Choose your pension: an analysis of the interaction between pension rules and overtime work by employees of the City of Philadelphia

Abstract

Underfunding of state and local pension plans in the US is a serious problem, amounting to more than $3 trillion. City of Philadelphia plans alone may be underfunded by as much as $15bn. We show that pension rules (which include overtime and other payments in the definition of salary used to determine pensions), give city workers a strong incentive to allocate overtime to senior workers within work teams. We illustrate the nature of the incentive and use individual-level payroll and pension data from the city to show that, indeed, overtime appears to be performed systematically by workers who have the highest pension costs within their work teams. We estimate that this may have added around $1.5bn to the city's pension liabilities. We show that this behavior appears to be consistent with an implicit contract between workers and the city, rather than arising endogenously within work teams. This paper is the first of which we are aware has examined the importance of the interaction between pension rules and workplace practices as a driver of pension cost, and illustrates the importance of integrating pension rules and workplace practices as part of overall financial planning in respect of pensions.

1. Introduction

Although recent estimates are not available[1], few analysts dispute that pension fund deficits in state and local pension plans are a pressing problem. Contributions to pension plans have rsien dramatically, placing municipal and state financing under strain. Most of these increases are in respect of deficits arising from obligations to employees in respect of past service, meaning that states and cities are having to raise current taxes, or reduce current service levels to their residents, to make good obligations incurred to pay for services received many years ago. Underfunded pensions have led to the outright default of at least one large US city (Detroit), and threaten the viability of several states (Illinois in particular) and cities (Los Angeles). Resolving this issue requires a comprehensive understanding of the factors that have led to it. Several causes have already been examined in the academic literature: insufficient contributions relative to benefits in past years (Elliot, 2010), accounting standards that allow cities and states to take advance credit for investment returns not yet earned (Novy-Marx and Rauh, 2010), governance problems in states and cities in the US related to political connections between political parties and public-sector trade unions (Anzia and Moe, 2014), and moral hazard problems associated with public finance more generally where one aspect of compensation (pensions) is opaque and not easily understood by voters (Glaeser and Ponzetto, 2014).

This paper develops a theory that provides another explanation, and tests the theory using payroll and pension data from the city of Philadelphia. It shows that pension rules with certain features that are common in state and local pension plans provide workers with a strong incentive to allocate overtime work to those workers within workgroups whose pensions increase the most (usually older workers with the longest service records), despite the fact that from the employer's point of view, value would be maximised by preferentially using workers furthest from retirement to work overtime. We show that in Philadelphia, overtime is indeed more likely to be done by employees who cost more, largely because of pensions, and that this practice has increased the compensation costs (including wages and the present value of future pension benefit costs in respect of those wages) of the city by $1.5bn between 2007 and 2017.

[1] The value placed on pension underfunding depends, *inter alia*, on the discount rate used (Brown et al) and the method used to apportion pension costs between past and future service (Novy-Marx and Rauh, 2009, 2010). Using a discount rate that reflects the risk of the liabilities (rather than the risk of the assets used to back them), and the same apportionment method as used in private-sector plans (the Projected Unit Credit method) indicates that deficits were around $3trn in 2008 (Novy-Marx and Rauh, 2009, 2010). An options-based approach that measures the extent of the risk taken on by the funding agency reaches a similar conclusion (Biggs, 2010). Other measures are summarized by Elliot (2010).

We suggest that this allocation of overtime – and the pension rules that allow workers to take credit for overtime when drawing a pension – together represent an implicit contract, and test two possible hypotheses regarding its origin. The first treats pension rules as exogenous, and argues that these rules have given rise to an implicit contract *within* groups of workers, who have an incentive to allocate overtime between themselves in ways that maximise pension benefits to the group. These work arrangements survive precisely because workers who give up opportunities for extra work when young expect to be rewarded with extra work opportunities when they, in turn, approach retirement. An alternative hypothesis is that the pension rules are endogenous, and that, in combination with the work rule, they represent an implicit contract between the employer and the workers. Here, informational problems of the type examined by Glaeser and Ponzetto (2014) allow cities to mask very generous pension promises to workers by choosing a seemingly 'respectable' pension plan design, but, by incorporating overtime in the measure of earnings used to determine pension benefits, and then stacking overtime systematically among senior workers, provide pension benefits that in practice are significantly more generous. We use a pension change in 2010, and variation in the proportion of workers subject to the new pension rules across workgroups to test the two hypotheses.

Work on implicit contracts in labour markets that are related to pensions (see, for example, Lazear, 1979, Bulow, 1982; Ippolito, 1985,) has focused on the implicit promise of the firm to maintain the pension plan over the long-term as a way of explaining why workers do not appear to demand offsetting changes in wages in response to – often highly significant – changes in the annual value of pension accruals. This work is not generally relevant for public entities, where constitutional and other provisions often constrain the ability of the employer to change existing plan designs (Brown et al, 2011). No papers that we have been able to find document implicit contracts of the type we propose here.

There is a large literature on the effect of pension incentives on retirement age (that is, on work incentives at the extensive margin). Fields and Mitchell (1984) examine how structures of earnings, Social Security, and pension benefits affect retirement behavior. They find that people with higher base wealth retire earlier and that those who expect to gain more by postponing retirement retire later. Gustman, Mitchell and Steinmeier (1994) show that workers in private-sector DB plans appear to be very responsive to plan rules when deciding to retire, a finding that has been widely replicated in studies of the relationship between public pensions and

retirement ages (see, for example Gruber and Wise (1999)). Coile and Gruber (2007) examine how Social Security incentives affect retirement behavior by implementing a forward-looking "peak value" (PV) measure that captures the financial gain from working to the future retirement date that maximizes the expected net present discounted value (PDV) of Social Security Wealth (SSW). However, we have been unable to find work that examines the effect of pension incentives on work at the intensive margin (that is, how much to work at each age, before deciding to leave the labor market permanently).

The closest paper to this one that we have been able to find is Fitzpatrick (2014). She examines how pension incentives influence the setting of teacher pay by school districts in Illinois. In her example, school districts have autonomy on pay-setting, but pension costs are shared across the state through a centralised plan. She shows that changes in pension rules limiting pay increases at the end of working careers changed how school districts set pay, but that, as a cost-saving measure, the rule change was ineffective because school districts gave the same overall pay increases to workers at the end of their careers, but spread these increases out over more years to comply with the new rules. Our work demonstrates the existence of a similar problem, but *within a single employer* (the city). Free-riding by unrelated employers who share pension costs cannot therefore explain the phenomenon.

This paper proceeds as follows. We first use a stylised model to show how pension rules and allocation of work within groups can affect pension costs. We then examine the pension fund rules of the city of Philadelphia, and explain our approach for measuring the compensation of workers for overtime, including the change in lifetime pension costs. We show that there are highly significant variations in the total cost of employment across workers, even at the same level and pay, largely caused by pension costs. The next section summarizes the pension fund and payroll data we have obtained from the city. After that, we describe our empirical strategy for testing whether these implicit contracts exist, and apply these tests to the data. A final section is a conclusion.

2. Theory and application to pension plans in Philadelphia

Our basic theoretical framework is an open group of workers tasked with performing particular duties for an employer. An example of such a functional group might be a group of call center workers with the responsibility to answer a particular telephone number, or a group of workers

responsible for cleaning or maintaining a particular building (e.g. washing the windows of Philadelphia Airport). Within this group, two conditions are necessary. First, there must be some extra work (which we call overtime) which allows workers to earn income over and above their regular salaries. Second, there must be differential compensation that workers receive in respect of overtime work that are related to their seniority. In our analysis, these differentials are provided largely by pension rules that include overtime pay in the definition of pensionable salary used to determine defined benefit (DB) pension benefits, but there could be other origins (such as seniority pay systems). Such rules are common in DB pension plans, and have the consequence that workers with long service records, or those near retirement, receive much greater compensation for a given hour of overtime work than newly-appointed or younger workers. We will show in a later section that, for Philadelphia city workers, compensation for the same work can vary by a factor of 5 across different members of the same work team, largely because of pension rules.

To abstract from unnecessary details, we propose an overlapping generations model of a functional work group with $2N$ members. Each member works for two periods: when they are young and when they are older. They spend one further period retired. There is no attrition and no mortality, so N of the workers are young, N are older and N retired. There is a constant flow of M period-equivalents of overtime work per period. We assume in this stylised example that all workers receive the same rate of pay per period worked, including overtime, W, but that income in the retired period is provided by a DB-type plan that provides a payment equal to a fraction α of total compensation during the second working period (α is called the accrual rate of the plan). For simplicity, we assume that W is constant. The flow of M overtime hours each period must be divided between the $2N$ working members of the group. Workers face no credit constraints and interest rates for borrowing and lending are assumed to be zero. Their lifetime utility thus depends on their lifetime income, not on how the income is allocated across periods.

If all M period-equivalents of overtime are always allocated to the younger employees, the aggregate pension amount paid will be αNW. Total compensation costs in each period are then $(2N+M+\alpha N)\,W$, and the lifetime income of each worker will be $(2+M/N+\alpha)\,W$. On the other hand, if all M period-equivalents of overtime are allocated to the older employees, the aggregate pension amount paid in time t will be $\alpha(N+M)\,W$. This is exactly equivalent to a pension scheme that does not pay pension benefits on overtime work, but which has a (higher) accrual

rate of $\alpha(1+M/N)$. Total compensation costs have now risen to $(2N+M+\alpha(N+M))\,W$, and the lifetime income of each worker is $(2+M/N+\alpha(1+M/N))\,W$. If the pension scheme used average compensation rather than final compensation to determine the pension, workers would be indifferent to the allocation of overtime across their working lives. The definition of final salary used to determine pension benefits thus drives worker – and employer – preferences for how overtime is allocated across working life.

Note that in order to project the financial development of this scheme correctly, actuaries need to allow for both wage progression (the change in W) *and* the effect of work practices regarding the allocation of overtime. If the actuary uses the fact that the enterprise's total wage bill (including overtime) is constant to infer that individual worker's wages are also constant, the normal cost of the scheme benefits will be understated and persistent deficits will arise. Rather, the actuary should use the *actual* progression of individual pensionable wages, taking account of changing work patterns over the life course.

