Public Employee Retention Responses to Alternative Retirement Plan Design

South Carolina Teachers and State Public Employees

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Preface

South Carolina, like many states, is considering changes to its retirement benefits for public employees make employer costs more predictable, reduce risk and uncertainty, and to shore up its pension system's long-run funding. Typically, alternative proposals are assessed in terms of their effects on pension cost and risk, but these proposals often have other consequences - importantly they can influence the retention of personnel in ways that can reshape the nature of the public workforce. This report models retention of public sector workers in South Carolina under current policy and effectively matches available demographic data, tests how the results shift based on changes to different benefit parameters and demonstrates how this tool can be applied to plan design proposals being considered by policymakers. In addition, we consider the sensitivity of changes to retirement plan features (e.g., eligibility ages, benefit levels, contributions) on worker retention decisions. Further, we analyze recent policy proposals and compare the long-term retention consequences of these proposals to those of the systems currently in place. This document is intended for both policymakers interested in the consequences of pension policy reform and policy researchers interested in methods and approaches to analyzing "what-if" policy scenarios.

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Abstract

Policy makers in South Carolina are considering changes to retirement benefits for public employees to make employer costs more predictable, reduce risk and uncertainty, and to shore up long-run funding of their pension system. These reforms typically involve prospective benefit reductions, contribution increases, or both for future entrants. Typically, alternative proposals are assessed in terms of their effects on pension cost and risk. We evaluate the impact of a range of potential pension reforms on employee retention. Using estimated economic models of the retention behavior of South Carolina public employees, we simulate the retention responses of these employees.

We find that changes in pension design, especially changes in the design of the defined benefit (DB) plan, create behavioral responses that influence how long these employees remain in public service. Further, reforms to the state's DB plan influence its relative value compared to the state optional alternative retirement plan, a defined contribution plan (DC), leading to shifts in employee choice between these plans.

We also considered recent reform proposals which have included an enhancement to the DC plan and a hybrid DB/DC plan. Both plans are predicted to lead to relatively small changes in employee retention, suggesting limited impact to employee turnover and longevity relative to the status quo. We find that our example hybrid plan comes closest to achieving no change in employee retention relative to the current DB plan with a slight increase or decrease in the average length of service depending on the group of public employees examined. The key implication of our analysis is that pension reform proposals should consider not just the effects of the proposals on pension funding and risk but also the effects on retention and the experience mix of the workforce.

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To shore up the long-run cost situation of their public pension systems and to make employer costs more predictable, policy makers in a number of states, including South Carolina, are considering changes to the pension benefits for public employees. These reforms typically involve prospective benefit reductions, contribution increases, or both for future entrants. Typically, alternative proposals are assessed in terms of their effects on pension funding and risk. But such changes could also have implications for the retained public employee workforce because changes in pension benefits may affect their retention behavior. Changes in retention behavior influence turnover, and hence the experience mix of the workforce and the cost of labor (as less experienced employees are typically paid less). If not considered as part of pension reform, changes in retention may lead to unintended consequences (e.g., a less experienced workforce may necessitate a larger workforce to compensate for productivity differences). In this paper, we estimate economic models of the retention behavior of South Carolina public employees and use the parameter estimates to predict their retention responses under a range of public employee pension reforms that might be considered as a means to improve the public pension system funding in South Carolina.

We model the retention decisions of individual public employees where the retention decision depends on current and future compensation including current pay and future pensions. The model allows for uncertainty in future periods and recognizes that employees may change their minds in the future as they get more information about the employment in the South Carolina public sector and their outside opportunities. It also recognizes that individuals differ in their preferences to serve in the public sector and accounts for these differences. Furthermore, the model is formulated in terms of the parameters that underlie the individual retention decisionmaking processes rather than on the average response of members to a particular compensation policy. The model is estimated using individual-level personnel data on South Carolina public employees covering the period 2010 to 2019. Because state public employees and public school teachers exhibit different retention behavior, we estimate separate models for these two groups. We then use the estimated model parameters to analyze counterfactual (i.e., what-if) scenarios where we simulate the effects of changes to different parameters of the South Carolina pension plans (holding other parameters fixed) on employee retention behavior as well the effects of changes to the pension plans as a whole. The scenarios were chosen to inform the potential consequences of alternative reforms. The main limitations of the model are that we imperfectly capture election of pension systems by employees due to lack of data on such choices and we only simulate the behavioral responses of employees who entered before age 30. Consequently, our model may imperfectly capture behavioral responses where election decisions differ from those we simulate using our model estimates and it is possible that the retention

behavior of those entering at older ages differ from that of younger entrants in ways that necessitate estimating separate models for their behavior. That said, the modeling approach we use is particularly well suited for assessments of alternative pension reforms that have yet to be tried and differ both modestly and substantially from current policy.

Findings

Our main finding is that across a variety of groups and under a variety of scenarios, changes in pension design, especially changes in the design of the South Carolina defined benefit (DB) plan, creates behavioral responses from employees in terms of their retention decisions and their decisions at hire to participate in the DB plan versus South Carolina state optional retirement plan (SORP) which is a defined contribution (DC) plan. In particular, we find that varying the DB multiplier, a multiplier of the final average salary and years of service that determines the annual retirement benefit, and/or varying the employee's annual contribution rate have the largest predicted effect on retention compared with the other scenarios we considered. In contrast, we find that changes to the DB retirement age/years of service eligibility rules and to the final average salary computation on which the retirement benefit is based have smaller effects. We also find that DC participation is sensitive to changes in the DB plan features. The effect on retention of reducing the generosity of the DB plan is lessened because more employees opt to participate in the DC plan. Similarly, the impact on retention of increasing DB pension generosity is amplified relative to the case without opt-in because fewer opt for the DC plan. Thus, having the DC plan choice is an important consideration in the DB plan design and its effect on retention. We also considered alternative DC employer contribution scenarios and DC vesting scenarios relative to a baseline of South Carolina's optional DC plan and find that that the predicted retention responses are small relative to the retention responses from changes to the DB multiplier. In sum, changes to DB plan characteristics have the potential to alter retention more than changes to DC plan characteristics.

Since enacting funding reforms in 2017, the South Caroline General Assembly has introduced legislation each year to make further changes to pension plan design for future South Carolina public employees. This includes making an enhanced version of the current defined contribution plan the default option for new works, as proposed most recently in Senate Bill 176 (S176) from January 2021. Under this proposal, the DC plan would be the default plan for new employees, and it would set default employee and employer contribution rates for the DC plan and rather than immediate vesting, vesting would be gradual with different schedules for teachers and state workers. The former group would be 100 percent vested after 5 years while the latter group would be fully vested after 2 years. We find that S176 could reduce mid-career retention but increase retention among senior personnel resulting in a small overall change in the average experience of the retained workforce. We also consider an example hybrid plan that combines elements of the existing DB and DC plans currently offered to South Carolina public employees.

Our simulations indicate that the hybrid plan we consider could increase or decrease the retention over the career of a given employee, albeit slightly, relative to retention under the current system. Whether it increases or decreases depends on the group of public employees examined. For teachers, there is a very small increase in average years of service, while state government employees with at least a bachelor's degree experience a decrease in average years of service. While the changes under both proposals are relatively small, the hybrid plan we considered is predicted to do a better job of sustaining the current rates of employee retention by experience of the workforce than does S176.

The key implication of the analysis is that pension reform proposals should assess not just the effects of the proposals on pension funding and risk but also the effects on retention. Because pension design changes can affect not only the average experience of the retained workforce but also the mix of junior and senior personnel, design changes can affect the wage bill of the workforce to the extent that junior personnel are paid less than senior personnel. Consequently, cost analyses of pension reforms should consider not just changes in pension costs but also changes in the wage bill produced by changes in the retention in response the design changes.

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Abbreviations

DB	defined benefit
DC	defined contribution
FAS	final average salary
PEBA	Public Employees Benefit Authority
RSIC	Retirement System Investment Commission
SCRS	South Carolina Retirement System
SORP	State Optional Retirement Plan
S176	South Carolina Senate Bill 176

1. Introduction

Like other state and local pension systems, South Carolina's public pension systems have faced large funding shortfalls in recent years. For example, in July 2018, the defined benefit (DB) retirement system that covers the majority of South Carolina's public employees had only 55 percent of the funding required to cover the pension obligations according to the Retirement System Investment Commission (2019a).[1]

Also, like other states, South Carolina has undertaken a number of major reforms aimed at shoring up the state's DB plan, changing the DB benefits in 2012 and changing the DB plan funding in 2017. Since the 2017 funding reforms, the South Carolina general assembly has introduced legislation each year to make further changes to pension plan design for future South Carolina public sector employees. This includes the South Carolina Senate Bill 176 introduced in January 2021 that would make a defined contribution (DC) plan the default system for new entrants. At the same time, Governor McMaster has called for enrolling all future employees in the existing defined contribution plan (Kozlowski, 2020) and policymakers have also discussed hybrid plans that combine a DB plan with a DC plan (Street, 2019). Given that investment returns in the DB pension plan have been well below the target rate of 7.25 percent, it is likely that additional reform proposals will be considered for South Carolina's public employee pensions.[2]

Past research shows such pension reforms can affect the retention and retirement decisions of employees, and consequently the experience mix and quality of the workforce (Stock and Wise, 1990; Brown, 2013; Asch et al., 2016; and Ni and Podgursky, 2016). For example, lower pension benefits in retirement or lower take home pay resulting from greater pension contributions could increase turnover, leading to a greater share of employees who are junior thus reducing the average experience of the workforce. Further, changes in the experience mix of the force would affect payroll and pension system costs, and therefore the cost or cost savings associated with any reform.

In this paper, we predict the behavioral responses under a range of South Carolina public employee pension reforms that might be considered as a means to improve pension system

[1] DB retirement plans, also known as pensions, pay a benefit based on a formula to a retirement eligible worker for life. A DB plan's investments and risk are managed by the pension fund. Defined contribution retirement plans are employee managed funds where an employer and/or employee make monetary contributions towards an employee's retirement, typically on a tax-deferred basis. The employee is responsible for managing investments and bares the risk of those investments.

[2] In fiscal year 2019 and 2020, investment returns in the pension plan were 5.8 percent and -1.6 percent respectively – well below the target rate of 7.25 percent (RSIC, 2019b; RSIC, 2020). The annualized rate of return at the end of fiscal year 2020 was 6.71 percent over the previous 10 years.

funding. In our analysis, we develop a model where South Carolina public employee retention decisions are based on forward-looking behavior that depends on current and future compensation including pay and pensions. The model allows for uncertainty in future periods and recognizes that employees may change their mind in the future as they get more information about the employment in the South Carolina public sector and their outside opportunities. It also recognizes that individuals differ in their preferences to serve in the public sector and accounts for these differences. Furthermore, the model is formulated in terms of the parameters that underlie the individual retention and retirement plan decisionmaking processes rather than on the average response to members to a particular compensation policy. Consequently, the model we estimate is structured to enable assessments of alternative pension reforms that have yet to be tried. The model is estimated using individual-level personnel data on South Carolina public employees. Because state public employees and public teachers exhibit different retention behavior, as we describe in more detail later, we estimate separate models for these two groups. We then use the estimated model parameters to analyze counterfactual (i.e., what-if) scenarios where we simulate the effects of changes to the South Carolina pension plans on employee retention behavior. The scenarios were chosen to inform the potential consequences of alternative reforms.

Our main finding is that across a variety of groups and under a variety of scenarios, changes in pension design, especially changes in the design of the DB plan, induce varying behavioral responses from employees in terms of their retention decisions and their decisions to participate in the DC versus the DB plan. We found that the largest retention effects occur when the DB plan multiplier, a multiplier of the final average salary and years of service that determine the annual retirement benefit, and/or the DB plan contribution rate was changed. Changes in DB plan retirement eligibility and the features of the DC plan produce smaller retention effects. The key implication of the analysis is that pension reform proposals should also consider not just the effects of the proposals on pension funding and risk but also the effects on retention. We illustrate this by examining recent policy proposals, including an enhancement to the state's DC plan and an example hybrid DB/DC plan.

The paper is organized as follows. The next section describes the South Carolina public pension systems in detail. This information is needed to better understand the reforms we analyze. Given this information, we also describe the reform scenarios we consider in our analysis. In section 3 we describe our administrative data on South Carolina personnel, report summary statistics of our sample, and describe how we estimate pay for continued work as well as if the worker chooses to leave. Section 4 introduces the structure of the model, describes how we estimate the model, and reports on the estimated model's ability to fit the observed data. In section 5, we use the estimated model to conduct counterfactual policy experiments to understand the sensitivity of retention to changes to pension design features. In section 6, we discuss implications and draw conclusions with respect to this sensitivity for setting pension reform policy.

2. Overview of the South Carolina Public Pension Systems

This section begins with a description of the South Carolina pension systems. The features of these systems are incorporated into our economic model of public employee and teacher retention decisions, described in section 4. The key objective of our analysis is to use the estimated models to simulate how retention would change under alternative pension reforms, and the second part of this section describes the pension reforms we consider in our analysis.

South Carolina Pension Systems

Since 2000, South Carolina teachers and state employees have had the option to choose between a DB plan that provides a guaranteed benefit (fixed monthly annuity) for life for vested employees, known as the South Carolina Retirement System (SCRS), or a DC plan where the employer contributes to a fund owned by the employee that vests immediately and is portable but where there is no guaranteed return on assets. The DC plan is known as the State Optional Retirement Plan (SORP). The SCRS is the default plan. Prior to 2000, all employees were covered by SCRS and had no DC option.

Table 2.1 details the retirement plan rules for SCRS and SORP. Employees face different pension rules under SCRS depending on when they were hired. Those hired on or after July 1, 2012, have more stringent requirements for collecting their benefit (e.g., more service required before a benefit can be collected). On the other hand, required employee contribution rates are the same, regardless of plan or hire date. Consistent with how the Public Employees Benefit Authority (PEBA) refers to the SCRS employees, we will refer to employees hired before July 1, 2012 as Class 2 SCRS employees and those hired after as Class 3 SCRS employees.

