Investigating Oregon PERS: Unfunded Actuarial Liability (UAL)

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Abstract

Oregon's Public Employee Retirement System has been under scrutiny for the past two decades due to its large, and continuously growing, unfunded liabilities. There have been several political battles within the State Legislature regarding how to move forward with tackling this issue. One such example is the recent 31-29 passage of the highly contentious Senate Bill 1049. The goal of SB 1049 is to extend the amortization period of the pension system's Unfunded Actuarial Liabilities (UAL), increase the contributions of active PERS members and direct a portion of those contributions towards PERS debt that would otherwise go into a personal retirement account. Because of the highly contentious nature of this issue, as well as the impact it has on the retirement benefits of current employees, this study aims to measure and forecast PERS UAL over the next 50 years and shed light on the necessity, and viability, of the proposed changes.

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Introduction:

The Oregon Public Employee Retirement System (PERS) is a defined benefit statewide pension system for all Oregon public employees. Over the past two decades, the program has been scrutinized due to its increasing deficit, which was reported at over $22 billion in unfunded liabilities at the end of 2017 (Milliman). Much of this can be accredited to overly generous benefit payouts throughout much of the 1990’s and early 2000’s, through which many public employees are now receiving retirement benefits greater than any salary they earned while employed. However, some of the perceived issue may also lay in the accounting rules and methods used to project the intensely complicated financial future of the system. Cost amortization periods much shorter than actual payment timelines, conservative economic assumptions, and a possibly skewed notion of what it means to fully fund a pension system may be inflating the underfunding issue of Oregon PERS. While it is often good for government programs to be financially conservative, this specific issue is causing cost increases for schools and government employers across the state, which is resulting in drastic budget cuts and downsizing (oregon live).

This issue has largely been communicated to the public through OregonLive reporter Ted Sickinger. In his article *Latest Warning for Oregon PERS: Negative Cash Flow*, Sickenger reports that for many the problem appears to be the program’s negative cash flow as “PERS pays out far more than it takes in before investment earnings.” However, as Sickenger points out, negative cash flow is not inherently an issue for a pension program. In fact, to some extent it is the point of the program; Employees (or in the case of Oregon PERS, employers) contribute some amount in the current period, which is then invested, and a larger amount is paid back in the future period. Ultimately, the problem Oregon PERS faces is the amount to which it must rely on investment earnings to pay current retirement benefits, and a spike in those benefits being predicted in the next two decades. In 2016, Oregon PERS negative cash flow as a percentage of total assets was -5%, which again is not an immediate problem, but it does make "Oregon's plan more vulnerable to market volatility" (OLive, neg cash flow). The fear is that consecutive years with poor investment returns could drain the plans assets to a point where it could no longer cover the negative cash flow involved in paying benefits in the near future.

In this paper, we attempt to build a model that accurately projects Oregon PERS costs and revenues until the year 2070 using the accounting assumptions currently used in Milliman's Valuation of the plan. We then test different contribution rates and amortization periods under various assumptions to offer a more holistic view on how the problem could be handled in the following years. Finally, we use a monte carlo simulation on investment earnings to test the plans resilience to various economic environments.

Literature Review:

There are two main types of retirement plans: defined contribution and defined benefit. A defined contribution plan is one in which the employee contributes a portion of their gross salary, which is matched by the employer up to a certain percentage. In this type of retirement plan the funds can be invested at the direction of the employee, and the employer has no obligation on the funds performance after deposit. A defined benefit retirement plan on the other hand is one in which the employee is guaranteed a specific benefit in retirement (often based on salary, years of service, and other factors) and it is the responsibility of the employer to determine contribution amounts, and invest the funds properly to cover the promised benefits. Because of this, defined benefit plans, such as Oregon PERS, place a large amount of risk on the employer.

The issue of defined benefit pension funding has been the topic of much debate. Research in this area concentrates on competing methods of pension funding, and the effects of an aging population on pension programs. There are two main pension-funding models discussed in the literature: the Pay-as-you-go model (PAYG), and the fully funded model. A pay-as-you-go system is one in which "pension payments to the retired are not drawn from a capital fund accumulated during their working lives but financed directly by the contributions of the current workers/contributors" (Breyer, 1989). In a fully funded system, payments are drawn strictly from a capital fund accumulated during employees working lives.

In support of the PAYG system, Friedrich Breyer's paper *On the Intergenerational Pareto Efficiency of Pay-as-you-go Financed Pension Systems* argues that PAYG systems are Pareto efficient, and that transition away from a PAYG system is impossible without making at least one generation worse off. Breyer begins by reviewing the previous literature on PAYG financed pension systems. He discusses how Samuelson (1975) showed that "the economy can reach a steady state with higher per-capita consumption than without *if* the economy is "over-capitalized" (as cited in Breyer, 1989) and that, as was shown in Spreman (1984), a "funded plan can *always* be Pareto-dominated by some pay-as-you-go plan *unless* the sum of population and wage growth is permanently smaller than the interest rate" (as cited in Breyer, 1989). At the time Breyer wrote this paper, it was questioned whether or not the conditions for pay-as-you-go pareto efficiency would hold in the future. Because of this, Breyer set out to evaluate the transition between a pay-as-you-go and fully funded pension system, specifically analysing the effect on transitional generations. To do so, he used the model outlined in *Public Choice and the Social Insurance Paradox: a Note* by Townley (1981), and extended it to consider a closed economy by making the variables of income per worker and interest rate endogenous. From this model, Breyer concluded that "when the pay-as-you-go system is replaced by a funded system… it is generally impossible to compensate the first generation of pensioners for the loss incurred without making at least one later generation worse off than under pay-as-you-go." (Breyer, 1989) Due to the extensions of the model made by Breyer, this conclusion holds in both open and closed economies. Additionally, since Breyer's model did not specify which financing system was used in the status quo situation, this "conclusion is valid both for the transition from pay-as-you-go to a funded system and for the opposite measure" (Breyer, 1989) Ultimately, Breyer's model suggests that "the decision to introduce the pay-as-you-go system after the second world war was not wrong on efficiency grounds", but the popular notion of switching to a funded system due to changing population projections and economic conditions "cannot provide *every* generation with a better yield on their social security contributions." (Breyer, 1989)