The above example illustrates that individual workers enjoy higher lifetime income if overtime is allocated to periods when wages are used to determine pension benefits. Provided younger workers have faith that this arrangement will be maintained, and in the absence of credit constraints, they therefore have an incentive to postpone overtime work until they are old. If, however, they believe that the arrangement will break down, perhaps because pension rules have changed, or because employer practices might change, then they have an incentive to try and do overtime when they are young.

The employer, on the other hand, reduces overall compensation costs, including pension costs, by allocating all overtime to employees when they are young.

In practice, factors such as impatience, myopia, and credit constraints will influence the worker's preferences regarding the allocation of overtime across their lives. Further, worker views about the likely durability of current pension arrangements will play a role. Although typically the city of Philadelphia does not change pension arrangements for existing employees (all changes are applied to new employees), worker preferences about the allocation of overtime when they are young will be affected by the extent to which they feel future young worerks may be unwilling to continue with the arrangement. Changes in the pension rules affecting young workers that reduce the attractiveness of overtime work may therefore cause the arrangement to

break down. This provides us with testable hypotheses regarding the origin of work practices that preferentially allocate overtime to senior employees.

Description and analysis of pension rules

The City of Philadelphia has several pension plans, described in detail in the Appendix. The plans that concern us here are called the '1967', '1987', '2010' and '2016' plans, referring to the years in which these plans were first created. Rules were obtained from plan summaries (Philadelphia, 2017b) and the Philadelphia City Code (Philadelphia, 2017c).

The '1967' and '1987' plans are very similar. Both plans are divided into various sections for different categories of workers. The 1967 plan has 3 sections. The first is for all police uniformed and investigatory employees, the second is for all fire employees, and the third is for other municipal and judicial employees, as well as employees of the Sheriff's office and Register of Wills. Plans have a 10-year vesting rule. We use the 1967 plan section for municipal workers to illustrate our approach, and relegate the analysis of the other plans to the Appendix. The most important plan feature relevant to this paper is the definition of salary used to determine pension benefits. The plan section for municipal workers includes overtime in this definition; the plan sections for the other workers do not. The accrual rate for the plan is 2.5% for each year of service up to 20 years, and 2% for any longer service, and the vesting period is 10 years. The pension cannot exceed 80% of average compensation (so only 35 years of service are used for the calculation). The annual pension after retirement for municipal workers is therefore calculated as:

$$P_i = \alpha(N_i) S_i ,$$

where P_i is the annual pension benefit of the i'th worker after they have retired, $\alpha(N_i) = \min(0.025 \times \min(N_i, 20) + 0.02 \times \max(N_i - 20, 0), 0.8)$ if $N_i > 10$ and $\alpha(N_i) = 0$ otherwise, N_i is the number of years of pensionable service the worker has completed on the day they retire, S_i is the worker's final salary on the day they retire, calculated as the average of the three highest years earnings, including overtime pay.

There are various possible measures of the pension cost of each employee. We focus on three. The first is the present value of the change in the lifetime income of the employee, including

pension benefits, taking account of the employee's past and expected future service, past and expected future wage progression, and expected retirement behavior. The first component of the change in the lifetime income of the employee is the actual wage earned. The second is the additional pension benefit, which will be 0 if the current year's earnings are not one of the employee's three lifetime highest. If the current year's earnings are one of the three highest, the lifetime pension benefit will increase by the wage earned multiplied by an annuity factor, multiplied by the total accrual rate of the employee at the date they retire.[2] The total benefit to an employee of an additional hour of overtime at time t can therefore be calculated as:

$$B^1_{i,t} = W_{i,t}(1 + E_t[(1+d)^{t-r} a_{i,r} I_{i,1,r}(t) \alpha(N_{i,r})]) \quad (1)$$

where $W_{i,t}$ is their hourly wage rate at time t, when they earn the overtime, $a_{i,r}$ is a random variable representing the present value of annuity payments to individual i, starting at their retirement date r,[3] d is an annual discount rate, $N_{i,r}$ is the number of years of service the individual will have at retirement, $I_{i,1,r}(t)$ is a random variable representing the fraction of the salary of year t that is used to calculate the pension benefit at retirement date r (if, at retirement, year t is one of the highest three year's earnings, and $t<r$, then $I_{1,r}(t)=1/3$ else it is 0). The first term in brackets represents the wage the employee receives from working the overtime and the second term represents the expected discounted present value of the lifetime increase in the employee's pension that they will receive as a result of working the overtime. The expectation is joint over random variables r, N, and $I_{1,r}$, and conditional on all information known to the employee up to that point.[4]

Insert Figure 1 near here

Figure 1 shows a stylized graph of the value of $B_{i,t} / W_{i,t}$ as a function of the number of overtime hours a particular employee works in a given year $t<r$. For overtime work where the amount of

2 Note that this definition is very different from the additional past service liability that will accrue to the pension plan, which takes account only of service and earnings progression up to this date.
3 We are awaiting a data download from the City of Philadelphia which includes the age of the employee. This will allow us to more accurately represent the prospective cost of the pension by incororpating a conditional estimate of the retirement age based on current age and length of service, and the discount factor between the date of retirement and the present.

overtime is not sufficient to ensure that this year's wage will enter into the pension calculation, this value is 1 (overtime hours < A). As the number of overtime hours increases, this value starts to increase. At some point, the probability that this year's salary enters into the final calculation is very high, and the marginal cost levels off (overtime > B). A depends on the past earnings and overtime history of each worker, and the distance between point A and point B depends on how close the individual is to retirement and how their wages are likely to evolve. The more complete the earnings record of the employee – that is, the nearer they are to retirement – the smaller the distance between A and B.

As can be seen in Figure 1, the degree of variation across employees in the total benefit of working and hour of overtime is very large. For a young employee, the current year's income will likely not enter into their pension calculation, meaning that the only benefit to them of overtime is the salary they receive. At the other extreme, a female employee aged 55 with 35 years service who is just about to retire, and who earns one of the three highest salaries of her career in that year (as a result of overtime or otherwise), $\alpha(N_i)=0.8$, $t=r$ and a_r is about 17 (valued using mortality assumptions appropriate for the plan taken from the actuarial report (City of Philadelphia, 2017a) and a Treasury discount yield, see Brown et al (2011)), meaning that she will receive additional lifetime pension benefits with a present value of around 4.5 times the value of overtime wages. The cost of overtime across different workers in a functional group can therefore vary by more than a factor of 5, even assuming that salaries for all workers in the group are the same. These large differentials create significant incentives to both the city and to workers to strategically allocate overtime between different employees in order to achieve different objectives.

The second measure of pension cost is (an approximation) of an Accumulated Benefit Obligation (ABO) liability. Here, we set:

$$B^2_{i,t} = W_{i,t}(1+15I_{i,3,t}(t)\alpha(N_{i,t})), \qquad (2)$$

where 15 is an approximate annuity factor[5], $N_{i,t}$ is the individual's current service, $I_{i,3,t}(t)$ is a random variable representing the fraction of the salary of year t that is used to calculate the

5 We are awaiting a full data download from the city that includes the age of the employee. This will allow us to alter the benefit cost to reflect discounting between the likely age of retirement and the present.

pension benefit at the current date, based on the individual's current earnings history. Hence, if current earnings are one of the highest three year's earnings then $I_{i,3,t}(t)=1/3$ else it is 0. This measure more closely approximates the ABO liability associated with each individual than the liability of equation (1). It does not therefore allow for the employees expectations about how earnings will develop until they retire or elect DROP (see below), or for future service. The third measure of pension cost abstracts from the annuity value and the current age of the employee and simply looks at the tenure of each employee. We therefore set:

$$B^3_{i,t} = N_{i,t}\,. \tag{3}$$

An important benefit in both the 1967 and the 1987 plans is that employees can elect what is called a "Deferred Retirement Option Plan" or DROP once their benefits have vested (so they have accrued more than 10 years service) and have reached the normal retirement age under the plan. When an employee elects DROP, their pension benefit is calculated as of the day before they elect the option and is frozen at that level. After this date, they can continue to work for the city, and earn the same salary as before, for up to four years (more years are possible under exceptional circumstances), but their pensions are paid into a special account, which accrues with interest. When they actually leave the city payroll, the accrued value of this account is paid to them as a lump sum and they receive monthly pension payments as calculated from that point onwards. Employees who have elected DROP can still work overtime, but their pension benefits will not change as a result of any salary they receive in respect of it (or any other changes in their salary). None of the pension cost measures allow for DROP. We control for this by interacting all pension measures with DROP in regressions.

We thus have various sources of variation across employees that influence the relationship between overtime pay and pensions: individual earnings histories, likely earnings expectations, length of service, and expectations thereof, plan type (1987, 1967, and police, fire or other), whether they have elected DROP or not, their current age and their likely age of retirement.

An important sea-change in pension provision for city workers occurred with the introduction of the '2010' plan. This plan was introduced in recognition of the high fiscal burden placed on the city by the '1967' and '1987' arrangements. It allowed new employees a choice of a plan with much lower generosity (the annual accrual rate was reduced to 1.75% for uniformed and 1.25% for non-uniformed employees, and service for the purposes of calculating the pension benefit was

capped at 20 years), AND membership of a defined contribution section (with a maximum annual contribution rate of 1.5% of salary), of the '1987' pure DB plans. In our analysis, we treat the proportion of employees in each work team who elected the DC plan as a measure of the views of the employees within that group regarding the resilience of the pension system. The more workers elected the DC plan, the less likely younger workers would be to accede to arrangements that required them to sacrifice overtime to older employees, with the expectation that they would be beneficiaries of the exchange in the future. We use this measure to test whether the employees or the employer is driving the allocation of overtime within each group.[6]

3. Data

Description of payroll and pension data from the City of Philadelphia

We have received a data download of the payroll of the City of Philadelphia, obtained through a freedom of information request. The data includes, by calendar year, for each worker, name, original appointment date, full time or part time, department and job title, salary rate for that position, actual gross salary in that calendar year, including overtime (and some other items not included in basic salary), and the gross amount of overtime pay that the worker earned in that calendar year (included in actual gross salary).

