APPENDIX B

Houston's Pension Shortfall: Implications of Basic Pension Analysis

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August 9, 2016

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I. INTRODUCTION

An issue that has received an increasing amount of attention is the state of the City of Houston's pension funds.

Reflecting recent changes in the Governmental Accounting Standards Board (GASB) rules, the City's latest Comprehensive Annual Financial Report (CAFR) for the year ended June 30, 2015, shows that the net pension liability of the three Houston pension funds is $5.6 billion. The net pension liability is $0.6 billion for the Houston Firefighters' Relief and Retirement Fund (HFRRF), $2.3 billion for the Houston Municipal Employees' Pension System (HMEPS), and $2.7 billion for the Houston Police Officers' Pension System (HPOPS). In addition, Houston has issued over $600 million in pension obligation bonds and used the proceeds to reduce the unfunded liabilities of HMEPS and HPOPS, which effectively transfers the liability to the general fund. Including this debt, the total net liability of providing pension benefits is $6.2 billion.

These totals are based on a multitude of actuarial assumptions, and the liability estimate can change significantly if underlying actuarial assumptions are changed. For example, as the latest CAFR notes, if the "discount rate" (i.e., the interest rate used to calculate the present value of future cash flows) for the three Houston pension funds is assumed to be 1 percentage point lower, then the net pension liability would increase from $5.6 to $7.4 billion. If the discount rate is assumed to be 1 percentage point higher, then the net pension liability would decrease from $5.6 to $4.1 billion. A number of actuarial assumptions are necessary to estimate pension costs, which underscores the substantial uncertainties in actuarial valuations.

In addition to discussing the basic framework and assumptions that make up an actuarial valuation, this paper is intended to shed light on the uncertainties and importance of a variety of actuarial assumptions.

II. BASIC PENSION METRICS

Actuarial valuations provide several metrics that are useful in determining the financial health and affordability of pension plans. This includes, for example, the net pension liability (NPL), the unfunded actuarial liability (UAL), the actuarial determined contribution (ADC, also referred to as the actuarial required contribution or ARC), and others.

NPL and UAL

The NPL is defined as the difference between the present value of pension benefits owed to current members for past service and the assets held in trust for the members and beneficiaries of the plan. NPL is similar to the UAL, which also measures the difference between the present value of pension benefits owed to current members and plan assets. The differences between NPL and UAL are based on reporting requirements in the GASB pension standards put forth in Statement No. 67 and Statement No. 68. These standards create differences between accounting and funding measures (i.e., information used in basic financial statements and information used in pension funding). In this case, NPL is differentiated from UAL because (1) the calculation of NPL uses a different discount rate depending on the funding status of the plan and (2) the calculation of the market value of assets used in accounting statements is different from the smoothed value (the phase-in of gains and losses over time) allowed in pension funding.

The new measures (e.g., NPL and pension expense) required by GASB for accounting purposes will likely show larger and more volatile measures of the unfunded

liability than measures used by pension plans for funding purposes (e.g., UAL and ADC). The NPL will be shown as a balance sheet item in the City's CAFR. For comparison, prior to GASB standard 68 the reported net pension obligation (which is the difference between the ADC and the actual contributions to the pension plan) was $1.2 billion for fiscal year 2014, while after GASB standard 68 the reported net pension liability was $5.6 billion for fiscal year 2015.

While this does not change the economic fundamentals (such as the ADC) underlying the pension fund's financial health, it does provide more information about the funded ratio of the pension. This additional information comes in several forms. Under the new standard, funded status information is moved from footnotes to the balance sheet and additional footnotes and supplementary information is required. In addition, the new standards focus more on the health of the balance sheet by examining the net pension liability, whereas the old standards focus more on the cash flow or income statement information by asking whether current contributions are sufficient (i.e., equal to the ADC). In addition, pension funds must report the NPL using a discount rate that is 1 percentage point higher and 1 percentage point lower than their standard assumption. The impact of this is that accounting and funding measures are now distinct. This may lead to changes in credit ratings, may increase scrutiny of the pension fund and its assumptions, and will likely lead to increased complexity in reporting.

ADC

The ADC (often referred to as the actuarially required contribution or ARC) is an estimate of the contributions that are necessary to maintain or return a pension plan to a fully funded state. This metric is important because current cash flows are critical to local

government officials that are constrained by annual budgets. However, no single metric can fully describe the state of a pension plan.

For example, the HFRRF has remained relatively well funded from 2000 to 2015. But the ADC as a percent of payroll has increased from 15.4 percent in 2000 to more than 31 percent in 2015. Thus, it is important to consider both funded ratios and contributions when examining the health of a pension.

In addition, it is important to compare the ADC to sources of revenues. Comparing the ADC to sources of revenues provides a sense of how affordable the contributions are compared to previous levels.

