Internet Appendix for

"Public Pension Promises: How Big Are They and What Are They Worth?"*

ROBERT NOVY-MARX and JOSHUA RAUH

This internet appendix presents material that is supplemental to the main tables in "Public Pension Promises: How Big Are They and What Are They Worth?" This Internet Appendix consists of three tables, one figure, and a technical note. The first table (Table IA.I) shows assets and liabilities as reported by state pension systems as of different reporting dates. The second table (Table IA.II) shows the detailed actuarial assumptions used in our calibrations that translate among different liability methods and discount rates. The final table (Table IA.III) shows a history of government employee wages alongside stock market returns. The figure (Figure IA.1) shows the effect of market rates on liability values during 2009, as well as Treasury yields at each date during 2009 at three maturities. Our main estimates in this paper use June 30, 2009 as a valuation date. Finally, the technical note demonstrates that accruals under the entry age normal method resemble money set aside in a DC savings plan.

* Citation format: Novy-Marx, Robert, and Joshua Rauh, Internet Appendix for "Public Pension Promises: How Big Are They and What Are They Worth?" 2011, *Journal of Finance* 66(4), 1211-1249, http://www.afajof.org/supplements.asp. Please note: Wiley-Blackwell is not responsible for the content or functionality of any supporting information supplied by the authors. Any queries (other than missing material) should be directed to the authors of the article.

Table IA.I
Assets and Liabilities as Reported by State Pension Systems

This table shows assets and liabilities as reported by state-sponsored public pension systems. In each panel, the plans are divided by the date of the latest Comprehensive Annual Financial Report (CAFR), which is the source of the information. The final row of the table shows the estimate of aggregate assets and liabilities harmonized to June 30, 2009. To calculate liabilities on a stated basis as of this date, the annual growth rate of aggregate liabilities is applied to move the liability forward or backward by the necessary number of months. To calculate assets on a stated basis as of this date, the annual growth rate of aggregate assets is applied to move the assets forward or backward by the necessary number of months.

	Liabilities		Assets	
Latest Report Date	Count	Amount ($ trillions)	Count	Amount ($ trillions)
December 31, 2009	3	0.02	4	0.04
June 30, 2009	48	0.93	82	1.33
December 31, 2008	12	0.31	14	0.26
June 30, 2008	37	1.23	5	0.04
Other Dates	16	0.54	11	0.29
Raw Sum of Latest	116	3.03	116	1.96
June 30, 2009 (Estimated)		3.14		1.94

Table IA.II
Actuarial Assumptions

This table sets out the actuarial assumptions we use to translate among different liability methods and discount rates. Panel A shows member counts and average salaries for plans by actuarial method, calculated using the CAFRs of the 116 sample plans. For Panels B and C, we examine the CAFRs of the 10 states with the largest total liabilities and take assumptions from the reports where they are usable: New York, Illinois, Pennsylvania, Ohio, and Texas. The figures represent an average over the reports. Where necessary we perform linear interpolations between age brackets. Panel D shows the age distribution of retirees, including salaries in each age range. The information in Panel D is only disclosed sporadically in the CAFRs, but by randomly sampling the CAFRs we obtain an average distribution across 10 plans covering approximately 1.2 million retirees. The plans entering the Panel D distributions are the Massachusetts Public Employee Retirement System, Employees' Retirement System of Georgia, Teachers' Retirement System of Illinois, Florida Retirement System, State Teachers Retirement System of Ohio, Tennessee Consolidated Retirement Systems, Pennsylvania Public School Employees' Retirement System, Louisiana State Employees' Retirement System, New York State Employees Retirement System, and Arizona Retirement System.

Panel A. Member Counts and Salaries as of June 2009

	Member Counts				
	Active	Annuitants	Separated & Vested	Total	Salary
Total	12,920,361	6,813,294	2,592,462	22,326,118	
Mean	111,382	58,735	22,349	192,466	$49,241
Median	61,240	35,678	6,144	103,483	$44,180
Std Dev	153,683	77,012	44,838	259,096	$17,767

Panel B. Salary Growth and Separation Rate by Age

Age	Salary Growth	Separation Rate
21-25	10.0%	19.8%
26-30	11.2%	9.1%
31-35	7.6%	6.8%
36-40	7.0%	6.0%
41-45	6.1%	4.9%
46-50	5.6%	4.7%
51-55	5.0%	4.7%
56-60	4.7%	21.4%
61-65	4.2%	23.3%
66-70	4.0%	26.1%
71-75	4.1%	54.9%

