A Pension Analysis Tool for Everyone

BY EDITOR, ON APRIL 2ND, 2012

A concern often voiced by pension reform activists and politicians interested in better understanding pension finance is that they have to depend solely on the information delivered by actuaries. This information, in turn, is typically delivered in a report so voluminous and so technical that the activists and politicians have to hire their own experts to explain it all to them. The mass of data and assumptions are usually so intimidating that ultimately many people who need to understand pension finance give up. Additionally, it is difficult to eradicate bias from expert analyses of pension solvency. The result is that many people, including paid professional spokespersons and other opinion makers, offer assertions that do not necessarily reflect the reality of pension finance, while voters and policymakers alike remain uncertain regarding the the nature and severity of the problem.

This post is to provide anyone who wishes to understand some of the fundamentals of pension finance a tool that allows them to do their own "what-ifs" on pensions. Because this model has distilled the mechanics of a pension fund to a single page of data and calculations, it offers a glimpse of how pensions operate that is relatively understandable and extremely transparent. This model is not intended in any way to replace the far more complex models used by actuaries, but it can be quite useful to illustrate, for example, how very sensitive the required annual contribution to a pension is to any change in other assumptions – especially the rate of return.

To download this Excel model, simply click on "pension analysis model" and you will have a spreadsheet to save and experiment with. Start with the first tab "constant inputs," the 2nd tab will be explained later. The graphic images below show the upper section of this spreadsheet; all of the cells that accept inputs are at the top of the spreadsheet and are highlighted in yellow. While this model is only designed to show the pension fund performance by year for one person, it is important to understand that pension funds that aggregate pension contributions and allocate pension benefits for thousands of people follow the same rules.

To use this model, simply enter the assumptions you would like to use into the yellow cells. Don't enter anything in a cell that is not highlighted in yellow or you will overwrite a formula. The result that matters is displayed in the one cell highlighted in green. If this number is positive, it indicates a pension would be adequately funded under the assumptions input by the user. If this number is negative, it shows by how much a pension would be underfunded. The goal is to enter a combination of assumptions in the yellow cells that yields the smallest amount in the green cell possible without being a negative number. That is a financially sustainable pension.

The three examples provided here are chosen because they clearly illustrate some of the key financial issues that challenge the solvency of pensions today. In all three examples, the pensioner is assumed to work 30 years and enjoy 25 years of retirement. They are assumed to earn a 1.0% increase in their salary each of those 30 years for merit (promotions and raises), and a 3.0% increase in their salary each year for cost of living adjustments (COLAs). Once retired, they are assumed to get a 2.0% COLA increase in their pension each year. These assumptions can all be changed, since they are all driven by inputs in the yellow highlighted cells, but to show the impact of two key variables – the pension benefit formula, and the rate of return – they are held constant on all three examples to follow.

The first example, on the table immediately below this paragraph, shows what public safety pensions were historically – up until somewhere between 5 and 15 years ago, when virtually every city and county in California adopted more generous pension formulas. In the "pension formula/yr" cell, 2.0% is entered, which means that for every year worked, the pensioner will receive 2.0% of their final salary in retirement. This means a person who works 30 years, as in this example, will receive 60% of their final salary per year as a retirement pension. In the "fund return %" cell, the typical long-term rate of return for the pension funds is entered, 7.75% per year. Once you enter all these numbers, go to the "% of salary to pension" cell and enter various amounts until you arrive at one that provides the smallest positive number possible in the green cell. Doing this indicates that under these assumptions, an employee would require an amount equivalent to 13.1% of their salary to be set aside each year to fund a pension benefit equal to 60% of their final salary.