Figure 1 shows property and sales tax revenue growth from 2000 to 2015. In general, property and sales taxes grew robustly from 2000 to 2009, except for a decline in sales tax revenue in 2003, which coincided with the period that Houston's three pension funds experienced significant underfunding and increases in the ADC. Figure 2 shows the ratio of the ADC to property tax revenue. From 2000 to 2003, the total ADC was about 16 percent of property tax revenues but then increased significantly to 43 percent of property tax revenues in 2005. Strong property tax revenue growth from 2006 to 2009 reduced the ratio to 30 percent by 2009. However, a decline in property tax growth in 2010 through 2012 and actual pension outcomes different than assumed actuarial outcomes (such as not achieving the assumed rate of return on assets and the failure of the city to contribute the actuarially determined amount) led to an increase in the ratio of ADC to property taxes back to 40 percent by 2014.

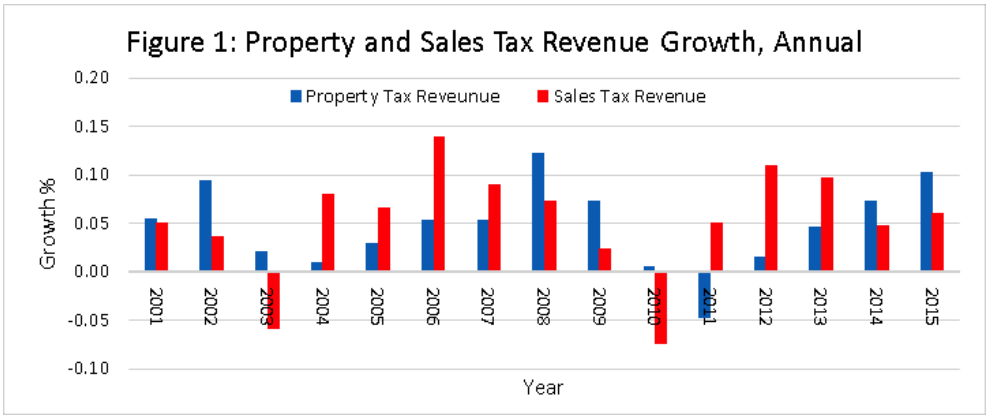
Figure 1: Property and Sales Tax Revenue Growth, Annual
Property Tax Reveunue
Sales Tax Revenue
Growth %
0.20
0.15
0.10
0.05
0.00
-0.05
-0.10
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Year

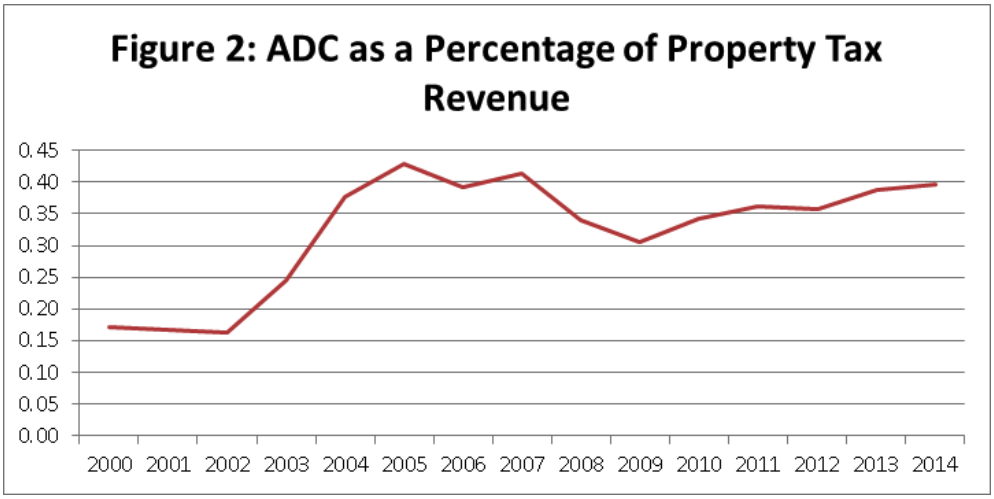
Figure 2: ADC as a Percentage of Property Tax Revenue
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014

III. PENSION ANALYSIS BASICS

The objective of a pension plan is to provide employees enrolled in the plan with a monthly benefit during retirement. Pension plans usually include a host of other benefits as well such as termination, disability, and death benefits. This paper focuses only on a subset of pension plans, in particular, what is normally referred to as a defined benefit (DB) plan, which is the type of plan currently used in all three Houston pension systems. In a DB plan, the employer pledges to pay the employee some amount on a regular basis once the employee retires. This amount is calculated based on a measure of the employee's average salary or years of service or both. In this case, the annual contributions made by the employer will need to be sufficient to pay the benefits defined under the plan.

By comparison, an increasingly common plan is a defined contribution (DC) plan, in which the employer contributes a defined amount — such as a specified percentage of the employee's salary — each year to a fund that is specifically tied to an employee. In a DC plan, the employer regularly contributes a fixed amount to an investment fund that becomes available to the employee upon retirement. The amount contributed each year is defined, while the amount of retirement benefits that are ultimately available to the employee is unknown until retirement. A key difference between a DC plan and a DB plan is that under the former, the amount available to employees in retirement is dependent upon investment returns, while under the latter the employees benefit is not dependent on investment returns (but the employers necessary contributions will depend on returns on accumulated assets). An example of a DC plan is a 401(k) plan, while an example of a (pay-as-you-go) DB plan is Social Security.