Based on department and job title, we divided the data into work teams. Workers with the same job title in the same department were assumed to be part of a single work team. There were around 175 work teams (numbers differ from year to year) with more than 10 members and where the average number of overtime hours per member per year was more than 50. We allocate each worker to a pension plan based on their department, job title and the date of their appointment, as described in the pension eligibility rules listed in the appendix for each plan and plan section.[7]

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6 Until we receive the data download we are expecting from the city, we use the number of employees in each group who were *offered* the choice as an (imperfect) instrument. See footnote 7.

7 We are currently awaiting a data download from the City of Philadelphia that includes the pension plan that each active employee is a member of. At the moment, being unaware of which union represents each employee, we allocate each employee to a plan based on their original hiring date. For those hired under the '2010' regime, there is a further complication: many of these employees (but not all) can elect to join the '2010' plan or choose the appropriate section of the '1987' plan, provided they make the election within 30 days of joining the city. The new data download will resolve these issues.

Insert Table 1 near here

A separate data download was obtained from the pension system of Philadelphia, also through a freedom of information request. This data set includes name, the pension plan and plan section the worker is a member of, the worker's birth year, the date at which the worker started to receive pension benefits from the plan (DROP members only receive benefits once they have actually ceased working, not on the date they elect to participate in DROP), the number of years service that was credited to their account (used to calculate pension entitlements), the monthly gross pension the worker receives, the value of the DROP account for that worker on the day they started to receive benefits (if the worker retired without electing DROP, this value is 0), and the benefit type (benefit types include normal retirement, retirement after having elected DROP, separation (those who left the City's employ but did not retire from the plan immediately) and optional early retirement)

Summary data is shown in Table 2.

Insert Table 2 near here

A third data download contained the names, dates they entered the DROP program, and their calculated pensions for workers who entered the DROP program but who were still on the city payroll at the time of the download.

Data verification process

To check the data, we merged the three datasets using name. We first deleted all individuals where the date the pension was first collected (which may differ from the retirement date for individuals who exercised the DROP option) was inconsistent with the payroll data (most often, individuals retired before the start of our payroll data in 2007). Second, we deleted all individuals with names that were duplicated. Third, we deleted all records that did not include a job title or department name. Fourth, we deleted all part-time workers, and all observations where payroll data indicated that pay was zero in that year. Using this merged data set, we calculated the pension entitlements of workers using the pension rules, and the different data items, and compared these with the pension entitlements in the pension database. Calculations were not always exact for various reasons. First, pension rules calculate the pension based on

the three highest earnings years (which could be calendar years or anniversary years). As we only have calendar year data, if the pension entitlement measured using anniversary years is higher, our calculation will be slightly wrong. Second, we only have ten years of payroll data. If the highest three years occur before this date, then our calculation will be wrong. Third, at retirement, workers can elect one of three options to take their pensions. If they elect a joint-and-survivor pension (where their surviving spouse or life partner continues to receive a pension payment after the retired worker has died) their pension will be reduced by a factor reflecting the value of the benefit to their spouse. The reduction depends on the age and sex of the member and their spouse, which are not observable to us. Some workers may have pension payments that are reduced due to divorces, separations or court orders arising from other circumstances. Finally, some workers have intermittent employment with the city, may have purchased service, or have other complicated issues that our simple analysis is not able to account for.

Despite these problems, we were able to replicate the pension calculations of a substantial number of workers within a reasonable error tolerance. We hope to improve the accuracy of the results when we receive the new data download. The results of this exercise are shown in Table 3.

Insert Table 3 near here.

4. Methods

We first calculate (roughly) the number of overtime hours worked by each worker i in each year t as follows:

$$, \; P_{i,t} = O_{i,t} / Y_{i,t} \times 48 \times 40 \qquad (4)$$

where $Y_{i,t}$ be their base salary that year (excluding overtime), and $O_{i,t}$ be their overtime pay in that year. 48x40 is roughly the number of hours in a working.

We then calculate the average of $P_{i,t}$ across work groups in each year and calculated the overtime of each worker relative to this average as:

$$P^*_{i,t} = \frac{P_{i,t} \sum_{\text{all } j \text{ s.t. } G(j,t)=G(i,t)} 1}{\sum_{\text{all } j \text{ s.t. } G(j,t)=G(i,t)} P_{i,t}}, \quad (5)$$

where $G(i,t)$ is a function identifying the workgroup to which worker i belonged in year t. If worker i worked the average amount of overtime as all workers in the group, $P^*_{i,t} = 1$.

The relationship between hourly overtime cost and doing overtime for individuals

We first performed individual-level regressions to test whether pension variables affect the relative amount of overtime worked by an individual in his or her group. As shown in the introduction, if workers have not yet selected the DROP retirement option, overtime has the potential to increase their pension permanently (as well as their take-home pay, but only for the current year). We therefore test whether there is any difference between the amount of overtime worked by workers depending on their DROP status, their pension plan and their tenure. We only focus on workers in teams with more than 10 members and where the average amount of overtime per group member was more than 50 hours in that year.

We therefore perform the following regressions:

$$P^*_{i,t} = \beta X_{i,t} + \alpha D_{i,t} + \gamma S_{i,t} + \delta B^k_{i,t} + \xi D_{i,t} \times B^k_{i,t} + controls + \varepsilon_{i,t} \quad (6)$$

where $D_{i,t}$ is an indicator variable that takes the value of 1 if the worker had selected DROP at any time before that year, and 0 otherwise, $X_{i,t}$ is a vector of control variables, including salary, length of service, $S_{i,t}$ is a set of indicator variables for pension plan type. We perform different regressions for different measures of pension cost $B^k_{i,t}$. We interact DROP status and pension cost measures to allow for the possibility that DROP causes the relationship between overtime and pension cost to break down.

The null hypothesis is that DROP does not affect the relationship between tenure and overtime work, that is:

$H1_0$: $\alpha = 0$

A second null hypothesis is that pension cost is independent of years of service and overtime are independent, that is that:

$$H2_0: \quad \delta = 0$$

We perform separate regressions for uniformed and non-uniformed employees.

Group characteristics and the allocation of overtime within groups

Our next test examines how team characteristics affect the allocation of overtime to workers *within* a particular work team. The idea here is to test whether there is any systematic relationship between the extent to which pension cost affects the allocation of overtime within a particualr group and the characteristics of the group itself. All else being equal, it would be cheaper for the city to allocate overtime to workers with the cheapest cost of employment, including the effect of overtime on pensions. On the other hand, as discussed in the introduction, implicit contracts (either within groups of workers, or between workers and their employer) may regulate the allocation of overtime systematically to workers who benefit the most, including the effect of overtime on pension payments. These regressions therefore allow us to test hypotheses regarding these implicit contracts.

We use the number of overtime hours worked by each worker in each year calculated in the previous section $P_{i,t} = O_{i,t} / Y_{i,t} \times 48 \times 40$. We then sort workers within each group by each measure of pension cost $B_{i,t}^{k} \times DROP$ (including DROP allows for the fact that workers that have elected DROP no longer earn pensions on any overtime they might work in the current year). We denote sorted variables with brackets in the subscript, so $P_{(i),t,j,k}$ is the number of hours of overtime worked by the worker with the i'th smallest per-hour cost of overtime in year t in worker group j using the k'th measure of pension cost. Under the assumption that pension cost has no influence on overtime allocation, overtime should be uniformly distributed across these workers. We therefore calculate a variant of the Kolmogorov-Smirnoff test statistic by comparing the empirical CDF of the allocation of overtime hours across each group of workers with the uniform distribution. The different measures of overtime cost serve as a robustness check.

We calculate two test statistics: the first the maximum distance that the empirical CDF lies above the uniform CDF, and the second is the maximum distance that the empirical CDF lies below the uniform CDF. We assign a negative sign to the former and a positive sign to the latter, and define them as:

$$T_{t,j,k}^{\max} = \sup_i \frac{i}{n} - \frac{\sum_{k=1}^{i} P_{(i),t,j,k}}{\sum_{j=1}^{n} P_{(i),t,j,k}} \text{ and } T_{t,j,k}^{\min} = \inf_i \frac{i}{n} - \frac{\sum_{k=1}^{i} P_{(i),t,j,k}}{\sum_{j=1}^{n} P_{(i),t,j,k}}. \quad (7)$$

The first term in each definition is the CDF of a uniform distribution, while the second term is the empirical CDF of the number of hours of overtime performed by workers, sorted by each measure of pension costs. Under the null hypothesis that pension cost and overtime allocation within the group are unrelated, $T_{i,j,k} = \max(|T_{t,j,k}^{\max}|, |T_{t,j,k}^{\min}|)$ will have a Kolmogorov distribution (percentiles of which can be derived from standard packages). Further, $T_{i,j,k}$ is as likely to correspond to a point above the uniform line as it is to a point below it. Applying this procedure to each workgroup, we have a measure of how the allocation of overtime is related to the allocation of pension costs, which allows hypotheses about the role played by pensions in the allocation of overtime to be tested.

Insert Figures 2 to 5 near here

To illustrate how the test statistic is calculated, we have included some figures of the allocation of overtime within some large work groups in figures 2 to 5. In each figure, the proportion of workers, ranked by our second measure of total overtime cost, $B_{i,t,j}^2$, is shown on the horizontal axis, and the proportion of overtime worked is shown on the vertical. These figures are called Lorenz curves. If there is no relationship between the two variables, the Lorenz curve should lie very close to the straight line, and the test statistic should be equally likely to be negative (above the line) or positive (below it). As can be seen in the figures, the curves almost always lie below the line, indicating that a greater share of overtime is done by workers with higher pension costs than workers with lower pension costs. This pattern seems to be worsening over time in all of the work groups shown.

To test hypotheses regarding the relationship between pension variables and the allocation of overtime in each workteam, we perform second-stage regressions of $T^{\max}_{t,j,k} + T^{\min}_{t,j,k}$ on various group characteristics, including group size, the proportion of the group offered the '2010' plan, the department in which the group is, the average salary, the amount of overtime and other variables.