Another paper supporting the PAYG system is *Should Public Retirement Plans Be Fully Funded?* By Henning Bohn, an economist at the University of California Santa Barbara. Bohn focuses on the fact that most U.S. voters and taxpayers are borrowers, citing that well over 80% of individuals under 65 reporting having debt, as well as 65% of those between 65 and 75 years old. He claims that "indebted taxpayers are better off if, instead of paying taxes to fund public pensions that earn the market return, they leave pensions unfunded, defer the taxes until pension payouts are due, and use the funds to reduce their debt, which accumulates at a higher interest rate." (Bohn, 2011) To support this Bohn built a 3-period life cycle model, that considers the national tax incentives and the borrowing/lending of participating members. According to Bohn, "A tax incentive arises because marginal (national) income tax rates are generally higher in working age than in retirement. This means retirement savings have an after-tax return strictly greater than the market return.” (2011) Because of this, voters have an incentive to leave pensions unfunded, pay back debts with higher rates in the current period, and defer local-taxes to fund pensions until a later period. Additionally, even middle-aged taxpayers without debt have incentive to defer pension funding as “they are better off if, instead of using after-tax income to fund public pensions, they save more on a pre-tax basis and pay local taxes later, out of less-taxed retirement income. Their incentives are aligned with debtors.” (Bohn, 2011). Bohn concludes that “intermediation costs create a wedge between the costs of borrowing and the returns on financial assets,” but taxpayers “could avoid the intermediation costs by underfunding public pensions and thereby deferring taxes.” (Bohn, 2011).

Contrasting the previous point of view, *The Pension Scheme Need Not Be Pay-as-you-go: an Overlapping Generational Approach* by Mauri Kotamaki argues that countries should transition to a fully funded pension scheme. Kotamaki analyzed the transitional and steady state effects of transitioning from a mixed funding scheme to both a PAYG and fully funded model. His basic argument is that in a fully funded system, pension contributions (x) are collected from the younger generation and collectively invested at rate (r), creating returns of (1+r)x in the next period. PAYG systems on the other hand collect contributions from the younger generation and transfer them to the older generation in the current period. This results in returns (1+n)r where n is the population growth rate. From this Kotamaki deduces that PAYG is not welfare enhancing if n is declining, and as is shown in several other works, PAYG systems “diminish aggregate savings compared to a world without the system in place, given that $n<r$.” (Kotamaki, 2013) One concession Kotamaki makes is that “if the pension reform is introduced in a bang-bang manner, the economy is best off

by not reforming at all.” (Kotamaki, 2013) However, if the reform is introduced over multiple time periods “social welfare is an increasing function of pension funding.” (Katamaki, 2013)

Results under aging populations are a common criticism of PAYG pensions systems. Giam Pietro Cipriani discusses the effects of aging on pension schemes in his paper *Aging, Retirement, and Pay-As-You-Go Pensions.* Cipriani concedes that population aging with restricted retirement age has a negative effect, however using a three-period model with endogenous retirement age he shows that “the effects of an aging population may not be detrimental to the PAYG pension system because agents could adjust their old-age labor supply accordingly.” (Cipriani, 2018). Cipriani’s model assumed three life periods: (1) childhood, no economic decisions made (2) Adulthood, must decide how much to save for retirement and spend on consumption (3) Late life, must decide how much to participate in the labor market or retire. Within this model, “optimal retirement increases with longevity” (Cipriani, 2018), suggesting that as populations age people should participate in the labor market longer. From this Cipriani concludes “governments should not restrict the elderly labor supply by imposing upper limits to the retirement age.” (Cipriani, 2018) The model also supported the common theory that “with full retirement, aging has an adverse effect on pension payouts”, however Cipriani claims that “the effects of aging on pensions may not be negative if the elderly are free to choose their retirement age, while they are always negative in the case of full retirement.” (Cipriani, 2018)

Finally, *Funding Public Pensions: Is Full Pension Funding a Misguided Goal?* By Tom Sgouros examines the problems with the accounting rules involved in pension valuations, and offers a different perspective on the severity of pension funding issues. Sgouros explains that under GASB accounting rules, unfunded liability is essentially a calculation of “how much the sponsoring government will owe if the system is closed tomorrow and all current pensions debts are paid off over the ensuing decades.” (Sgouros, 2017) This is useful in the private sector, as private firms could be liquidated and have to pay all debts at anytime. However public governments do not face this same risk of liquidation, and should not be preparing for it.

Additionally, GASB rules require that liabilities be amortized over a 30-year period. This is too short of a horizon, as “the last payment owed by any pension system will not be made until the youngest current employee dies If the youngest employee is in their 20s, this could be more than 60 or 70 years in the future.” (Sgouros, 2017) Sgouros also points out that full funding is not required to pay all pension debts. He argues, “A pension fund must pay 100 percent of its debts. But it need not pay them a moment before they are actually due, and since a pension plan is constantly receiving new contributions… even if all the debts are paid, at any one time, the fund itself may be at some level well below 100 percent funding.” (Sgouros, 2017)

Another issue in accounting rules is the requirement to use a risk-free rate of return to estimate liabilities. The risk-free rate of return is essentially what a portfolio would earn if invested fully in U.S Treasury bonds. However, “a fund can continue to use whatever funding strategy its managers see fit to use. But the liabilities will be calculated using this lower rate of return, thus will appear much larger than if calculated with a higher rate.” (Sgouros, 2017) Sgouros also points out that overfunding a pension system would be “a tangible waste of resources, money unnecessarily diverted from other priorities.” Additionally, any system at full funding or near to it will face political pressures to either increase benefits or divert funds to other priorities. “In other words, it is virtually a law of nature that an overfunded pension plan -- or any plan over, say, 90 percent funded -- will see retiree benefits increase or budget contributions decrease.” (Sgouros, 2017) Ultimately, the paper argues that many of the accounting rules around pension systems “represent little more than blind acceptance of precedent”, and should be designed to reflect a more realistic model future performance. And while full funding may be a valuable goal, in the end “full funding of any pension system requires more money than necessary to meet the government's obligations.” (Sgouros, 2017)

PERS Basics:

We used the October 2018 edition of *PERS By The Numbers* by the Oregon Public Employees Retirement System to understand the current Oregon PERS program. This report breaks down the demographics, benefit payouts, and funding of the Oregon Pension system.