Cost Methods

Within the category of DB plans, there are several cost methods that could be adopted by employers. A cost method is defined as any scheme for allocating the present value of future benefits across the working life of employees. There are a number of different cost methods (e.g., Unit Credit, Entry Age Normal, Individual Level Premium, Frozen Entry Age, etc…). A thorough discussion of these methods is beyond the scope of this paper, which will instead focus on a simple discussion of the Unit Credit (UC) and Entry Age Normal (EAN) cost methods. Chen and Matkin (2015) find that 13 percent of all defined benefit pension funds use the UC method and 72 percent of plans use the EAN method. HPOPS uses the UC method, while HMEPS and HFRRF use the EAN method.

United Credit Cost Method

The UC cost method is unique, and thus merits a detailed explanation, because under this method the accrued liability is defined as the present value of future benefits. It is based on the assumption that the plan is currently fully funded and that the "normal cost" (defined as the amount that must be contributed to the plan each year to keep it fully funded assuming that all actuarial assumptions are equal to the actual outcomes). There will be an additional cost if assumptions do not match reality or if past experience (such as larger or smaller investment returns than assumed) has led to a difference in the value of assets in the pension fund relative to the present value of future benefits owed to pensioners.[1] Thus, under the UC method the total cost of the pension in any year will

[1] The unfunded accrued liability in this case is defined at the present value of accrued benefits minus assets.

equal the normal cost plus the amortization of the unfunded accrued liability over some period of time minus the amortization of gains (where a loss is a negative gain) based on doing better or worse than expected (gains are equal to expected unfunded accrued liability minus actual unfunded accrued liability). A problem with the UC method is that normal costs tend to increase faster than payroll in many circumstances if benefits are based on a measure of average salary.

Entry Age Normal Cost Method

Under the EAN cost method accrued liability is defined as the present value of future benefits minus the present value of future normal costs. Thus a difference between UC and EAN is related to the treatment of normal costs. Under the EAN method, unfunded accrued liability is the present value of future benefits after subtracting the present value of future normal costs and assets under the EAN method, whereas under the UC method normal costs are ignored in calculating the accrued liability. This implies that the normal cost is a level percentage of payroll across all years of an employee's tenure if benefits are based on average salary. As with the UC cost method, under the EAN cost method there will be an additional cost if assumptions do not represent reality or if past experience has led to an unfunded accrued liability. Thus, under the EAN method the total cost of the pension in any year will equal the normal cost plus the amortization of the unfunded accrued liability over some period of time minus the amortization of gains (where a loss is a negative gain) based on doing better or worse than expected.

The Importance of the Cost Method

Chen and Matkins (2015) find that switching from UC to EAN would decrease the funded ratio by 6.7 percentage points and increase the ADC by 0.9 percentage points. They note that the changes in the ADC are different depending on the demographics of the pension plan. In particular, switching from UC to EAN in a plan with a younger population would increase the ADC by 1.9 percent, while plans with an older demographic would experience a decrease in the ADC of 1.2 percent. Both methods accumulate the same accrued liability by retirement, but the EAN method accumulates more costs in the early years of employment and UC method accumulates more costs as employees near retirement.

Regardless of the cost method chosen, many actuarial assumptions must be predicted to accurately project the cost of funding a pension plan. These assumptions can often be described as either demographic (referencing the population make-up of the pension plan) or economic in nature.

Demographic Based Actuarial Assumptions

Demographic assumptions are often modeled using a rate of decrement. Decrements describe the probability that plan participants enter a new status under the plan, such as death, termination, disability, or retirement. Thus, the rate of decrement governs the rate that plan participants enter a particular status. Active employees exist in a multiple-decrement environment since their current status could change because of multiple events (i.e., an active employee could be terminated, retire, or die in a given year). Non-active employees are primarily only at risk of mortality, although it is possible

they could re-enter the workforce as well. The retirement decrement commences the payment of pension benefits.

Entering a decrement status has complex effects on the calculation of pensions. For example, mortality eliminates the retirement benefit obligations for active members and the ongoing obligation for non-active members. However, mortality can trigger another benefit obligation, such as payments to the surviving spouse. Termination prevents employees from reaching retirement age and generally reduces pension costs for the employer. Disability is likely to lower retirement-based costs, but could lead to additional costs depending on the plan's disability benefits.

The mortality assumption measures the rate that plan participants move from life to death at each age (i.e., the probability of plan participants dying at each age or the life expectancy of participants at each age). In general, mortality assumptions are derived from mortality tables published by the Society of Actuaries (SOA) and by examining the mortality experience of the specific plan in question. These tables are then used to project the life expectancy of current and future age cohorts, using either a static or generational method. The static method uses mortality rates at a point in time for all future generations. The generational method projects mortality changes in the following years, which are based on changes in the life expectancy of participants in each age group. For example, if gains in life expectancy are expected to occur in the future, then under the generational method the life expectancy of the age 60 cohort in 2020 will be shorter than the life expectancy of the age 60 cohort in 2040.