Panel C. Age-Service Matrices

Age-Service Weights (share of workforce in a given age-service bracket)

Age		Years of Service										
Min	Max	0-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55
21	25	0.033	0.000									
26	30	0.108	0.021	0.000								
31	35	0.053	0.068	0.010	0.000							
36	40	0.038	0.042	0.044	0.007	0.000						
41	45	0.036	0.027	0.024	0.027	0.006	0.000					
46	50	0.032	0.027	0.019	0.018	0.023	0.006	0.001				
51	55	0.023	0.024	0.022	0.019	0.018	0.028	0.013	0.000			
56	60	0.014	0.015	0.017	0.020	0.018	0.016	0.026	0.004	0.000		
61	65	0.007	0.005	0.006	0.007	0.007	0.005	0.004	0.003	0.000		
66	70	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.000	0.000	0.000	
71	75	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Age-Service Relative Wages (as a fraction of overall average wage)

Age		Years of Service										
Min	Max	0-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55
21	25	0.570	0.441									
26	30	0.698	0.844	0.767								
31	35	0.718	0.911	0.882	0.695							
36	40	0.655	0.899	1.069	1.123	1.020						
41	45	0.603	0.804	1.037	1.174	1.204	0.948					
46	50	0.588	0.746	0.927	1.125	1.245	1.253	0.959				
51	55	0.610	0.761	0.906	1.056	1.215	1.325	1.367	1.344			
56	60	0.659	0.772	0.903	1.043	1.168	1.307	1.413	1.478	1.352		
61	65	0.686	0.745	0.868	0.998	1.119	1.202	1.318	1.491	1.461		
66	70	0.760	0.848	0.911	1.011	1.083	1.164	1.241	1.345	1.429	1.160	
71	75	0.718	0.722	0.540	0.764	0.878	0.880	1.132	1.301	1.172	1.358	1.276

Panel D. Age Distribution of Retirees with Average Salaries

	Equal Weighted		Person Weighted	
	Share	Average Salary	Share	Average Salary
Under 50	1.1%	$ 22,531	1.4%	$ 19,564
50-54	2.1%	$ 25,977	2.0%	$ 24,109
55-59	10.8%	$ 33,227	10.5%	$ 28,584
60-64	20.9%	$ 31,043	19.8%	$ 28,263
65-69	19.9%	$ 25,901	19.7%	$ 22,677
70-74	15.6%	$ 23,184	15.7%	$ 20,756
75-79	12.4%	$ 20,354	12.7%	$ 18,159
80-84	9.0%	$ 17,937	9.5%	$ 16,444
85-89	5.2%	$ 15,408	5.5%	$ 13,368
90+	2.8%	$ 15,124	3.0%	$ 13,379
Total	100%	$ 25,054	100%	$ 22,117

Table IA.III
Government Employee Wage Data and the Stock Market

Wages are for government workers only and are calculated from the CPS. Inflation data are from the BLS. The return on the U.S. stock market and the risk free rate are extracted from the data made available by Kenneth French.

