

The Fiscal Implications of Massachusetts Retirement Boards' Investment Returns

No. 90
October
2012

A Pioneer Institute White Paper

by Iliya Atanasov



PIONEER INSTITUTE
PUBLIC POLICY RESEARCH

Pioneer's Mission

Pioneer Institute is an independent, non-partisan, privately funded research organization that seeks to improve the quality of life in Massachusetts through civic discourse and intellectually rigorous, data-driven public policy solutions based on free market principles, individual liberty and responsibility, and the ideal of effective, limited and accountable government.

Pioneer's Centers



This paper is a publication of the Center for Better Government, which seeks limited, accountable government by promoting competitive delivery of public services, elimination of unnecessary regulation, and a focus on core government functions. Current initiatives promote *reform of how the state builds, manages, repairs and finances its transportation assets as well as public employee benefit reform*.



The Center for School Reform, which seeks to increase the education options available to parents and students, drive system-wide reform, and ensure accountability in public education. The Center's work builds on Pioneer's legacy as a recognized leader in the charter public school movement, and as a champion of greater academic rigor in Massachusetts' elementary and secondary schools. Current initiatives promote *choice and competition, school-based management, and enhanced academic performance in public schools*.



The Center for Economic Opportunity seeks to keep Massachusetts competitive by promoting a healthy business climate, transparent regulation, small business creation in urban areas and sound environmental and development policy. Current initiatives promote market reforms to *increase the supply of affordable housing, reduce the cost of doing business, and revitalize urban areas*.



The Center for Health Care Solutions seeks to refocus the Massachusetts conversation about health care costs away from government-imposed interventions, toward market-based reforms. Current initiatives include *driving public discourse on Medicaid; presenting a strong consumer perspective as the state considers a dramatic overhaul of the health care payment process; and supporting thoughtful tort reforms*.

Pioneer Institute is a tax-exempt 501(c)3 organization funded through the donations of individuals, foundations and businesses committed to the principles Pioneer espouses. To ensure its independence, Pioneer does not accept government grants.

The Fiscal Implications of Massachusetts Retirement Boards' Investment Returns

Iliya Atanasov

Contents

Introduction	1
The State of Public Pensions in Massachusetts	1
Whither Investment Returns?	4
Fiscal Impact of Investment Returns in Different Scenarios	5
UAAL Amortization Schedules in Different ARR Scenarios	7
Conclusion	9
About the Author	10
Appendix I: Data Description	12
Appendix II: Methodology	12
Appendix III: Cost-of-Living Adjustments	13
Appendix IV: Duration Analysis	13
Endnotes	14

■ The Fiscal Implications of Massachusetts Retirement Boards' Investment Returns

Introduction

Throughout the US, the number and scope of defined-benefit pension plans have been on the wane for over a quarter century.¹ Many private-sector workers have had their benefits wiped out by bankruptcies and fire sales of distressed businesses despite the legislative push from pay-as-you-go to fully funded pension plans.² Meanwhile, funded government-backed retirement systems have suffered massive investment losses from the dotcom and real-estate bubbles. Massachusetts has managed to preserve most of the benefits for its 500,000 retirees and active public employees, but its retirement system has been hit hard by the sharp decline and increased volatility of asset prices. The persistently strenuous economic conditions impose some tough choices regarding the state's approach to funding its pension obligations, as retirement funds have largely failed to adjust their investment-return assumptions to the new asset-markets realities. Consequently, taxpayers and public employees alike could benefit from a timely reevaluation of the retirement system's actuarial standards and, most importantly, the pension funds' assumed rates of return (ARR).

The State of Public Pensions in Massachusetts

Funding requirements were first established for public pensions in Massachusetts in the early 1980s and the Commonwealth has gradually decreased its share of contributions towards public employees' pensions. The state's share of the cost of earned benefits is known as the net normal cost. By 2010, it had declined to 2.6% of payroll, while the employees' contribution had risen to 9.1% of payroll or about 78% of the total normal cost.

Correspondingly, net normal cost declined from 1.09% of the state budget in 2001 to 0.88% in 2010. By comparison, if the state were to abolish its pensions altogether, it would have to contribute 6.2% of payroll to Social Security, more than double its net normal cost in 2010.³

Unfunded accrued actuarial liabilities (UAAL) are mostly a legacy of the pay-as-you-go system, but investment underperformance can lead to even greater funding problems down the road. The 2010 financial reports of the 105 Massachusetts retirement boards listed combined pension liabilities of over \$92bn, almost \$31bn of which remained unfunded. Some \$61bn of the total pension liabilities pertained to retirement funds such as Massachusetts Teachers which are to be funded directly by the state (Fig. 1) and \$17.6bn of those were UAAL that still had to be paid down (Fig. 2). The state also has provided limited financial incentives to local retirement boards to fund their own UAALs better. Overall, the state government's appropriation for normal cost and unfunded liabilities was \$1.4bn or 4.3% of the budget for FY 2011. Just over \$1bn, or 3.42% of state expenditures, went towards funding UAAL.

Figure 1: Pension Liabilities by 2010 Actuarial Estimates (\$mn)⁴

Mass Housing Finance Agency	\$82
Mass Port Authority	\$420
Mass Water Resources Authority	\$321
State	\$26,316
Total State & Agency	\$27,139
+	
Mass Teachers	\$33,784
Total State-Level	\$60,922
+	
Total Local	\$31,543
Grand Total	\$92,465

Figure 2: UAAL by 2010 Actuarial Estimates (\$mn)

Mass Housing Finance Agency	\$29
Mass Port Authority	\$6
Mass Water Resources Authority	\$44
State	\$5,000
Total State & Agency	\$5,079
+	
Mass Teachers	\$12,500
Total State-Level	\$17,579
+	
Total Local	\$12,944
Grand Total	\$30,522