The PERS system consists of three different retirement plans, determined by the employee’s date of hire. Tier 1 consists of employees who were hired prior to January 1, 1996, Tier 2 employees are those who were hired between January 1, 1996 and August 28, 2003, and OPSRP includes all employees hired after August 28, 2003. They differ according to the contribution and benefit schemes used throughout the employees’ lifetime. Beneficiaries are paid using three different options: Full Formula, Formula + Annuity, and Money Match.

The Full Formula Method uses three factors to compute monthly retirement benefits: the employee’s final average monthly salary, years of creditable service as of the date of retirement, and a factor that depends on what tier the employee belongs to (Tier 1&2: 1.67% general service, 2% police and firefighters; OPSRP: 1.5% general service, 1.8% police and firefighters).

Full Formula: Average Monthly Salary * length of PERS creditable service * factor (1.67% or 2%)

The formula plus annuity method is only available to those who paid-in prior to August 21, 1981. This method is similar to the Full Formula method, but it computes the employer's monthly portion of employee benefits. First, a percentage (1% for general service, 1.35% for legislators, police and firefighters) of employees' final average salary (FAS) is multiplied by their years of creditable service. This is then added to the monthly annuity payment that each member's account provides. The annuity payments from the member accounts are calculated based on account balance and life expectancy.

Full Formula Plus annuity:

Employer Contribution = FAS * factor (1% or 1.35%) * length of PERS creditable service

Monthly Annuity Payment = Account Balance * % (dependent on life-expectancy)

Total Annuity payout = Employer Contribution + Monthly Annuity Payment

Lastly, in the money match method employers match the benefit from employees' account balance by an equal amount. Monthly benefit is dependent on account balance and life expectancy for persons in a particular age group. There is no reduction for early retirement, but annuity payouts will be reduced due to the longer periods of payments being made.

Money Match Formula: Account Balance * % (based on life expectancy)

All OPSRP retirees benefits are calculated using the full formula method. For Tier 1&2 employees throughout much of the 1990's and until 2003, the money match method was the most popular benefit calculation selected. Since 2003 the full formula method has become the most commonly selected benefit calculation method, and in 2018 55% of retirements were calculated using the full formula method, 43% used the money match method, and just 2% used the formula plus annuity method.

As of December 31, 2017, Oregon PERS was 73% funded with an Unfunded Actuarial Liability (UAL) of $22.3 billion (80% funding, with $16.7 billion in UAL when considering side accounts). PERS operates under the funding equation:

Benefits = Contributions + Earnings

<u>Our Model:</u>

In order to project the Oregon PERS UAL in future years, we needed to estimate the level of actuarial accrued liabilities and assets for each year. These projections required estimates of future contributions, benefit payouts, and investment earnings as well as several other inputs. Many of these inputs depend on the number of public employees in the system as well as their wages, and thus workforce and total payroll were projected as well. In this section each input, and our method of projection are explained in detail beginning with workforce projections, and concluding with the calculation of final UAL reflecting side accounts.

Many assumptions specific to each input will be discussed below, however, a few assumptions were made that are relevant to many of the inputs in our model. Based on the assumptions made in relevant literature, and recent economic forecasts, we assumed that inflation will be 2.0% per year, and nominal wage growth will be 3.5% per year. Combining these two assumptions, we used a real wage growth of 1.5%. Additionally, as is consistent with Milliman's assumptions in their 2017 valuation report of Oregon PERS, we assumed that the returns from investment would be 7.2% per year. Finally, based on recent U.S. census data, and assumptions made in the relevant literature, we assumed a 4% death rate for Oregon PERS retirees.

It is important to note that the effects of the Individual Account Program (IAP) and the Oregon PERS Retiree Health Care Program were excluded from our model. This is because the IAP does not affect the pooled funds of the program, and due to time and resource constraints, we were not able to model the health care program.

Workforce:

In order to calculate many of the financial factors of the Oregon PERS Program, we needed to project the Oregon public workforce over time. The Oregon PERS public workforce is broken into two categories, active and inactive. Active employees are people who are currently employed by a PERS participating employer. Inactive employees are people who were previously employed by a PERS participating employer, but are currently employed outside of Oregon PERS. Inactive employees are tracked because, while they may not retire from a PERS participating employer, they will still receive benefits from the PERS fund during retirement. Both active and inactive employees were projected for Tier 1&2 and OPSRP, however different methods were used to project the Tier 1&2 and OPSRP workforce.

Tier 1&2:

Public employees stopped being added into the Tier 1&2 versions of the PERS program in August, 2003. Because of this, the active population will only diminish in the following years.

We assumed that this decline would happen in a linear fashion over the next 25 years. 25 years was determined by the assumption that the youngest person hired in 2003 would retire approximately 40 years later (2043) which is 25 years from the beginning of our model (2018).

According to the December 31, 2017 Milliman Valuation, there were 56,528 active and 27,674 inactive Tier 1&2 employees in 2018. Based on our assumption of a linear decline over the next 25 years, we projected that 2,261 active employees and 1,107 inactive employees would retire each year, until 2043. After 2043 both held at zero.

OPSRP:

Because public employees are still being added into the OPSRP program, we had to estimate the workforce differently. To do this we assumed the ratio of active public employees to total working age population of Oregon would hold constant throughout the foreseeable future. We calculated this ratio at 5.88% using the active population given in the December 31, 2017 Milliman valuation, and the Oregon working age population given by the World Population Review. From this we calculated the total active public employee population as 5.88% of the Oregon working age population, which was forecasted by the World Population Review.