CPS Year	Government Mean Wage Income	Standard Deviation of Wages	Growth in Mean Wages	CPI Inflation	Wage Growth Minus CPI Inflation	Risk free rate (r_f)	Stock Market Return (r_m)	Excess Return (r_m-r_f)
1962	5000	2724				2.7%	-10.3%	-13.1%
1963	5033	2446	0.7%	1.3%	-0.7%	3.1%	20.9%	17.8%
1964	5327	2881	5.8%	1.3%	4.5%	3.5%	16.3%	12.8%
1965	5471	2632	2.7%	1.6%	1.1%	3.9%	14.4%	10.5%
1966	5791	3159	5.9%	2.9%	3.0%	4.8%	-8.7%	-13.4%
1967	6023	2874	4.0%	3.1%	0.9%	4.2%	28.6%	24.4%
1968	6598	3699	9.6%	4.2%	5.4%	5.2%	14.2%	9.0%
1969	7148	4188	8.3%	5.5%	2.9%	6.6%	-10.8%	-17.4%
1970	7734	3686	8.2%	5.7%	2.5%	6.5%	0.1%	-6.4%
1971	8446	4279	9.2%	4.4%	4.8%	4.4%	16.2%	11.8%
1972	8814	5184	4.4%	3.2%	1.2%	3.8%	17.3%	13.5%
1973	9357	4777	6.2%	6.2%	-0.1%	6.9%	-18.8%	-25.7%
1974	9977	5379	6.6%	11.0%	-4.4%	8.0%	-27.9%	-36.0%
1975	10556	5762	5.8%	9.1%	-3.3%	5.8%	37.4%	31.6%
1976	11499	5646	8.9%	5.8%	3.2%	5.1%	26.8%	21.7%
1977	12248	5944	6.5%	6.5%	0.0%	5.1%	-3.0%	-8.1%
1978	12924	6336	5.5%	7.6%	-2.1%	7.2%	8.6%	1.4%
1979	13829	7108	7.0%	11.3%	-4.3%	10.4%	24.4%	14.0%
1980	14879	8008	7.6%	13.5%	-5.9%	11.3%	33.2%	22.0%
1981	16236	7193	9.1%	10.3%	-1.2%	14.7%	-4.0%	-18.7%
1982	17813	7941	9.7%	6.2%	3.6%	10.5%	20.4%	9.9%
1983	18333	9481	2.9%	3.2%	-0.3%	8.8%	22.7%	13.9%
1984	19926	10540	8.7%	4.3%	4.4%	9.8%	3.2%	-6.7%
1985	21048	11155	5.6%	3.6%	2.1%	7.7%	31.4%	23.7%
1986	21657	11127	2.9%	1.9%	1.0%	6.2%	15.6%	9.4%
1987	23038	11824	6.4%	3.6%	2.7%	5.5%	1.8%	-3.7%
1988	24311	12388	5.5%	4.1%	1.4%	6.4%	17.6%	11.2%
1989	25143	12972	3.4%	4.8%	-1.4%	8.4%	28.4%	20.1%
1990	26749	13631	6.4%	5.4%	1.0%	7.8%	-6.1%	-13.9%
1991	27400	13880	2.4%	4.2%	-1.8%	5.6%	33.6%	28.0%
1992	29008	14717	5.9%	3.0%	2.9%	3.5%	9.1%	5.6%
1993	30067	15131	3.7%	3.0%	0.7%	2.9%	11.6%	8.7%
1994	30719	15738	2.2%	2.6%	-0.4%	3.9%	-0.8%	-4.7%
1995	31699	16922	3.2%	2.8%	0.4%	5.6%	35.7%	30.1%
1996	33301	24617	5.1%	3.0%	2.1%	5.2%	21.2%	16.0%
1997	33627	22699	1.0%	2.3%	-1.3%	5.3%	30.3%	25.1%
1998	34860	21563	3.7%	1.6%	2.1%	4.9%	22.3%	17.4%
1999	36204	21813	3.9%	2.2%	1.6%	4.7%	25.3%	20.6%
2000	37003	21555	2.2%	3.4%	-1.2%	5.9%	-11.1%	-16.9%
2001	39358	24954	6.4%	2.8%	3.5%	3.9%	-11.3%	-15.1%
2002	40366	25560	2.6%	1.6%	1.0%	1.6%	-20.8%	-22.5%
2003	41402	28042	2.6%	2.3%	0.3%	1.0%	33.1%	32.1%
2004	43600	30343	5.3%	2.7%	2.6%	1.2%	13.0%	11.8%
2005	43281	27485	-0.7%	3.4%	-4.1%	3.0%	7.3%	4.4%
2006	45182	33045	4.4%	3.2%	1.2%	4.8%	16.2%	11.4%
2007	45969	30834	1.7%	2.8%	-1.1%	4.7%	7.3%	2.6%
2008	47416	29402	3.1%	3.8%	-0.7%	1.6%	-38.3%	-40.0%
Mean			5.0%	4.8%	0.6%	5.7%	11.0%	5.3%
Volatility			2.6%	3.1%	2.6%	2.8%	17.9%	17.9%