We hypothesise that if *workers* are arranging overtime systematically between themselves without the involvement of the employer, the proportion of workers in each team that are offered the '2010' plan should be negatively related to the test statistic $T^{\max}_{t,j,k} + T^{\min}_{t,j,k}$. This is because as the proportion of workers offered the '2010' scheme rises, the implicit contract between workers should break down as workers lose confidence in the sustainability of the city's pension arrangements. As their numbers rise, the pressure on the group as a whole to abandon the use of pension costs in overtime allocation should rise.

$H2A_0$: Workers are arranging the allocation of overtime in an implicit contract with each other.

On the other hand, if the implicit contract is between employers and workers, then there will be no relationship between the proportion of workers in each team who are offered the '2010' plan and the allocation of overtime within the group: employers will honor the implicit contract to existing workers, and have set up a separate deal with newer workers.

$H2B_0$: The implicit contract regarding the allocation of overtime is between employers and workers.

If there is a *positive* relationship between the proportion of workers who are offered the '2010' plan and the sensitivity of overtime allocation to pension cost measures, then this is suggestive of an implicit contract between workers and the city that is attempting to correct for the reduction in pension plan generosity by increasing the skewness of overtime generosity between workers.

5. Results

We first discuss the results of the individual regression, equation (6), shown in Tables 4A (the measure of pension cost $B^2_{i,t}$) and 4B (the measure of pension cost $B^3_{i,t}$). In each table, results

for non-uniformed workers are shown on the left, and results for uniformed workers are shown on the right.

We focus on results in Table 4A. For both uniformed and non-uniformed workers, the intercept is near 1, which is what we could expect given the response variable: the average worker works about the average amount of overtime. But for both uniformed and non-uniformed workers, the coefficients on DROP are significantly negative. Non-uniformed workers who have elected DROP reduce their overtime by on average 24.9% of the average amount of overtime done by workers in their workgroups. For uniformed workers, the effect is much stronger at 65%. This provides strong evidence that workers are, in fact, taking account of pension incentives when deciding how to allocate overtime.

Tenure is significantly positive for both uniformed and non-uniformed workers. A uniformed worker with 25 years tenure is expected to do 25% of the workgroup average overtime more than a worker who has just been hired. For non-uniformed workers, the effect is about one-third as large, but still statistically significant. Relative earnings are also significantly positive: those workers with higher relative earnings in a workgroup do much more overtime.

For non-uniformed workers, pension plan does not appear to significantly affect the choice of overtime, after controlling for salary, DROP status and tenure. Those offered the choice of joining plan '2010' do slightly less overtime than those in the '1967' plan (the omitted category), and those in plan '1987' (plan Y) slightly more, but neither coefficient is significant. The effects for uniformed workers are much greater. The omitted category is the '2010' plan. Firemen and women in plan '1967' (plan X) and plan '1987' (plan A) appear to do much less overtime than those who were offered membership of plan '2010'. Police in plan '1967' (plan D) do slightly less overtime than and those in plan '1987' do slightly more, but the effects are smaller.

Results in Table 4B are similar for non-uniformed workers, but for uniformed workers, they are quite different to the results in Table 4A. Disappointingly, DROP is now no longer significant (although DROP x COST is). Pension plan variables are still significant, which is also not what we would have expected. Part of the explanation may be the uncertainty about precisely how overtime affects pension costs, discussed in the appendix. We leave this point to further investigation.

We now turn to the group-level regressions. Table 5 shows the largest 15 work teams. In every case, the magnitude of the mean across years of $T^{\max}_{t,j,k}$ is larger than the magnitude of the mean across years of $T^{\min}_{t,j,k}$. Table 6 shows summary statistics of the test statistics of the values of $T^{\max}_{t,j,k}$ and $T^{\min}_{t,j,k}$, calculated using measure of pension cost (1-DROP) x $B^3_{i,t}$. The absolute values of $T^{\max}_{t,j,k}$ are greater than the absolute values of $T^{\min}_{t,j,k}$ in around 80% of cases, with an increasing trend from year to year. The t-statistics for the test that pension cost and overtime allocation are unrelated are highly significant, meaning that there is strong evidence that more expensive workers are doing more overtime than cheaper workers.

We explore these patterns across all large workteams in the regression reported in Table 7. This regression is again calculated ranking individuals within each workgroup by (1-DROP) x $B^3_{i,t}$. Variables are as would have been expected. The higher the variation in salary or cost within a group, the greater $T^{\max}_{t,j,k} + T^{\min}_{t,j,k}$. The size of the group has no effect. Importantly, however, the proportion of members offered the option of joining the '2010' plan has no effect on how overtime is allocated within groups for non-uniformed workers, and a *positive* effect for uniformed workers. Results when pension cost is allocated using (1-DROP) x $B^2_{i,t}$ are very similar and hence not reported. The evidence is thus in favor of the allocation of overtime being an implicit contract between workers and the employer, rather than being something driven within groups of workers.

We calculate a rough estimate of how much this has cost the city by running the following thought experiment. What would the effect on pension costs be if overtime were allocated uniformly across employee workgroups, rather than weighted to higher-cost individuals, as it is currently? Specifically, the pension cost if overtime is allocated strategically is calculated as:

$$C^S_{2007-2017} = \sum_{i,t} \left(B^2_{i,t} \times P_{i,t} \right).$$

On the other hand, the pension cost if overtime is allocated uniformly is calculated as:

$$C^U_{2007-2017} = \sum_{i,t} \left(B^2_{i,t} \times \frac{\sum_{\text{all } j \text{ s.t. } G(j,t)=G(i,t)} P_{i,t}}{\sum_{\text{all } j \text{ s.t. } G(j,t)=G(i,t)} 1} \right)$$, where $\frac{\sum_{\text{all } j \text{ s.t. } G(j,t)=G(i,t)} P_{i,t}}{\sum_{\text{all } j \text{ s.t. } G(j,t)=G(i,t)} 1}$ is the average overtime hours of the group in which individual i works and $B^2_{i,t}$ is the hourly overtime cost to pension as defined

before. We find that $C^{S}_{2007-2017} \approx$ \$3.26bn and $C^{U}_{2007-2017} \approx$ \$3.03bn using our available individuals. This implies that the strategic allocation has increased the total pension cost for the city 7.6%. Applying this increase to the total pension liability of \$20bn results in around a \$1.52bn increase. While this approximation can be refined further, it provides a quantification of the likely costs to the city – and the additional pensions earned by city workers – as a result of the allocation of overtime work.

6. Conclusion

In this paper, we have analysed the incentives provided by pension plan rules in the city of Philadelphia and examined how workers respond to them. There are two aspects of the pension rules that are important. First, some types of compensation are pensionable, which means that workers earning the same salary can increase the lifetime present value of their pension benefits by up to 5 times the value of the wages they earn by doing overtime. Second, workers can freeze their pension benefits, but elect to continue working for the city.

We have shown that workers in Philadelphia appear to respond to the incentives provided by their pension plans when they allocate overtime among themselves. First, workers who have elected deferred retirement (that is, to freeze their pension benefits, but remain on the payroll of the city) work much less overtime after this point than they did before. The magnitude of the effect differs across worker type. For municipal employees, the effect is around 25% of the average overtime worked by workers with those particular characteristics; for uniformed employees (policy and fire) the effect appears to be much larger. Second, within work teams, overtime appears to be systematically allocated to workers that have more expensive overtime (largely due to pensions). Third, tests using the proportion of workers who have been offered the option of joining a hybrid DB-DC pension plan introduced in 2010 as an instrument for the confidence workers have in the sustainability of the city's pension arrangements indicate that there is either no effect on how workers distribute work across the group (non-uniformed workers) or a large positive effect (worker groups with less confidence about the sustainability of city pensions appear to allocate a greater share of overtime to more expensive workers). This suggests that the allocation of overtime is not arising from within worker groups, but rather forms part of an implicit contract between workers and the city. One interpretation of this conclusion is that reductions in pension generosity are being compensated for by an increased

allocation of overtime in ways that systematically compensate workers for cuts in pension amounts.

This research has several important implications. First, it is the first paper of which we are aware that demonstrates that workers respond to pension incentives by working more at the intensive margin. Most research up to this point has examined pension and other incentives on labor supply at the extensive margin (that is, the incentive to retire completely from the labor force). Second, it is the first paper of which we are aware that examines the interaction between pension rules and workplace practices and explores the implications for pension finances. Although exact quantification is difficult, we estimate that had the city implemented a rule that allocates overtime evenly across employees within work groups, pension costs would have been reduced by around 8%. This suggests that unwritten rules within workplaces may be an important factor driving the emergence of pension deficits in state and local authorities across the US. As funding problems become more severe, reducing pension costs may require that these workplace rules be examined more closely.

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8. Tables and figures

TABLE 1: Summary statistics for payroll data

Year	Mean (Base salary)	Mean (Overtime)	Mean (Overtime proportion)	Mean (Years of service)	Number of workers	Members of pension plan								Total number of work teams	Number of big work teams
						A	B	X	D	Y	J	10U	10N		
2007	$47,155	$6,557	0.141	12.19	22,623	1,414	4,710	477	1,013	9,768	4,809	0	0	2,400	162
2008	$48,751	$6,819	0.141	12.29	24,179	1,475	5,068	467	1,007	10,911	4,787	0	0	2,531	167
2009	$51,965	$5,725	0.114	13.00	24,484	1,483	5,053	459	996	11,293	4,743	0	0	2,553	150
2010	$50,840	$5,638	0.115	13.56	25,068	1,481	5,037	451	994	11,811	4,689	141	0	2,596	158
2011	$50,716	$5,807	0.119	13.91	25,370	1,468	5,004	425	955	12,303	4,464	261	0	2,613	164
2012	$52,590	$6,708	0.131	14.65	24,371	1,444	4,912	392	896	11,869	4,114	259	2	2,541	161
2013	$49,039	$6,110	0.118	13.12	28,137	1,458	4,821	366	832	15,521	3,760	804	40	2,674	167
2014	$50,189	$6,635	0.126	12.95	28,011	1,391	4,686	244	694	14,853	3,327	966	1,323	2,658	181
2015	$51,879	$7,205	0.129	12.66	28,626	1,396	4,574	199	607	13,766	2,907	1,471	3,149	2,693	200
2016	$51,708	$7,058	0.123	12.42	29,038	1,362	4,456	148	506	13,079	2,484	1,778	4,661	2,737	190
2017	$53,828	$7,075	0.120	12.41	29,162	1,339	4,323	132	381	12,251	2,238	2,173	5,791	2,736	202

NOTE: Work teams are groups of workers in the same department (e.g. Police, Fire, Streets, Water etc) with the same job title (e.g. Police Officer 1, 3-1-1 Call Center Agent etc). Big work teams are defined as teams with more than 10 members where each member performs an average of at least 50 hours of overtime per year in that calendar year.