age of retirement	% cola growth/yr	years working	years retired	pension formula/yr	pension cola %
55	3.0%	30	25	2.0%	2.0%

life expectancy	age began working	% merit growth/yr	% of salary to pension	fund return %	pension % of salary
80	25	1.0%	13.1%	7.75%	60%

age	years worked/ retired	final salary 100,000	fund inputs	fund beginning balance	fund earnings	pension payments	fund ending balance
80	25	-	-	111,993	8,679	96,506	[redacted]
79	24	-	-	191,747	14,860	94,614	111,993
78	23	-	-	264,042	20,463	92,759	191,747
77	22	-	-	329,450	25,532	90,940	264,042
76	21	-	-	388,498	30,109	89,157	329,450
75	20	-	-	441,677	34,230	87,409	388,498
74	19	-	-	489,440	37,932	85,695	441,677
73	18	-	-	532,208	41,246	84,014	489,440
72	17	-	-	570,372	44,204	82,367	532,208
71	16	-	-	604,291	46,833	80,752	570,372
70	15	-	-	634,302	49,158	79,169	604,291
69	14	-	-	660,713	51,205	77,616	634,302
68	13	-	-	683,812	52,995	76,095	660,713
67	12	-	-	703,865	54,550	74,602	683,812
66	11	-	-	721,118	55,887	73,140	703,865
65	10	-	-	735,799	57,024	71,706	721,118
64	9	-	-	748,119	57,979	70,300	735,799
63	8	-	-	758,274	58,766	68,921	748,119
62	7	-	-	766,444	59,399	67,570	758,274
61	6	-	-	772,797	59,892	66,245	766,444
60	5	-	-	777,488	60,255	64,946	772,797
59	4	-	-	780,659	60,501	63,672	777,488
58	3	-	-	782,444	60,639	62,424	780,659
57	2	-	-	782,964	60,680	61,200	782,444
56	1	-	-	782,333	60,631	60,000	782,964
55	30	100,000	13,100	712,964	56,270	-	782,333
54	29	96,154	12,596	649,087	51,280	-	712,964
53	28	92,456	12,112	590,289	46,686	-	649,087
52	27	88,900	11,646	536,186	42,457	-	590,289
51	26	85,480	11,198	486,423	38,566	-	536,186
50	25	82,193	10,767	440,669	34,986	-	486,423

In the next example, shown below, one can view the impact of a change in the benefit formula from 2.0% to 3.0%. That is, the only change that has been made to the assumptions is the change in the "pension formula/yr" cell from 2.0% to 3.0%. This is to model the current typical pension formula for safety employees, 3.0% times years worked, times final salary. As shown, in order to still have a positive fund ending balance in the green cell, the amount to be contributed each year into the pension fund, "% of salary to pension," now has to increase from 13.1% to 19.6%.

It is important to digress here to point out that because the change in the pension benefit formula from 2.0% to 3.0% (or from 1.25% to 2.0% for non-safety employees) was done *retroactively*, pension funds would have been required to increase their rate of contributions far beyond 19.6% going forward. This is because, for example, a mid-career employee, suddenly receiving this retroactive benefit enhancement, would have only been putting 13.1% into their pension fund for the entire first half of their career, a critical period since money invested that early has more time for earnings to compound. The impact of making the benefit enhancement retroactive will be explored at the end of this post.

	age of retirement	% cola growth/yr	years working	years retired	pension formula/yr	pension cola %
	55	3.0%	30	25	3.0%	2.0%
life expectancy	age began working	% merit growth/yr	% of salary to pension		fund return %	pension % of salary
80	25	1.0%	19.6%		7.75%	90%