The state population forecasts given by the World Population Review were in five year increments out to 2050. In order to calculate a projected state population for the years not given we assumed a linear progression between each reported value. To get from the final projected population in 2050 to the end of our model in 2070, we assumed that the total percentage growth from 2050-2070 would equal that of 2030-2050. After calculating a population for 2070, we assumed a linear progression between the two years.

To calculate the OPSRP active population, we subtracted the projected Tier 1&2 active population from the projected total active public employee population. After 2043 the Tier 1&2 active population is projected to be zero, and thus the active OPSRP population equals the total active public employee population.

To calculate the OPSRP inactive population, we assumed the ratio of inactive to active OPSRP employees would hold constant over time. This ratio was calculated at 13.82% for 2018 from the data given by the Milliman 2017 valuation report. Thus, in each year the inactive OPSRP population was calculated by taking 13.83% of the projected active OPSRP population.

Payroll:

Total payroll is the sum of all wages paid to active employees within a given year. Payroll was projected separately for tier 1&2 and OPSRP, but used the same method.

We began by calculating the average individual salary in 2018 for both Tier 1&2 and OPSRP employees. This was done by taking each tier's total payroll for 2018 and dividing it by the tier's active population given in the 2017 Milliman Valuation Report. From this, we projected future average salaries by adding our assumed 1.5% real wage growth each year. Total Payroll for Tier 1&2 and OPSRP was then calculated by multiplying each tier's projected average salary by its projected active population.

Actuarial Accrued Liabilities (AAL):

Liabilities in our model began with the value reported in the December 31, 2017 Milliman Valuation. This was our value for the beginning of 2018, which was reported at

$84,563,000,000.00. From this, the beginning liabilities of future years were calculated by the following formula:

$$AAL_t = AAL_{t-1} + \text{Normal Cost}_{t-1} + \text{Administrative Expenses}_{t-1} + \text{Interest On Liabilites}_{t-1} - \text{Total Benefit Payouts}_{t-1}$$

This calculation held constant throughout the entirety of our model.

Normal Cost:

Normal Cost represents the liabilities accrued by the active population in the current year. It is commonly given as a percentage of total payroll, and can most easily be understood as the percentage of payroll that, if contributed and invested today, would cover the benefits earned by those employees during the current year. Tier 1&2 and OPSRP normal costs were calculated separately in our model and used slightly different assumptions.

Tier 1&2:

According to the 2017 Milliman Valuation Report, Tier 1&2 normal cost rates have been around 15% in recent years. Additionally, the normal cost rate will be held at 15.27% for 2019-2021, and we assumed that this rate would hold constant for the foreseeable future. Thus for each projected year in our model, Tier 1&2 normal cost was calculated using the formula:

$$NC_{\text{Tier 1\&2}} = \text{Total Payroll}_{\text{Tier 1\&2}} * 15.27\%$$

OPSRP:

OPSRP normal cost rates have been reported at around 10% in recent years, and will be held at 10.72% for 2019-2021. We assumed this rate would hold constant for the foreseeable future. Thus for each projected year in our model, OPSRP normal cost was calculated using the formula:

$$NC_{OPSRP} = \text{Total Payroll}_{OPSRP} * 10.27\%$$

Administration Expenses:

Administration expenses account for the yearly costs to keep PERS running. We included this in our model to more closely match Milliman's calculations of actuarial liabilities and total assets. For this input, we simply kept the expenses constant throughout our model in an effort to mimic Milliman's assumptions. While the real cost of administrative expenses fluctuates above and below this figure in reality, we felt that $37.5 Million was a reasonable assumption in the long-run.

Benefit Payouts:

To calculate projected benefit payouts for each year, we multiplied a projected retired population by a projected average annual benefit. These projections were done separately for each tier.

Tier 1&2:

We began with the retired population reported in the 2017 Milliman Valuation Report, which was 140,867 individuals. To project the retired population from 2018-2043, we added the amount assumed to be leaving the workforce, 3,368, and subtracted the individuals projected to die that year, assuming a 4% death rate. After all active Tier 1&2 employees were projected to have retired in 2043, we assumed that all Tier 1&2 retirees would be deceased by the year 2063. From 2043-2063 our projected Tier 1&2 retired population was calculated assuming a linear decrease from 92,880 individuals in 2043 to 0 individuals in 2063, with 5,231 dying each year.

Average annual benefit was calculated in 2018 by dividing the total Tier 1&2 benefits paid by the total Tier 1&2 retired population, both values being drawn from the 2017 Milliman Valuation Report. To project future average annual benefits, we assumed that the 1.5% real wage growth would be reflected in benefit payments.

Total Tier 1&2 annual benefit payouts were calculated by multiplying the projected retired population by the projected average annual payout for each year.

OPSRP:

Our model started with the 2018 retired population reported in the 2017 Milliman Valuation. To project future retired populations we began by assuming that the percentage of active and inactive OPSRP employees eligible to retire (55-70 years old) would match the percentage of total Oregon state workforce within that age group. We used the population projections from the World Population Review to calculate the percent of workers eligible to retire each year, and multiplied this percentage by our projected active and inactive OPSRP workforce to calculate the number of OPSRP employees eligible to retire each year. Then, using the retirement assumptions table provided by Milliman's 2017 valuation report, we determined that an average of 7.2% of those eligible to retire would retire each year. By multiplying this percentage by the projected amount of employees eligible to retire, we calculated the number of employees that would retire each year. Prior to 2033, total OPSRP retired population was calculated by adding the number retiring each year to the previous years total OPSRP retired population. After 2033 we also subtracted out deceased retirees assuming a 4% death rate.

Average OPSRP annual benefit was calculated in 2018 by dividing the total benefits paid by the OPSRP retired population. This number was very low, $5,978.13, because current OPSRP retirees had low years of service and low final annual salaries. Using the results of a system wide study reported in the October 2018 *PERS by the Numbers* report, we determined that the average Oregon PERS beneficiary had 25 years of service, and a final annual salary of $80,845 in 2018 dollars. When these average values are entered into the OPSRP benefit formula:

Annual Benefit = 1.5% * Years of Service * Final Annual Salary

The average annual benefit is $30,316.88. We assumed that the OPSRP retirements would be representative of the total system once all Tier 1&2 employees had retired in 2043. Thus we calculated an average OPSRP annual benefit by adding our assumed 1.5% wage growth to the number calculated above out to 2043, resulting in an average annual benefit in 2043 of $43,988.13. We assumed a linear progression from the reported average OPSRP annual benefit in 2018 to this assumed benefit in 2043, increasing the average benefit by $1,520.40 each year from 2018-2043. After 2043 we assumed the average OPSRP annual benefit payment would reflect our assumed 1.5% annual real wage growth.