SCRS Pension System

SCRS follows a traditional DB formula, where the benefit is equal to:

$$\text{Benefit} = \text{Benefit Multiplier} \times \text{Final Average Salary} \times \text{Years of Service} \qquad (2.1)$$

Both Class 2 and 3 SCRS employees have a DB multiplier of 1.82 percent (0.0182) but differ in the computation of final average salary (FAS); for Class 2 employees, FAS is based on the average of the highest three years of earnings while FAS for Class 3 employees is based on the average of the highest five years of earnings. Class 2 and 3 employees also have different qualification criteria for full retirement benefits. Vesting, defined as the minimum years required to be entitled to a lifetime benefit payment, is five years for Class 2 employees and eight years for Class 3 employees. Furthermore, employees have two alternative ways of becoming eligible

for full benefits, with different criteria for each Class under each alternative. The first way employees can be eligible for full benefit is based on years of service. In particular, Class 2 employees are required to have at least 28 years of service regardless of age, e.g., an employee starting at age 22 can collect full benefits starting at age 50, while Class 3 employees are required to satisfy the rule of 90, meaning that age plus years of service must equal 90 e.g., an employee starting at age 22 can collect full benefits starting at age 56 with 34 years of service. Alternatively, employees have a second way to be eligible for full benefits; vested employees must be at least age 65 with 5 years of service for Class 2 employees and 8 years of service for Class 3 employees.

Table 2.1. South Carolina Public Pension Rules

	SCRS Class 2 DB (Hired before July 1, 2012)	SCRS Class 3 DB (Hired on or after July 1, 2012)	SORP DC (Since 2001)
Employee contribution rate	Varies (Currently 9%, see figure 1.1)	Varies (Currently 9%, see figure 1.1)	Varies (Currently 9%, see figure 1.1)
Employer contribution rate	Varies (See figure 1.1)	Varies (See figure 1.1)	5%
Vesting service requirement	5 years	8 years	Immediate
DB Benefit Multiplier	1.82%	1.82%	n.a.
DB Full Benefit Eligibility Requirements	Any age with 28 or more years of service, or Age 65 with at least 5 years of service	Rule of 90 (Age + Years of Service), or Age 65 with at least 8 years of service	n.a.
DB Early Benefit Eligibility Requirements [Reduction for each year]	Age 55 with 25 or more years of service [4%], or Age 60 with at least 5 years of service [5%]	Age 60 with at least 8 years of service [5%]	n.a.
DB Final Average Salary	Average of salary for 3 highest consecutive earnings years	Average of salary for 5 highest consecutive earnings years	n.a.
DB Cost of Living Adjustment	1% (up to $500)	1% (up to $500)	n.a.
Social Security Coverage	Yes	Yes	Yes

NOTE: n.a. = Not applicable.

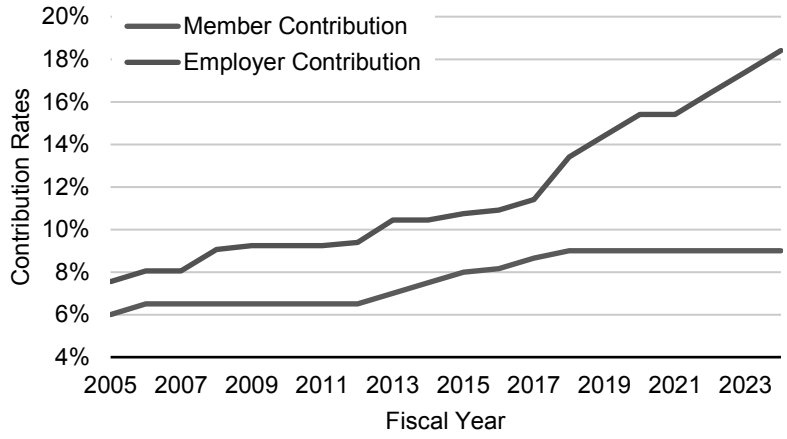
SCRS members can retire early if they accept a reduced lifetime benefit. For Class 2 members, there are again two alternative ways to qualify for early benefits. The first criterion requires that an employee has at least 25 years of service and is at least 55 years old. Under this criterion, the benefits in equation (2.1) are reduced by 4 percent for each year prior to full benefit eligibility. The alternative way to be eligible for early benefits is for the vested SCRS Class 2 employee to be at least age 60 with 5 years of service. In this case, the benefits in equation (2.1) are reduced by 5 percent for each year prior to full benefit eligibility. Class 3 members are only eligible for early benefits under the second approach, i.e., at least age 60 with 8 years of service.

Finally, benefits for both employee classes are adjusted annually for cost of living, either by 1 percent or $500, whichever is lower, and all South Carolina employees are also covered by Social Security.[3]

SORP System

When an employee is hired into a position covered by SCRS, he or she is defaulted into SCRS, but has the option to switch to SORP within the first five years of employment. Like other DC plans, the employee and employer make contributions to an individual SORP fund and the employee manages how the balance is invested and is responsible for the risk associated with variable returns on the fund. The SORP employer contribution is computed as 5 percent of the employee's salary, regardless of the employee's contributions.

Figure 2.1. South Carolina Public Pension Contribution Rates



Prior to 2012, SORP employee and employer contribution rates were relatively constant, with adjustments to employee rate made periodically by the legislature and to employer rates by SCRS (RSIC, 2019a). Starting with the reforms in 2012, both employer and employee contributions have increased, as demonstrated in Figure 2.1. Under current law, an employee's contribution will remain constant at 9 percent of pay. The employer's contributions were scheduled to increase from 13 to 18 percent starting in fiscal year 2018. Differences between the employer's contribution rate and the 5 percent paid to an employee's SORP account go towards funding legacy costs associated with the SCRS. In 2020, the scheduled contribution increase was delayed due to COVID-19.

[3] South Carolina law enforcement officers are covered by a separate pension system, so we exclude them from our analysis.

3. Data and Sample

In order to understand employment responses arising from alternative pension plan designs, we estimate models of retention behavior that require longitudinal data on employees. We collected personnel data from South Carolina state agencies that track employee retention and can be used to infer retirement eligibility. Additionally, we used public-use survey data to estimate private and public-sector earnings over the lifecycle.

In this chapter, we briefly discuss the personnel data. We then describe the samples, selected from these populations, used to estimate our retention models. Finally, we estimate the earnings by sector and years of service (earnings trajectories) for South Carolina workers.

Public Employee Personnel Data

Longitudinal public employee data was collected from the South Carolina Department of Administration covering 2010 to 2019 and longitudinal teacher data was collected from the South Carolina Department of Education (SCDE) covering 2008 to 2020. Both data requests were based on Freedom of Information Act requests. Personnel data from each source includes information on demographics (e.g., gender, race, age, educational attainment) and characteristics about the individual's employment in South Carolina's civil service or public schools (e.g., job title, full-time/part-time status, pay, years of service).

Table 3.1 reports statistics on workforce characteristics as of 2019 both for the original dataset and the subsamples we use in estimating our retention model (We describe the selection criteria for the subsamples in the next subsection but show the subsamples here to enable comparisons with the original datasets later in the chapter). The majority of South Carolina public employees are female, white, and have at least a bachelor's degree, with the overall share in each of these categories being larger for teachers relative to state employees. The majority of state employees in 2019 were ages 45+, while the majority of teachers were under age 45. Regarding tenure in these workforces, we observe that 59 percent of state employees have less than 10 years of service, 37 percent have 10 to 30 years, and 4 percent have more than 30 years. For teachers, 43 percent have less than 10 years of service, 51 percent have 10 to 30 years, and 6 percent have more than 30 years. South Carolina teachers start employment at public schools at much younger ages, with 69 percent starting at or before age 30, compared with 40 percent of state employees.

Table 3.1. Public Employee Descriptive Statistics (2019)

	State Employees	Teachers	State Employees (After Selection)	Teachers (After Selection)
Population size	60,374	51,701	3,260	20,368
Gender (%)				
Male	41.4	18.9	31.9	17.2
Race (%)				
White	61.6	78.0	57.5	82.1
Black	33.5	15.5	40.7	13.9
Other/missing*	4.8	6.5	1.9	4.0
Educational Attainment (%)				
Less than BA	37.0	*	-	*
BA+	59.8	97.4	100	99.5
Unknown/missing	3.2	2.6	-	0.5
Age (%)				
Less than 25	3.3	3.3	**	**
25-34	19.8	27.1	23.0	27.7
35-44	23.6	27.5	31.9	34.3
45-54	26.5	24.9	31.3	26.7
55+	26.8	16.8	13.7	11.2
Years of service (%)				
Less than 5	42.3	24.1	7.5	7.4
5-9	16.7	18.4	19.0	20.6
10-14	14.3	18.0	17.9	19.9
15-19	9.0	14.0	12.8	16.2
20-24	8.2	11.6	17.1	16.4
25-29	5.3	6.4	14.9	9.6
30+	4.3	6.4	10.8	10.0
Entry Age (%)				
Less than 22	3.1	0.1		
22-30	36.8	68.8	100	100
31-35	17.1	12.2		
36-40	13.7	7.9		
41-45	10.2	4.8		
46-50	8.1	2.4		
51-55	5.9	1.0		
56+	5.0	0.4		

NOTES: (*) The administrative file does not separately identify teachers with unknown education and those with less than a bachelor's degree. (**) Since we restrict our sample to entrants 22 and older and teachers that enter SC schools before 2016, the youngest entrants in the last year would be 25 by 2019.

Relative to South Carolina teachers, state employees exhibit greater variation in educational attainment, entry age, and demographic factors such as gender and race. This likely reflects the broader range of jobs for state employees. Table 3.2 explores differences in educational attainment and the fraction of the workforce that are law enforcement officers in the largest 15 state departments (all state colleges and universities are lumped into a single department). We highlight law enforcement officers because this group has alternative pension qualification rules. We find that educational attainment varies substantially by state department. In some state organizations, such as universities, Department of Social Services, and the Department of Probation, Parole and Pardons, 75 percent or more of their employees have at least a bachelor's degree. Alternatively, in the departments of Corrections, Transportation, Disabilities and Special Needs, and Motor Vehicles, less than 25 percent of employees have a bachelor's degree. This reveals that state departments differ greatly in characteristics of their workforces. Differences in employee characteristics may reflect requirements or characteristics of positions they fill (e.g., certain positions may be intended for short-term workers) and may also relate to employee retention. Consequently, in our main analysis, we will not treat state employees as a single workforce, but rather as a collection of workforces that reflect different preferences for public-sector employment.

Table 3.2. State Employees by Department (2019)

Department	Count	Law Enforcement Officers (%)	Educational Achievement (%)	
			Less than BA	BA+
Post-secondary Education	22,865	1.8	19.0	80.7
Corrections	4,678	60.8	85.3	12.3
Transportation	4,200	0.0	75.4	24.6
Mental Health	4,070	2.2	42.0	56.8
Social Services	4,064	0.1	24.6	75.2
Health and Environmental Control	2,942	0.3	32.0	67.1
Disabilities and Special Needs	1,591	0.0	69.4	16.8
Health and Human Services	1,280	0.0	40.0	59.1
Public Safety	1,236	75.8	71.7	28.0
Motor Vehicles	1,220	0.0	76.5	23.2
Juvenile Justice	1,147	29.4	41.3	57.7
Education	1,064	0.6	41.6	55.4
Vocational Rehabilitation	971	0.0	22.9	61.6
Natural Resources	807	29.0	32.1	66.9
Probation, Parole, and Pardons	688	35.2	23.1	76.7
All other departments	7,551	4.4	29.0	54.9

NOTES: All colleges and universities are collapsed into a single category, "Post-secondary Education." Sum of percentage with less than BA and BA+ educational achievement may be less than 100 percent due to missingness in the educational achievement variable as of 2019.

Sample Selection

In estimating our model of retention behavior, we select a sample of employees from the longitudinal data that can help identify the parameters of the model. These parameters reflect workers' preference for staying or leaving public employment (we describe this model in detail in the next chapter) by capturing how workers weigh compensation by the state (or the school district), including current pay and future pension benefits, versus compensation by a private employer. In the model, workers consider these monetary tradeoffs as well as any additional non-monetary benefits/costs of state employment and uncertainty surrounding transitory factors that may impact their decision to stay or leave in the future. As a consequence, the model needs to be estimated on a group of employees that have similar potential career trajectories and incentives. Tables 3.1 and 3.2 suggest that state employees may be too aggregated of a group to exhibit a common career trajectory, whereas teachers tend to exhibit similar characteristics (e.g., entering

teaching at or before 30). In the next chapter, we estimate two models: one for teachers and one for a subsample of state employees that are similar to teachers.[4]

In Table 3.3, we identify two initial sample restrictions for state employees and teachers aimed at ensuring similar potential career trajectories: we restrict to employees with at least a bachelor's degree and individuals first employed by the South Carolina state government or as a public school teacher at or before age 30. This exclusion affects some of the characteristics of the sample, as shown in Table 3.1. For example, a higher share of employees entering at or before age 30 have longer tenures, such as at least 30 years of service than the general samples, because those entering at younger ages have more opportunity to accumulate longer tenures than those entering at older ages. Additionally, we exclude university employees because their career trajectories may differ from other state agencies (e.g., tenure-track faculty). We identify five additional sample restrictions for state employees and teachers aimed at ensuring similar incentives. We exclude state employees working for the Department of Transportation because a special retention program was introduced during the time covered by our data that provided a strong financial incentive to continue employment. We also exclude state workers who have a gap in employment and teachers with more than a two-year gap in employment.[5] Similarly, we drop re-hires (individuals hired in during the period of our data but that begin with non-zero years of service). Excluding workers with extended gaps and re-hires is done because they generally reflect new spells of employment with the same employer, an aspect not accounted for in the model presented in the section.[6] Additionally, we exclude individuals that work less than full-time or more than full-time because we their work incentives may differ from traditional full-time workers. We also exclude law enforcement officers because they have different pension qualifications that permit retirement with full benefits at younger ages. We make three additional sample selections based on data limitations. We exclude teachers with records that start before age 18 or after 100, as these likely reflect data entry errors. We exclude employees entering public sector employment before 1978. Finally, we exclude entrants who start after 2015 because of an insufficient length of time to observe their retention behavior.

[4] We select a sample of state employees that look similar to teachers in order to facilitate a more direct comparison or model parameter estimates and predictions. In Appendix A, we also look at South Carolina state employees overall.

[5] Teachers are often permitted to take a limited employment gap related to a life event, such as having a child, while retaining the right to return to their previous position at the end of gap.

[6] Allowing for multiple spells of employment significantly increases the complexity of the model.