The most recent General Court legislation (MGL c. 32) requires that retirement boards statewide adopt amortization schedules that fully finance the UAAL by 2040. The last extension of the deadline – from 2025 to 2040 – was a response to the massive investment losses in 2008-2009. The law added a 4.5% ceiling on the annual increase of UAAL amortizations in order to prevent retirement boards from backloading their funding schedules excessively.⁵ The legislation also prohibits the adoption of updated timetables that for any given year budget smaller payments than the preceding schedule⁶ and requires that the governor propose an annual budget appropriation for the state’s UAAL amortization payments of no less than 1.3% of payroll.⁷

Figure 3: Number of Boards by Funding Deadline

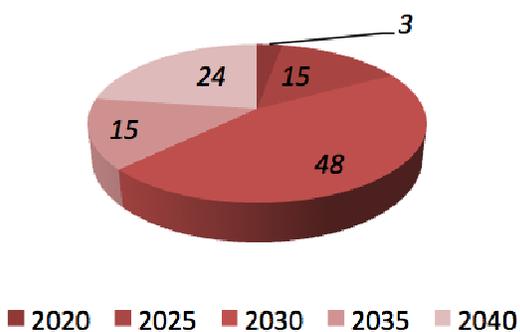
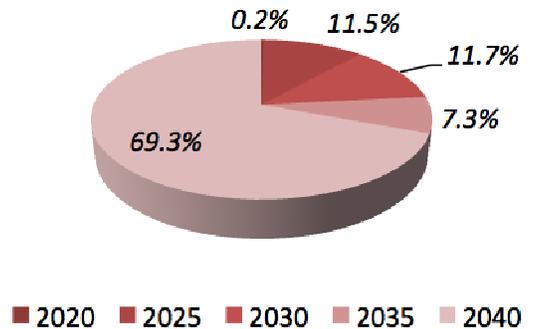


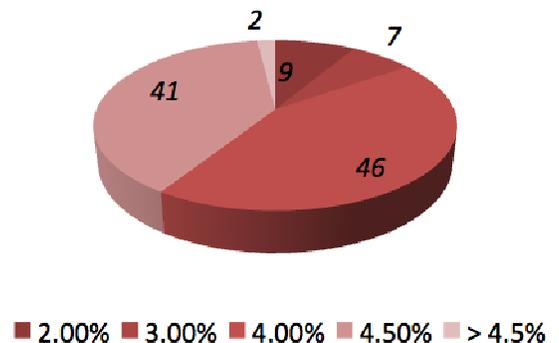
Figure 4: Distribution of UAAL by Funding Deadline



As of yearend 2010, the deadlines to full funding of the retirement boards ranged from 2018 to 2040 with a median of 2030. The state’s and the teachers’ board’s funding schedules, accounting for the bulk of the liabilities, had been extended to 2040. All but 18 boards had already adopted schedules ending after the prior statutory deadline of 2025 (Fig. 3); they accounted for nearly 88% of the total UAAL (Fig. 4). Meanwhile, the 24 boards with funding deadlines after 2035 accounted for a whopping 69% – or about \$21bn – of the total UAAL estimate. Overall, the bulk of the UAAL funding has already been extended well towards the statutory limit.

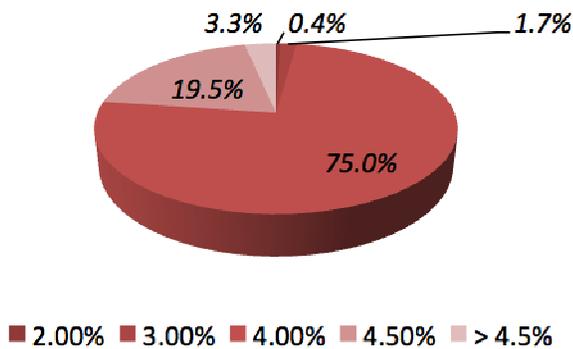
A cursory look at the amortization growth rates of the funding schedules reaffirms this conclusion. The 89 boards having adopted schedules at a rate above 3% (Fig. 5)

Figure 5: Distribution of Boards by Amortization Growth Rate



■ The Fiscal Implications of Massachusetts Retirement Boards' Investment Returns

Figure 6: Distribution of UAAL by Amortization Growth Rate



accounted for 97% of the total UAAL (Fig. 6), while the 43 boards above 4% accounted for almost 23% of the total UAAL. The two boards with the largest UAALs – state and teachers – both had already adopted 4% schedules through 2040. Overall, almost without exception, the boards with the farthest deadlines – 2035 and later – planned to grow the annual amortization at 4% or more. These facts imply that as of yearend 2010 retirement boards had stretched out the UAAL payments almost as far as the legislative mandates would allow.

The projected amortization schedules are consistent with this conjecture. The state budgeted over \$1bn for its 2011 UAAL contribution, which is to grow to about \$1.8bn in 2025 and peak at \$3.2bn in 2040 (Fig. 7). These numbers roughly correspond to 3%, 6% and 10% of the commonwealth's FY 2011 budget. The UAAL amortization total for the local retirement boards was expected to peak in 2025 at over \$1.5bn by the then current schedules – probably because some boards had not yet extended their schedules all the way to the statutory deadline of 2040. The statewide amortization total for FY 2011 was 0.5% of Massachusetts GDP⁸ and, assuming a 2% real GDP growth rate, it would gradually increase as proportion of GDP, peaking at under 0.7% around 2025.