Currently, most pension plans use RP-2000 (mortality tables for Retired Pensioners, thus the RP, published by SOA in year 2000) and update the tables using

scale AA (which is static) or scale BB (which uses a generational projection). The updating scale is used to project the mortality data beyond year 2000. SOA (2014) put out a new mortality table, referred to as RP-2014, and a new updating scale, referred to as MP-2014, in 2014. SOA (2014) states that switching from RP-2000 with scale AA to the new tables (RP-2014 with scale MP-2014) will have a much larger impact on liabilities than switching from RP-2000 with scale BB to the new tables.

The new tables and scale show that life expectancies are lengthening and the rate of mortality is improving. This implies that plans using RP-2000 with the static scale AA are likely underestimating pension costs, and that the underestimation is likely significant. In addition, Munnell, Aubry, and Cafarelli (2015b) discuss the importance of changes in the mortality assumption on the cost of plan benefits. They find that each additional year of life expectancy increases pension plan liabilities by 3.5 percent. For example, they note that when CalPERS recently updated its mortality assumptions the result was a significant increase in liabilities and a 5 percent decline in the funded ratio.

Recently, HMEPS updated its mortality assumption by switching to scale BB from scale AA and noted "that this had a significant impact on costs and liabilities" (HMEPS, Actuarial Experience Study, 2015, p. 7). After the update, an age 60 male who retirees in year 2010 would be expected to live 23.1 years, an age 60 male who retirees in year 2015 would be expected to live 23.7 years, an age 60 male who retirees in year 2020 would be expected to live 24.3 years, and an age 60 male who retirees in year 2030 would be expected to live 25.4 years. HPOPS mortality rates are based on RP-2000 and scale BB (which implies mortality improvements are accounted for across cohorts).

HFRRF mortality rates are based on RP-2000 and scale AA (a static scale which does not account for mortality improvements across cohorts).

Economic Based Actuarial Assumptions

The economic assumptions necessary to estimate the cost of providing a pension include the salary growth rate and the rate of return on assets, which is often used as the discount rate. Each of these parameters is a composite function of several components. The salary growth rate is a composite function of changes in merit, productivity, and inflation. The rate of return on assets is a composite function of the risk-free rate of return, a risk premium, and the rate of inflation.

Salary Growth Rate

Since benefit formulas are often functions of salary, a cost projection must be based on an estimate of the path of each employee's salary over their working years. Salary growth is a composite function of different factors including salary increases based on merit, salary increases reflecting labor's share of productivity gains, and nominal salary increases related to the rate of inflation. There is substantial uncertainty that surrounds the salary growth rate assumption, with much of the uncertainty related to the difficulty of projecting productivity growth and inflation. In addition, payroll growth will depend on the growth rate in salaries as well as the growth rate in the number of employees. For cities that are struggling to pay the ADC, it is possible that increased contributions could crowd out public services, and thus the labor input to produce those services. A shrinking number of employees would make it more difficult to fund an existing UAL.

1. Productivity Growth

Since 1970, productivity growth has been lower than at any time in the postwar era, and in particular the productivity gains for low-skilled workers have been very small. The relatively low rate of productivity growth has been blamed on increasing globalization, large fiscal deficits, increasing income inequality, and a relatively slow rate of education growth (Gordon, 2016). In addition, the slow growth of low-income worker's wages has been attributed to increased low-skilled immigration and technological change that is leading to the automation of many low-skilled jobs. Thus, there is much uncertainty about productivity growth in the future. To the extent that future productivity growth is below prior experience, there is a risk of underfunding pensions. This is because assumptions are determined by actuarial experience studies that are partially backward looking in nature.

2. Inflation Rate

Inflation is another significant source of uncertainty in the salary growth rate. Knotek, Zaman, and Clark (2015, p. 1) find that forecasting inflation is more difficult today than it has been in the past, and note that "it is well known that forecasting inflation far into the future is always difficult." Data from the Public Plans Data (PPD), which is produced by the Center for Retirement Research at Boston College in partnership with the Center for State and Local Government Excellence and the National Association of State Retirement Administrators, shows that the average inflation rate is 3.47 percent for

all plans in the Public Plans Database, with a maximum value of 5.5 percent and a minimum value of 1 percent.

All three Houston pension systems assume inflation rates below the national average. HFRRF assumes a value of 3 percent for the inflation component, HMEPS recently changed from 3 percent to 2.5 percent for the inflation component (as explained in the 2015 HMEPS actuarial experience study), and HPOPS assumes a 2 percent value for the inflation and productivity component plus a service related component ranging from 0 to 12 percent based on years of service.