Table 3.3. Sample Selection Criteria

	State Employees			Teachers		
	2019 Sample	2010-2019 Persons	2010-2019 Person-Year	2019 Sample	2008-2020 Persons	2008-2020 Person-Year
Original Sample	60,374	126,335	591,646	51,701	101,186	645,931
Subsample after restricting to those with at least a bachelor's degree	36,127	68,534	345,711			
Subsample after excluding university and Dept. of Transportation	16,731	32,134	148,197			
Restrict to entry cohorts before 2016	10,118	23,443	131,309	41,139	84,100	601,664
Records dropped by reason						
Eliminate workers with observed gaps*	1,402	2,030	11,112	1,816	3,218	20,052
Eliminate workers ever working less or more than full-time	52	87	620	1,719	2,834	26,573
Eliminate people with ages ever reported that are less than 18 or greater than 100	-	-	-	11	34	120
Eliminate Law Enforcement Officers	870	1,896	11,199			
Drop observed re-hires (i.e., keep only new entrants)	944	1,764	7,383	9,928	18,389	77,403
Restrict to entry cohorts after 1978	57	341	1,652	193	4,062	17,679
Restrict to workers entering between ages 22 and 30	3,533	9,274	52,078	7,104	17,083	133,867
Final sample size	3,260	8,051	47,265	20,368	38,480	325,970
Percent of original subsample**	32.2	34.3	36.0	49.5	45.8	54.2

NOTES: (*) Teachers with employment gaps of two years or less are retained. (**) Restricting to pre-2016 hires. For state employees, the percentage is based off of the subsample after limited to workers with at least a bachelor's degree and not employed at a university or the Department of Transportation. (-) We do not currently restrict to full-time workers for state employees.

Looking at reductions in sample size due to these characteristics can be confusing so we present both person and person-year reductions for our overall panel dataset. In particular, for each group—state employees and teachers—the first column in the table shows the sample selection for the 2019 sample while the second column shows the sample selection for all individuals in the 2010-2019 samples. The third column for each group converts the 2010-2019 sample into person-years. Note that we also apply the same rules to our 2019 data to demonstrate the impact of our selection criteria on our final sample size. While the sample restriction drops many observations, there are over 47,000 person year observations for the state employee sample and over 325,000 observation for the teacher sample.

Table 3.1 demonstrates how our sample selection impacts the characteristics of the sample present in 2019. We observe an increased representation of women (58 to 68 percent) for state workers, but a relatively minimal effect on the gender representation in the sample of teachers. In both cases, the employees present in 2019 skew towards more years of service and are more likely to be between the ages of 25-54 than employees present in earlier years.

Earnings

In our model of retention behavior, a worker considers his or her current pay relative to their next best option if they were to leave public sector employment. Therefore, we need earnings estimates for both their current employment and their next best option.

We estimate five earnings trajectories: for public sector workers with at least a bachelor's degree and for those without, for private sector workers with at least a bachelor's degree and for those without, and for public school workers. We use the 2003-2018 American Community Survey (ACS) to estimate public and private sector earnings trajectories in South Carolina. We use the teacher personnel data from the SCDE, which includes pay, to estimate South Carolina teacher earnings. For both South Carolina teachers and state employees, we assume their next best option is the average private sector pay conditional on their age and educational achievement.

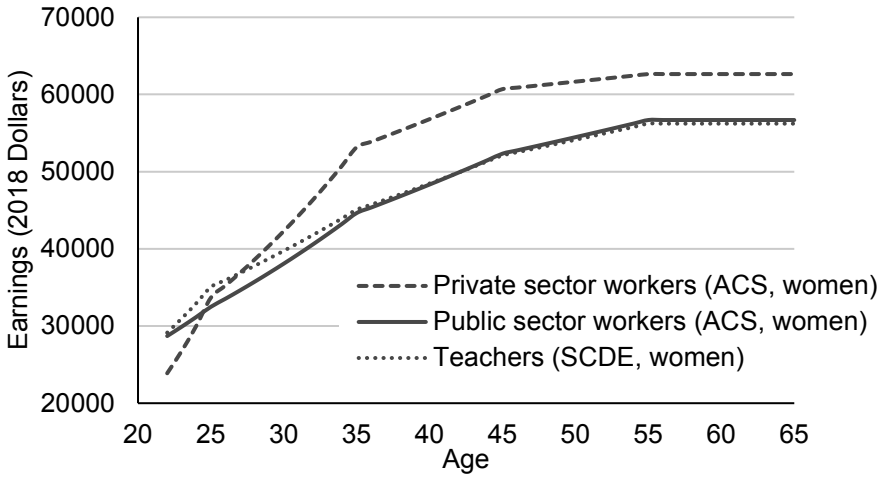
We estimate a piecewise linear model of the wage trajectories over a career for public sector workers, private sector workers, and public school teachers. Since ACS earnings are top coded (i.e., exact earnings above 99.5% are not reported), we use a Tobit model to estimate earning trajectories and include age, gender, and veteran's status as explanatory factors.[7] Earnings trajectories are estimated separately by education (i.e., less than a bachelor's degree; at least a bachelor's degree) and sector (i.e., South Carolina private sector full-time workers; South Carolina state and local public sector full-time workers). For South Carolina teachers, we follow a similar model, except for an ordinary least squares regression is used in place of a Tobit model

[7] Age is modeled as a spline capturing ages less than 25, 25-34, 35-44, 45-54, and 55 and over.

because there is no top coding and veteran status is excluded from that model as that is not an observed factor.[8] Additionally, the teachers' model is restricted to 2017 to mirror the cross-sectional ACS data.[9] This model is reported in Appendix C.

Figure 3.1 depicts the earnings trajectories for these groups. Earnings trajectories are predicted by age for non-veteran women. Earnings after age 55 are assumed to be constant to avoid selection based on retention, retirement decisions, and work effort. South Carolina teachers exhibit earnings trajectories that are similar to their public-sector counterparts. Initial earnings are similar regardless of sector, although an earnings premium for private sector employment relative to public sector jobs emerges around age 25 and reaches $8,000 by age 35, narrowing only slightly at later ages. These earnings trajectories suggest that deferred compensation (through the public pension) or nonmonetary benefits from public service would typically need to exceed the private sector pay premium in order for these employees to remain in their public sector positions.

Figure 3.1. Earnings Trajectories for South Carolina Private Sector and State Workers and Teachers (2018 dollars)



NOTES: Earnings trajectories reflect workers will at least a bachelor's degree. Earning trajectories are assumed to be constant after age 55.

[8] We treat employment as a teacher as a full-time job. As most teachers have summers off, they often have fewer days worked than other professions, meaning their hourly earnings may be greater. We do not account for this in our analysis.

[9] We use the 2018 ACS in our analysis, which reflects 2017 earnings.

4. Model and Fit

In this section we describe the model, our approach to estimating the model, and the model's fit with the data. The section concludes with a discussion of the limitations and advantages of the model. The mathematical model and retention likelihoods used in estimation are described in Appendix B.

Dynamic Retention Model

SC Public Employee Model Overview

In the following discussion we will focus on the SC state employee model. The general description is also largely applicable to the SC public school teachers model; we discuss the differences between these two models in the next sub-section.

The Dynamic Retention Model (DRM) is an empirical behavioral model of retention decision making over a career with a given employer (Gotz, 1990; Asch and Warner, 2001; Goldberg, 2002; Mattock and Arkes, 2007; Asch et al., 2008; Knapp et al., 2016). As noted in section 1 and discussed further later in this section, the DRM was chosen as the modeling approach because, among other advantages, it is formulated in terms of the parameters that underly the retention decision process and consequently it particularly well-suited to assess policy alternatives that have yet to be tried. Individuals are assumed to be rational and forward-looking, taking into account expected future earnings from the employer, their own preference for employment with that employer, and uncertainty about future events that could cause them to value their current service more or less, relative to their external opportunities. The parameters of the model can be estimated from longitudinal data on individual employee retention decisions. The estimated model can be used to simulate the retention profile of an entry cohort of employees under the employer's existing compensation policy (baseline retention), as well as the retention profile under alternative compensation policies, such as changes to the retirement system. The simulations can reveal the effect of those policies on the size of the workforce retained and the number of additional hires needed to sustain the overall workforce should it decrease.

In the DRM for SC public employees, the value of staying depends on an employee's expected earnings in each year of service and the employee's taste for working as an SC public employee relative to the external market. Taste represents the monetary equivalent of the individual's preference for working as an SC public employee relative to an external job. The model uses estimated earnings-age curves to represent the expected SC public employee salary and external salary. An individual might believe his or her expected salary is persistently higher or lower than those curves, and the net effect of the perceived difference enters into the taste

term. In effect, taste is as a person-specific fixed effect.[10] It is unobserved, and we assume it has a normal distribution among employees entering public service at the beginning of their work career. We estimate the mean and standard deviation of the taste distribution at entry; the population taste distribution of a cohort evolves over employee's careers because of selective retention, which depends in part on taste. As time goes on higher taste employees tend to stay, while lower taste employees tend to leave.

The model also includes shocks associated with being an SC public employee and with an external career. Examples of shocks are changes in job assignments, transfer opportunities, external job offers, or tied moves (e.g., when a partner's job location changes).

In addition, the value of staying as a SC public employee includes the value of the option to leave at a later date. The option value comes from being able to revisit the stay/leave decision in each future period. Although the shocks that will be realized in future periods are not known in the current period, there is value in being able to choose between staying and leaving in each future period as compared to committing in the current period to a certain length of stay, or certain time of departure, in the future. Like taste, the shock is unobserved, but we assume shocks follow an extreme value distribution with zero mean, and we estimate the standard deviation of the distribution.

Choices made in the current period affect the value of choices in the future. An SC public employee choosing to stay adds a year of service, moving closer to retirement eligibility and increasing retirement benefits, thereby influencing the value of staying in the future. Similarly, past choices affect the value of staying in the current period.

An additional choice is available to public employees entering after the year 2000: the choice of a retirement program. Employees are by default placed into the defined-benefit SCRS DB program but may opt-out of the defined-benefit system and opt-in to the SORP DC. In the model employees make this choice at the end of the first period, and this choice is reflected in the value of leaving.

The value of leaving includes expected earnings in the external market, plus SC retirement benefits, if any, plus the shock. An individual who leaves SC public service may obtain work in a similar occupation, switch to a different occupation, work full- or part-time, or leave the labor force. To represent external earnings, we use ACS 2018 data on earnings by age for women who are full-time private-sector workers in SC. We use women's wages because the majority of SC public employees are women. The value of leaving does not include a term representing preference for external work, non-pecuniary factors, or person-specific differences between the individual's own expected wage and the representative expected wage, because these factors are subsumed in the taste for working as an SC public employee.

[10] This fixed effect also includes the difference in retirement wealth between private-sector retirement plans and state retirement plans.

The model parameters include the mean and variance of taste (assumed to be normally distributed), the scale parameter of the shock distribution (assumed to be extreme-value distributed), and the personal discount factor. We statistically estimate the model parameters using maximum likelihood.

Finally, the SC public employee data we use includes both newly entering employees for years 2010 through 2015, as well as incumbent employees as of 2010, all followed through 2019. The new entrants in our data will not have accumulated the required age and years of service by 2019 to be eligible to retire, implying that the data would not include retention decisions over likely retirement years. Consequently, we adapted the DRM to allow inclusion of incumbent employees in the estimation sample in a manner similar to the approach we took in Knapp et al., (2016). To do this, we derived expressions for the posterior taste distribution of the employee population conditional on years of service and then developed career retention likelihoods for incumbent employees, given their years of service in 2010. The model and retention likelihoods used in estimation are described in Appendix B.

Differences Between the SC Public Employees and SC Public School Teachers Models

The general structure of the SC public employees and SC public school teachers models are identical but parameters are estimated separately for each model. What differences exist are due to differences in the data sample (public school teachers rather than public employees) and a different estimated earnings-age curve to represent the expected SC public school teacher salary. We assume teachers and public employees with at least a bachelor's degree have the same next best outside option: private sector earnings conditional on age. Like public employees, newly entering teachers can also choose to participate in either the defined-benefit SCRS plan or the defined-contribution SORP plan.

Model Estimation

To estimate the DRM, we use the mathematical structure of the model together with assumptions about the distribution of tastes across employees and the shock distribution. This allows us to derive expressions for the probability of staying which are then used to compose an expression for the likelihood of each individual's total years of service. Importantly, each transition probability is itself a function of the underlying parameters of the DRM. These are the parameters of the taste distribution, the shock distributions, and the discount factor. The estimation routine finds parameter values that maximize the likelihood.

The probability of staying is the probability an individual of a particular age chooses to stay in a given period. Because we assume that the probability of an individual staying in a given period only depends on their state in the previous period, that the shock has an extreme value distribution, and that the annual shocks are uncorrelated from year to year, we can derive closed-form expressions for the probability of staying.

The probabilities of staying in each period are independent and can be multiplied together to obtain the probability of any given individual's career that we observe in the data. Multiplying the career profile probabilities together gives an expression for the sample likelihood that we use to estimate the model parameters by using maximum likelihood methods. Optimization is done using standard hill-climbing methods, and we also use standard methods to compute the standard errors of the estimates. To judge goodness of fit, we use parameter estimates to simulate career profiles for synthetic individuals (characterized by tastes drawn from the taste distribution) who are subject to shocks (drawn from the shock distributions), then aggregate the individual profiles to obtain a state-level retention curve and compare it with the retention curve computed from actual data.

We estimate the following model parameters:

- the mean and standard deviation of taste
- the scale parameter of the idiosyncratic shock distribution
- the personal discount factor[11]

Once we have parameter estimates for a well-fitting model, we can use the logic of the model and the estimated parameters to simulate the cumulative probability of retention to each year of service in the steady state for a given policy environment, such as a change to the parameters of the DB retirement plan. By *steady state*, we mean when all public employees have spent their entire careers under the policy environment being considered. The simulation output includes a graph of the retention profile by year of service. We show model fit by simulating the steady-state retention profile in the current (and, where appropriate, historical) policy environment and comparing it with the retention profile observed in the data.

Table 4.1 shows the parameter estimates for both public employees and public school teachers. The scale of the transitory shock, and the mean and standard deviation of taste are all denominated in thousands of dollars. Public employees have a mean taste of -$25,900 at entry, with a standard deviation of $28,100, while teachers have a positive mean taste of $5,800 at entry, with a standard deviation of $23,200. In other words, the non-monetary taste associated with teaching is higher *on average* than the taste for SC public employment, which reflects the higher retention rate for teachers compared with public employees at all years of service. The scale of the transitory shock is about the same for public employees ($110,400) and for public school teachers ($101,900). In both cases the scale of the transitory shock is about four times the standard deviation of the taste distribution, indicating that while taste is an important determinant

[11] The personal discount factor equals $1/(1 + r)$ where r is the personal discount rate. For example, a personal discount factor of 0.88 corresponds to a discount rate r of 13.6 percent. The interpretation of the personal discount factor is how much an individual values future compensation (compensation given in one year's time) relative to compensation received today. For example, an individual with a discount factor of 0.88 would value $100 to be received in a year's time the same as $88 received today.

of retention, idiosyncratic shocks to individuals are even more so.[12] The discount factor is 0.98 for SC public employees and is 0.96 for public school teachers; these correspond to discount rates of 2 percent and 4.2 percent respectively, which are low compared to rates estimated for other populations using the DRM.