Overall, MGL c. 32 aims to strike a reasonable balance between resolving the funding issue in a timely manner and leaving enough breathing space for state and local budgets already strained by the tough economic environment. One of the strictest and simplest of its kind in the US, this legal

Figure 7: Estimated UAAL Amortization Totals by Yearend 2010 Growth Rates and Deadlines (\$mn)

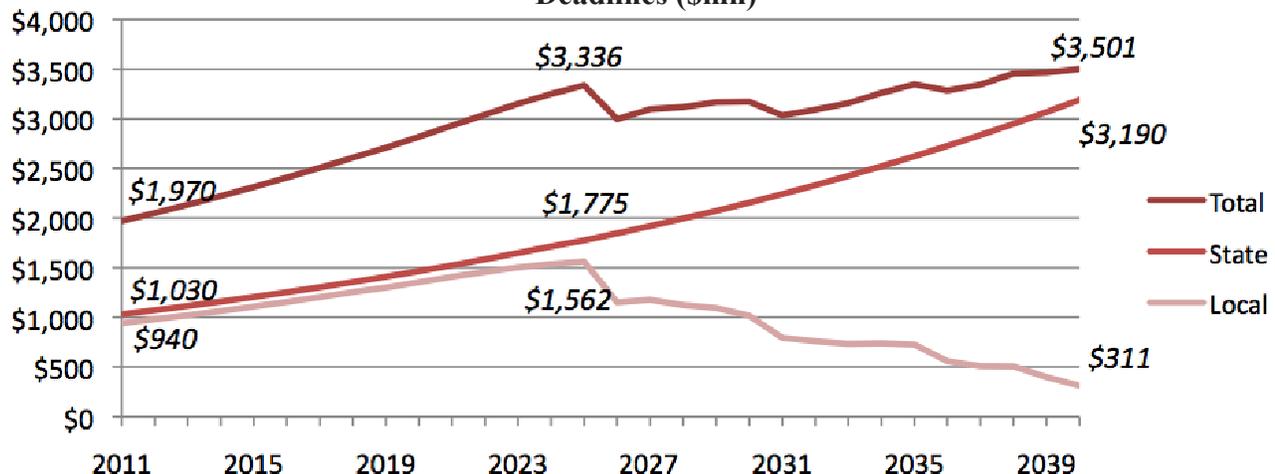
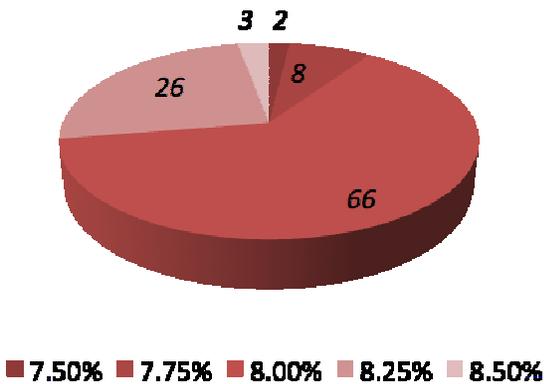


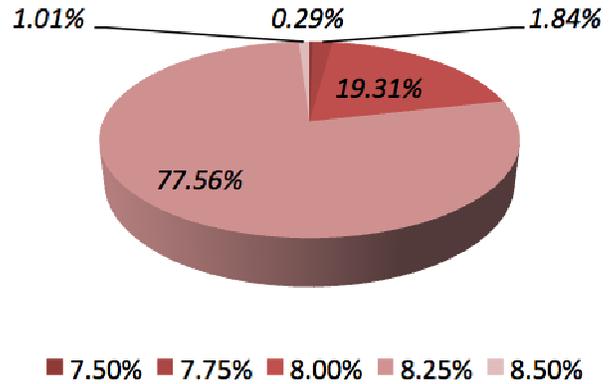
Figure 8: Distribution of Boards by ARR



framework leaves an important loophole which, in the long run, may have a devastating effect on local budgets and, ultimately, on the pension plans’ solvency – the actuarial rate of return used in discounting future benefit outlays. While governments throughout the state may be aware of and planning for the growing UAAL amortization burden, the volatility of asset returns, when coupled with the state’s funding mandates, may increase it significantly in short order. Even if existing funding schedules are adequate under the boards’ actuarial assumptions, they could be rendered irrelevant by lower investment returns, leading to higher overall costs to taxpayers and chronic underfunding.

To protect themselves from these problems, many companies are offloading pension liabilities from their balance sheets. S&P 1500 companies had their plans funded at 82% as of March 2012, but just 35% of the Fortune 200 companies offered traditional pensions in 2011, down from 54% in 2006.⁹ The PERAC data show that at yearend 2010 Massachusetts public-sector pensions were funded just under 67%. Meanwhile, the boards’ assumed rates of return ranged narrowly between 7.5 and 8.5% (Fig. 8) with a liability-weighted average of 8.19%, compared with ARR closer to 4–5% in the private sector. Massachusetts boards with

Figure 9: Distribution of Liabilities by ARR



ARRs above 8% accounted for nearly 79% of the total liabilities, while only 2% of the liabilities were estimated with an ARR assumption of 7.75% or less (Fig. 9). Even though the commonwealth’s public pensions are funded better than most other states’, the sea change in asset markets over the past few years calls for a reexamination of actuarial assumptions and funding plans.¹⁰

Whither Investment Returns?

Present economic and asset-market conditions pose significant challenges to a system relying on investment returns to fund a large portion of retirement liabilities. A breakdown of the boards’ portfolio allocations and their performance potential illustrates this point:

- A large proportion of investments, typically over 20%, is allocated to US stocks, which are likely to remain volatile over the short to medium term.
- A similar fraction of assets consists of emerging markets and global stocks, which exhibit even higher volatility than US shares.
- The third-largest allocation is in fixed income, predominantly government bonds, which are already at record-low yields that do not offer a substantial upside.

■ **The Fiscal Implications of Massachusetts Retirement Boards' Investment Returns**

- In recent years, retirement boards have shifted more of their funds into illiquid, but volatile, assets such as private equity, venture capital and real estate.

Regardless of the long-term sensibility of these investment strategies, the short- and medium-term implications are clear – the return on their assets is unlikely to help retirement boards make up for the shortfalls accumulated in the past decade, while volatility may increase the short-run actuarial deficits even further, thereby adding to the budgetary strain.