Actuarial firms use experience studies, which often are based on various sources of information, to predict future values of important parameters such as the inflation rate. For example, the 2015 HMEPS actuarial experience study (for the 5-year period ending June 30, 2014), discusses the data used in setting the inflation rate assumption (an assumption that feeds into the salary growth rate and investment return assumption). The report begins with an examination of past inflation experience by looking at average inflation over successive 5-year periods starting in 1965, which over the last 20 years averages between 1.7 to 2.6 percent. The report also considers average inflation over the last 5, 15, and 30 years (as well as 10, 20 and 25), which shows that inflation was 1.7, 2.25, and 2.7 percent respectively over those periods. In addition, the report considers the forecasts from investment consulting firms, which all currently assume inflation will be 2.5 percent or less with an average assumption of 2.3 percent. The report notes that the Social Security Administration is predicting a long-term average inflation of 2.7 percent, with a low of 2 percent and a high of 3.4 percent. HMEPS calculates that the long-term bond market is predicting inflation over the next 20 years of 1.8 percent. Finally, HMEPS

notes that the survey of the Society of Professional Forecasters predicts an average inflation rate of 2.1 percent over the next ten years (2015 to 2024). Given this information, the experience study recommended lowering the inflation rate from 3.0 to 2.5 percent in 2015

3. Effects of Changing the Salary Growth Rate

Chen and Matkin (2015) find that increasing the salary growth rate by one percentage point reduces the funded ratio by 1.8 percentage points and increases the ADC by 5.2 percentage points. They show that both the assumed cost method and the age demographic of the plan influence the impact of changing the salary growth rate assumption. They find that the funded ratio is more sensitive to changes in the salary growth rate under the UC relative to the EAN method, and that funded ratios and the ADC are more sensitive with an older age demographic.

Rate of Return on Assets

Another important assumption is the assumed rate of return on assets in the fund. This is also used as the discount rate to calculate the present value of future liabilities.. Simply put, since the function of pension plans is to provide a flow of benefits at a future date, the benefits must be discounted at some rate of return. Thus, the rate-of-return assumption affects the actuarial value of assets as well as the present value of future benefits.

The rate of return is made up of three components: a risk-free rate of return, a risk premium, and inflation. For the standard pension plan examined in Winklevoss (1993)

these three values are assumed to be 1 percent, 3 percent and 4 percent, respectively. The question is which of the three components in the total rate of return assumption should also be used to discount future benefits. The risk-free rate is the rate that prevails for a completely secure investment in a non-inflationary environment (i.e., net of the impact of inflation). The risk premium is a payment for incurring risks since risk is generally considered a "bad." In standard financial theory it is widely recognized that the characteristics of risk and return are inversely related. In addition, pensions must account for inflation since they are essentially contracts to provide benefit payments to employees that will ensure reasonable living standards over long periods of time.

1. Choosing The Discount Rate

Determining the appropriate discount rate is a contentious issue. One camp argues that the rate of return on a risky portfolio of assets should not be used as a discount rate for future liabilities that are much more certain. For example, Brown and Wilcox (2009) state that "finance theory is unambiguous that the discount rate used to value future pension obligations should reflect the riskiness of the liabilities." Modigliani and Miller (1958) argue that future payment streams should be discounted to reflect their risks. Elliot (2010) argues that using the return on assets as the discount rate is incorrect and that "virtually all economists, many actuaries, and the author, take issue with this approach to choosing a discount rate, an approach inconsistent with standard practice in finance, economics, and accounting for private sector firms." More recently, Moody's Investor Services (2013) adjusted the way it calculates net pension liability by adopting a method based more on the returns in the bond market, which have risk characteristics more in line

with pension benefits. The new GASB rules also require a blended discount rate (i.e., a discount rate that is a weighted average of the assumed rate or return on assets and an interest rate on a municipal bond, with weights determined by the unfunded liability) for plans that are not sufficiently funded.

Others argue against using a lower discount rate in the calculation of actuarial valuations. For example, Picur and Weiss (2011) argue that using a risk-free rate could have negative consequences for public pensions including contribution rate volatility, funding levels that are misleading or confusing, contribution rates that are greater than necessary, lower investment returns as a result of shifting from equities to fixed income, and the abandonment of DB for DC plans. Interestingly, a recent J.P. Morgan study (Mergenthaler and Zang, 2010) finds that U.S. public pension plans tend to have higher equity exposure than corporate plans. This is consistent with the Picur and Weiss argument on asset allocation implying that there is a positive relationship between the rate used to discount future liabilities and the amount of risk that pension plans take on.

2. Effects of Changing the Discount Rate

Chen and Matkin (2015) use a simulation model to examine the impact of changing various actuarial assumptions on the ADC and funded ratio of the "median" plan (a plan that is described by the median assumptions in the PPD). They simulate 10,000 runs of the median plan assuming that expected returns follow a normal distribution with a mean return of 8 percent and standard deviation of 7.8 percent. Thus, they are able to examine the effects of changing an actuarial input both in the short run and long run. For example, they examine the effect of only changing the discount rate

(i.e., assuming no change in rate of return on assets). They find that the immediate effect of decreasing the discount rate by 1 percentage point, from 8 to 7 percent, is to reduce the funded ratio from 85.4 to 75.6 percent (in their sample plan) and increase the ADC from 17.4 to 25.4 percent. However, after 20 years, the funding ratio is 105.8 percent and the ADC is 10.6 percent. In fact, the funded ratio returns to its initial level after 7 years and the ADC returns to its initial level after about 11 years.