TABLE 2: Summary statistics for pensioner data (2018)

PLAN	Dropped	Mean(Credited year)	Mean(Monthly gross pension)	Mean(Age)	Number of workers
A	0	19	$2,247	60	40
A	1	20	$2,313	64	71
B	0	20	$2,640	59	104
B	1	20	$2,372	62	212
D	0	24	$1,934	75	3,120
D	1	27	$3,401	67	1,851
J	0	23	$1,669	79	4,922
J	1	26	$2,702	71	6,047
X	0	26	$2,104	76	779
X	1	31	$3,630	70	1,077
Y	0	13	$1,082	72	893
Y	1	14	$1,240	72	1,139
A	0	19	$2,247	60	40
A	1	20	$2,313	64	71

NOTE: No-one has yet retired from plans 10U or 10N.

TABLE 3: Results of data verification process replicating pension amount from 2018 pension data with plan rules and wage information from payroll data

	Number of individuals matched	Proportion
Error less than 5%	1,196	0.214
Error between 5% and 10%	814	0.145
Error between 10% and 15%	804	0.144
Error between 15% and 20%	740	0.132
Error between 20% and 25%	497	0.089
Error between 25% and 30%	447	0.080
Error greater than 30%	1,101	0.197
TOTAL	5,599	1.000

NOTE: This table reports the results of an exercise replicating the pension amount using payroll data for pensioners in 2018. Not all pensioners were in the payroll data as many retired before the payroll data started in 2007. Reasons for poor matches are listed in the text.

TABLE 4A: Individual-level regression of the overtime worked by each worker on individual pension characteristics, teams with more than 10 members and where average overtime was more than 50 hours per workers per year

	Non-uniformed workers					Uniformed workers				
	Estimate	Std. Error	t value	Pr(>|t|)		Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	0.969	0.026	37.381	0.000	***	1.088	0.023	47.384	0.000	***
ln(RELEARNING)	0.264	0.006	46.773	0.000	***	0.423	0.009	49.092	0.000	***
DROP	-0.249	0.072	-3.482	0.000	***	-0.650	0.094	-6.921	0.000	***
TENURE ($B_{i,t}^2$)	0.003	0.001	4.431	0.000	***	0.010	0.001	15.929	0.000	***
DROP#TENURE ($B_{i,t}^2$)	-0.001	0.003	-0.303	0.762		0.006	0.003	2.090	0.037	**
Plan10N	-0.040	0.026	-1.572	0.116						
PlanY	0.024	0.015	1.614	0.107						
PlanA						-0.152	0.022	-6.830	0.000	***
PlanB						0.036	0.018	2.022	0.043	**
PlanD						-0.010	0.026	-0.392	0.695	
PlanX						-0.309	0.032	-9.659	0.000	***
Year2008	-0.004	0.017	-0.243	0.808		0.006	0.016	0.365	0.715	
Year2009	-0.008	0.017	-0.456	0.648		-0.019	0.016	-1.191	0.234	
Year2010	-0.006	0.017	-0.332	0.740		-0.020	0.016	-1.275	0.202	
Year2011	-0.001	0.017	-0.055	0.956		-0.019	0.016	-1.194	0.232	
Year2012	-0.003	0.017	-0.153	0.878		-0.027	0.016	-1.687	0.092	*
Year2013	0.007	0.017	0.409	0.683		0.001	0.016	0.074	0.941	
Year2014	0.007	0.017	0.395	0.693		-0.029	0.016	-1.794	0.073	*
Year2015	0.012	0.017	0.715	0.475		-0.016	0.016	-0.950	0.342	
Year2016	0.027	0.017	1.598	0.110		-0.030	0.017	-1.816	0.069	*
Year2017	0.025	0.017	1.428	0.153		-0.043	0.017	-2.526	0.012	**
POLICE DEPARTMENT						-0.217	0.024	-9.148	0.000	***
DEPARTMENT CONTROLS	X									
Number of observations:	85,449					85,613				
Adj. R-squared:	0.029					0.042				

NOTE: The response variable is the number of overtime hours worked by each worker in each year, divided by the average number of workers worked by members of that team in that year. The omitted categories for non-uniformed workers are pension plan J, year 2007 and REVENUE DEPARTMENT. The omitted categories for uniformed workers are pension plan 10U, year 2007 and fire department. ln(RELEARNING) is defined as the natural logarithm of an individual worker's gross pay less overtime divided by the mean of gross pay less overtime for that team in that year, DROP is 1 if the worker has chosen the DROP retirement option (see text), and 0 otherwise, TENURE is the number of years since the original appointment date of the worker as recorde in the payroll, PLANxxx refers to the pension plan of which the worker is a member and YEARxxx are year fixed effects. Department controls are included for non-uniformed workers but are not significant and omitted for presentational clarity.

TABLE 4B: Individual-level regression of the overtime worked by each worker on individual pension characteristics, teams with more than 10 members and where average overtime was more than 50 hours per workers per year

	Non-uniformed workers					Uniformed workers				
	Estimate	Std. Error	t value	Pr(>|t|)		Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	0.796	0.023	33.996	0.000	***	0.982	0.023	42.983	0.000	***
ln(RELEARNING)	0.228	0.006	39.416	0.000	***	0.342	0.009	37.342	0.000	***
DROP	-0.222	0.032	-6.831	0.000	***	-0.002	0.040	-0.057	0.955	
COST ($B_{i,t}^3$)	0.004	0.000	23.768	0.000	***	0.006	0.000	29.792	0.000	***
DROP#COST ($B_{i,t}^3$)	0.000	0.000	0.257	0.797		-0.005	0.000	-12.697	0.000	***
Plan10N	0.122	0.021	5.878	0.000	***					
PlanY	0.139	0.011	12.146	0.000	***					
PlanA						-0.191	0.022	-8.871	0.000	***
PlanB						0.019	0.017	1.125	0.260	
PlanD						-0.230	0.026	-8.999	0.000	***
PlanX						-0.552	0.032	-17.349	0.000	***
Year2008	-0.013	0.017	-0.780	0.435		-0.002	0.016	-0.158	0.874	
Year2009	-0.021	0.017	-1.242	0.214		-0.055	0.016	-3.443	0.001	***
Year2010	0.006	0.017	0.334	0.738		-0.035	0.016	-2.221	0.026	**
Year2011	0.018	0.017	1.082	0.279		-0.051	0.016	-3.228	0.001	***
Year2012	0.012	0.017	0.721	0.471		-0.063	0.016	-3.944	0.000	***
Year2013	0.023	0.016	1.425	0.154		-0.066	0.016	-4.071	0.000	***
Year2014	-0.006	0.016	-0.356	0.722		-0.091	0.016	-5.527	0.000	***
Year2015	-0.010	0.016	-0.630	0.529		-0.105	0.017	-6.289	0.000	***
Year2016	-0.001	0.017	-0.083	0.934		-0.115	0.017	-6.836	0.000	***
Year2017	-0.011	0.017	-0.674	0.500		-0.150	0.017	-8.699	0.000	***
POLICE DEPARTMENT						-0.228	0.024	-9.619	0.000	***
DEPARTMENT CONTROLS	X									
Number of observations:	85,449					85,613				
Adj. R-squared:	0.029					0.042				

NOTE: The response variable is the number of overtime hours worked by each worker in each year, divided by the average number of workers worked by members of that team in that year. The omitted categories for non-uniformed workers are pension plan J, year 2007 and REVENUE DEPARTMENT. The omitted categories for uniformed workers are pension plan 10U, year 2007 and fire department. ln(RELEARNING) is defined as the natural logarithm of an individual worker's gross pay less overtime divided by the mean of gross pay less overtime for that team in that year, DROP is 1 if the worker has chosen the DROP retirement option (see text), and 0 otherwise, TENURE is the number of years since the original appointment date of the worker as recorde in the payroll, PLANxxx refers to the pension plan of which the worker is a member and YEARxxx are year fixed effects. Department controls are included for non-uniformed workers but are not significant and omitted for presentational clarity.

TABLE 5: Largest 15 work teams by number of members

Department Name	Job Title	Average test statistic T		Average OT hours	Average base salary	Average number of members/year
		Mean(max)	Mean(min)			
POLICE DEPARTMENT	POLICE OFFICER 1	0.131	0.000	249.5	$67,707	4251
PHILA. PRISONS	CORRECTIONAL OFFICER	0.109	0.000	730.1	$37,480	1628
FIRE DEPARTMENT	FIREFIGHTER	0.082	-0.003	308.6	$66,607	1218
STREETS DEPARTMENT	LABORER	0.130	-0.005	314.0	$28,055	627
DEPARTMENT OF HUMAN SERVICES	SOCIAL WORK SERVICES MANAGER 2	0.055	-0.042	265.2	$49,938	592
POLICE DEPARTMENT	POLICE SERGEANT	0.082	-0.008	231.6	$79,632	496
POLICE DEPARTMENT	DETECTIVE	0.136	-0.001	503.7	$79,107	484
FIRE DEPARTMENT	FIRE LIEUTENANT	0.058	-0.003	408.7	$80,861	259
POLICE DEPARTMENT	POLICE LIEUTENANT	0.112	-0.019	187.0	$91,045	216
FIRE DEPARTMENT	FIRE SERV PARAMEDIC	0.118	-0.009	441.7	$70,398	213
STREETS DEPARTMENT	HEAVY EQUIPMENT OPERATOR 1	0.086	-0.005	567.7	$39,432	185
AIRPORT / COMMERCE	CUSTODIAL WORKER 1	0.136	-0.004	323.5	$26,997	172
CITY SHERIFF'S DEPARTMENT	DEPUTY SHERIFF OFFICER	0.112	-0.001	515.3	$46,370	170
DEPARTMENT OF HUMAN SERVICES	SOCIAL WORK SUPERVISOR	0.113	-0.032	218.4	$62,514	164
POLICE DEPARTMENT	POLICE CORPORAL	0.091	-0.035	126.3	$76,602	155

NOTE: The test statistic reported is the average test statistic over the years included in the sample.

