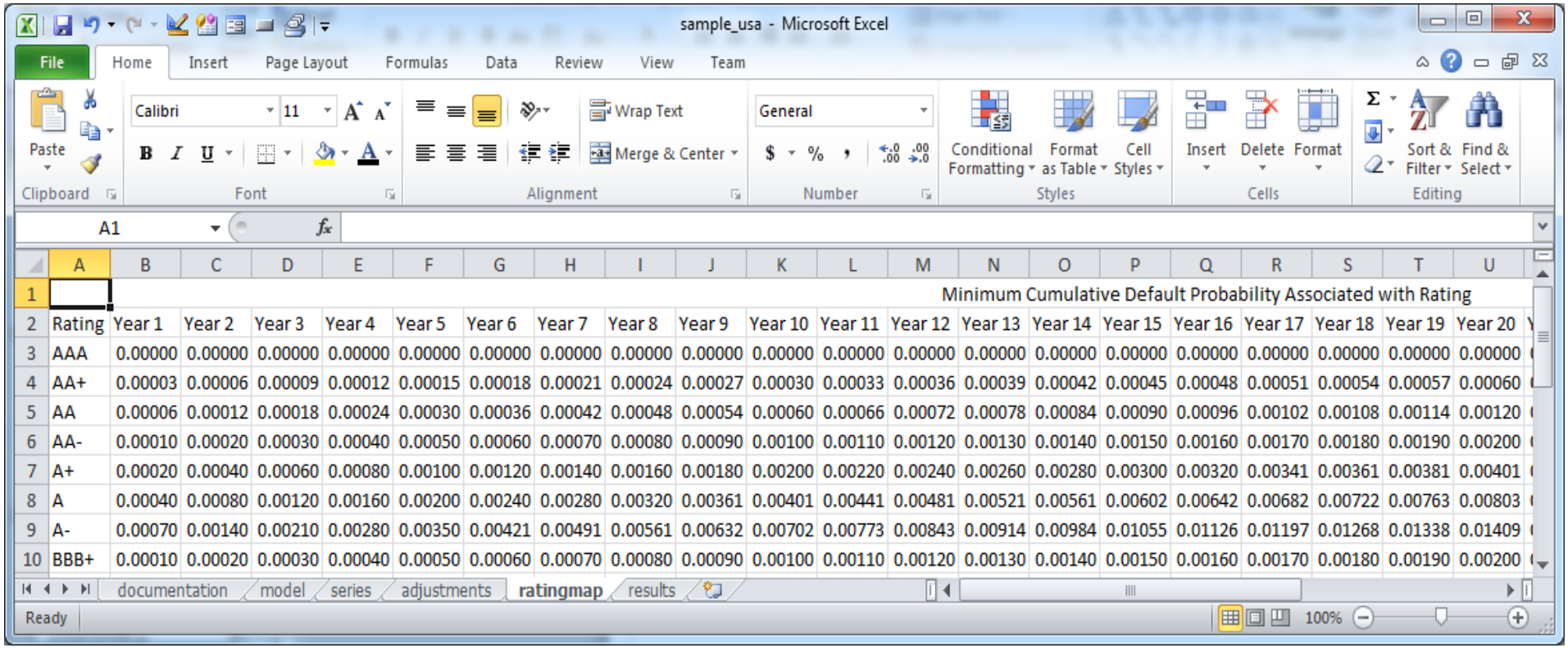
Walkthrough Part 5: Adjustments Sheet (Optional)



	A	B	C	D	E	F
1	Adjustment Name	Expression to Evaluate	Relation to Threshold	Threshold Value	Series to Adjust if Threshold is Surpassed	Distribute Adjustment to Related Series
2	Expense Adjustment for Large Deficit	totrev[y]/totexp[y]	<	0.5	totexp[y]	defense[y]
3						medicaid[y]
4						othermandatory[y]
5						domesticdiscr[y]
6						

- Legislative/executive decisions to reduce deficits (or spend large surpluses) can be simulated in the adjustments sheet.
- Revenue/Expenditure ratios can be bounded and changes to either revenues or expenditures can be distributed pro rata back to select budget lines.
- We expect to enhance this feature in future releases.