age	years worked/ retired	final salary 100,000	fund inputs	fund beginning balance	fund earnings	pension payments	fund ending balance
80	25	-	-	150,079	11,631	144,759	[illegible]
79	24	-	-	270,998	21,002	141,921	150,079
78	23	-	-	380,637	29,499	139,138	270,998
77	22	-	-	479,858	37,189	136,410	380,637
76	21	-	-	569,460	44,133	133,735	479,858
75	20	-	-	650,184	50,389	131,113	569,460
74	19	-	-	722,715	56,010	128,542	650,184
73	18	-	-	787,691	61,046	126,022	722,715
72	17	-	-	845,700	65,542	123,551	787,691
71	16	-	-	897,288	69,540	121,128	845,700
70	15	-	-	942,962	73,080	118,753	897,288
69	14	-	-	983,189	76,197	116,425	942,962
68	13	-	-	1,018,405	78,926	114,142	983,189
67	12	-	-	1,049,010	81,298	111,904	1,018,405
66	11	-	-	1,075,378	83,342	109,709	1,049,010
65	10	-	-	1,097,853	85,084	107,558	1,075,378
64	9	-	-	1,116,753	86,548	105,449	1,097,853
63	8	-	-	1,132,376	87,759	103,382	1,116,753
62	7	-	-	1,144,994	88,737	101,355	1,132,376
61	6	-	-	1,154,859	89,502	99,367	1,144,994
60	5	-	-	1,162,207	90,071	97,419	1,154,859
59	4	-	-	1,167,254	90,462	95,509	1,162,207
58	3	-	-	1,170,199	90,690	93,636	1,167,254
57	2	-	-	1,171,229	90,770	91,800	1,170,199
56	1	-	-	1,170,514	90,715	90,000	1,171,229
55	30	100,000	19,600	1,066,724	84,190	-	1,170,514
54	29	96,154	18,846	971,153	76,725	-	1,066,724
53	28	92,456	18,121	883,181	69,851	-	971,153
52	27	88,900	17,424	802,233	63,523	-	883,181
51	26	85,480	16,754	727,778	57,701	-	802,233
50	25	82,193	16,110	659,322	52,346	-	727,778

The third and final example, below, shows the impact of a lowering of the fund's rate of return. In this case, not only is the benefit formula enhanced from 2.0% per year to 3.0% per year, but the rate of return for the fund is lowered from 7.75% per year to 6.00% per year. At this rate of return, pension solvency would not require an annual contribution equivalent to 13.1% of payroll, or 19.6% of payroll, but 31.4% of payroll. This is a huge adjustment. In the concluding section of this post, a more in-depth analysis is presented explaining why even this may not be enough.

	age of retirement	% cola growth/yr	years working	years retired	pension formula/yr	pension cola %
	55	3.0%	30	25	3.0%	2.0%

life expectancy	age began working	% merit growth/yr	% of salary to pension	fund return %	pension % of salary
80	25	1.0%	31.4%	6.00%	90%

age	years worked/ retired	final salary 100,000	fund inputs	fund beginning balance	fund earnings	pension payments	fund ending balance
80	25	-	-	149,291	8,957	144,759	[redacted]
79	24	-	-	274,728	16,484	141,921	149,291
78	23	-	-	390,440	23,426	139,138	274,728
77	22	-	-	497,028	29,822	136,410	390,440
76	21	-	-	595,060	35,704	133,735	497,028
75	20	-	-	685,069	41,104	131,113	595,060
74	19	-	-	767,558	46,053	128,542	685,069
73	18	-	-	842,999	50,580	126,022	767,558
72	17	-	-	911,840	54,710	123,551	842,999
71	16	-	-	974,498	58,470	121,128	911,840
70	15	-	-	1,031,369	61,882	118,753	974,498
69	14	-	-	1,082,824	64,969	116,425	1,031,369
68	13	-	-	1,129,213	67,753	114,142	1,082,824
67	12	-	-	1,170,865	70,252	111,904	1,129,213
66	11	-	-	1,208,089	72,485	109,709	1,170,865
65	10	-	-	1,241,177	74,471	107,558	1,208,089
64	9	-	-	1,270,402	76,224	105,449	1,241,177
63	8	-	-	1,296,022	77,761	103,382	1,270,402
62	7	-	-	1,318,280	79,097	101,355	1,296,022
61	6	-	-	1,337,403	80,244	99,367	1,318,280
60	5	-	-	1,353,606	81,216	97,419	1,337,403
59	4	-	-	1,367,089	82,025	95,509	1,353,606
58	3	-	-	1,378,043	82,683	93,636	1,367,089
57	2	-	-	1,386,644	83,199	91,800	1,378,043
56	1	-	-	1,393,060	83,584	90,000	1,386,644
55	30	100,000	31,400	1,282,808	78,852	-	1,393,060
54	29	96,154	30,192	1,180,004	72,612	-	1,282,808
53	28	92,456	29,031	1,084,180	66,793	-	1,180,004
52	27	88,900	27,914	994,897	61,369	-	1,084,180
51	26	85,480	26,841	911,741	56,315	-	994,897
50	25	82,193	25,809	834,325	51,608	-	911,741