Table 4.1. Parameter Estimates

Parameters	State Workers	Teachers
Scale of transitory shock (λ)	110.4	101.9
	(4.1)	(0.8)
Mean of taste distribution (μ)	-25.9	5.8
	(1.1)	(0.0)
Standard deviation of taste (σ)	28.1	23.2
	(0.6)	(0.4)
Discount Factor (β)	4.0 [0.98]	3.2 [0.96]
	(0.1)	(0.0)

NOTES: Parameters estimates based on maximum likelihood. Standard errors in parentheses. Parameter estimate for the discount rate is transformed to bound the parameter between 0 and 1. The value in square brackets reflects the transformed parameter estimate.

Model Fit

To assess model fit, we used the parameter estimates to simulate the behavior of twenty thousand synthetic SC public employees represented by tastes drawn from a taste distribution and subject to shocks drawn from a shock distribution with parameters for both distributions equal to the estimated values. Given taste, current-period shock values, knowledge of the expected pay environment in public service and the civilian world, and knowledge of the shock scale parameter, each synthetic individual, behaving as a dynamic-program decisionmaker, makes a stay-or-leave decision in each year. This generates a career length of service as an SC public employee. We obtained the predicted retention profile by adding together these individual simulated retention profiles across a large number of simulated individuals. The predicted profiles are plotted against the actual profiles to assess goodness of fit.

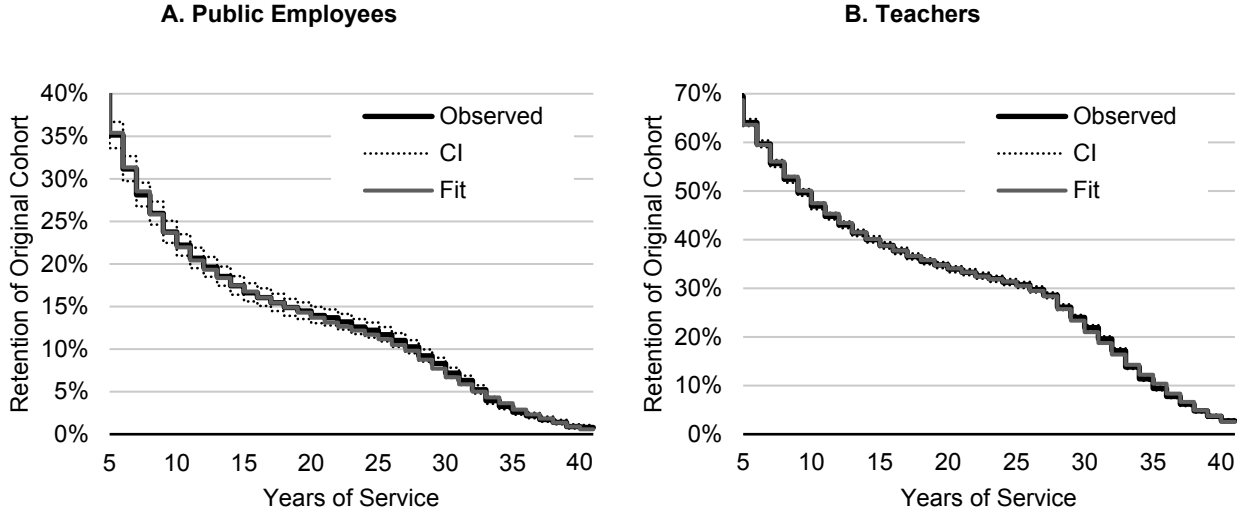
Figures 4.1 shows the model fit graphs for SC public employees and SC public school teachers. The red lines are the simulated cumulative retention, and the black lines are the retention observed in the data. The figures show the Kaplan-Meier survival curves for the observed data, and the dotted lines show the 95 percent confidence intervals for the Kaplan-Meier estimates. The horizontal axis counts years since the individual was observed beginning

[12] The standard deviation of an extreme-value distribution is equal to $\sqrt{\pi^2/6}$ or approximately 1.28 times the value of the scale parameter.

public service. The vertical axis shows the cumulative probability of retention until that year. For example, at entry, year of service is 0 and the fraction of personnel retained is 1, and the fraction of the workforce retained falls over a career as public employees leave their jobs. The solid black line shows the actual retention of individuals in our cohorts, and the red line shows the predicted retention. We assess goodness of model fit by visual inspection, that is, in terms of how well the black and red lines coincide.

Visual inspection reveals that model fit is good for both SC public employees and SC public school teachers. In both cases the simulated retention line lies close to the observed retention line and reflects the pattern of retention seen in the data with attrition first being high, then slowing after mid-career as vesting in the defined-benefit retirement approaches, and then gradually accelerating once the vesting point is reached.

Figure 4.1. Comparisons of Retention of South Carolina Public Employees and Teachers to Model Fit (Employees with at Least a Bachelor's Degree)



NOTE: The figures present years of service 5 to 40 to make the figure easier to view, but the model predicts retention following hire.

Limitations and Advantages

The DRM is a partial equilibrium model that has several limitations.[13] The model assumes stationarity - that the distribution of new employees' taste for public employment does not change over time, and that real public employee and teacher pay as well as their external pay

[13] A partial equilibrium model does not consider the consequence of changes on other inputs of the model, such as a decrease in generosity of pension benefits leading to labor shortfalls that may then lead to increased starting salaries.

opportunities, conditional on age, do not vary across years.[14] It also does not explicitly model other factors that can affect retention and retirement including health status and health care benefits. It also assumes that individuals are risk neutral, that is, they only care about the expected value of future compensation, and do not care about the variance.[15] Furthermore, the model assumes the same outside opportunities for teachers and public employees. In addition, the analysis focuses on retention and does not model the hiring decision or the decisions of employees to enter public service or some other employment, as mentioned earlier in this section. As discussed in the context of our sample selection, the data excludes those who leave public service and are rehired or those with long gaps in their service.[16] Our sample selection is also restricted to employees with at least a bachelor's degree. We estimated models and conducted simulations for a sample of employees with less than a bachelor's degree (not shown) and found that the results we report in the next section are qualitatively similar.

Another limitation is that we only estimate the model and simulate behavioral responses for entrants at or before age 30. We have estimated variants of the model that consider older entrants and we find that their preferences, and consequently retention behavior, differ from that of younger entrants in ways that necessitate estimating separate models for their behavior. While we have not done that in this paper, a more complete view of the impact of a policy change on total population of public sector workers would have to consider separate models for their retention behavior.

It is also important to recognize some limitations of our modeling that are specific to simulating pension reform. The DRM does not model members' choices regarding an annuity or lump sum option and does not model employee savings decisions and therefore their decisions regarding whether and how much to contribute to their pension.[17] An additional limitation of our data and modeling is that we do not observe the DB/DC plan election decision in our personnel data. Therefore, our model may imperfectly capture behavioral responses where election

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[14] Stationarity means that the model will not capture the consequences of changes in hiring practices overtime that may lead to new hires having a different preference for continued employment. As our model is estimated using data from 2010-2019, it will reflect the average preference over that time period. Another consequence of stationarity is that it does not allow for general equilibrium effects, for example, less generous retirement plans leading to higher pay. Higher pay could be added as an offsetting effect in model simulation.

[15] With improved data (particularly with respect to the choice of a DB versus DC plan), we could potentially incorporate risk aversion with respect to the shock term in the model, though doing so would substantially complicate the mathematical structure of the model as well as the computing time required to estimate the model parameters.

[16] We also do not see people switching between teaching and public employment.

[17] Related, we do not model the retirement decision separately from the labor force exit decision, as we do not see retirement for employees that leave. In the model, increasing disutility from work could be modeled as the outside option improving relative to continuing in public employment at later ages, but given the relative youth of our sample (i.e., age 22-30 at entry), we would have difficulty identifying this as a separate preference parameter because many people would reach eligibility for their DB plan prior to ages (e.g., 60 and above) that are normally associated with voluntary retirement.

decisions in the targeted population differ from those who we simulate using our model estimates. We find that predicted plan elections in our model are primarily determined by the estimated discount factor, which, in turn, is identified by the shape of the aggregated retention profile predicted when the model allows plan choice. But if factors other than those currently included in the model determine plan choice (e.g., people do not switch from the default option, the DB plan), then changes in election decisions may affect the magnitude of the simulated retention response to changes in plan design. To address this limitation, we focus our narrative in the next section on simulations without DB/DC choice at the start of the career but consider how behavioral responses may be tempered by this initial choice. Simulation results based on DB/DC choice, including the fraction of new entrants electing the DC plan, are available in Appendix A.

That said, the estimated models fit the observed data well for both the public employees and teacher samples, as shown in Figure 4.1. Further, on a more general level, the DRM approach has several rich and realistic features that make it well suited for analyzing the retention effects of pension reform. It is a lifecycle model where retention decisions are made each year over an entire career, and not just once. Those decisions are based on forward-looking behavior that depends on current and future public employee and external compensation. The model allows for uncertainty in future periods and recognizes that people may change their mind in the future as they get more information about continuing in public service and their external opportunities. Furthermore, the model is formulated in terms of the parameters that underlie the retention decision processes rather than on the average employee responses to a particular retirement reform policy. Consequently, it is structured to enable assessments of alternative pension reforms that have yet to be tried. Put differently, the DRM is particularly suited to assess major structural changes in the compensation system and pension policy that do not have any historical antecedent.

The DRM approach has advantages over alternative retention modeling approaches. Goldberg (2002) provides an extensive discussion of the history of retention models in the military context while Gotz (1990) provides a detailed discussion of the advantages over other approaches. A common alternative approach is the so-called option value approach.[18] It is a multi-period model of retention decision making and could be estimated with regression programs available when it was introduced in the late 1970s, a time when no routines existed to estimate dynamic programming models such as DRM. The tractability of the option value approach comes at a cost, however. It selects a single future year when it is best to leave public service. Decision makers behave as if they know with certainty when they will leave public service, so they are repeatedly surprised by random factors in each future period, even though

[18] In its simplest form, the option value is the difference in the present value of the income stream to be had from leaving immediately and the income stream from staying s more years in service, put on an annualized basis. It is formulated as the maximum of the expected value of staying and the value of leaving. In contrast, the DRM is formulated as the expected value of the maximum of the value of staying and the value of leaving.

random factors always occur. Said differently, the option value approach does not permit the decision maker to re-optimize depending on the conditions realized in future period. From a practical standpoint, the approach can lead to implausible predictions about the retention effects of certain pay and pension policies, thereby leading to flawed policy recommendations. The DRM approach addresses these drawbacks. Apart from the option-value approach, other retention models were one-period models and were not structured to handle retention behavior over a career or to have forward-looking decisions.

5. Analysis of Alternative Policies

Using the model estimated in section 4, we can simulate alternative DB and DC plan policies to understand behavioral responses to changes in plan design. In conducting the simulations, we assume all other characteristics are held constant (e.g., pay, preferences to teach, entry age composition of teachers) except the changes to the pension. As noted in the last section, one of our main limitations is that we do not have data on plan choice, so our model may not well capture the choice of DB versus DC plans by teachers at the start of their career. As a result, we simulate two alternative baseline scenarios. In the first, all employees have the post-2012 (Class 3) DB plan. This scenario abstracts from plan choice and highlights retention changes from retirement plan reforms relative to a fixed plan design. In the second, employees have the choice between the post-2012 DB plan and the SORP DC plan. This scenario highlights how plan choice can amplify or mitigate retention changes from retirement plan reforms. The exception to using the post-2012 DB plan as a baseline is where we conduct simulations of the behavioral responses to changes in the SORP DC plan. In that case, the baseline is either the SORP DC plan or the choice of the post-2012 DB and SORP DC plan.

Conceptually, varying the DB or DC plan design affects both retention incentives and the choice between DB and DC plans. The retention effects of a change in DB plan design can differ depending on whether an employee is retirement eligible. For example, increasing the DB multiplier increases the incentive for mid-career employees to stay until retirement but also increases the incentive to leave once the employee is eligible for retirement. The overall change in retention and average length of service will depend on the relative size of these opposing effects. Changes in the DB design that reduce its generosity will increase the share of employees that participate in the DC plan, assuming employees are able to change plans. This behavior will moderate any negative retention effects of the DB design change and exaggerate any positive effects. Likewise, a change in the generosity of the DC plan (e.g., an increase in DC generosity by adding an employer match) can alter retention and encourage individual to change their initial plan election. Consequently, it is useful to consider both the retention effects and the participation effects of plan design changes.

Reform Scenarios

Despite the reforms in 2012 and 2017, South Carolina law makers have continued to consider reforms to shore up the long-run funding of SCRS for future employees and to encourage greater uptake of the SORP option. We consider both broad reform scenarios (i.e., multiple changes to the retirement plan's design) and single change to elements of the current plan design.

One broad reform proposal introduced recently in January 2021 was Senate Bill 176 (S176), formerly Senate Bill 167 introduced in 2019. Under this proposal, the DC plan would be the default plan for new employees. Table 5.1 compares the elements of the DC plan under S176 to the Class 3 DB and SORP DC plans. The proposed plan would set default employee and employer contribution rates and rather than immediate vesting, vesting would be gradual with different schedules for teachers and state workers. The former group would be 100 percent vested after 5 years while the latter group would be fully vested after 2 years.

Table 5.1. South Carolina Public Pension Rules and Proposed Reforms

	SCRS Class 3 DB (Hired on or after July 1, 2012)	SORP DC (Since 2001)	S176 DC Proposal	Hybrid DB/DC Plan Example
Employee contribution rate	Varies (Currently 9%, see figure 1.1)	Varies (Currently 9%, see figure 1.1)	9% default (min. 5%, max. 15%)	DB: 4.5% DC: 4.5%
Employer contribution rate	Varies (See figure 1.1)	5%	5% mandatory/ 7% default (up to 2% match)	DB: Varies DC: 2.5%
Vesting service requirement	8 years	Immediate	Teachers*: vested in 20% of employer contributions per year; State workers: vested in 50% of employer contributions per year, 100% vested after 2 years	DB: 8 years DC: Immediate
DB Benefit Multiplier	1.82%	n.a.	n.a.	1.00%
DB Full Benefit Eligibility Requirements	Rule of 90 (Age + Years of Service), or Age 65 with at least 8 years of service	n.a.	n.a.	Rule of 90 (Age + Years of Service), or Age 65 with at least 8 years of service
DB Early Benefit Eligibility Requirements [Reduction for each year]	Age 60 with at least 8 years of service [5%]	n.a.	n.a.	Age 60 with at least 8 years of service [5%]
DB Final Average Salary	Average of salary for 5 highest consecutive earnings years	n.a.	n.a.	Average of salary for 5 highest consecutive earnings years
DB Cost of Living Adjustment	1% (up to $500)	n.a.	n.a.	1% (up to $500)
Social Security Coverage	Yes	Yes	Yes	Yes

NOTE: n.a. = Not applicable.