Walkthrough Part 6: Mapping to Ratings (Optional)



Rating	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
AAA	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
AA+	0.00003	0.00006	0.00009	0.00012	0.00015	0.00018	0.00021	0.00024	0.00027	0.00030	0.00033	0.00036	0.00039	0.00042	0.00045	0.00048	0.00051	0.00054	0.00057	0.00060
AA	0.00006	0.00012	0.00018	0.00024	0.00030	0.00036	0.00042	0.00048	0.00054	0.00060	0.00066	0.00072	0.00078	0.00084	0.00090	0.00096	0.00102	0.00108	0.00114	0.00120
AA-	0.00010	0.00020	0.00030	0.00040	0.00050	0.00060	0.00070	0.00080	0.00090	0.00100	0.00110	0.00120	0.00130	0.00140	0.00150	0.00160	0.00170	0.00180	0.00190	0.00200
A+	0.00020	0.00040	0.00060	0.00080	0.00100	0.00120	0.00140	0.00160	0.00180	0.00200	0.00220	0.00240	0.00260	0.00280	0.00300	0.00320	0.00341	0.00361	0.00381	0.00401
A	0.00040	0.00080	0.00120	0.00160	0.00200	0.00240	0.00280	0.00320	0.00361	0.00401	0.00441	0.00481	0.00521	0.00561	0.00602	0.00642	0.00682	0.00722	0.00763	0.00803
A-	0.00070	0.00140	0.00210	0.00280	0.00350	0.00421	0.00491	0.00561	0.00632	0.00702	0.00773	0.00843	0.00914	0.00984	0.01055	0.01126	0.01197	0.01268	0.01338	0.01409
BBB+	0.00010	0.00020	0.00030	0.00040	0.00050	0.00060	0.00070	0.00080	0.00090	0.00100	0.00110	0.00120	0.00130	0.00140	0.00150	0.00160	0.00170	0.00180	0.00190	0.00200

- Associate cumulative default probabilities with rating grades.
- Any rating system can be used.
- System returns a vector of annual ratings recognizes that bonds with different tenors carry different levels of risk.