Moderately higher inflation would boost nominal tax receipts and make appropriations more affordable, while possibly also raising most asset prices and thus improving boards' funding ratios. However, the economic outlook makes inflation in consumer, labor and asset markets unlikely, pushing inflation and return rates well below most actuarial assumptions. Persistent deflationary conditions, which suppress both investment returns and tax receipts, have kept inflation subdued despite repeated rounds of monetary expansion by central banks. Most of the extra supply of money ends up on banks' (through the discount window) and governments' (through sales of debt instruments) balance sheets. Wage growth remains subdued as well, which militates against inflation and a consumption-driven domestic recovery, while emerging markets and particularly China have been showing signs of a long-term slowdown. The situation is similar, if not worse, in most asset markets, where demand (and trading volume) is down significantly and falling further because of retail investors' risk-aversion and a swell of baby boomers cashing in assets to finance their retirement.

In an environment where both governments and consumers are retrenching, there is little hope for a spike in demand that could spark consistently higher inflation in either real or asset markets. Inflationary expectations remain subdued as repeatedly indicated by Fed surveys,¹¹ ranging down to 1.8% per annum for the next decade.¹² The takeout for pension funding over the next 10-15 years is twofold:

- Diversified-investment returns across asset classes are likely to remain below long-term averages and well below those of the late 20th century.
- Inflationary pressures are unlikely to provide fiscal relief by increasing nominal tax receipts and/or decreasing the real value of pension obligations.

Fiscal Impact of Investment Returns in Different Scenarios

To gage the implications of subpar investment returns on pension liabilities and, consequently, on Massachusetts budgets, three possible scenarios were considered:

- PERAC has previously suggested that an investment return assumption of 7-7.75% may become the standard for the state¹³ – an “optimistic” scenario of 7.5% annual returns, which is also the lowest actuarially assumed rate for any board.
- A “baseline” scenario using long-term GDP growth expectations of below 2%¹⁴ plus an allocation-adjusted asset premium of 3%¹⁵ for a total of a 5% annualized rate of return. The long-term compounded return of US equities is also about 5% annually.¹⁶
- A 2% “worst-case”¹⁷ scenario consistent with the current yields of 10-year

treasury notes and the dividend-yield aggregate of the S&P 500 (assuming no capital gains or losses).

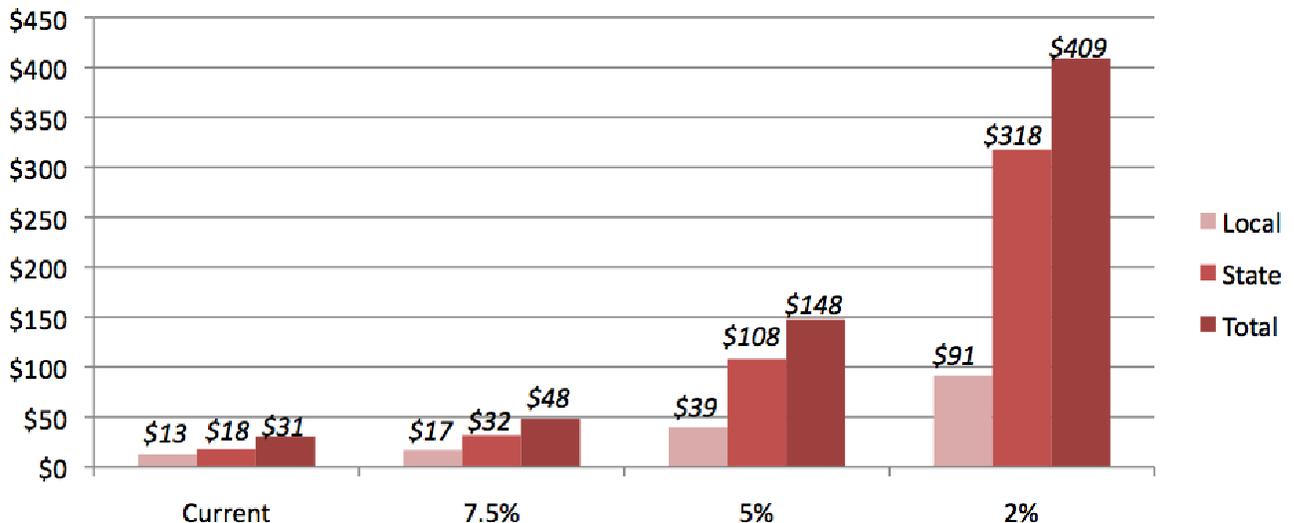
Zero-Coupon Valuation

To circumvent a detailed actuarial reevaluation of each of the 105 retirement funds’ liabilities, the impact of fluctuations in investment yields was first approximated by valuing the total liabilities as a zero-coupon bond maturing in the year wherein the corresponding retirement board had projected to be fully funded. The zero-coupon assumption eliminates the need to account for the returns on any intermediate payments into the fund or the interest implications of cash flows after maturity, which is why *this is only a reasonable approximation* for the liabilities. Boards recognize changes in the market value of assets over a five-year period, but in this case the reported valuations are very close to market values, so no explicit correction was made for this deferment of gains and losses.

The face value of the bond was estimated by appreciating the total current liabilities of the corresponding board at its ARR to maturity. A rational investor would then be indifferent between a sum equal to total liabilities at the time of their actuarial valuation and the face value of the bond paid at maturity, given no inflation, an expected return equal to the ARR and the availability of credit at that rate. The imputed face value of the bond approximates the “target future value” necessary to meet all the fund’s payments during the period and all the obligations accrued under EAN beyond that year as estimated by the retirement board. The face value was discounted back to yearend 2010 at each of the three scenario rates and the fund’s assets were subtracted from it in order to obtain estimates for the present value of the UAAL in each scenario.