Total OPSRP annual benefit payouts were calculated by multiplying projected retirement population by projected average annual benefit payment for each year.

Interest:

The inclusion of interest in our model essentially represents the money that would have been earned, had the Actuarial Accrued Liabilities (AAL) been included in the PERS fund. This figure was included in all of Milliman's Valuation reports, and recorded as a liability. To better understand this figure and why it was included, we reached out to Debra Hembree, the Actuarial Services Coordinator with Oregon PERS. She responded with the following explanation:

> "The interest figure… is the interest on the actuarial accrued liability since the previous valuation. Because the AAL is a debt -- an obligation for benefits earned but not yet paid out -- it is projected forward with interest. That interest figure basically represents money that would have been earned if the AAL amount were available in the PERS fund."

To include this calculation in our model, we simply multiplied each year's AAL by 7%. This was to mimic the calculation in Milliman's Actuarial Valuation report.

Total Assets:

Total assets were a fairly straightforward calculation as very little assumptions needed to be made. 2015-2018's total assets were pulled directly from the Milliman Valuation report. After 2018, total assets acted as more of an output in the model. It was calculated by taking the previous years total assets and adding in contributions (both OPSRP & Tier 1&2), as well as any earnings made on investments. From there, only benefit payouts and administrative costs were subtracted out. This calculation remained constant throughout the lifetime of our model.

Contributions:

Tier 1 & 2:

Using the Milliman Actuarial Valuation report, we had access to Tier 1&2's population demographics (total active and inactive), payroll and contributions, which we then were able to use to calculate the total average contribution rate for the group, which ended up being about 30%. After knowing how much of the total payroll would be contributed each year, all that was left was to forecast out future Tier 1&2 payrolls. Because only active Tier 1&2 members would be contributing to the fund, we only used the active population in our forecasts.

With Tier 1&2 population and payroll forecasted through 2043, all that was left to do was multiply each year's payroll by the contribution rate, and plug it into our model. Our model was setup to allow us to plug in different contribution rates as needed to test the effect of different contribution rates on Tier 1&2 contributions over time.

OPSRP

Contributions for the OPSRP group were calculated in a similar manner as Tier 1&2, but posed a different obstacle. Because all new public employees are put into OPSRP, this active population would grow over time, rather than shrink with an expiration date. Not only would the active OPSRP population grow with the population, but all employees who were hired to replace Tier 1&2 employees would also be added.

With active OPSRP population and payroll forecasted throughout the lifetime of our model in the "Workforce" and "Payroll" sections, all that we needed was to calculate OPSRP contributions. To get total contributions from OPSRP members, we simply multiplied 2018's contribution rate by the total payroll. The contribution rate was calculated by taking the total contributions from 2018 and dividing it by 2018s total payroll, for OPSRP. By setting up our model this way, it allows us to easily see how a change in the contribution rate affects OPSRP contributions over time, and therefore affects the UAL.

Earnings from Investment:

The Oregon PERS investment fund, or OPERF, is managed by the Oregon State Treasury under the direction of the Oregon Investment Council (OIC). In the Oregon Investment Council's "Statement of Fund Governance" the OIC clearly states the guiding principles and purpose of the fund, as well as how the fund's investment decisions will be controlled. In short, the guiding principles of the fund state that the investment program exists "To fulfill its role as primary *governing fiduciary*... the general duty of the council 'is to make [investment funds] moneys as productive as possible." Further, the document goes on to state that they are to ensure that investment fund assets are prudently, profitably and effectively managed on a day-to-day basis.

After building the overall model out in Excel, it was easy to see that the Earnings from Investment would be one of the most impactful inputs. For the sake of testing the effects of different contribution rates on the Unfunded Actuarial Liabilities (UAL), we assumed an annual return of 7.2%. This assumption was taken directly from Milliman's Valuation report and aligns very closely with the historical average annual return of the overall PERS portfolio, which is a mix of equities, fixed income and venture investments. By assuming a 7.2% annual return, we were able to identify how, on average, the number of years to 0 UAL would change given different contribution rates.

We know that an assumed 7.2% return does not necessarily represent reality. Because the Earnings from Investment input in our model has such a significant impact on the performance of the overall pension fund, we needed to see how it performs in a variety of different economic environments. In order to simulate this, we conducted a Monte Carlo simulation in Excel that would pull returns in each given year from a normal distribution (N~(6.24%, 10.60%)). Where 6.24% is the average rate of return for Oregon PERS investments since 1970, and 10.60% represents its standard deviation. These draws would be taken each year covered by our model, 2018 through 2070, 1000 times each, while holding contribution rates constant. From there, the results of the Monte Carlo simulation would be plugged into our model and the "Years to 0 UAL" recorded, using an Excel data table. The final output would show each iteration and its "Years to 0 UAL." Using this, we were fundamentally able to answer the question "If nothing changes, when are we most likely to reach 0 UAL, on average?" This will be discussed further in the Results section.

UAL (End):

Finally, after accounting for all of the above inputs, the key output from our model could be calculated. The entire foundation of our paper focuses on calculating how long, under different circumstances, it will take to reach a UAL of 0 (where PERS would be fully-funded). We recognize that PERS may go from fully-funded in year 16 to again having unfunded liabilities in year 17 due to turbulent market conditions. However, these short term periods of "Unfunded

Liabilities" are made up for in positive long-run returns and the self-sustaining nature of OPSRP. Because of this, the UAL is entirely dependent on the inputs. The UAL is simply calculated by taking the year's starting Actuarial Accrued Liabilities (AAL) and adding in administrative expenses and benefit payouts and interest. Then total Assets are subtracted to show us how much of PERS' current liabilities are unfunded. The reason that contributions are not included is to avoid double counting, as they had already been taken into account in Total Assets.