Another broad reform scenario is the introduction of a hybrid DB/DC plan. A hybrid DB/DC plan has been introduced in other states in recent years, such as Tennessee, as well as by the U.S. military. These plans offer a DC component but also have a reduced DB multiplier. Eligibility conditions may also differ. The last column in Table 5.1 offers an example hybrid plan that maintains many of the same aspects of the DB plan, including similar eligibility requirements and the same total employee contributions, but trims the DB multiplier from 1.82 percent to 1 percent. According to a Pew Charitable Trust analysis in 2015, a 1 percent multiplier was the most common multiplier among the state pension hybrid systems they analyzed (Pew Charitable Trusts, 2015). The hybrid system also introduces a SORP-like DC plan that received half the total employee contribution and also received a 2.5 percent contribution from the employer.

Table 5.2 summarizes the additional scenarios where we consider singular changes to the current DB or DC plans in order to understand sensitivity to particular elements of the current plan design. For the SCRS DB plan, we simulate the retention response to changes in the DB multiplier and/or employee contribution rate,[19] the eligibility criteria for full and early retirement, the number of years upon which the FAS is computed, and the size of the annual cost of living adjustment (COLA) for retired pay recipients. For the SORP DC plan, we consider scenarios where the employer contribution rate or the vesting years of service is increased or reduced. For each policy reform we compare overall retention, as measured by the average experience of the workforce retained, with overall retention under the baseline where the baseline assumes all employees are currently covered by the SCRS Class 3 DB plan (if simulating changes to the DB plan) or the SORP DC plan (if simulating changes to the DC plan). As mentioned, we also compare overall retention under a baseline where employees can select into the DB or DC plan at hire to reflect selective retention associated with DB/DC choice. Under this baseline, the share of employees opting for SORP could change under each scenario. Choice will moderate behavioral responses based only on one type of plan, as workers that are unlikely to remain for an entire career will pick the DC plan since it offers portable benefits. We report the DC plan take-up rate in Appendix A.

[19] We simulate, first, how changing the DB multiplier would affect retention, holding contribution rates constant and second, how changing both would affect retention. We consider the first case as well as the second case so as to assess how changing the DB multiplier, holding constant the effects of changing the contribution rate, would affect retention.

Table 5.2. Singular Changes to Elements of Current DB and DC Plan Design Analyzed

DB	DC
DB Multiplier and DB employee contribution rate	DC employer contribution rate
Reduce multiplier only	Reduce contribution rate
Increase multiplier only	Increase contribution rate
Reduce contribution rate only	
Increase contribution rate only	
Reduce contribution rate & reduce multiplier	
Increase contribution rate & increase multiplier	
DB retirement age/years of service eligibility	DC vesting years of service
Reflect Class 2 retirement rules	Reduce years of service
Increase retirement ages	Increase years of service
DB Final average salary	
Fewer years of service	
More years of service	
DB COLA	
Reduce COLA	
Increase COLA	

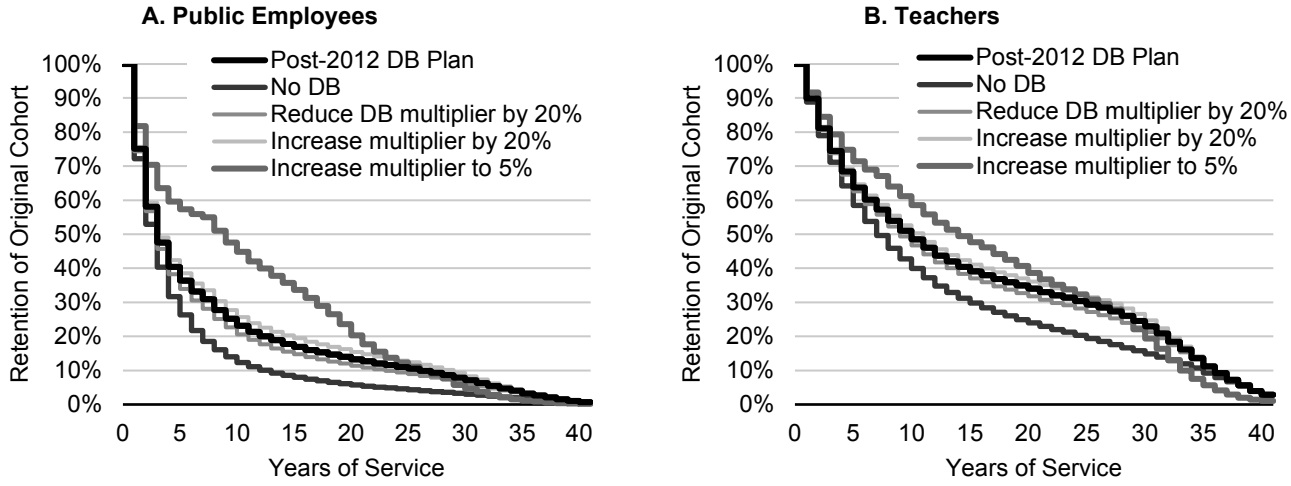
In our presentation of results, we first show the range of results when we vary individual parameters of the DB and then the DC plan, as summarized in Table 5.2. We then summarize the results of the two broader proposals that vary multiple parameters, S176 and the hybrid plan example.

Alternative DB Plan Designs

This subsection shows the simulated effects on average experience from varying alternative DB features relative to these outcomes to a baseline reflecting the post-2012 DB plan. It also considers the results under our second baseline where employees have a choice between the post-2012 DB and DC plan in the model. We will show that having a choice will tend to mitigate any reductions in retention. In the baseline, the average experience of the public employee and teacher workforces retained are 8.0 and 15.3. When considering a model with DB/DC choice, the average experience of the public employee and teacher workforces are 7.7 and 15.1 respectively, with 43 percent and 69 percent of employees, respectively, taking the DC option. For each workforce, Table 5.1 summarizes the percent change in the simulated average years of service under the alternative DB plan changes with only a DB plan and with a choice of a DB or DC plan (Appendix A reports the simulated percent of the retained workforce choosing the DB plan). Note that the percent changes in average experience will generally be smaller for teachers than for public employees because the baseline level is higher for teachers, implying that the same

magnitude change in average years worked for both groups will imply a smaller percentage change for teachers. Also, to highlight how changes in DB features affect cumulative retention over a public employee or a teacher's career, Figure 5.1 shows simulations of the effects on retention of alternative DB multipliers for the post-2012 DB pension while Figure 5.2 shows the simulated effects of alternative COLA provisions, both analyses assuming no DB/DC choice.

Figure 5.1. Alternative DB Multipliers for Post-2012 DB Plan



NOTES: BA plus only. No DB/DC choice.

Figure 5.1 shows that predicted retention behavior varies across the career with different post-2012 DB multipliers. The left-most column in Table 5.1 shows the baseline DB multiplier percent of 1.82 percent and the alternative multipliers. For example, we consider an increase in the multiplier by 20 percent to 2.18 percent. As before, the baseline retention profile is shown in black. The largest predicted change occurs for both public employees and teachers when the DB multiplier is increased for the baseline of 1.82 percent to 5 percent (the dark green line). Increasing the multiplier increases the incentive to stay until the employee or teacher is eligible for either early or full retirement because the retirement formula in equation (2.1) shows that each additional year increases the retirement benefit both directly and indirectly to the extent that salaries rise with years of service. Not surprisingly, increasing the multiplier increases retention through year 25 for public employees and year 30 for teachers. The employee continues to have an incentive to stay even after he or she is eligible for either early or full retirement. But the employee who is eligible to immediately collect retirement benefits also has an incentive to leave. For both public employees and teachers, we find that increasing the DB multiplier reduces retention in the most senior years when employees are eligible for retirement benefits.

Whether average experience increases or decreases depends on the relative size of the changes in retention among early and mid-career employees and the changes in retention in the opposite direction among late-career employees. Table 5.3 shows that when the DB multiplier is

increased, average years of service also increases, even when the increase in the multiplier is modest, such as 1 percent increase to 1.84 percent. Thus, the increase in retention in the early years offsets the lower retention in the senior years when the multiplier increases. Similarly, reducing the DB multiplier to zero (red line) reduces retention in the early and mid-career and increases retention at the end of the career in Figure 5.1 with a reduction in average years of service for both teachers and public employees, as shown in Table 5.3.

When plan choice is allowed, the changes are far more modest when the DB multiplier is reduced. This is because employees exercise the option to take the DC plan instead (see Appendix Table A.3). The percent of employees taking the DC plan increases when the DB multiplier is reduced. When it is reduced to zero, the DC participation rate increases to 100 percent. When the DB multiplier is increased, the response grows because more employees switch from the DC to the DB plan. In short, the ability of employees to participate in the DC plan may moderate reductions and magnify increases in the generosity of the DB plan.

The table also shows the responses to changing both the DB multiplier and/or the employee contribution rate. We consider these together because changes in the generosity of the DB multiplier might occur in tandem with changes in the required employee contribution to the DB. Reducing the contribution rate to 0 percent without any other change increases the generosity of the DB plan and would increase the average experience level by 15.6 percent and 13.5 percent. Allowing for choice magnifies this response to 17.8 percent and 15.3 percent, respectively, for public employees and teachers by reducing the DC participation rate to 19 percent and 0 percent. However, if the reduction to 0 percent were also combined with a reduction in the DB multiplier to 0 percent, the change in the average experience would, instead, be negative for both public employees and teachers, as this eliminates any retirement plan from their compensation. Public employees exhibit a larger decline in average years of service in both magnitude and percentage terms (21.2 percent) relative to teachers (5.2 percent). This reflects that teachers have a higher average taste for their career, meaning that even without a pension the call to teach will remain a significant retention lever for many. Allowing for DC option significantly mitigates the negative effects of eliminated the DB plan, particularly for teachers who exhibit a slight increase (0.3 percent) is average years served.

Table 5.3. Predicted Change in Average Years of Service to Alternative DB Plan Policies (with and without DB/DC plan choice)

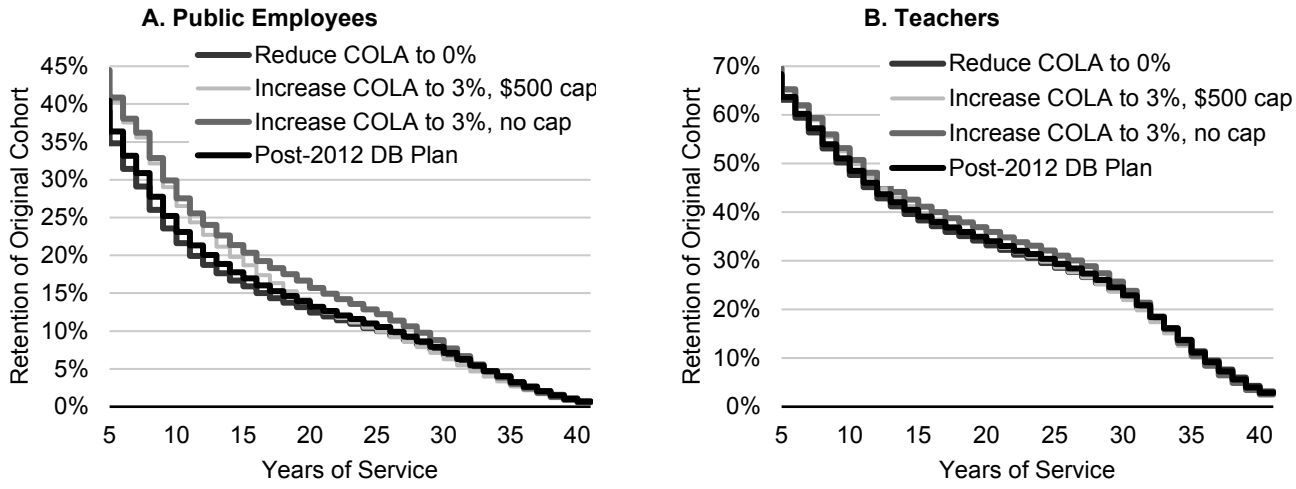
Simulated Policy Change	All employees in DB plan		With DB/DC plan choice	
	Public Sector	Teachers	Public Sector	Teachers
Average years of service at baseline	8.0	15.3	7.7	15.1
DB Multiplier (Baseline: 1.82%)				
Reduce to 0%	-31.9%	-17.6%	-6.6%	0.3%
Reduce by 20% (1.46%)	-7.7%	-3.7%	-7.3%	0.3%
Reduce by 1% (1.80%)	-0.2%	-0.3%	-0.2%	-0.1%
Increase by 1% (1.84%)	0.3%	0.2%	0.2%	-0.1%
Increase by 20% (2.18%)	8.2%	3.6%	8.2%	3.3%
Increase to 5%	41.3%	7.5%	44.5%	9.1%
DB Multiplier (Baseline: 1.82%) & DB Contribution Rate (Baseline: 9%)				
Reduce contribution rate to 0%	15.6%	13.5%	17.8%	15.3%
Increase contrib. rate to 12%	-4.5%	-4.3%	-3.8%	0.3%
Reduce contribution rate to 0%; Reduce multiplier to 0%	-21.2%	-5.2%	-6.6%	0.3%
Increase contribution rate to 12%; Increase multiplier to 5%	36.4%	3.5%	39.1%	4.5%
DB retirement age/years of service eligibility Normal retirement eligibility baseline: Rule of 90 (age + years of service), or age 65 with at least 8 years of service Early retirement eligibility baseline: Age 60 with at least 8 years of service				
Reflect pre-2012 retirement rules (more generous) Normal retirement eligibility: 28 years of service or age 65 with 5 years of service Early retirement eligibility: age 55 with 25 years of service or age 60 with 5 years of service	1.0%	-0.3%	1.2%	-0.3%
Increase retirement ages (less generous) Normal retirement eligibility: Rule of 95 or Age 65 with 10 years of service Early retirement eligibility: Age 60 with 10 years of service	-0.9%	0.1%	0.3%	0.3%
Final average salary (Baseline: highest 5 years)				
Highest 3 years (more generous)	0.8%	0.5%	1.2%	0.1%
Highest 10 years (less generous)	-2.2%	-1.2%	-1.4%	0.3%
COLA (Baseline: 1% up to maximum of $500 per year)				
Reduce COLA to 0%	-3.7%	-1.3%	-2.9%	0.3%
Increase COLA to 3%, maximum of $500 per year	4.8%	0.1%	5.3%	0.5%
Increase COLA to 3%, no maximum	11.0%	3.0%	11.3%	3.4%

NOTES: Relative to post-2012 DB plan and post-2012 SORP DC plan.