Investment underperformance could significantly increase the present value of the UAAL – up to more than five times the actuarial estimates in the baseline scenario and thirteen times in the worst-case scenario (Fig. 10), where returns average those of the

Figure 10: Approximate Upper Bounds of UAAL with Different Rates of Return (\$bn)



■ The Fiscal Implications of Massachusetts Retirement Boards' Investment Returns

Great Depression stock market after the 1929 crash.¹⁸ To emphasize again, this method is likely to overvalue the UAAL increasingly as the scenario rate moves further from the FY 2010 ARR because of compounding effects.¹⁹

UAAL Amortization Schedules in Different ARR Scenarios

Applying the 5% ARR to the existing UAAL amortization deadlines and growth rates would require a total increase in amortization costs of nearly 50bn 2011 dollars, the state's share whereof is over \$37bn. To put that into perspective, the then-current schedules projected the state's amortizations to peak at nearly \$3.6bn in 2040 (Fig. 7), which would have to increase by over \$2bn in the baseline scenario (Fig. 11).

When investment returns are below the ARR, higher amortization appropriations become necessary to pay down the UAAL. To provide a clearer picture of the potential fiscal impact of returns in each scenario, new amortization schedules were drawn under each scenario's ARR with the same funding deadlines and growth rates as reported in the retirement

boards' FY 2010 statements. The optimistic scenario requires moderate increases in the schedules, the state's contribution rising from \$1.8bn to \$2bn in 2025 and from \$3.2bn to \$3.6bn at peak in 2040 (Fig. 12). Under these assumptions the local boards' appropriations do not require substantial increases, which reflects the fact that their amortization schedules typically have lower durations than the state-level boards'. In the peak year (2025), their payments would have to increase by only about \$100mn or about 7%.

The picture changes more dramatically in the baseline (Fig. 13) and worst-case (Fig. 14) scenarios. The baseline case would require the state to increase its amortization to \$1.7bn immediately (a raise of about 70%), which amounts to almost 40% of payroll appropriations in the FY 2011 state budget. The state's UAAL payments would grow to about \$3bn in 2025 and about \$5.2bn in 2040. In the worst-case scenario those numbers would have to be even higher – \$4.4bn and \$7.9bn respectively – with an immediate boost of amortization payments to over

Figure 11: Projected Increases in Annual UAAL Amortizations from 2010 ARR Rates to 5% ARR (\$mn).

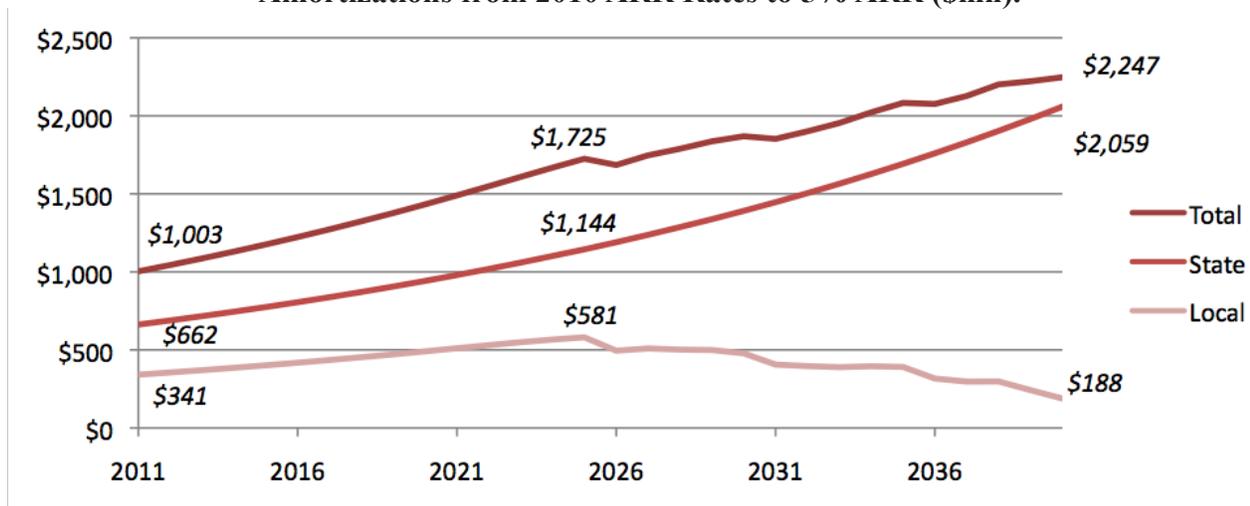


Figure 12: UAAL Amortization Payments at 7.5% ARR (\$mn)

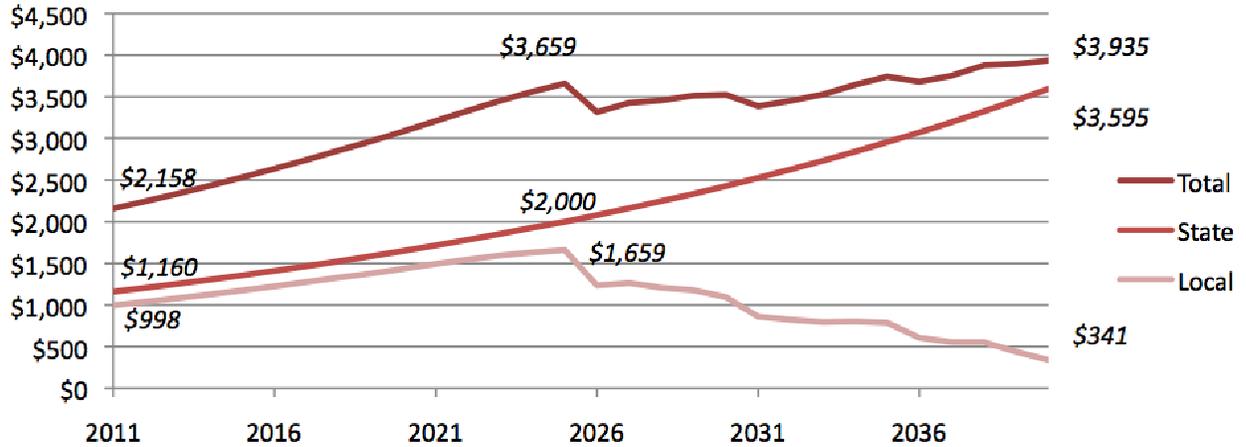


Figure 13: UAAL Amortization Payments at 5% ARR (\$mn)