3. Effects of Changing the Rate of Return on Assets

Munnell, Aubry, and Hurwitz (2013) examine the sensitivity of public pension funded ratios to the rate of return assumption. They simulate 100,000 potential outcomes using a Monte Carlo procedure assuming that the mean real return is 4.45 (with inflation of 3.3 percent this would imply a nominal return assumption of 7.75 percent.) This method yields 10,000 outcomes with a 30-year average real return below 1.9 percent, 25,000 outcomes with a 30-year average real return below 3.1 percent, 50,000 outcomes with a 30-year average real return below 4.45 percent, 75,000 outcomes with a 30-year average real return below 5.8 percent, 100,000 outcomes with a 30-year average real return below 7.0 percent. They also assume that employers pay 80 percent of the ADC and that they use an open 30-year amortization window (i.e., unfunded liabilities are amortized over 30 years and that the 30-year window restarts every year.) In this case, even if the average real return is met the funded ratio will be between 75 and 80 percent (after starting from a funded ratio of 78 percent). They note that this outcome occurs for two reasons.

First, employers are assumed to only be contributing 80 percent of the ADC. If employers contributed 100 percent of the ADC the results imply that the funded ratio would increase to about 87 percent. Thus the only way to achieve full funding would be to earn more than the assumed rate of return on average. In addition, this shows the importance of assuming an open 30-year amortization period. Munnell, Aubry, and Hurwitz (2013, p. 6) state that under an open 30-year amortization scheme "sponsors will never contribute enough to fully fund the plan" assuming employers pay the full ADC and the fund earns the real rate return on investment. Their analysis also highlights the inherent uncertainties in pension funding. Note that under their initial assumptions (employers pay 80 percent of the ADC and an open 30-year amortization) 25 percent of the time the funded ratio ended up at about 50 percent and 10 percent of the time it ended up below 40 percent funded. This is the case even when the long-run average return of the 100,000 simulations is equal to the assumed real rate of return. If the U.S. is entering a new phase of slower economic growth, then the potential outcomes could be grim.

4. Houston Data on the Rate of Return of Assets

Data from the PPD shows that the average rate of return assumption among plans nationwide is 7.86 percent, with a maximum value of 9.0 percent and a minimum value of 3.5 percent. HFRRF assumes a value of 8.5 percent for its investment rate of return and discount rate. This equals a real rate of return of 5.5 percent and an inflation rate of 3.0 percent. The total rate of return is net of all investment expenses implying a gross return higher than 8.5 percent. The 2015 CAFR for the HFRRF plan shows how sensitive the NPL is with respect to the discount rate. The estimated NPL is $578 million assuming

a discount rate of 8.5 percent, but would be $990 million (71 percent higher) assuming a discount rate of 7.5 percent.

HMEPS assumes a real rate of return of 5.5 percent and as discussed above recently lowered its inflation assumption from 3 percent to 2.5 percent, which implies a total nominal return of 8.0 percent (down from 8.5 percent in 2014 given the reduction in the inflation rate). The real rate of return is net of all investment expenses implying a gross rate of return higher than 8 percent. HMEPS collects the administrative expenses of 1.19 percent from the City by adding 1.19 percent to the ADC (this was a recent change based on a recommendation in the 2015 actuarial experience study).

HPOPS assumes an annual rate of return on investments of 8 percent net of expenses, with 8 percent also used as the discount rate. The rate of return is composed of a 5.25 percent real return and 2.75 percent inflation rate.

5. Effects of Changing the Rate of Inflation

The above discussion implies that a change in the rate of return assumption will have different impacts depending on which component of the rate of return is assumed to change. A change in the real rate of return would only affect the value of asset returns and the present discounted value of accrued benefits (as shown in Munnell, Aubry, and Hurwitz, 2013). However, a change in the inflation rate would affect the rate of return on assets, the present value of accrued benefits, and the rate of salary growth, and thus, have an additional impact on the projection of future benefits.

This implies that changing the inflation rate has counterbalancing effects. While these changes offset one another in terms of their effects on pension costs, they do not

cancel out. The discount rate effect on the present discounted value of benefits operates over the full lifetime of the individual, while the reduction in the salary scale only affects the calculations up to the time of retirement. Thus, the reduction in the inflation rate should have a larger impact on the pension costs through the lower discount rate (which tends to increase pension costs) than through the reduction in salary growth (which tends to reduce pension costs). As a result, the net effect of a change in inflation should be an increase in pension costs. However, if the change in inflation also affects cost of living adjustments then this result is not guaranteed to hold.

An interesting example is HMEPS' change in the assumed inflation rate, real wage growth assumption, and service-related component of salary growth. Table 1 shows the comparison of the service-related components before and after the change in 2014 as well as the total annual rate of increase, which is the sum of all of the components.