We also find that changes in the retirement eligibility criteria and the years of service basis for computing FAS have far more modest effects on average experience than changes in the DB multiplier or the contribution rate. For example, the more generous pre-2012 rules for retirement eligibility, without any other change, would increase average experience by 1.0 percent for public employees and decrease retention by 0.3 percent for teachers. Similarly, making the eligibility rules less generous by changing the rule of 90 to a rule of 95 or requiring 10 years of service at age 65 would decrease average experience by 0.9 percent for public employees but increase retention by 0.1 percent for teachers. Although retention falls for junior and early-career personnel because the plan is less generous, retention increases for those in later years because more years must be served to become eligible for retirement; the latter effect slightly outweighs to former effect for teachers, resulting in a slight increase in average experience. Meanwhile, the reverse is true for public sector workers. Qualitatively, the results are similar, and relatively small, for the scenarios where we increase or reduce the number of years over which FAS is computed. For both types of policies—changing the retirement eligibility rules and FAS years of service— when allowing DB/DC choice, increasing the generosity of the DB plan reduces participation in the DC plan while reducing the generosity increases participation in the DC plan, for both public employees and teachers, but neither has a substantial effect of the average years served.

Finally, we consider how alternative COLA policies would affect predicted outcomes. The current policy is to increase the annuity by 1 percent per year with a $500 annual cap on the increase. Figure 5.2 illustrates differences in predicted retention over a career for public employees and teachers under a less generous COLA policy of no COLA and more generous policies that would offer a 3 percent annual COLA with and without a $500 annual cap. As expected, offering a 3 percent annual COLA with no cap has the largest predicted effect on average years of service for both teachers and public employees, with fewer employees in both groups participating in the DC plan. Adding the $500 cap to the 3 percent annual COLA more than halves the percent change in average experience. As shown in Figure 5.2, retention increases in the early and mid-career for both employee groups when the COLA is increased. Reducing the COLA to 0 percent has a negative predicted retention effect for public employees and teachers. Consistent with our other findings, introducing DB/DC choice magnifies responses when the DB COLA is made more generous and mitigates responses when it is made less generous.

Figure 5.2. Alternative COLAs for Post-2012 DB Plan



NOTES: BA plus only. No DB/DC choice. The figures present years of service 5 to 40 to make the figure easier to view, but the model predicts retention following hire.

In sum, varying the DB multiplier and/or contribution rate has the largest predicted effect on retention compared with the other scenarios we considered. We also found that DC participation is sensitive to changes in the DB plan features. The effect on retention of reducing the generosity of the DB plan is lessened because more employees opt to participate in the DC plan. Similarly, the impact on retention of increasing generosity is amplified because fewer opt for the DC plan. Thus, having the DC plan choice is an important consideration in the DB plan design and its effect on retention.

Alternative DC Plan Designs

We next show results for the predicted responses to changes in DC plan policies. Table 5.4 shows the changes in the simulated average years of service when we consider alternative DC employer contribution scenarios and DC vesting scenarios, relative to a baseline of the SORP DC plan. We also consider a baseline where employees have the DB/DC choice. We find that the predicted retention responses are small relative to the retention responses to increases in the DB multiplier shown Table 5.3. For example, increasing the DC employer contribution rate from the baseline of 5 percent to 7 percent is predicted to increase average years of service by 4.5 percent for public employees and by 2.4 percent for teachers. Increasing the DC vesting years of service from immediate to up to 10 years is predicted to have a less than 1 percent change in average experience. As was the case with the DB policy scenarios, DB/DC plan choice moderates the effects of changes that make a DC plan less generous and amplifies the effects of changes that make a DC plan more generous for teachers. For public employees, if there is a DB/DC choice, changes in the DC plan have minimal effect on participation decisions, minimizing any response.

For example, when the employer contribution rate increases to 7 percent, the DC participation rate is predicted to increase from 69 percent to 100 percent for teachers, whereas for public employees it increases from 43 to 44 percent.[20]

Table 5.4. Predicted Change in Average Years of Service to Alternative DC Plan Policies

Simulated Policy Change	All employees in SORP DC plan		With DB/DC plan choice	
	Public Sector	Teachers	Public Sector	Teachers
Average years of service at baseline	7.2	15.2	7.7	15.1
DC Employer Contribution (Baseline: 5%)				
3%	-4.0%	-2.8%	0.4%	0.0%
4%	-2.0%	-1.4%	0.2%	-0.5%
6%	2.3%	1.3%	0.5%	1.6%
7%	4.5%	2.4%	0.9%	2.7%
DC vesting years of service (Baseline: immediate)				
2 years of service	0.3%	0.1%	0.3%	0.1%
5 years of service	0.5%	0.2%	0.7%	0.2%
10 years of service	0.7%	0.4%	0.8%	0.3%

NOTES: Relative to post-2012 DB plan and post-2012 SORP DC plan.

Alternative Valuations of DC plans

An underlying assumption of our analysis is that individuals make retention decisions by weighing the value of staying versus the value of leaving, recognizing that current and future compensation including pensions affect the value of leaving versus staying, that individuals have differing preferences, and that the value of staying and leaving are subject to random shocks. As discussed earlier, the formulations of the value of staying or leaving do not incorporate risk aversion or other factors, such as financial literacy and the efficacy of financial education, that could affect an individuals' valuation of staying versus leaving over above the factors we include. For example, if individuals are risk averse, they may consider DC plan benefits as less generous than DB plan benefits that give the same expected value. Because DB plan benefits are

[20] A common thread in our comparisons between South Carolina state employees with at least a BA and teachers is that teacher's DB/DC plan choice is more sensitive to changes in pension plan design. This can be explained from differences in model estimates between the two groups. Workers with a high taste for their current job are typically more likely to stay for a career and will often choose a DB plan since it rewards staying until the plan's retirement benefit eligibility age or years of service. An exception to this relationship occurs when the DC plan is relatively generous and/or when individuals have a very high taste for a job. Teachers have a greater average taste for teaching (see Table 4.1) and increasing the contribution rate from 5 to 7 percent is making a DC plan relative more generous compared to the current DB plan. Since DB plans require leaving a job to collect benefits, a more generous DC plan enables teachers with a strong preference to continue teaching to do so while still growing their retirement benefit.

defined, they are viewed as subject to less risk whereas DC benefits are viewed as riskier because they depend on the amount and timing of contributions and how the value of the DC fund changes over time.[21] In short, employees may value DC benefits by less than the value we include in our model.

To explore how alternative valuations of the DC plan would affect our retention results, we simulated how average years of service would change when the DC plan is discounted by 75 percent, 50 percent, and 25 percent of its true value. This analysis is exploratory because our model estimates are based on a model where the DC plan is valued at 100 percent of its true value. Table 5.5 summarizes the results. As expected, retention as measured by average years of service falls in each case we consider because undervaluation of the DC benefit is equivalent to a cut in compensation. The magnitudes of the reductions are larger than the effects of any of the DC plan design alternatives we consider in Table 5.4. Not surprisingly, when employees have a choice to take the DB plan instead, the reduction in retention is more than mitigated because the estimated change in retention is positive rather than negative. While these results are exploratory, they suggest that the effects of factors such as risk aversion that could result in employees undervaluing their DC benefit could be mitigated with having a choice of taking a DB plan.

Table 5.5. Predicted Change in Average Years of Service based on Lower Perceived DC Valuation

Simulated Policy Change	All employees in SORP DC plan		With DB/DC plan choice	
	Public Sector	Teachers	Public Sector	Teachers
Average years of service at baseline	7.2	15.2	7.7	15.1
Valuation of DC plan				
75% of true value	-6.8%	-4.5%	0.6%	0.6%
50% of true value	-13.0%	-8.9%	2.0%	1.1%
25% of true value	-18.9%	-12.8%	2.6%	1.5%

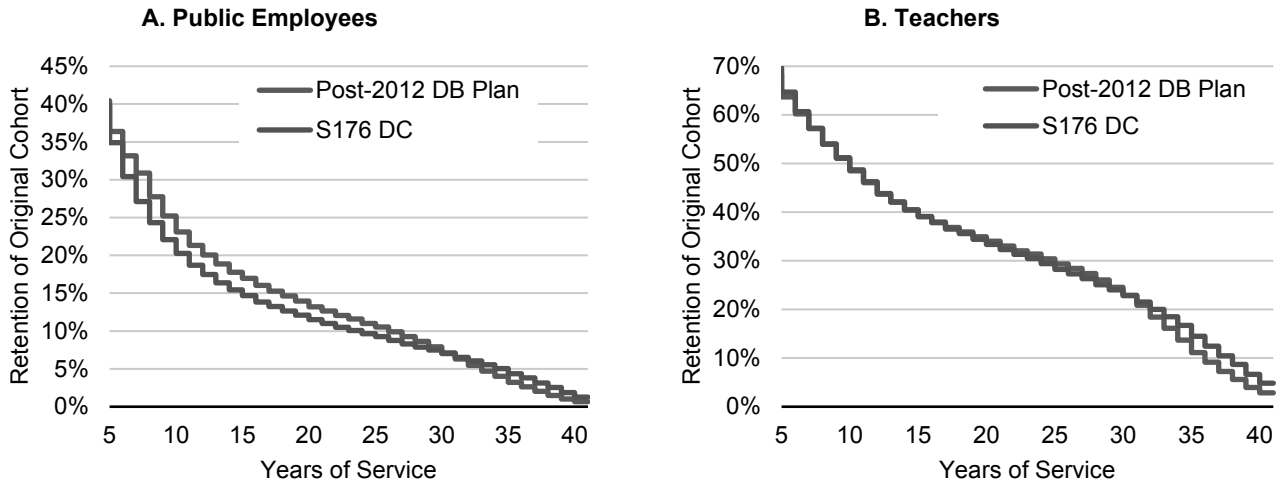
NOTES: Relative to post-2012 DB plan and post-2012 SORP DC plan.

S176 Proposed DC Plan

We next consider the estimated retention effects of the S176 proposed DC plan. Figure 5.3 demonstrates the simulated effect on retention of everyone having the S176 DC plan versus everyone having a post-2012 DB plan (the current default plan for new hires). For public employees, the average years of service decreases by 5.1 percent (-0.4 years) and for teachers, the average years of service increase by 1.4 percent (0.2 years).

[21] Of course, DB benefits may not be risk-free if DB benefits are subject to cuts when employers—or the state—are unable to fully fund the benefit.

Figure 5.3. Impact of S176 DC Plan on Retention Behavior



NOTES: Simulations reflect only employees with at least a bachelor's degree based on model estimates in Chapter 4 and samples described in Chapter 3. The figures present years of service 5 to 40 to make the figure easier to view, but the model predicts retention following hire.

Differences in average years of service hide commonalities in behavioral responses. In both samples, the DC plan retains employees through the first couple years of service at higher rates because a DC plan offers benefits even for workers with a short employment history. From roughly 8 to 31 years of service, a DC plan is associated with lower retention rates because it does not provide the same financial pull to stay in teaching or public service as a DB plan's eligibility age. It also does not have the financial push to leave after DB eligibility. After 31 years of service, the additional benefits of continued employment under a DC plan remain, while a DB plan's benefit growth is generally limited. In the case of a DB plan, after retirement eligibility an additional year of service may grow the permanent monthly benefit but also results in a year of foregone benefits leading to net retirement savings growth being small or potentially negative. This effect leads to comparatively lower retention after 30 years of service for employees with the post-2012 DB plan relative to employees with the proposed S176 DC plan. For public employees, 3 percent less of the original cohort are retained through 10 years of service under the DC plan, decreasing the average number of years served. For teachers, the difference between the plans in retention through 10 years of service is less than one percent of the original cohort. Since the DC plan reduces the push to leave teaching for senior teachers, relative retention in later years is much higher under a DC plan. For teachers, these additional years are sufficient to offset any additional mid-career turnover under a DC plan leading to a positive change in average years of service. For public sector employees these additional years are insufficient to offset mid-career turnover, leading to a negative change in average years of service for public sector employees. Both responses are relatively small, suggesting that the post-2012 plan is comparable to the S176 DC plan on average.

Subgroup Response to S176 DC Plan

In Appendix A, we report model estimates for alternative groups of South Carolina public employees, including South Carolina public university employees with at least a BA, all public employees (including non-university employees) with a BA, public employees in non-University associated state agencies with less than a BA, and employees in the Department of Mental Health with less than a BA.[22] Table 5.6 considers the sensitivity of the responsiveness of South Carolina public sector workers compared to our focal groups of non-university state employees and teachers. All employee groups exhibit similar patterns – the shift from the post-2012 DB plan to the proposed S176 DC plan would increase retention very early in the career, decrease retention during the middle of a career, and increase retention of workers late in their career, typically beyond 30 years of service. Similar to public school teachers, university employees with at least a BA degree and state employees with less than a BA exhibit an increase in the average years of service under the DC plan, meaning that the additional years from late-career workers would more than offset the higher mid-career turnover. Regardless of subgroup, changes to retention under the S176 proposal are broadly consistent in that they are relatively small compared to the status quo DB plan.

Table 5.6. Response to S176 DC plan

Sample	Average service under Class 3 DB plan	Change in average service with S176 DC	Percent change in average service with S176 DC plan
Public sector: non-university, BA+	7.98	-0.41	-5.1%
Teachers	15.34	0.22	+1.4%
Additional groups of public employees			
Public sector: university, BA+	9.78	0.13	+1.4%
Public Sector: All, BA+	8.74	-0.20	-2.3%
Public sector: non-university, less than BA	5.80	0.03	+0.5%
Public sector: Department of Mental Health, less than BA*	4.81	0.15	+3.0%

NOTES: Assumes no DB/DC choice. Models estimates reported in Appendix A, including fit.