Table 6: Summary statistic of test statistic T (calculated using measure of pension cost $B_{i,t}^{3}$) by year & hypothesis test of the independence of overtime allocation within teams and individual pension cost

Year	Mean(max)	SD(max)	Mean(min)	SD(min)	Number of work teams	Number of abs(max)>abs(min)	Proportion	t-stat	p-value	
2007	0.150	0.118	-0.076	0.099	162	119	0.735	5.971	0.000	***
2008	0.142	0.110	-0.081	0.104	167	118	0.707	5.339	0.000	***
2009	0.141	0.118	-0.082	0.103	150	104	0.693	4.736	0.000	***
2010	0.162	0.123	-0.064	0.090	158	124	0.785	7.160	0.000	***
2011	0.168	0.111	-0.058	0.074	164	136	0.829	8.433	0.000	***
2012	0.169	0.113	-0.059	0.075	161	134	0.832	8.433	0.000	***
2013	0.180	0.120	-0.049	0.072	167	141	0.844	8.899	0.000	***
2014	0.163	0.115	-0.059	0.069	181	146	0.807	8.251	0.000	***
2015	0.164	0.120	-0.062	0.081	200	162	0.810	8.768	0.000	***
2016	0.167	0.107	-0.062	0.087	190	152	0.800	8.270	0.000	***
2017	0.169	0.111	-0.061	0.085	202	164	0.812	8.865	0.000	***

NOTE: Under the null hypothesis that the allocation of overtime between workers is independent of the pension cost of individual workers, T should be equally likely to be positive and negative and the magnitude should come from the same distribution independent of sign. The magnitudes are clearly different (with the average max greater than the average min in every year) and the proportion of teams with abs(max)>abs(min) is clearly not normally distributed with mean 0.5 and variance 1/4n, where n is the number of teams, which is what it should be under the null.

TABLE 7 Group-level regression of max(T)+min(T) on group characteristics.

	Non-uniformed workers					Uniformed workers				
	Estimate	Std. Error	t value	Pr(>|t|)		Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	0.136	0.027	5.055	0.000	***	0.045	0.060	0.748	0.455	
MEANSALARY	-0.004	0.001	-5.028	0.000	***	0.001	0.001	1.221	0.224	
MEANPENSIONCOST	-0.001	0.000	-1.308	0.191		-0.003	0.001	-2.716	0.007	***
STDSALARY	0.005	0.001	3.965	0.000	***	0.000	0.002	0.041	0.967	
STDPENSIONCOST	0.003	0.001	3.816	0.000	***	0.005	0.002	2.686	0.008	***
#MEMBERS	-0.000	0.000	-0.025	0.980		-0.000	0.000	-0.320	0.750	
PERCNTOFFERED2010	0.023	0.035	0.674	0.500		0.195	0.070	2.802	0.006	***
MEANOTHRS	-0.000	0.000	-2.130	0.033	**	-0.000	0.000	-1.444	0.151	
Year2008	-0.008	0.018	-0.471	0.638		0.024	0.041	0.593	0.554	
Year2009	-0.002	0.018	-0.135	0.893		-0.025	0.041	-0.618	0.537	
Year2010	0.023	0.018	1.286	0.198		0.039	0.042	0.921	0.358	
Year2011	0.040	0.018	2.196	0.028	**	0.058	0.042	1.383	0.169	
Year2012	0.047	0.018	2.543	0.011	**	0.010	0.042	0.238	0.813	
Year2013	0.065	0.018	3.574	0.000	***	0.016	0.044	0.355	0.723	
Year2014	0.026	0.018	1.486	0.138		0.038	0.045	0.846	0.399	
Year2015	0.035	0.018	1.948	0.052	*	-0.059	0.046	-1.297	0.196	
Year2016	0.032	0.019	1.717	0.086	*	-0.026	0.046	-0.569	0.570	
Year2017	0.040	0.019	2.086	0.037	**	-0.043	0.047	-0.918	0.360	
POLICE DEPARTMENT						0.032	0.021	1.511	0.133	
CITY CONTROLLER'S OFFICE	-0.171	0.058	-2.929	0.003	***					
COMMON PLEAS COURT	0.122	0.045	2.706	0.007	***					
DEPARTMENT OF HUMAN SERVICES	0.042	0.017	2.401	0.016	**					
DEPARTMENT OF LICENSES & INSPECTIONS	0.081	0.023	3.510	0.000	***					
DEPARTMENT OF PUBLIC HEALTH	0.050	0.020	2.574	0.010	**					
DISTRICT ATTORNEY'S OFFICE	0.433	0.107	4.062	0.000	***					
REVENUE DEPARTMENT	0.044	0.020	2.142	0.032	**					
OTHER DEPARTMENTS	X									
Number of observations:	1,626					175				
Adj. R-squared:	0.120					0.145				

NOTE: The response variable is the sum of the max(T) and the min(T)***. Only teams with more than 10 members where the average overtime worked is more than 50 hours per group member in each year are included. The omitted categories for non-uniformed workers are year 2007 and ***. The omitted categories for uniformed workers are year 2007 and fire department. MEANSALARY is the average salary in $000's of members of the group in each year, MEANPENSIONCOST is the mena pension cost of members of the group in each year. STDxxx are standard deviations of these variables. #MEMBERS is the number of members of the group. PERCNTOFFERED2010 is the proportion of the group that was offered the option to join the '2010' DB-DC hybrid plan, and MEANOTHRS is the average number of overtime hours worked by members of the group in that year. Department controls that are not statistically significant were included in the regression but are omitted from the table for ease of presentation.

FIGURE 1: The relationship between the number of overtime hours worked in a given year and the marginal lifetime benefit to the employee of each hour of overtime worked, expressed as a ratio to current wage.

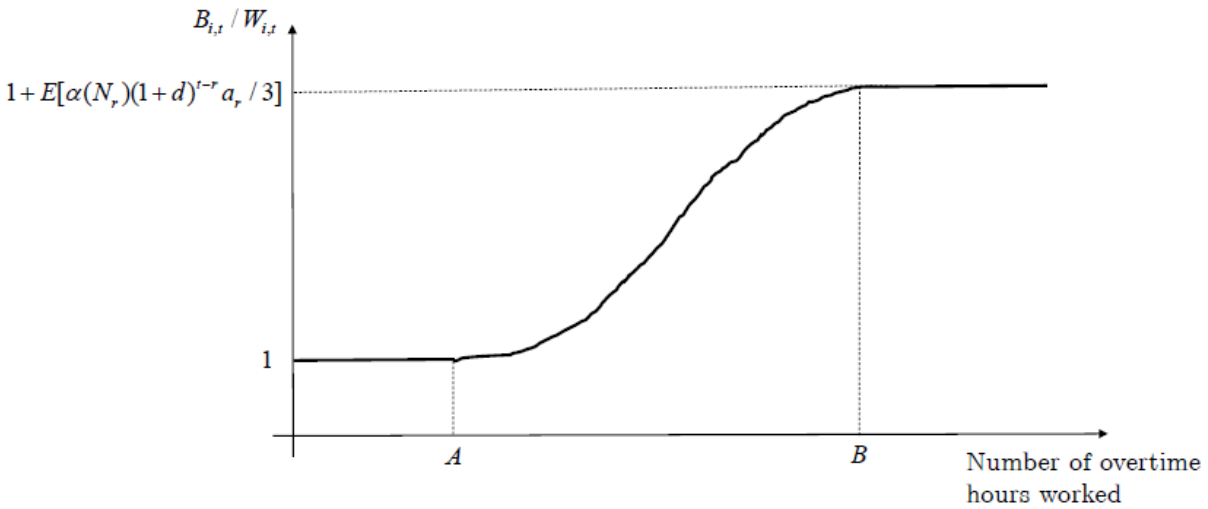


FIGURE 2: The relationship between the proportion of employees in the team (ranked by pension cost) and the proportion of overtime worked 2007-2017: Laborers in the Streets Department

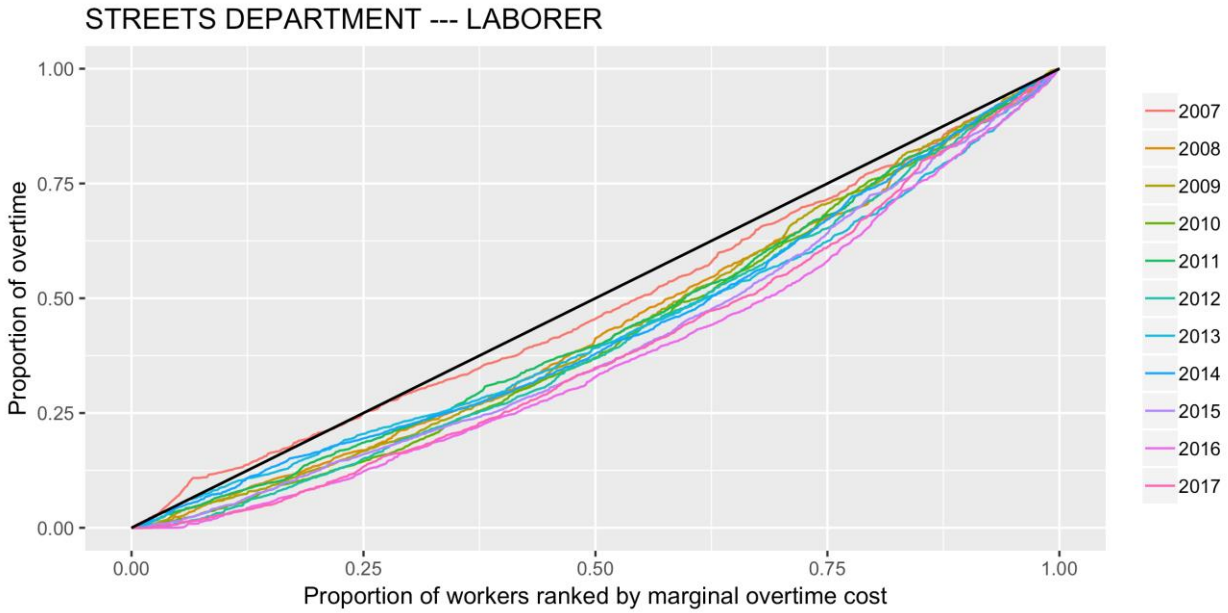


FIGURE 3: The relationship between the proportion of employees in the team (ranked by pension cost) and the proportion of overtime worked 2007-2017: Custodial workers 1 in the Airport