TABLE 1: HMEPS Service-Related Component, Inflation, and Wage Growth

	Service Related Component		Total Annual Rate of Increase Including Inflation Component and Wage Growth Rate	
Years of Service	Before Change	After Change	Before Change	After Change
1	3	2.25	6	5.5
2	2.75	2.25	5.75	5.5
3	2.5	2.75	5.5	6
4	2	2.25	5	5.5
5	1.75	1.75	4.75	5
6	1.75	1.5	4.75	4.75
7	1.5	1.25	4.5	4.5
8	1.25	1	4.25	4.25
9	1.25	0.75	4.25	4
10-14	1	0.5	4	3.75
15-19	0.75	0.5	3.75	3.75
20-24	0.5	0.5	3.5	3.75
25+	0	0	3	3.25

The 2015 HMEPS Actuarial Experience Study states that these combined changes will have minimal impact on the plans liabilities or normal costs because the decrease in wage inflation and the increase in real wage growth mostly offset each other. However, since the reduction in inflation is offset on the benefit side by an increase in real wage growth, the net effect of reducing the assumed inflation rate will be an increase in normal costs, the unfunded accrued liability, and the ADC. This is because the inflation rate enters the rate of return and thus the present value of accrued benefits. While it is very difficult to separate numerous recommended changes, most of the changes were relatively small or are noted to offset each other. Thus, a significant portion of the remaining impact of the actuarial changes should be due to the change in the inflation rate (operating through the discount rate).

The 2015 HMEPS Actuarial Experience Study shows that the normal costs increased by 1.02 percent of payroll (a 17 percent increase in normal costs from 5.85 to 6.87 percent), the UAL increased by $293 million (a 16 percent increase), and the ADC increased by 3.52 percent of payroll (not including the 1.19 percent increase related to the recommendation to increase the 30-year contribution rate by an estimate of the funds' administrative expenses.)

Changes in the rate of return, inflation rate, and salary growth rate assumptions can have significant impacts on the costs of providing benefits. Ironically, it is also the case that these assumptions are the most uncertain in the pension valuation process. Changes in decrements such as termination, disability, death, and retirement generally have smaller impacts on the cost of providing benefits. In addition, we generally have

better estimates of decrement assumptions, especially for larger plans with many members.

IV. THE IMPORTANCE OF PLAN BENEFITS

The discussion above which examines the importance of various assumptions in estimating the cost of providing a pension to employees is crucial to understand the true size of the cost. But changing assumptions is not a solution to a currently underfunded plan. A change in the actual value of one of the assumed parameters may lead to actuarial gains or losses and thus could decrease or increase the unfunded liability of the plan. In addition, more accurate assumptions reduce the probability of ending up with a large unfunded liability. However, moving from a situation in which a plan is significantly underfunded to a fully funded plan will generally require either an increase in contributions, by the city or the employees or both, or a decrease in benefits.

This section discusses the impact of altering plan benefits. Ultimately, the impact of altering plan benefits depends on the specific plan. Winklevoss (1993) examines the impact of benefit changes by adopting and then modifying a sample pension plan. The sample plan includes a retirement age of 65, early retirement at 55 with 10 years of service with an actuarially reduced benefit, a 1.5 percent benefit based on the final average salary over 5 years, vesting after 5 years, accrued unreduced disability benefits with eligibility after age 40 and 10 years of service, a death benefit after 5 years of service equal to 50 percent of the accrued benefit payable for life to a living spouse starting when the employee would have been eligible for early retirement, and no employee contributions. He examines a number of benefit changes to test the sensitivity of the plan costs and liabilities.

Benefit Formula and Average Salary

He begins by examining a change in the benefit formula by comparing the impact of using a final average salary based on the last 3 years of employment and an average salary based on an employees' entire career with the initial assumption of a final average salary based on the last 5 years of employment (he also examines a flat dollar unit benefit which is not discussed in this paper). He finds that using a 3-year, instead of 5-year, final average salary would increase normal costs by 5.5 to 5.7 percent depending on the cost method used (e.g., unit credit or entry age normal), and that accrued liability would increase by 3.5 to 3.9 percent. Using a career average salary instead of the 5-year final average salary would decrease normal costs by 42.2 to 29.3 percent depending on the cost method used, and accrued liability would decrease by 0 to 20.1 percent.

Early Retirement Benefit

Winklevoss (1993) shows that early retirement benefits may also have a significant impact on pension costs. He shows that adding an early retirement benefit with an average retirement age of 61.4 to the sample plans (as described above) increased normal costs by 9.9 to 22.1 percent and the accrued liability by 7.1 to 15.2 percent (depending on the cost method used) compared to a plan with no early retirement benefit. He also shows the costs are larger (30 percent increase in normal costs and 20 percent increase in accrued liabilities) if the early retirement benefit is not actuarially reduced.