Side Accounts & UAL Reflecting Side Accounts:

Side accounts are accounts that Oregon PERS employers can contribute to in years of surplus to ease the demands when contribution rates are raised or cash is short. These accounts are not included in the UAL calculation, but it is useful to consider what the UAL would be if these funds were contributed in the current period.

In 2018, the program's side accounts held a total of $5,561,202,783.48. We assumed that there would be no more contributions to these accounts, and that they would diminish in a linear fashion over the next 20 years. UAL reflecting side accounts was calculated by subtracting the remaining side account balance from the year end UAL.

Results:

Changing Contribution Rates:

One of the core purposes of this paper is to investigate the best course of action in tackling the massive UAL that Oregon PERS has accumulated over the past two decades. One suggestion, and current political goal of the Oregon Legislature, is to increase the contribution rates of current public employees to reduce the current $22 Billion in Unfunded Liabilities. To test how changing the net contribution rates of both OPSRP and Tier 1&2 affected the UAL, we decided to conduct a sensitivity analysis. This sensitivity analysis was conducted in an environment with static annual returns of 7.2% on PERS investments. The assumption of 7.2% was gathered from Milliman's valuation report and mimics their estimated returns for the system.

Because required contribution rates typically shift by very little each biennium, we decided to set our range at 10%, with increments of 5%. OPSRP would be tested at 1%, 6%, 11% (current), 16% and 21% contribution rates, while Tier 1&2 would be tested at 20%, 25%, 30% (current), 35% and 40%. The sensitivity analysis shows that if contribution rates were to remain at their current levels, Oregon could expect PERS' $22 Billion UAL to reach 0 in 16 years (Appendix B). After the UAL reaches 0, PERS would begin to accumulate a surplus, reaching approximately $33 Billion in 20 years (2038).

At the lower end of contribution rates (1% for OPSRP and 20% for Tier 1&2) results suggest the UAL will first reach 0 in 19 years (2037), still under the legislature's target of 20 years. On the other hand, if contribution rates were to rise to 21% and 40%, for OPSRP and Tier1&2 respectively, the UAL would reach 0 in 2030, only 12 years from today (Appendix B).

PERS Performance Given Different Economic Environments:

Years to 0 UAL

Because a static economic environment is not a realistic assumption, we chose to run a Monte Carlo simulation to see, under different market conditions, how long PERS would take to reach 0 UAL with its current contribution rates. This Monte Carlo was constructed using returns from Oregon PERS investments since 1970. These returns have been adjusted from nominal to real returns using the CPI of each year as a proxy for inflation. After adjustment, PERS averaged an average real return of 6.24%, with a standard deviation of 10.6%. Using this information, a Monte Carlo simulation was ran, drawing random returns for each year of our simulation (from 2018 through 2070), 1000 times. The results were then plugged back into our model, and the "Years to 0 UAL" recorded using a Microsoft Excel Data Table.

Years to 0 UAL		
0-10 Years	304	30%
11-20 Years	230	23%
21-30 Years	110	11%
31-40 Years	93	9%
41-50+ Years	263	26%

*Monte Carlo Results Table - Years to 0 UAL

The results show that in 304 draws (30%) Oregon PERS reaches 0 UAL within 10 years. 230 draws (23%) show it reaching 0 UAL within 11-20 years, 110 (11%) show it reaching 0 within 21-30 years, 93 (9%) show it reaching 0 in 31-40 years, and 263 draws (26%) show it reaching 0 more than 40 years out. Over half of the time (53%), without changing contribution rates, PERS' UAL reaches 0 within the legislature's 20 year timeframe (Appendix C). The statistics generated from this Monte Carlo show that the average years to 0 UAL is 11.35, with a standard deviation of 10.79 years.

UAL at 20 Years

Because the legislature has set a goal for reaching 0 UAL within 20 years, we wanted to dig a bit deeper and see, under the current contribution rates and changing market conditions, what the UAL looks like at 20 years across all simulations. To do this, we simply added the calculation to our model, and re-ran the data table.

The results, listed in Appendix D, show that after 20 years the average UAL will be approximately $21 Billion. This is accompanied by a standard deviation of about $114.6 Billion. The range of the Monte Carlo shows a surplus (minimum) of approximately $616 Billion in the best case scenario. The maximum would be a UAL of $210.4 Billion in the worst case scenario. The median of this simulation is a UAL of $38.7 Billion at 20 years, the year 2038 (Appendix D).

Conclusion:

The results of our model provide a basis for discussions on how to deal with Oregon PERS' UAL. First, the changes in net contribution rates had a minimal effect on UAL amortization. As can be seen in Appendix B, if both OPSRP and Tier 1&2 net contribution rates were increased by 10% (OPSRP to 21%, Tier 1&2 to 40%), the UAL would reach 0 in 12 years, only 4 years sooner than if contribution rates were to remain the same. On the other hand, if net contribution rates were to be cut to 1% and 20%, for OPSRP and Tier 1&2 respectively, our model suggests that the UAL would still reach 0 in 19 years, within the Oregon legislature's 20 year timeline. From these results, we can conclude that the changing of contribution rates have a very minimal effect on the system's unfunded liabilities.

When running our Monte Carlo simulation, our priority was to run the model enough times such that it would provide satisfactory results. After running the Monte Carlo simulation 1,000 times, and receiving an average annual return of 6.25%, with a standard deviation of 10.63% across all simulations, was dead on with OPERF's real returns. The goal of this simulation was to see how PERS fairs in different economic environments, and how their performance in the market impacts the UAL.