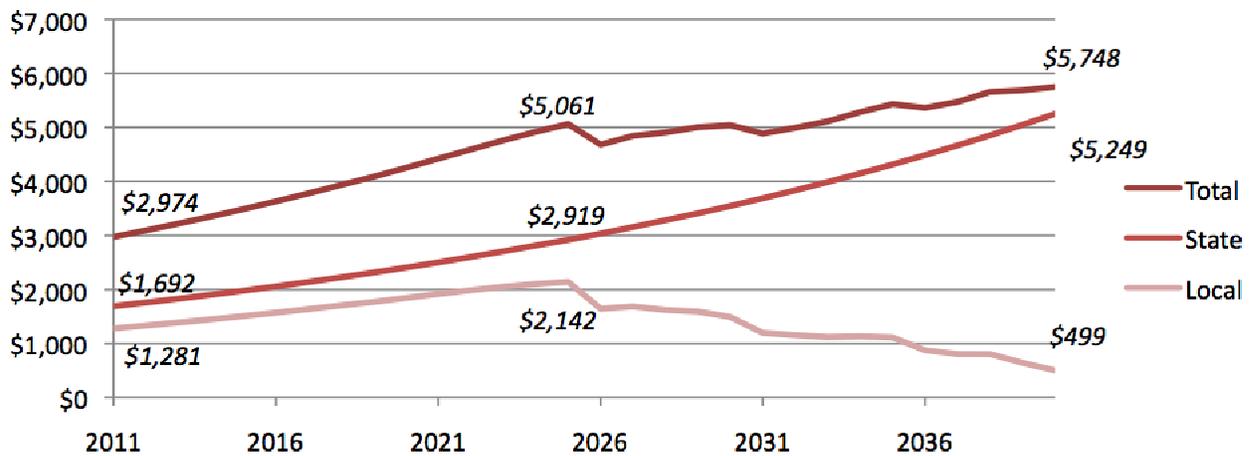
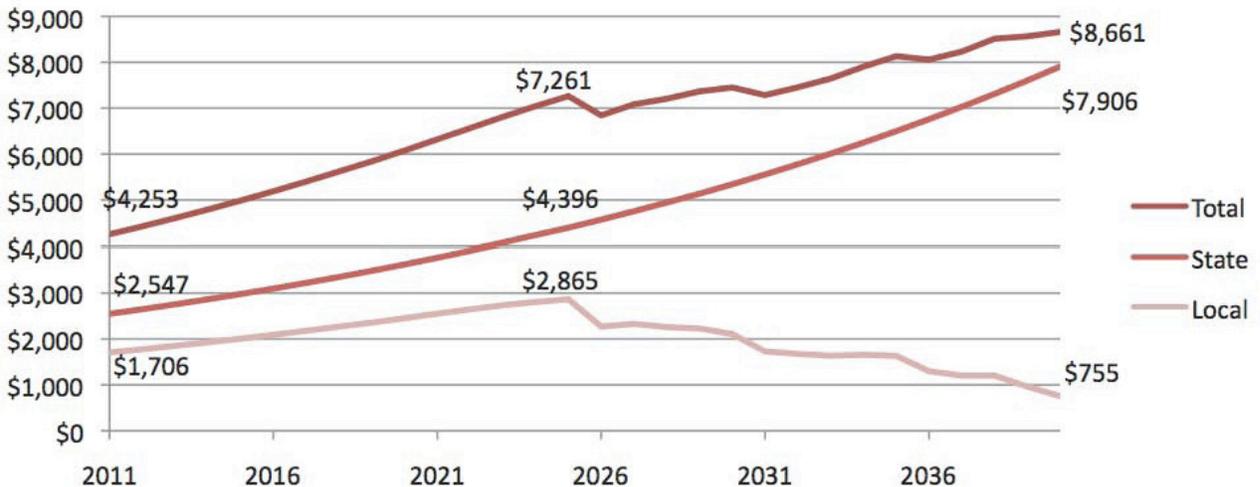


Figure 14: Projected UAAL Amortization Payments at 2% ARR (\$mn)



■ **The Fiscal Implications of Massachusetts Retirement Boards' Investment Returns**

\$2.5bn, which would constitute an increase of about 150%.

Even though in any case the state's burden by far outstrips the local boards', they may find it more difficult to meet the demands of an updated funding schedule because of more severe budgetary constraints. Local payments would have to increase by about a third immediately and by \$581mn – to over \$2.1bn – in 2025. This creates the potential danger of further extension of the amortization schedules to 2040 as many local boards had not taken advantage of the new deadline, which would additionally increase the total amortization cost because of the loss of returns. For some localities which have already undergone substantial budget cuts, adverse situations such as the baseline and worst-case scenarios may entail a bankruptcy or even a bailout by the Commonwealth.

Conclusion

Massachusetts retirement boards have been grossly underfunded for years. To counter this trend, state legislators have enacted – and repeatedly extended – funding mandates that require increasing budget appropriations to make up for the difference. Governments across the state and their retirement boards have drawn up plans to meet the funding standards based on actuarial assessments of the boards' liabilities premised upon unrealistic assumptions about investment returns. Apart from the perilous implications for the long-term health of the state's retirement system and the workers relying on it for their retirement benefits, these assumptions may present a multitude of budget surprises for various constituencies in the state. A comparison of performance scenarios demonstrates that even minor fluctuations in investment returns can have

substantial impact on government budgets. In the interest of prudent management and government accountability, more rigorous actuarial assumptions and accelerated funding of liabilities must be an integral part – and perhaps even the first step – of more comprehensive pension reform.