The model presented thus far is not designed to allow the user to input differing values in each year under analysis, but in the same Excel file "pension analysis model," there is a 2nd tab, "flexible inputs," that does provide this ability to the user. To delve into the details of how to use this model would go beyond the scope of this post. In short, any cell highlighted in yellow is an input cell, including entire columns where each row corresponds to a different year. The user will still iterate to achieve a near-zero result in the lone green cell which represents the final ending balance of the fund. The model on the 2nd tab uses exactly the same formulas and logic as the model illustrated above, except the user can assume and input differing values per year on this version. Here is a summary of the default case that is already entered on the downloadable spreadsheet, tab two, entitled "variable inputs:"

This analysis assumes that the change to the benefit formula from 2.0% per year to 3.0% per year was done in late 2000, in mid-career for the employee (year 15 of a 30 year career). This means that through the year 2000, holding all other assumptions constant, the annual pension contribution was only 13.1% of salary (because at through that point, that was all it needed to be – see example #1 above). What also happened starting around the year 2001 was the rate of return earned by pension funds fell – they have actually fallen to around 4.0% during the past decade, but in this analysis, the rate is lowered to 6.0% per year and held there through the rest of the timeline. Prior to 2001, from 1985 through 2000, the rate of return is assumed to be 7.75% per year.

Based on these assumptions, which reflect a fairly realistic assessment of history to-date, starting in 2001 it is necessary for an employee with these rate-of-return and benefit changes to make an annual contribution to their pension fund equaling 54.5% of their salary. And for every year they have not done this, that percentage must rise. Nowhere in this analysis, moreover, is the all-too-frequent practice of "spiking" accounted for, which raises necessary annual contributions still further.

By using in this final example a person for whom the pension fund adjustment was made in mid-career, it is reasonably accurate to say that whatever unfunded liability may exist in reality in this individual case, could be used as a basis for calculating the total unfunded liability of the fund in aggregate. To get a global estimate, of course, one must input a blended benefit rate that takes into account the lower formulas that apply to non-safety employees, or run them as separate studies.

Again, this model is not meant to replace actuarial models that take into account specific fund demographics and deliver results precisely aggregated for all participants in the fund. But actuarial models, for all their precision and complexity, must nonetheless rely on the same set of assumptions this model does, and how those assumptions are made delivers vastly differing outcomes. For anyone who uses it, this model may serve as a useful tool to better understand and communicate the dynamics of pensions, and to sanity check whatever does come out of the black boxes reserved for qualified actuaries.

GOVERNMENT INSOLVENCY, RETIREMENT BENEFITS PENSION ANALYSIS MODEL

2 comments to A Pension Analysis Tool for Everyone

Jim McKee

APRIL 3, 2012 AT 10:34 AM · REPLY

I think your effort to translate the actuarial science and language into basic soundbytes for broader consumption is commendable. I also think that anyone with an understanding of pension science will recognize that the discount rate lever is arguably the most powerful and dangerous assumption to play with among public funds. Fortunately, this assumption is more strictly regulated among corporate pension funds, so they don't have as much discretion to understate their pension liabities and funding needs.

The link to the pension model doesn't seem to have the complete set of spreadsheet files in the zipped file for the reader to use. Any help to fix or clarify the downloading process would be appreciated.