Average UAL @ 20 Years:	$ 20,943,516,989
Standard Deviation:	$ 114,646,849,182
Max:	$ 210,440,783,907
Min:	$ (615,908,345,078)
Median:	$ 38,770,079,143

The Monte Carlo simulation results posed a very interesting conclusion, as well. With an average UAL of $21 Billion in 20 years (compared to $22 Billion now), and a standard deviation of $114.6 Billion, the simulation suggests that PERS investment returns have the largest impact on the system's unfunded liabilities. A well-performing, long-term investment plan, even if it had minimal returns, would have a larger impact on the UAL than even a 10% net increase in net contribution rates across OPSRP and Tier 1&2.

Beyond these results, in each year of our model, total assets are much larger than total benefit payments. This suggests that, given our population forecasts, OPSRP should not run into liquidity issues when paying benefits to retirees in the near future. Additionally, once all Tier 1&2 active members retire, OPSRP is completely self-sustaining, and even generates a surplus. In the long-term, benefit payments start decreasing once Tier 1&2 members begin dying, which allows Oregon PERS to generate a surplus.

With the conclusion that OPSRP is ultimately self-sustaining, and even profitable, we believe that Oregon PERS is sustainable in the long-run despite the current levels of unfunded liabilities. In the near future, the Oregon legislature is concerned with liquidity issues should a large number of active Tier 1&2 members retire at once. The results from our paper suggest that, should Tier 1&2 members retire more quickly than our forecast predicts, PERS would be wise to extend the amortization period and sell bonds to satisfy liquidity needs. This is a much more favorable solution than increasing current contribution rates and firing employees, which adds very little benefit when compared with the short term costs.

<u>Issues & Improvements on the Model</u>

One of the biggest issues we ran across when constructing our model was accurately measuring the retirement of active Tier 1&2 members. While we were able to obtain an average age, we could not find a standard deviation which prevented us from building a distribution and ultimately accurately predicting the impending "bulge" of Tier 1&2 retirees. While our model is still accurate and useful as a long-term stochastic forecast of the overall system, it could be improved in the short term (20 years) by having a more accurate forecast of Tier 1&2 retirees. Beyond this, the accuracy of the forecasts could be improved by the inclusion of benefit and contribution data for each individual member of the system.

Another improvement on the model would be the addition of the system's cash flow. While we have all the necessary components to calculate cash flow in each year, time constraints made this impossible to add. Including cash flow for the model would be useful for seeing when, and if, the system would need to issue bonds to satisfy short term liquidity needs, and how much they would have to raise.

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Debra Hembree - Actuarial Services Coordinator of Oregon PERS. Debra helped provide us with the resources we used to gather data and test our findings. Specifically, she gave us access to the Experience Study - Economic Assumptions and Actuarial Methods of Oregon PERS for May and June of 2017. On top of this, she provided us a financial modeling presentation, past data guidelines and requests from Milliman, as well as an Excel document with the summary

UAL for individual employers. Beyond the data she provided us with, she was very helpful in answering questions throughout our project. One such example is quoted in the “Interest” section of our model explanation.

Milliman - Actuarial Services. Milliman was crucial to our project, both for collecting data from their reports as well as comparing forecasts. Through reading Milliman’s papers, we obtained a better understanding of not only Oregon PERS, but of the actuarial methods and assumptions used to create this forecast.

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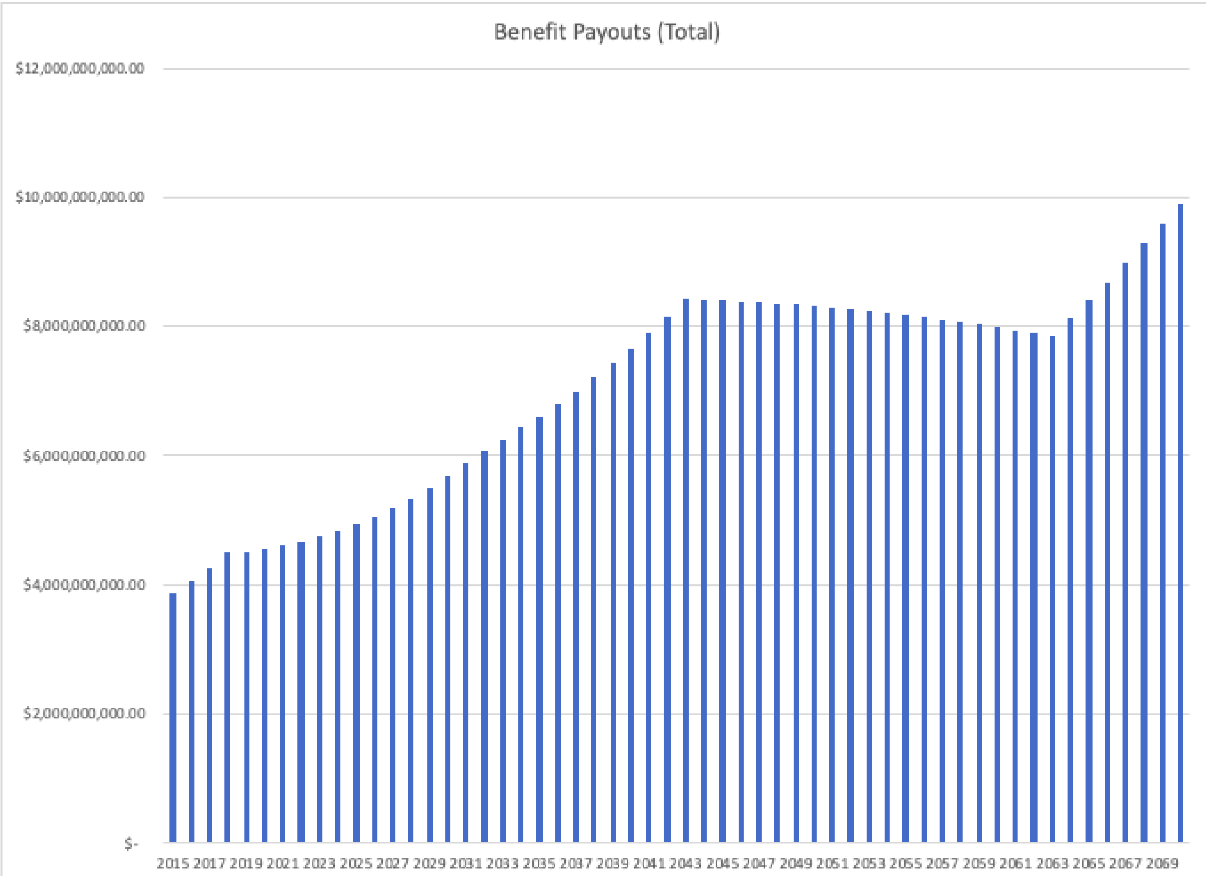
Appendix:

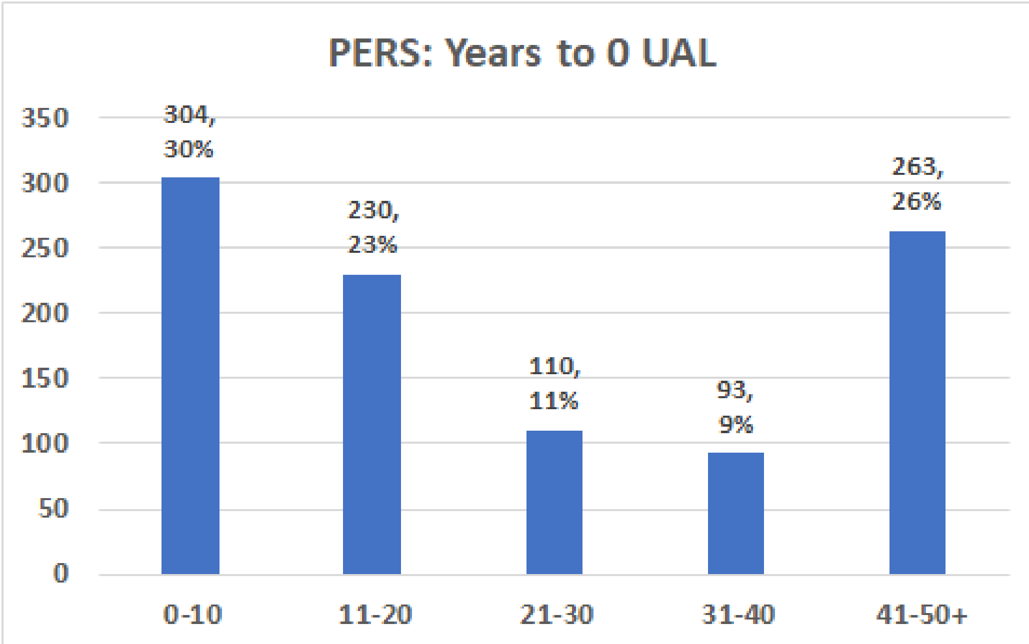
A: Total Benefit Payouts Over Time



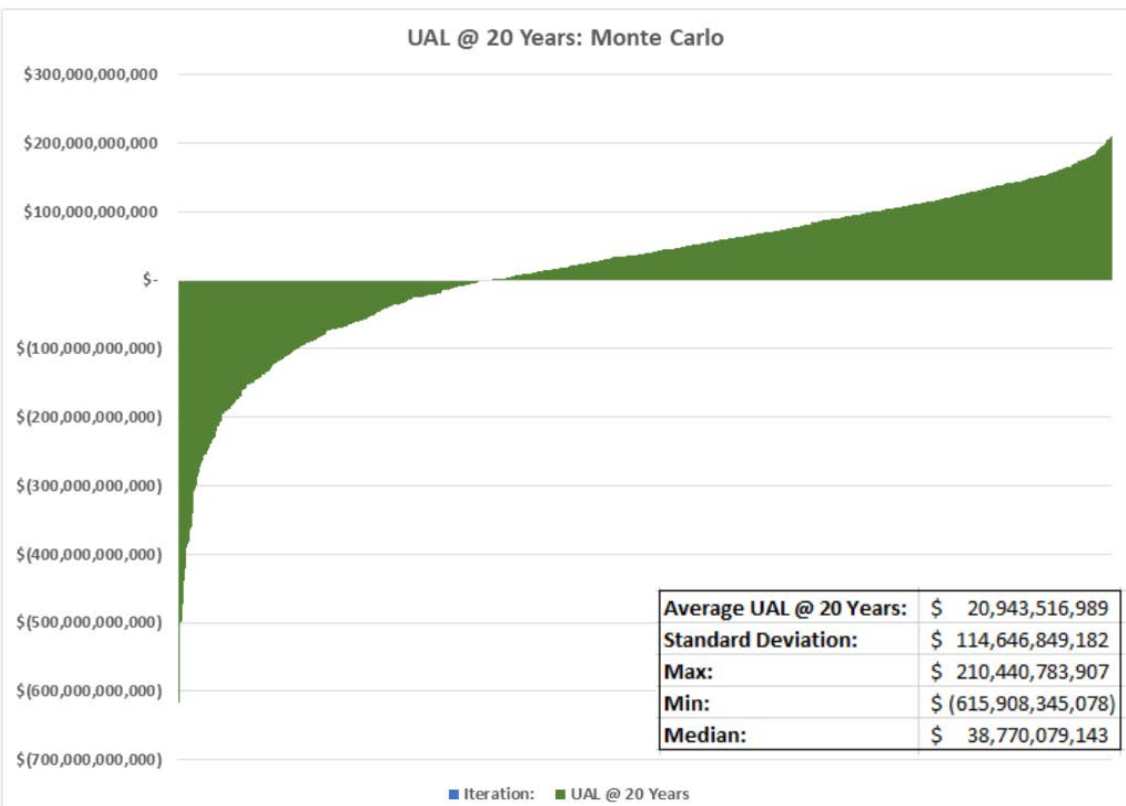
B: Sensitivity Analysis of Changing Contribution Rates

		OPSRP Contribution Rates				
		1%	6%	11%	16%	21%
	20%	19	18	17	15	14
Tier 1&2 Contribution Rates	25%	18	17	16	15	14
	30%	18	17	16	14	13
	35%	17	16	15	14	13
	40%	17	16	14	13	12

C: Monte Carlo - Years to 0 UAL



D: UAL at 20 Years



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