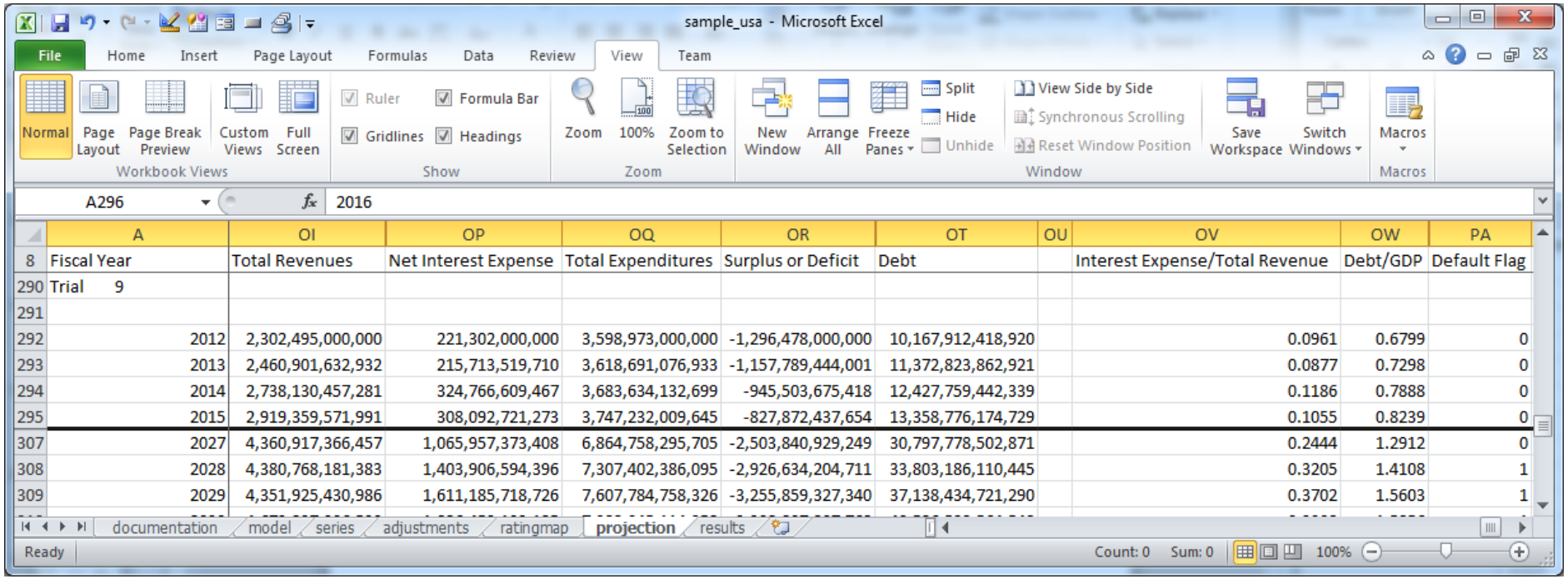
Walkthrough Part 7: Results Sheet

	A	B	C	D	E	F	G	H	I
1	PSCF Fiscal Projection								
2	Government Entity	United States							
3	Model Description	US Federal Budget Sample							
4	Currency Units in	USD							
5	Trials	1000000							
6	Run Date/Time	Sun Apr 29 20:45:17 2012							
7									
8	Year	Default Count	Default Probability	Cumulative Default Count	Cumulative Default Probability	Rating Equivalent		Minimum Interest Expense/Total	Maximum Interest Expense/Total Revenue
9	2011	0	0.0000	0	0.0000	N/A		0.0961	0.0961
10	2012	0	0.0000	0	0.0000	AAA		0.0746	0.0901
11	2013	0	0.0000	0	0.0000	AAA		0.0525	0.1681
12	2014	0	0.0000	0	0.0000	AAA		0.0398	0.2752
13	2015	41	0.0000	41	0.0000	AAA		0.0311	0.3716
14	2016	1128	0.0011	1128	0.0011	AA-		0.0237	0.5216
15	2017	6830	0.0068	6854	0.0069	A		0.0191	0.6042
16	2018	19744	0.0197	19994	0.0200	BBB+		0.0184	0.7066
17	2019	38303	0.0383	39388	0.0394	BBB-		0.0143	0.8430
18	2020	60262	0.0603	63145	0.0631	BBB-		0.0111	0.9304
19	2021	83528	0.0835	89419	0.0894	BB+		0.0082	1.0620
20	2022	106365	0.1064	116580	0.1166	BB+		0.0058	1.1602
21	2023	130937	0.1309	144942	0.1449	BB		0.0029	1.2817
22	2024	155633	0.1556	174300	0.1743	BB		-0.0127	1.4470
23	2025	181347	0.1813	204772	0.2048	BB		-0.0376	1.6018
24	2026	206237	0.2062	234958	0.2350	BB-		-0.0587	1.5884
25	2027	229649	0.2296	264085	0.2641	BB-		-0.0759	1.5737
26	2028	252446	0.2524	292445	0.2924	BB-		-0.0902	1.7109

documentation / model / series / adjustments / ratingmap / graph / **results**

Ready 100%

Walkthrough Part 8: Projection Sheet



	A	OI	OP	OQ	OR	OT	OU	OV	OW	PA
8	Fiscal Year	Total Revenues	Net Interest Expense	Total Expenditures	Surplus or Deficit	Debt		Interest Expense/Total Revenue	Debt/GDP	Default Flag
290	Trial 9									
291										
292	2012	2,302,495,000,000	221,302,000,000	3,598,973,000,000	-1,296,478,000,000	10,167,912,418,920		0.0961	0.6799	0
293	2013	2,460,901,632,932	215,713,519,710	3,618,691,076,933	-1,157,789,444,001	11,372,823,862,921		0.0877	0.7298	0
294	2014	2,738,130,457,281	324,766,609,467	3,683,634,132,699	-945,503,675,418	12,427,759,442,339		0.1186	0.7888	0
295	2015	2,919,359,571,991	308,092,721,273	3,747,232,009,645	-827,872,437,654	13,358,776,174,729		0.1055	0.8239	0
307	2027	4,360,917,366,457	1,065,957,373,408	6,864,758,295,705	-2,503,840,929,249	30,797,778,502,871		0.2444	1.2912	0
308	2028	4,380,768,181,383	1,403,906,594,396	7,307,402,386,095	-2,926,634,204,711	33,803,186,110,445		0.3205	1.4108	1
309	2029	4,351,925,430,986	1,611,185,718,726	7,607,784,758,326	-3,255,859,327,340	37,138,434,721,290		0.3702	1.5603	1

- Optional projection tab shows trial-by-trial, year-by-year results for each variable you want to see.
- Default flag is set whenever the first metric specified in the “model” sheet surpasses the default threshold.

Key

- DP = default probability
- GO = general obligation (bond)

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