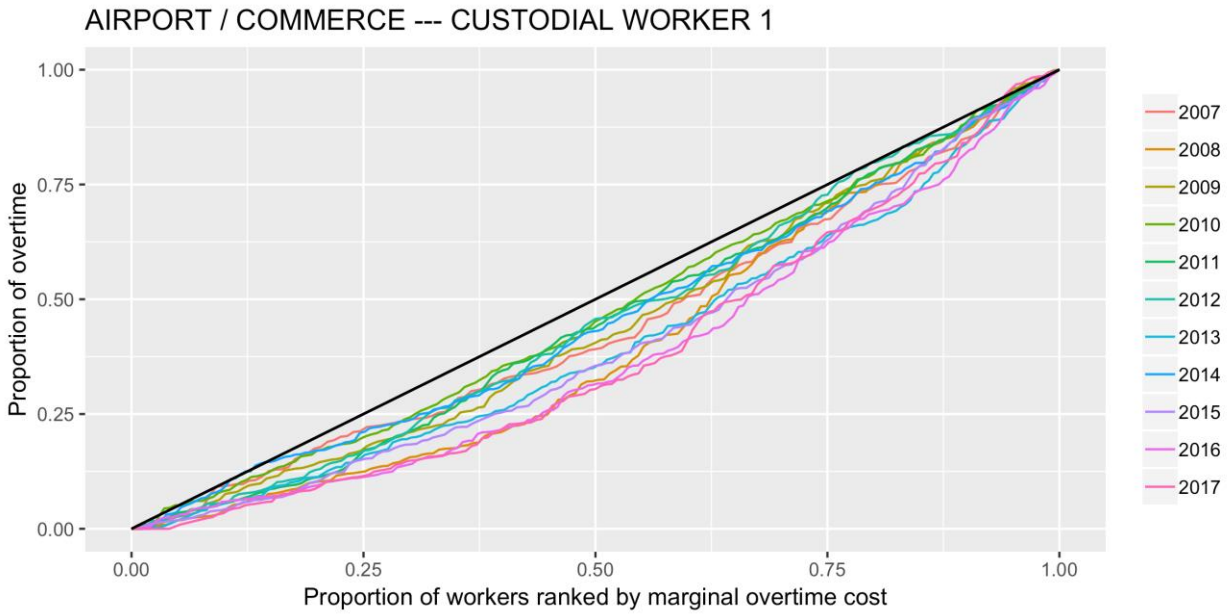


FIGURE 4: The relationship between the proportion of employees in the team (ranked by pension cost) and the proportion of overtime worked 2007-2017: Correctional Officers, Philadelphia Prisons

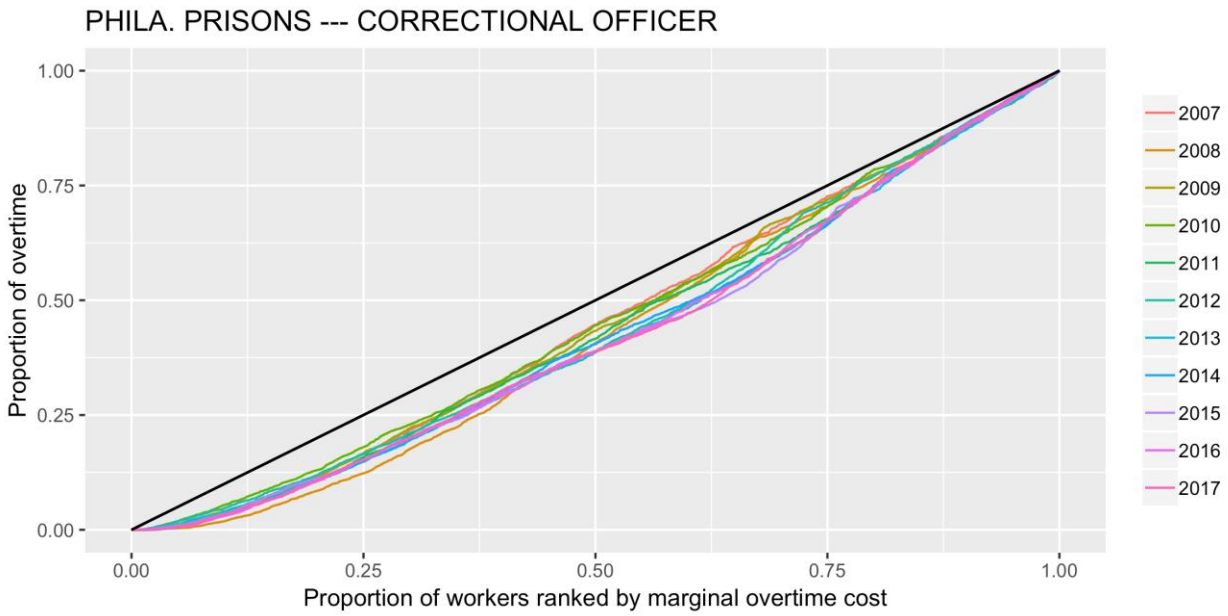
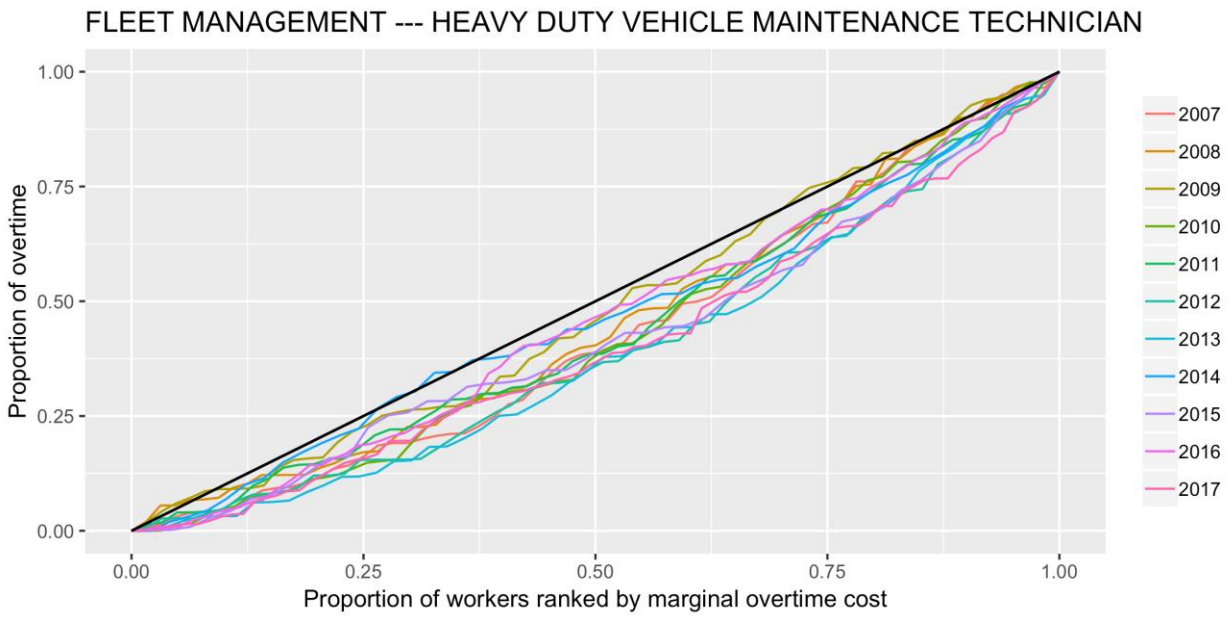


FIGURE 5: The relationship between the proportion of employees in the team (ranked by pension cost) and the proportion of overtime worked 2007-2017: Heavy Duty Vehicle Maintenance Technicians, Fleet Management



9. Appendix

1967 Plan

Section X - All Fire employees employed before 1988-07-01, and section D - All Police uniformed and investigatory employees employed before 1988-07-01

The annual pension after retirement for police and fire employees is calculated as:

$$P_i = [0.025 \times \min(N_i, 40)] \times S_i ,$$

where P_i is the annual pension benefit of the i'th worker after they have retired, N_i is the number of years of pensionable service the worker has completed on the day they retire, and S_i is the worker's final salary on the day they retire, calculated as the highest salary during an uninterrupted 12-month period. Salary for this purpose includes base pay, longevity and police stress pay, as well as fire premium pay, but excludes overtime, shift differential, holiday pay and lump sum payments. If an employees final base rate of pay plus stress or premium pay is higher, this is used instead. Although overtime is not directly pensionable, there appears to be a relationship between overtime pay and the other elements of compensation. Regression

analysis indicates that overtime pay increases the non-overtime related pay elemnts by around 1/6 of the value of the overtime. The total benefit to an employee of an additional hour of overtime at time t can therefore be calculated as:

$$B^1_{i,t} = W_{i,t}(1 + \tfrac{1}{6} E_t[(1+d)^{t-r} a_{i,r} 0.025 \times \min(N_{i,r}, 40) \times I_{1,r}(t) \times I_{2,r}]) ,$$

where $I_{1,r}(t)$ is a random variable representing the fraction of the salary of year t that is used to calculate the pension benefit at retirement date r (if year t is the highest year's earnings, then $I_{1,r}(t)=1$ else it is 0) and $I_{2,r}$ is a random variable representing whether the individual's pension benefit has vested at retirement or not (if $N_{i,r}>10$, $I_{2,r}=1$ else it is 0).