The primary purpose of actuarial valuations is not purely informational; rather, they are an essential tool in strategic management, especially in the context of long-term asset holding. The current actuarial assumptions of most of the Massachusetts retirement boards do not indicate an appropriate level of caution in their funding plans. Only ten boards have assumed investment returns below 8%. The prevalence of such high assumed returns is likely to engender long-term underfunding and, ultimately, insolvency or significant cuts in benefits. The condition of the retirement system will present a significant fiscal challenge to the state, which allocated about 4.3% of its budget to all payroll-related appropriations in 2011.

Without reforms to improve investment management and restrict the growth of liabilities, the General Court will probably keep extending the funding deadlines indefinitely into the future. Backloading the funding schedules by extending the deadlines increases the contribution that government has to make at a given rate of return. Returns on capital compound annually so that the low appropriations effectively make the benefits more costly to the fisc. A dollar invested today produces much more investment returns than a dollar committed ten years from now. Unreasonably low funding now will cost more to prop up the underfunded boards down the line. This growing fiscal strain will inevitably force governments to raise

taxes, cut services and/or significantly reduce benefits for future retirees. To minimize these costs, Massachusetts must lead the way for the rest of the US and require its retirement boards to lower their ARR to a more prudent 5% rate of return and revise their funding schedules to accelerate the amortization of UAAL accordingly.

About the Author:

Iliya Atanasov is Pioneer's Senior Fellow on Finance, leading the research tracks on public pensions, infrastructure and municipal performance. His other research interests include game theory, portfolio management and tax policy. Iliya is a PhD Candidate in Political Science and Government and MA Candidate in Statistics as well as a former Presidential Fellow at Rice University. He also holds BAs in Business Administration, Economics and Political Science/International Relations from the American University in Bulgaria.

■ **The Fiscal Implications of Massachusetts Retirement Boards' Investment Returns**

About Pioneer:

Pioneer Institute is an independent, non-partisan, privately funded research organization that seeks to change the intellectual climate in the Commonwealth by supporting scholarship that challenges the “conventional wisdom” on Massachusetts public policy issues.

Recent Pioneer Publications

Impact of the Federal Health Law's “Cadillac Insurance Tax” in Massachusetts: Thousands of \$\$\$ in New Taxes for Middle-Class Workers, Policy Brief, October 2012

How Common Core's ELA Standards Place College Readiness at Risk, White Paper, September 2012

A Changing Bureaucracy: The History of the Massachusetts Department of Elementary and Secondary Education, White Paper, May 2012

Controlling Education from the Top: Why Common Core Is Bad for America, White Paper, May 2012

Urban and Rural Poverty and Student Achievement in Massachusetts, White Paper, April 2012

Rhode Island Jewish Day Schools and Scholarship Tax Credits, White Paper, March 2012

Follow us on Twitter:

<http://twitter.com/PioneerBoston>

Find us on Facebook:

<http://www.facebook.com/PioneerInstitute>

Appendix I: Data Description

The data for this study were collected from the 2010 annual financial reports of the 105 active Massachusetts public-employee retirement boards and included their own assessments of future liabilities, the vast majority of which had been calculated using the entry-age normal-cost (EAN) method. Under EAN, the present cost of projected benefits is assigned on a level annual basis between the hiring age and the assumed exit age. This method does not project any liabilities that may arise from future hiring, only those expected to be incurred towards current employees under certain widely accepted actuarial assumptions (longevity, disability, choice of retirement option, raises, disbursements to surviving relatives, etc). Because any potential underfunding of future service is therefore not counted in the analysis, any estimate of the impact of lower investment returns would most probably understate the real effect.

The original data included the following variables:

BOARD	board name
RATIO	funded ratio
ARR	assumed rate of return
AMORT	growth rate of the UAAL amortization appropriation
YEAR	year fully funded (according to the then current schedule)
UAAL	unfunded accrued actuarial liability
APPR	total pension appropriation for FY 2011

The original data were then used to derive the values for several variables of interest:

PERIOD	number of years until fully funded
FVS	future value shortfall – the future value of the UAAL in the year fully funded at the assumed rate of return
BASE	2011 amortization

Appendix II: Methodology

The then current amortization schedules were derived in two steps. First, it was necessary to infer the “base” UAAL amortization for 2011:

$$BASE = FVS / \sum_{t=1}^{PERIOD} (1 + AMORT)^t * (1 + ARR)^{PERIOD-t}$$

Then, it was possible to estimate the scheduled amortization for each board-year according to the formula:

$$PMT_t = BASE * (1 + AMORT)^t$$

The amortization schedules for the three alternative return scenarios were computed using the same algorithm by substituting the appropriate ARR. Amortization durations were estimated from each schedule based on the standard formulae for MacD, ModD and DV01.

Appendix III: Cost-of-Living Adjustments

Actuarial estimates and funding plans can also be undermined by assumptions about inflation. Pensions include cost-of-living adjustments (COLAs) on the first \$12,000 of annual benefits indexed to the inflation rate in the 0-3% band. This COLA structure means that the liabilities on any benefits above the \$12,000 threshold are fully discounted by the assumed inflation rate (in addition to the ARR). The 2010 actuarial evaluations are based on a 3% rate of inflation, but inflation rates have been substantially below that threshold over the past few years, implying that the benefits above the COLA threshold are overly discounted. This fairly marginal undervaluation would increase only moderately if inflation rates fall further, but it would become much more prominent if they become negative because the real value of all liabilities would rise. None of these inflationary considerations were included in the numerical analysis and would likely lead to even higher estimates for the real value of liabilities. In any case, from a fiscal perspective the effects of the rates of return are much more important at near-zero inflation than the expected rate of inflation. If inflation ran at over 3%, it could overwhelm the effect of subpar returns and help reduce the liabilities in real terms.