COLAs

Winklevoss (1993) also examines the impact of COLAs on the normal costs and accrued liabilities of the sample plan. He finds that the normal costs and accrued

liabilities increase by about 8 percent for each percentage point increase in the COLA. Thus, a 3 percent COLA would increase long-run costs of the plan by about 25 percent. He points out that if a plan without a COLA adopts a 3 percent COLA it would increase short-run costs by more than 25 percent because the adoption of the COLA would create an unfunded liability. Note that this also works in the opposite direction. Thus, a reduction in a COLA benefit will reduce short-run costs more than long-run costs because it would reduce the existing unfunded liability immediately. This is because cutting future benefits does not reduce the accrued liability (benefits that have already been earned), while cutting the COLA does reduce the accrued liability because increases in accrued benefit payments are accounted for in pension valuations. Other benefit reductions do not offer such an immediate easing of the problems related to an underfunded pension plan. In addition, reducing COLAs is an attractive fix for pension problems because it has withstood challenges in court, unlike other attempts to reduce benefits.

Bradford (2012) finds that 11 states have reduced COLAs for either current or future employees since 2009. From 2010 to 2014, Munnell, Aubry, and Cafarelli (2015a) find that 39 state and local plans have reduced, suspended, or eliminated COLAs. Munnell, Aubry, and Cafarelli (2015a, p.3) state that "Cutting COLAs is an extremely attractive option to plan sponsors, because it is virtually the only way to make large reductions in a plan's unfunded liability."

Munnell, Aubry, and Cafarelli (2015a) discuss how and how often reductions in COLAs have been implemented by either eliminating the COLA for some period of time, reducing the adjustment value of the COLA, or by lowering the cap for CPI linked

COLAs. New Jersey and Rhode Island both eliminated their COLAs until the plans were above 80 percent funded. Oklahoma required that COLA be prefunded which virtually guarantees the absence of COLAs in the future. States with fixed COLA increases (such as 3 percent on an annual basis) were the most likely to change their COLAs. This is likely because the low inflation environment since the 2009 financial crisis implies that fixed increases of 3 percent were equivalent to an increase in benefits. Six states with COLAs linked to the CPI reduced benefits by lowering the cap that determines the maximum COLA allowed. They calculate that eliminating a 2 percent COLA would reduce liabilities by 15–18 percent and eliminating a 3 percent COLA would reduce liabilities by 22–26 percent (depending on the assumed discount rate).

Disability Benefits

Winklevoss (1993) finds that changes to the plans disability benefits has limited impacts on the plans costs and liabilities. He also shows that changes to the surviving spouse benefits, such as making them immediate or increasing them to 100 percent, raise the normal costs by about 5 percent and increase liabilities by about 3 percent when enacted at the same time. Thus, changes are relatively small compared to changes in the COLA and other benefits.

Deferred Retirement Options

Winklevoss does not discuss issues related to deferred retirement options (DROPS). This is an additional benefit available to a worker who is eligible to retire and start receiving retirement benefits but instead opts to continue working. In this case, the employees' retirement benefits are recorded and build up with interest in an account. Upon actual retirement the employee receives the value of the account as a lump sum

payout and commences to receive normal retirement benefits based on pay and years of service at the time of the original retirement date (i.e., not including the time for which the DROP account was active). Mason (2011) states that the HFRRF DROP is "more generous than the firefighter plans in Austin, Ft. Worth, Dallas, and San Antonio." In addition, he adds that it could more than double the benefit provided by the standard pension benefit formula. Thus, these are likely also benefit provisions that would be worth studying more carefully.

V. CONCLUSION

The objective of a pension plan is to provide enrolled employees with a monthly benefit during retirement. Pension plans usually include a host of other benefits as well such as termination, disability, and death benefits. This paper focuses only on a subset of pension plans, in particular, what is normally referred to as a defined benefit (DB) plan. The paper discusses two cost methods — the unit credit and entry age normal costs methods. Regardless of the cost method that is chosen a number of assumptions must be chosen, which can be described as either demographic (referencing the population make-up of the pension plan) or economic in nature. Reducing COLAs offer the most immediate benefits to an underfunded pension plan. In addition, reducing COLAs is a technique attractive to those who are seeking to reduce pension obligations because it has withstood challenges in court, unlike other attempts to reduce benefits. Changes in demographic decrements such as termination, disability, death, and retirement generally have smaller impacts on the cost of providing benefits. However, we generally have better estimates of these assumptions, especially for larger plans with many members.

In terms of the economic assumptions, changes in the interest rate, inflation rate, and salary growth rate can have significant impacts on the costs of providing benefits.Unfortunately, these assumptions are the most uncertain in the pension valuation process. In addition, changes in the rate of return assumption (or salary growth rate) will have different impacts depending on which component of the rate of return (salary growth rate) is assumed to change. Recall that a change in the real rate of return would only affect the value of asset returns and the present discounted value of accrued benefits. However, a change in the inflation rate would affect the rate of return on assets, the

present value of accrued benefits, and would also change the rate of salary growth and thus have an additional impact on the projection of future benefits.

There are many significant uncertainties in estimating costs of providing employees with a monthly benefit during retirement. Unfortunately, these risks are correlated with other citywide risks such as slower economic growth and reduced revenues that may accompany a negative shock (such as a significant and prolonged oil price shock or financial crisis such as in 2009) to the Houston metropolitan area. This is particularly true for Houston which has been struggling to afford the current ADC for its pension plans.

VI. **REFERENCES**

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