Similarly,

$$B^2_{i,t} = W_{i,t}(1 + \tfrac{15}{6} 0.025 \times \min(N_{i,t}, 40) \times I_{1,t}(t) \times I_{2,t})$$

where $W_{i,t}$ is their hourly wage rate at time t, when they earn the overtime.

Section J - All Municipal employees represented by AFSCME District Council 33 and AFSCME District Council 47, Locals 2186 and 2187 employed before 1992-10-02, all Civil Service-Exempt, appointed, and non-represented employees, and employees of the First Judicial District of Pennsylvania employed before 1987-01-08, all employees of the Sheriff's Office and Register of Wills employed before 1988-07-01

The annual pension after retirement for municipal workers is calculated as:

$$P_i = [0.025 \times \min(N_i, 20) + 0.02 \times \max(N_i - 20, 0)] \times S_i ,$$

where P_i is the annual pension benefit of the i'th worker after they have retired, N_i is the number of years of pensionable service the worker has completed on the day they retire, and S_i is the worker's final salary on the day they retire, calculated as the average of the three highest years earnings, including overtime pay. The accrual rate for the plan is 2.5% for each year of service up to 20 years, and 2% for any longer service. The three measures of benefit costs can therefore be calculated as:

$$B^1_{i,t} = W_{i,t}(1 + E_t[(1+d)^{t-r} a_{i,r} (0.025 \times \min(N_{i,r}, 20) + 0.02 \times \max(N_{i,r} - 20, 0)) \times I_{1,r}(t) \times I_{2,r}])$$

$$B^2_{i,t} = W_{i,t}(1+15(0.025\times\min(N_{i,t},20)+0.02\times\max(N_{i,t}-20,0))\times I_{1,t}(t)\times I_{2,t})$$

where $W_{i,t}$ is their hourly wage rate at time t, when they earn the overtime, $a_{i,r}$ is a random variable representing the present value of annuity payments to individual i, starting at their retirement date r, d is an annual discount rate, $N_{i,r}$ is the number of years of service the individual will have at retirement, $I_{1,r}(t)$ is a random variable representing the fraction of the salary of year t that is used to calculate the pension benefit at retirement date r (if year t is one of the highest three year's earnings, then $I_{1,r}(t)=1/3$ else it is 0) and $I_{2,r}$ is a random variable representing whether the individual's pension benefit has vested at retirement or not (if $N_{i,r}$ >10, $I_{2,r}=1$ else it is 0).

<u>*1987 plan*</u>

Section A – All fire employees employed between 1988-07-01 and 2010-10-05, and section B – All police uniformed and investigatory employees employed between 1988-07-01 and 2010-01-01

The annual pension after retirement for police and fire workers is calculated as:

$$P_i = [0.022\times\min(N_i,20)+0.02\times\max(N_i-20,0)]\times S_i\,,$$

where P_i is the annual pension benefit of the i'th worker after they have retired, N_i is the number of years of pensionable service the worker has completed on the day they retire, and S_i is the worker's pensionable salary on the day they retire, calculated as the average of the two highest years earnings, excluding overtime pay. The total benefit to an employee of an additional hour of overtime at time t can therefore be calculated as:

$$B^1_{i,t} = W_{i,t}(1+\tfrac{1}{6}E_t[(1+d)^{t-r}a_{i,r}[0.022\times\min(N_i,20)+0.02\times\max(N_i-20,0)]\times I_{1,r}(t)\times I_{2,r}])\,,$$

where $W_{i,t}$ is their hourly wage rate at time t, when they earn the overtime, and $I_{1,r}(t)$ is a random variable representing the fraction of the salary of year t that is used to calculate the pension benefit at retirement date r (if year t is the highest two year's earnings, then $I_{1,r}(t)=1/2$ else it is 0) and $I_{2,r}$ is a random variable representing whether the individual's pension benefit has vested at retirement or not (if $N_{i,r}>10$, $I_{2,r}=1$ else it is 0).

Section Y – All municipal employees represented by AFSCME District Council 33 and AFSCME District Council 47, Locals 2186 and 2187 employed between 1992-10-01 and 2014-03-05, AFSCME District Council 33 employed between 1992-10-01 and 2014-09-09, all Civil Service-Exempt, Appointed, and Non-represented employees and employees of the First Judicial District of Pennsylvania employed between 1987-01-08 and 2014-11-14, Deputy Sheriffs and employees of the Register of Wills, between 1988-07-01 and 2012-01-01

The annual pension after retirement for municipal workers is calculated as:

$$P_i = [0.022 \times \min(N_i, 10) + 0.02 \times \max(N_i - 10, 0)] \times S_i ,$$

where P_i is the annual pension benefit of the i'th worker after they have retired, N_i is the number of years of pensionable service the worker has completed on the day they retire, and S_i is the worker's pensionable salary on the day they retire, calculated as the average of the three highest years earnings, including overtime pay (the average is calculated using either calendar years or anniversary years, and the higher value is used). The accrual rate for the plan is 2.2% for each year of service up to 10 years, and 2% for any longer service. The total benefit to an employee of an additional hour of overtime at time t can therefore be calculated as:

$$B^1_{i,t} = W_{i,t}(1 + E_t[(1+d)^{t-r} a_{i,r}(0.022 \times \min(N_{i,r}, 10) + 0.02 \times \max(N_{i,r} - 10, 0)) \times I_{1,r}(t) \times I_{2,r}])$$

$$B^2_{i,t} = W_{i,t}(1 + 15(0.022 \times \min(N_{i,t}, 10) + 0.02 \times \max(N_{i,t} - 10, 0)) \times I_{1,t}(t) \times I_{2,t}])$$

where $W_{i,t}$ is their hourly wage rate at time t, when they earn the overtime, $a_{i,r}$ is a random variable representing the present value of annuity payments to individual i, starting at their retirement date r, d is an annual discount rate, $N_{i,r}$ is the number of years of service the individual will have at retirement, $I_{1,r}(t)$ is a random variable representing the fraction of the salary of year t that is used to calculate the pension benefit at retirement date r (if year t is one of the highest three year's earnings, then $I_{1,r}(t) = 1/3$ else it is 0) and $I_{2,r}$ is a random variable representing whether the individual's pension benefit has vested at retirement or not (if $N_{i,r} > 10$, $I_{2,r} = 1$ else it is 0).

Section L – Elected officials in any general, municipal or special election between 1987-01-08 and 2014-11-14

We ignore this section as the number of people concerned is very small.

2010 plan

Around 2010, a new plan was created to give new employees a choice about whether to join a hybrid DB-DC plan (the 2010), or to remain members of the DB plan. The choice was given to: uniform police employees employed after 2010-01-01, uniform fire employees employed after 2010-10-15, employees of the Sheriff's Office represented by Lodge 5 of the FOP employed after 2012-01-01, employees represented by DC 47 employed after 2014-03-05, all municipal employees in the civil service not represented by a union employed after 2014-05-14, employees represented by DC 33 (excluding guards & employees of the OHCD) employed after 2014-09-09, municipal employees not in the civil service and not represented by a union employed after 2014-11-14, officials elected after 2014-11-14. Employees of the Register of Wills employed after 2012-01-01 and all Guards represented by DC 33 employed after 2014-11-14 were not given an election and must join the 2010 plan.

Our measures of benefits costs are:

$$B^1_{i,t} = W_{i,t}(1 + E_t[(1+d)^{t-r} a_{i,r}(0.0175 \times \min(N_{i,r}, 20)) \times I_{4,r}(t) \times I_{2,r}])$$

$$B^2_{i,t} = W_{i,t}(1 + 15(0.0175 \times \min(N_{i,t}, 20)) \times I_{4,t}(t) \times I_{2,t}$$

for uniformed (fire and police) employees and

$$B^1_{i,t} = W_{i,t}(1 + E_t[(1+d)^{t-r} {}^{a_{i,r}}\!/_{6}(0.0125 \times \min(N_{i,r}, 20)) \times I_{4,r}(t) \times I_{2,r}])$$

$$B^2_{i,t} = W_{i,t}(1 + {}^{15}\!/_{6}(0.0125 \times \min(N_{i,t}, 20)) \times I_{4,t}(t) \times I_{2,t}$$

for other workers.

For this plan, the average of pensionable salary used to calculate the final pension benefit is now averaged over 5 years, rather than 3. $I_{4,r}(t)$ is an indicator variable that includes this change in the defintion, so $I_{4,r}(t)$ is a random variable representing the fraction of the salary of year t that is used to calculate the pension benefit at retirement date r (if year t is one of the highest five year's earnings, then $I_{4,r}(t) = 1/5$ else it is 0).

2016 plan

Around 2016, a new plan was created. This plan restored the 3-year rule of the 1987 plan, but introduced a cap on eligible compensation to be taken into account for the purposes of determining the pension benefit of $65,000 per year. Plan membership comprises employees represented by AFSCME District Council 33 first hired or rehired on or after August 20, 2016, employees represented by Lodge 5 of the F.O.P. who are employees of the Sheriff's Office or the Register of Wills first hired or rehired on or after a certain date and municipal employees not represented by a union and employees represented by AFSCME District Council 47 first hired or rehired on or after January 1, 2019.

$$P_i = [0.022 \times \min(N_i, 10) + 0.02 \times \max(N_i - 10, 0)] \times \min(S_i, \$65{,}000) ,$$

The benefit measures can then be calculated as:

$$B_{i,t}^1 = W_{i,t}(1 + E_t[(1+d)^{t-r} a_{i,r}(0.022 \times \min(N_{i,r}, 10) + 0.02 \times \max(N_{i,r} - 10, 0)) \times I_{5,r}(t) \times I_{2,r}])$$

$$B_{i,t}^2 = W_{i,t}(1 + 15(0.022 \times \min(N_{i,t}, 10) + 0.02 \times \max(N_{i,t} - 10, 0)) \times I_{5,t}(t) \times I_{2,t})$$

$I_{5,r}(t)$ is an indicator variable that includes this change in the defintion, so $I_{5,r}(t)$ is a random variable representing the fraction of the salary of year t that is used to calculate the pension benefit at retirement date r (if year t is one of the highest three year's earnings, and the average of these is lass than $65,000 then $I_{5,r}(t) = 1/3$ else it is 0).