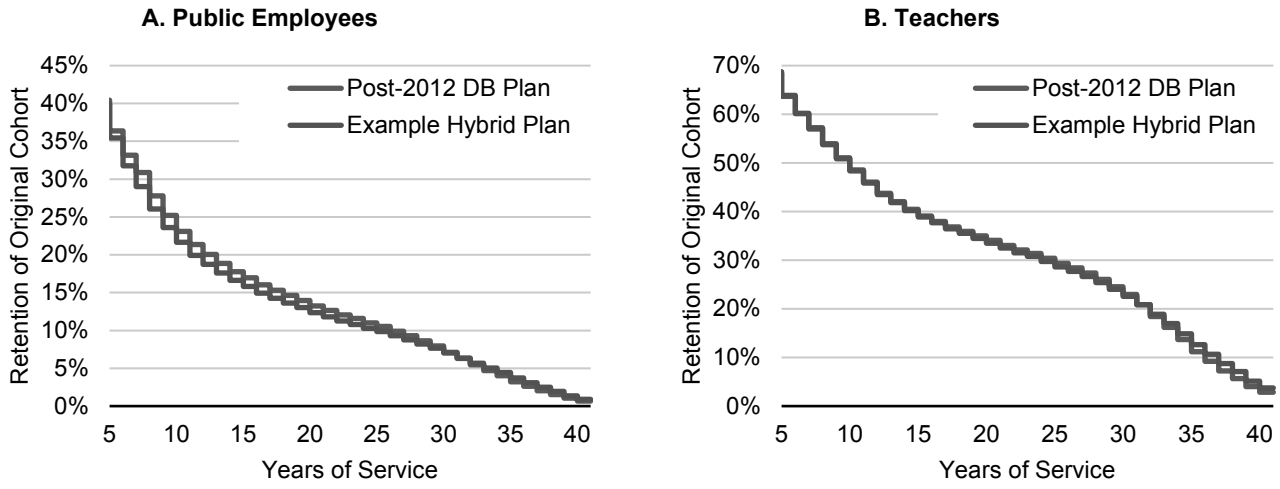
[22] The Department of Mental Health was chosen because it had the largest sample of public employees with less than a BA outside of public universities, the Department of Corrections (comprised mostly of LEOs with different pension incentives), and the Department of Transportation (which had a special retention program during our observed period).

Example Hybrid Plan

Conceptually, the hybrid plan offers a mix of the retention benefits unique to DB and DC plans. The DC component provides both a separation and retention incentive to workers who are likely to have a limited career; while these workers leave with a DC benefit, thereby increasing their incentive to leave, staying an additional year also results in additional DC employer and employee contributions, thereby increasing the incentive to stay. For mid-career workers, the DB component provides a pull to remain with the employer, and in the late stages of the career, the strong push of the DB plan is weakened, and the DC plan offers benefits from continued employment.

Figure 5.4 demonstrates the effect on retention of everyone having the example hybrid plan versus everyone having a post-2012 DB plan. Overall, the effects on average years of service are small. For public employees, the average years of service decreases by 3.0 percent (-0.2 years) and for teachers, the average years of service increase by 0.1 percent (less than 0.1 years).

Figure 5.4. Impact of Example Hybrid Plan on Retention Behavior



NOTES: Simulations reflect only employees with at least a bachelor's degree based on model estimates in Chapter 4 and samples described in Chapter 3. The figures present years of service 5 to 40 to make the figure easier to view, but the model predicts retention following hire.

The hybrid plan does a somewhat worse job of retaining public employees over most of their career. For public employees, years of service decline prior to 31 years of service and slightly increase after with the loss or gain being less than one percent of the original cohort in many years of service. The loss in retention is greater than one percent from 6 to 19 years of service. For teachers, the gain or loss is less than one percent of the original cohort in most years of service, with the gain in retention being greater than one percent after 31 years of service. As the difference between retention under the post-2012 DB plan and the proposed hybrid plan are

relatively small, a more generous hybrid plan could lead to greater retention relative to the post-2012 DB plan.

Subgroup Response to the Example Hybrid Plan

Similar to our subgroup analysis of the S176 DC plan, Table 5.7 considers the retention sensitivity of South Carolina public sector worker subgroups under the example hybrid plan relative to the post-2012 DB plan. Employee groups differ in whether the example hybrid plan leads to an increase or a decrease in average labor supply over the career as measured by average years of service when shifting from the post-2012 DB plan to the example hybrid plan. Additionally, the groups differ in where their gains and losses are concentrated.[23] For non-university employees with at least a BA, the loss in concentrated in mid-career (6 to 19 years of services). For university employees with at least a BA, the changes are fairly minor and well distributed across the career, leading to no meaningful change in average years of service. For employees in groups with less than a BA, small gains are concentrated in the early part of the career (3 to 5 years of service) or after 30 years of service. For the broad category of non-university employees with less than a BA, losses in the mid-career (6 to 19 years of service) offset these small gains leading to a slight decrease in overall average years of service. These mid-career losses are not observed for the Department of Mental Health. These findings suggest that a DC component may be helpful at extending employment in early and late portions of the career, but the limited changes also clarify that such plan is unlikely to dramatically change the substantial turnover observed in the first 10 years of public service. Similar to the S176 proposal, changes to retention under the example hybrid plan are relatively small regardless of subgroup. The hybrid plan does a better job of sustaining the size and experience mix of the workforce retained than does S176, generally leading to small average increase in years of service. The amount of the change is sensitive to the design of the hybrid plan, and less generous benefits may lead to a decline in average years of service.

[23] We define a concentrated gain in retention as a retention difference in a specific year of service exceeding 1.5 times the average retention gain over the predicted 40-year period.

Table 5.7. Response to Example Hybrid Plan

Sample	Average service under Class 3 DB plan	Change in average service with hybrid plan	Percent change in average service with hybrid plan
Public sector: non-university, BA+	7.98	-0.24	-3.0%
Teachers	15.34	0.01	+0.1%
Additional groups of public employees			
Public sector: university, BA+	9.78	0.01	+0.1%
Public Sector: All, BA+	8.74	-0.14	-1.6%
Public sector: non-university, less than BA	5.80	-0.05	-0.9%
Public sector: Department of Mental Health, less than BA*	4.81	+0.04	+0.9%

NOTES: Assumes no DB/DC choice. Models estimates reported in Appendix A, including fit.

6. Conclusions and Implications

As states, including South Carolina, seek to shore up the long-run cost of their public pension systems and to make employer costs more predictable for existing employees, policy makers are considering changes to pension benefits. But such changes have implications for the public employee workforce because pension benefits affect their retention behavior. In this paper, we predict behavioral responses and their magnitudes based on a range of reforms that could be done to make employer costs more predictable using estimated models reflecting employees' incentives to continue in public service based on pay and pensions. This section summarizes our main conclusions regarding design changes to the SCRS DB plan and DC plan as well as regarding two possible reform alternatives.

We find that among the DB design changes we considered, varying the DB multiplier and/or contribution rate has the largest predicted effect on retention compared with the other scenarios we considered. Whether average experience among the public employees and teachers increases or decreases when the design of the DB plan changes depends on the relative size of the changes in retention among early and mid-career employees who are influenced by the pull incentives of the DB plan to reach retirement and the changes in retention in the opposite direction among late-career employees who face a push incentive to leave once they are eligible for retirement. When the DB multiplier is reduced, average experience falls for both public sector employees and South Carolina teachers and it increases when the DB multiplier is increased. For example, reducing the DB multiplier by 20 percent from 1.86 percent to 1.46 percent reduces average experience by 7.7 percent and 3.7 percent for public sector employees and South Carolina teachers, respectively while increasing it by 20 percent to 2.18 percent increases average experience by 8.2 percent and 3.6 percent for the two populations, respectively. Note that the percent changes in average experience will generally be smaller for teachers than for public employees because the baseline experience level is higher for teachers, implying that the same magnitude change in average years worked for both groups will imply a smaller percentage change for teachers. In terms of the design features that have the smallest estimated effect on retention, we find that changes to the DB retirement age/years of service eligibility rules and to the final average salary basis have smaller effects than changes to the DB multiplier and/or contribution rate.

Underlying these results is the assumption that employees are not allowed to opt to participate in the DC plan. We find that DC participation is sensitive to changes in the DB plan features and we consider an alternative baseline and scenarios where employees have a choice of plans. The effect on retention of reducing the generosity of the DB plan is lessened because more employees opt to participate in the DC plan. Similarly, the impact on retention of increasing

generosity of the DB plan is amplified because fewer opt for the DC plan. Thus, having the DC plan choice is an important consideration in the DB plan design and its effect on retention.

We also considered alternative DC employer contribution scenarios and DC vesting scenarios, relative to a baseline of the SORP DC plan. We find that that the predicted retention responses are small relative to the retention responses to increases in the DB multiplier. For example, reducing the employer DC contribution by 20 percent from a baseline of 5 percent to 4 percent reduces average years of experience by 2 percent for public employees and by 1.4 percent for teachers. These estimated effects were even smaller if employees and teachers are permitted to opt to participate in the DB plan instead. In sum, changes to DB plan characteristics have the potential to change retention more than changes to DC plan characteristics.

In January 2021, South Carolina law makers proposed S176 to entice greater use of the DC plan relative to the DB plan. Under this proposal, the DC plan would be the default plan for new employees, it would create an employer match that could lead to higher employer contributions than the previous DC plan and set vesting under the DC plan to be gradual rather than immediate. An alternative reform that has also been considered is a hybrid plan that offers both a DB and DC plan in combination. Our simulations indicate that relative to post-2012 DB plan, both S176 and the example of a hybrid plan that we consider would produce small overall changes in average experience but would affect the experience mix of junior and senior personnel. In particular, S176 would reduce mid-career retention but increase retention among senior personnel while the hybrid plan we considered could increase or decrease retention over most of the career depending on the public employee group examined, albeit slightly. While the changes under both proposals are relatively small, the hybrid plan we considered does a generally better job of sustaining the size and experience mix of the workforce retained than does S176, insofar as policy makers seek to sustain the retained workforce as it pursues pension reform.

Implications

Our analysis shows that changes in pension design, especially changes in the design of the DB plan, creates behavioral responses from employees in terms of their retention decisions and their decisions to participate in the DC versus the DB plan. Furthermore, because changes in retention decisions in response to design choices can affect the mix of junior versus senior personnel, the design changes can affect the extent of expertise, knowledge, and competency of the workforce as well as the overall pay bill faced by South Carolina. If the workforce becomes more senior in terms of experience mix, the pay bill will increase insofar as senior employees are paid more. Consequently, cost analyses of pension reforms that only consider changes in pension costs could understate or overstate the change in total cost if the pay bill changes as well. In short, the analysis implies that pension reform proposals should also consider the effects on the workforce as well as on cost. While the DRM approach has limitations, as a structural

dynamic programming model, it is unique in its advantage to permit analysis of reform proposals that have yet to be tried.

Appendix A. Robustness Checks

In the main text, we considered a number of alternative population groups to understand the sensitivity of our model's parameter estimates and retention predictions made using those parameter estimates. In this appendix, we report those model estimates. We also expand on the reported retention responses in Chapter 5 by computing the fraction of the sample electing a DC plan when DB/DC choice is introduced into the model.

Alternative Model Estimates for Additional of South Carolina Public Employees

In Chapter 4, we reported model predictions for South Carolina non-university state workers with at least a bachelor's degree (BA+) and public school teachers.[24] We estimated the model for four alternative groups of South Carolina public employees:

1. South Carolina public university employee with BA+,
2. all public employees (including non-university employees) with BA+,
3. public employees in non-University associated state agencies with less than a bachelor's degree (less than a BA), and
4. employees in the Department of Mental Health with less than a BA.

Our focus on BA+ workers was because retention of these workers over the career was notably greater than individuals without a BA degree (less than BA). For non-university state workers, 24 percent of BA+ employees make it to 10 years of service compared with 16 percent for those with less than a BA. Over their career, the average years of service for a non-university public employee with BA+ is 7.9 years compared with 5.9 years for a non-university public employee with less than a BA. Additionally, we focus on non-university state employees because they have notably lower retention than their university employee counterparts. For university employees with BA+, 29 percent reach 10 years of service and have 9.7 years of service on average over a worker's career. The Department of Mental Health was chosen because it had the largest sample of public employees with less than a BA outside of public universities, the Department of Corrections (comprised mostly of law enforcement officers with different pension incentives), and the Department of Transportation (which had a special retention program during our observed period).

Table A.1 reports the model estimates for each subgroup. Consistent with higher retention, university workers with BA+ have a higher mean taste for their job at entry than state workers

[24] As noted in Chapter 2, most teachers have at least a bachelor's degree.

excluding university workers. University workers also have a higher transitory shock scale, meaning they are more likely to leave for factors over their career that are not accounted for in the model. A lower discount rate, along with a high transitory shock scale also mean that long-term deferred compensation, such as a DB plan, will be less salient to their decision to stay or leave their current employment compared with non-university state workers with at least a BA. When combining all state workers with BA+, the parameter estimates blend the two groups.

Relative to state workers with at least a BA, state workers with less than a BA have a similar average taste but a lower standard deviation of taste. The discount factor is similar as well. The scale of the transitory shock is lower for workers with less than a BA, likely reflecting the lower overall compensation for these workers (e.g., lower pay means a smaller transitory shock would be required to elicit a behavioral response to leave). Lower retention among state workers with less than a BA is likely due to the lower standard deviation in the taste factor (i.e., fewer workers in this groups would have a particular high taste for state government employment) and the lower relative compensation late in the career relative to the public sector (see Figure C.2). Relative to non-university state workers with less than a BA, the model estimates for employees with less than a BA in the Department of Mental Health have lower taste and a discount factor, a similar transitory shock and higher standard deviation of taste.

Table A.1. Parameter Estimates

Parameters	State Workers, Exclude University Workers (BA+)	Teachers	University Workers (BA+)	All State Workers (BA+)	State Workers Exclude University Workers (Less than BA)	Dept. of Mental Health (Less than BA)
Scale of transitory shock (λ)	110.4	101.9	144.1	127.4	58.4	57.0
	(4.1)	(0.8)	(13.4)	(0.0)	(3.2)	(0.0)
Mean of taste distribution (μ)	-25.9	5.8	-11.8	-23.3	-25.8	-29.8
	(1.1)	(0.0)	(1.1)	(0.0)	(1.6)	(0.2)
Standard deviation of taste (σ)	28.1	23.2	39.4	32.0	20.8	23.6
	(0.6)	(0.4)	(2.5)	(0.0)	(1.0)	(0.0)
Discount Rate (β)	4.0 [0.98]	3.2 [0.96]	3.0 [0.95]	3.7 [0.98]	3.9 [0.98]	3.4 [0.97]
	(0.1)	(0.0)	(0.0)	(0.0)	(0.1)	(0.1)

NOTES: Parameters estimates based on maximum likelihood. Standard errors in parentheses. Parameter estimate for the discount rate is transformed to bound the parameter between 0 and 1. The value in square brackets reflects the transformed parameter estimate. BA+: Sample with at least a bachelor's degree; Less than BA: Sample with less than a bachelor's degree. Note: All samples exclude Department of Transportation.

Alternative Pension Policies Allowing for DB/DC Choice at Entry

In Table 5.1, using the four additional groups considered above, we evaluate the responsiveness of the proposed S176 DC plan relative to the post-2012 DB plan. In Table A.2, we examine the sensitivity of those responses when DB/DC choice is introduced and predict the shift in DC participation rates.