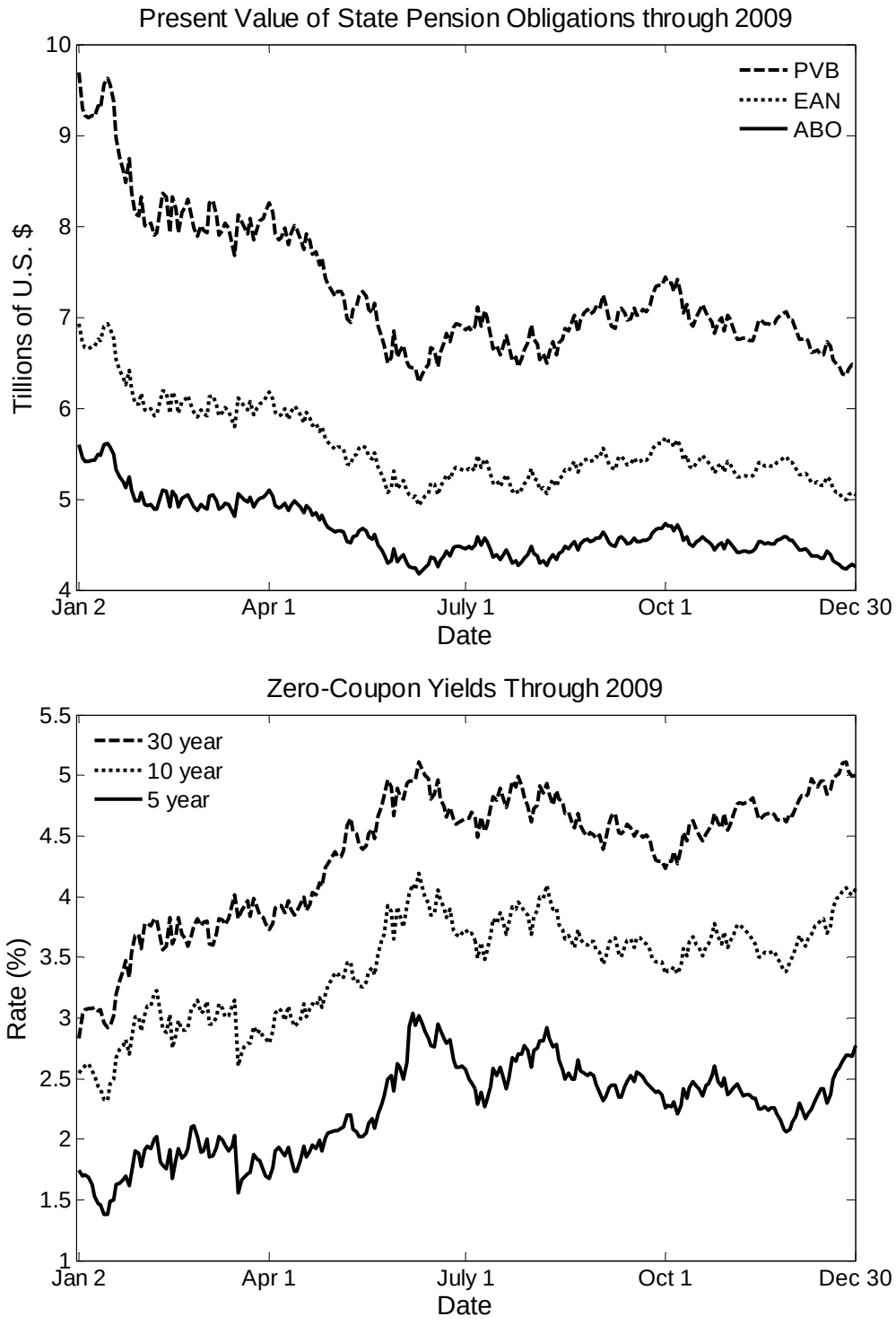

Figure IA.1: Effect of market rates on liability values during 2009. The top figure shows the present value of state pension obligations using Treasury discounting at each day during 2009. The bottom shows the Treasury yields at each date at three maturities. Our main estimates in this paper use June 30, 2009 as a valuation date.

Technical Note: Normal Costs Under the Entry Age Normal Accrual Method

To see that the EAN accruals resemble money set aside in a DC saving plan, note that under the EAN method the Normal Cost for a worker of age *a* with *s* years of service, that is, the liability accrued for the current year of service, is given by

$$NC\_EAN_{a,s}^{T} \;=\; EAN_{a,s}^{T} - \left(\frac{1+r}{S_{a-1,1}}\right) \times EAN_{a-1,s-1}^{T+1},$$

the difference between the current liability and last year's liability grossed up by the discount rate and adjusted to account for the fact that the worker survived from last year. Substituting our formula for the EAN into the previous equation and simplifying yields

$$NC\_EAN_{a,s}^{T} \;=\; \left(\frac{PVB_{a-s,0}^{s+T}}{\sum_{i=1}^{s+T} \frac{S_{a-s,i}}{(1+r)^{i}} \times W_{a-s+i,i}}\right) \times W_{a,s}.$$

The term in the parentheses on the right-hand side of the previous equation is unchanged if *a* and *s* increase by one while *T* decreases by one. That is, it is invariant over the employee's tenure.