Appendix IV: Duration Analysis

To provide a point estimate of the effect of returns on the then current UAAL schedules, fund assets were next structured as a bond that pays the projected cash flow from the existing amortization schedules. The *Macaulay duration* of that bond would then provide the average number of years to full repayment of the UAAL. From it, one can also derive the asset's *modified duration (ModD)*, which is used in finance to measure the impact of changes in yields (in this case, returns) on bond prices (i.e., the present value of UAAL). ModD represents the percentage change in price resulting from a percentage change in yield over the remaining lifetime of the asset. This is the simplest indicator of UAAL responsiveness to changes in investment returns at a certain ARR.²⁰ The product of the modified duration and the current valuation of the asset provides the present absolute change in value triggered by a percentage change in yield – the asset's *dollar duration (DV01)*. The deferment of payments further into the future increases the durations of the liabilities and their sensitivity to expected returns.

The duration structure of the retirement system under the boards' actuarial assumptions and funding plans varies, with a wide range of uncertainty for retirees and for the constituencies' budgeting. The amortization payments had an aggregate Macaulay duration of 10.88 years with a maximum of 12.56 years. The maximum ModD is 11.68% (Medford) with only seven boards scoring under 5%. A vast proportion of the retirement boards' liabilities has a ModD above 10% with system-wide liabilities having a ModD of just over 10% and DV01 of over \$3bn at yearend 2010. The lion's share of the DV01 belongs to state-level funds, which account for nearly 2/3 of it – the teachers' board with amortization DV01 of almost \$1.4bn and the state board with DV01 of \$558mn. In other words, a 1% change in the underlying return rates would increase the state's direct liability *on the UAAL amortizations alone* by \$2bn. The ModD of the total accrued liabilities must be substantially higher than that. The DV01 of the amortizations increases substantially if schedules at alternative ARR are considered. Given 2011 deadlines, the statewide DV01 rises to \$3.8bn at 7.5% return, \$8.4bn at 5% and \$22.4bn at 2%. *The lower the returns, the more sensitive the dollar values are to marginal changes in returns.*

Endnotes

1. Butrica, Barbara A., Howard M. Iams, Karen E. Smith and Eric J. Toder. 2009. “The Disappearing Defined-Benefit Pension and Its Potential Impact on the Retirement Incomes of Baby Boomers.” *Social Security Bulletin*: 69 (3); cf. Roberts, Dexter. “US Automakers Cut Retirees Loose.” *Bloomberg Businessweek*, 2012.07.02: 14-16.
2. The Pension Benefit Guaranty Corporation (2011 Annual Report, <http://www.pbgc.gov/res/reports/ar2011.html>, retrieved 2012.06.27) assumed responsibility for 57,000 workers in 137 failed plans in FY 2011. Over 150 underfunded single-employer plans terminated that fiscal year, “most often in bankruptcy,” up from just over 100 in 2001. PBGC receivership indicates an immediate freeze of all benefits even if any future increases have been accrued or contracted; accrued benefits above the maximum guaranteed amount are lost.
3. Massachusetts Budget and Policy Center. “Demystifying the State Pension System.” 2011.05.07, http://www.massbudget.org/report_window.php?loc=Pension_3_11.html, retrieved on 2012.06.20.
4. Numbers may not add correctly due to rounding.
5. Massachusetts General Laws (MGL) c. 32 §22F(a).
6. *Ibid.*, §22F(b).
7. *Ibid.*, §22B.
8. GDP data retrieved from FRED on 2012.07.24, <http://research.stlouisfed.org/fred2/series/MANGSP?rid=140>. All GDP rates are in real terms unless otherwise noted.
9. Dexter, 2012.
10. For a discussion of the impact of inflation assumptions and cost-of-living adjustments, please refer to Appendix III.
11. Federal Reserve Bank of Philadelphia. “Short-Term and Long-Term Inflation Forecasts: Survey of Professional Forecasters,” <http://www.phil.frb.org/research-and-data/real-time-center/survey-of-professional-forecasters/historical-data/inflation-forecasts.cfm> last update 2012.05.11, retrieved 2012.06.20.
- Federal Reserve Bank of St. Louis. “University of Michigan Inflation Expectation (MICH)” 2012.06.15 <http://research.stlouisfed.org/fred2/series/MICH> retrieved 2012.06.20.
12. Federal Reserve Bank of Cleveland. “Cleveland Fed Estimates of Inflation Expectations.” 2012.06.14, http://www.clevelandfed.org/research/data/inflation_expectations/, retrieved 2012.06.15.
13. Massachusetts Budget and Policy Center 2011.

■ **The Fiscal Implications of Massachusetts Retirement Boards' Investment Returns**

14. Baker, Dean, J. Bradford DeLong & Paul Krugman. "Asset Returns and Economic Growth," Brookings Papers on Economic Activity 1: 2005; International Monetary Fund. "World Economic Outlook, April 2012." Washington, DC: IMF, 2012.
15. Antti Ilmanen. Expected Returns on Major Asset Classes. Charlottesville, VA: Research Foundation of CFA Institute, 2012.
16. Reid, Jim & Nick Burns, "Long-Term Asset Return Study." London, UK: Deutsche Bank 2010, http://www.etf.db.com/UK/pdf/EN/research/researchfixedincome_2010_09_13.pdf, retrieved 2012.07.17.
17. Obviously, much worse outcomes are possible under uncertainty and many of those would have nontrivial probabilities if any could be assigned. This rate is taken as a tentative indicator of the baseline return on – presumably – risk-free and broadly diversified assets.
18. Chris Farrell. "Investing during a Great Depression." <http://www.marketplace.org/topics/your-money/getting-personal/investing-during-great-depression>; the stock market returned 1.42% in 1929-1939 while bonds returned 6.04% annually.
19. For further duration analysis, please refer to Appendix IV.
20. More complex measures such as convexity that would provide a fuller view along the ARR curve were not considered as the liability is not tradable and so they would apply to more detailed and shorter-term evaluations of cash flows and plan solvency.