For non-university state employees, we find that the introduction of choice causes average years of service to increase relative to a baseline where there was a choice between the post-2012 DB/DC plan. This differs from the model where there was no choice, reported in Table 5.1, where average years of service declined for some groups. Here, the increase in average service is driven by greater initial sorting in the baseline scenario (43 percent of non-university state employees with at least a BA were predicted to choose the DC plan at entry). When S176 is introduced, since it is an enhancement of benefits relative to the post-2012 SORP DC, it leads to increase years of service and greater DC plan election rates. This is true regardless of group.

Table A.2. Response to S176 DC Plan

Sample	Average service under Class 3 DB/DC plan	Change in average service with S176 DC	Predicted DC participation Class 3	Predicted DC participation S176
Public sector: non-university, BA+	7.72	0.11	43%	44%
Teachers	15.11	0.45	69%	100%
Additional groups of public employees				
Public sector: university, BA+	9.74	0.18	100%	100%
Public Sector: All, BA+	8.52	0.04	46%	58%
Public sector: non-university, less than BA	5.60	0.22	54%	100%
Public sector: Department of Mental Health, less than BA	4.84	0.12	100%	100%

NOTES: Assumes DB/DC choice. DC participation rate reflects participation decision of entrants.

In Tables 5.3 and 5.4, we report the difference in retention behavior for non-university state workers with BA+ and public school teachers for alternative DB and DC plan policies. These differences are computed relative to a baseline where everyone is under the post-2012 DB plan (Table 5.3) or the post-2012 DC plan (Table 5.4) and, alternatively, a baseline where everyone has a choice between the post-2012 DB and DC plans. Table A.3 and A.4 repeat the percentage changes in average years of service under a baseline where everyone has a choice between the

post-2012 DB and DC plans but add the fraction of each sample predicted to choose a DC plan at baseline and under the alternative policy (these shifts were discussed in Chapter 5). In general, teacher DB/DC election decisions are predicted to be more sensitive to DB or DC plan policy changes.

Table A.3. Predicted Response to Alternative DB Plan Policies

Simulated Policy Change	Percentage Change in Average Years of Service Relative to Baseline		Predicted DC Participation Rate	
	Public Sector	Teachers	Public Sector	Teachers
Average years of service/ Predicted Participation Rate at Baseline	7.7	15.1	43%	69%
DB Multiplier (Baseline: 1.82%)				
Reduce to 0%	-6.6%	0.3%	100%	100%
Reduce by 20% (1.46%)	-7.3%	0.3%	66%	100%
Reduce by 1% (1.80%)	-0.2%	-0.1%	43%	78%
Increase by 1% (1.84%)	0.2%	-0.1%	43%	65%
Increase by 20% (2.18%)	8.2%	3.3%	33%	35%
Increase to 5%	44.5%	9.1%	8%	4%
DB Multiplier (Baseline: 1.82%) & DB Contribution Rate (Baseline: 9%)				
Reduce contribution rate to 0%	17.8%	15.3%	19%	0%
Increase contrib. rate to 12%	-3.8%	0.3%	49%	100%
Reduce contribution rate to 0%; Reduce multiplier to 0%	-6.6%	0.3%	100%	100%
Increase contribution rate to 12%; Increase multiplier to 5%	39.1%	4.5%	10%	10%
DB retirement age/years of service eligibility Normal retirement eligibility baseline: Rule of 90 (age + years of service), or age 65 with at least 8 years of service Early retirement eligibility baseline: Age 60 with at least 8 years of service				
Reflect Class 2 retirement rules (more generous) Normal retirement eligibility: 28 years of service or age 65 with 5 years of service Early retirement eligibility: age 55 with 25 years of service or age 60 with 5 years of service	1.2%	-0.3%	32%	46%
Increase retirement ages (less generous) Normal retirement eligibility: Rule of 95 or Age 65 with 10 years of service Early retirement eligibility: Age 60 with 10 years of service	0.3%	0.3%	43%	99%
Final average salary (Baseline: highest 5 years)				

Highest 3 years (more generous)	1.2%	0.1%	39%	56%
Highest 10 years (less generous)	-1.4%	0.3%	44%	100%
COLA (Baseline: 1% up to maximum of $500 per year)				
Reduce COLA to 0%	-2.9%	0.3%	49%	100%
Increase COLA to 3%, maximum of $500 per year	5.3%	0.5%	27%	35%
Increase COLA to 3%, no maximum	11.3%	3.4%	27%	28%

NOTES: Relative to Class 3 SCRS DB plan and post 2012 SORP DC plan. Assumes DB/DC choice.

Table A.4. Predicted Response to Alternative DC Plan Policies

Simulated Policy Change	Percentage Change in Average Years of Service Relative to Baseline		Predicted DC Participation Rate	
	Public Sector	Teachers	Public Sector	Teachers
Average years of service/ Predicted Participation Rate at Baseline	7.7	15.1	43%	69%
DC Employer Contribution (Baseline: 5%)				
3%	0.4%	0.0%	36%	38%
4%	0.2%	-0.5%	39%	50%
6%	0.5%	1.6%	44%	100%
7%	0.9%	2.7%	44%	100%
DC vesting years of service (Baseline: immediate)				
2 years of service	0.3%	0.1%	43%	69%
5 years of service	0.7%	0.2%	41%	69%
10 years of service	0.8%	0.3%	40%	69%

NOTES: Relative to Post 2012 DB/DC plan. Assumes DB/DC choice. DC participation rate reflects participation decision of entrants.

Appendix B. Technical Details of Model

Model for SC Public Employees Observed from the Beginning of Their Career

The value of staying an SC public employee of at age *a* at time *t* is $V_{a,t}^{S} + \varepsilon_t^c$, where $V_{a,t}^{S}$ represents the expected value of staying and ε_t^c is a random shock. The expected value of staying is

$$V_{a,t}^{S} = \gamma^c + w_{a,t}^c + \beta E_t\left[Max\left(V_{a+1,t+1}^{S} + \varepsilon_{t+1}^c, V_{a+1,t+1}^{L} + \varepsilon_{t+1}^e\right)\right] \quad \text{(B.1)}$$

where

γ^c is individual taste for being an SC public employee relative to an external position

$w_{a,t}^c$ is SC employee average annual earnings for age *a* at time *t* (and experience in SC public service is also *t*)

β is the personal discount factor of time

$V_{a+1,t+1}^{S}$ is the value of staying as an SC public employee at age *a* + 1 and time *t* + 1

$V_{a+1,t+1}^{L}$ is the value of leaving SC public employment at age *a* + 1 and time *t* + 1

$E_t\left[Max\left(V_{a+1,t+1}^{S} + \varepsilon_{t+1}^c, V_{a+1,t+1}^{L} + \varepsilon_{t+1}^e\right)\right]$ is the expected value at *t* of being able to choose "stay" or "leave" in *t* + 1, depending on which has a higher realized value

The expected value of leaving SC public service at age *a* and time *t* is $V_{a,t}^{L} + \varepsilon_t^e$, where $V_{a,t}^{L}$ is the expected value of leaving and ε_t^e is the random shock. Given we do not allow in the model for returning to public employment, employment in the private sector is an absorbing state and there is no choice left that we model. The expected value of leaving includes external earnings and SC public employee retirement benefits, if any. Thus,

$$V_{a,t}^{L} = w_a^e + \sum_{s=a+1}^{A} \beta^{s-a} w_s^e + R_{a,t}^c \quad \text{(B.2)}$$

where

w_a^e is average annual earnings in the external market at age *a*

$\sum_{s=a+1}^{A} \beta^{s-a} w_s^e$ is the present value of all future external earnings through period *A*

$R_{a,t}^c$ is the present discounted value of retirement benefits accrued for an SC public employee leaving at age *a* with *t* years of service as an SC public employee

Consistent with policy, equation B.2 assumes that to claim SC public employee retirement benefits, the individual must have left SC public employment.[25] Also, in ${R_a}^c{}_{,t}$, t is the time period as well as the number of years of service in CPS. The notation could be extended to have separate clocks for the time period and for years of service.

An individual decides to continue as an SC public employee at age a and time t if the value of staying is greater than the value of leaving, or

$$\text{Stay at age } a \text{ and time } t \text{ if } {V_a}^S{}_{,t} + {\varepsilon_t}^c \geq {V_a}^L{}_{,t} + {\varepsilon_t}^e$$

This expression is not an expected maximum but a simple maximum because the shocks in t have been realized and are known to the decision maker. Thus, the probability of staying as an SC public employee at age a and time t is

$$Pr_{a,t}(Stay) = Pr\left({V_a}^S{}_{,t} + {\varepsilon_t}^c \geq {V_a}^L{}_{,t} + {\varepsilon_t}^e\right) = Pr\left({\varepsilon_t}^e \leq {\varepsilon_t}^c + {V_a}^S{}_{,t} - {V_a}^L{}_{,t}\right)$$

Assuming the shock terms have an extreme value distribution with zero mean and scale parameter λ, the probability of staying has a closed-form expression (Train, 2009):

$$Pr_{a,t}(Stay) = \frac{e^{\frac{V^S_{a,t}}{\lambda}}}{e^{\frac{V^S_{a,t}}{\lambda}} + e^{\frac{V^L_{a,t}}{\lambda}}} \qquad \text{(B.3)}$$

We do not observe individuals' tastes for SC public employment or random shock terms. Instead, we assume they are each distributed according to known types of probability distributions with unknown parameters that we estimate using available data. Specifically, we assume individuals' tastes for SC public employment are normally distributed and the random shocks have an extreme-value type 1 distribution with zero mean. Given these distributional assumptions, we can derive choice probabilities for each alternative at each decision year and the cumulative choice probabilities or survival probabilities for an entering cohort at each decision year, and then write an appropriate likelihood equation to estimate the parameters of the model. These include the standard deviation of the probability distribution for the shock terms, the mean and standard deviation for the taste distribution of employees at entry, and the discount factor.

We next present the choice probabilities, the cumulative retention probabilities, and the likelihood equation. The extreme-value distribution, $EV[a, b]$, has the form $\exp(-\exp((a - x)/b))$ with a mean of $a + b\Gamma$ and a variance of $\pi^2 b^2/6$ (or a standard deviation of $\frac{\pi b}{\sqrt{6}} \approx$

[25] In some public defined benefit systems, it is possible to retire and begin collecting retirement benefits but continue working as a part-time or contract employee after a certain time away.

1.28b), where Γ is the Euler–Mascheroni constant (approximately 0.577), a is the location parameter, and b is the scale parameter. We assume the shock terms have a zero mean and scale λ, implying that they have the extreme-value distribution $EV[-\Gamma\lambda, \lambda]$, i.e., $a = -\Gamma\lambda$ and $b = \lambda$. Both $\varepsilon_t{}^e$ and $\varepsilon_t{}^c$ have an extreme value distribution, and the difference $\varepsilon_t{}^e - \varepsilon_t{}^c$ in Equation B.3 is known to have a logistic distribution. With this information, the expected value of the maximum has a closed form:

$$
\begin{aligned}
&E_t\left[\max\left(V^S_{a+1,t+1} + \varepsilon^c_{t+1}, V^L_{a+1,t+1} + \varepsilon^e_{t+1}\right)\right] \\
&= \iint \max\left(V^S_{a+1,t+1} + \varepsilon^c_{t+1}, V^L_{a+1,t+1} + \varepsilon^e_{t+1}\right) d\varepsilon^c_t d\varepsilon^e_t \\
&= \lambda ln\left[e^{\frac{V^S_{a+1,t+1}}{\lambda}} + e^{\frac{V^L_{a+1,t+1}}{\lambda}}\right]
\end{aligned}
$$

Substituting this into the expected value of staying (equation B.1), we have

$$
V^S_{a,t} = \gamma^c + w^c_t + \beta\lambda ln\left[e^{\frac{V^S_{a+1,t+1}}{\lambda}} + e^{\frac{V^L_{a+1,t+1}}{\lambda}}\right] \qquad \text{(B.4)}
$$

Thus, we have an explicit expression for the value function of staying, given (unobserved to the analyst) taste for being an SC state employee, γ^c.

The expression for the value function for leaving, $V^L_{a,t}$, is straightforward and given in equation (B.2).

The expressions on the right-hand side of (B.2) and (B.4) are used in model estimation when recursively evaluating the probability that an employee chooses to stay at age *a* and having reached time *t,* $Pr_{a,t}(Stay)$*,* which is given by equation (B.3). The probability of leaving at age *a* and time *t* is $1 - Pr_{a,t}(Stay)$.

Given independent shock draws in each period, the cumulative probability that an SC state employee entering at time 0 with age *a* will stay through *t* - 1 may be written[26]

$$
cumulativePr(Stay)_{a,t} = \prod_{s=0}^{t-1} Pr_{a+s,a+s+1}(Stay)
$$

The cumulative probability that an SC state employee who enters at age *a* stays for *t* – 1 years and leaves at *t* is

[26] At entry, each employee is assumed to decide to stay for the first period. In other words, when an employee enters, it is assumed that the employee has in effect decided to stay for the first period: $Pr_{a+0,1}(Stay) = 1$. Hence, the first stay/*leave* decision occurs at the beginning of the second period.

$$cumulativePr(Leave)_{a,t} = \prod_{s=0}^{t-2} Pr_{a+s,a+s+1}(Stay)(1 - Pr_{a+t-1,a+t}(Stay))$$

These probabilities are conditioned on the unobserved taste parameter, γ^c. We assume the taste parameter has a normal distribution $g(\gamma^c)$ with mean μ and standard deviation σ. We use this information to formulate the expected cumulative probability of a given career path, or the likelihood of that path. Thus, for an employee in our data who enters at age *a*, stays through $t - 1$ and leaves at *t*, the likelihood of that career path is

$$\mathcal{L}_i(\mu, \sigma, \lambda, \beta) = \int_{-\infty}^{\infty} \prod_{s=0}^{t-2} Pr_{a+s,a+s+1}(Stay)(1 - Pr_{a+t-1,a+t}(Stay))\, g(\gamma^c) d\gamma^c \quad \text{(B.5)}$$

The subscript *i* in $\mathcal{L}_i$ denotes the *i*th employee. Similarly, if the individual stays through *t* and is then censored, the likelihood is

$$\mathcal{L}_i(\mu, \sigma, \lambda, \beta) = \int_{-\infty}^{\infty} \prod_{s=0}^{t-1} Pr_{a+s,a+s+1}(Stay)\, g(\gamma^c) d\gamma^c$$

Thus, the likelihood for the entire data sample, N, is given by

$$\mathcal{L}(\mu, \sigma, \lambda, \beta) = \prod_{i=1}^{N} \mathcal{L}_i(\mu, \sigma, \lambda, \beta)$$

Extending the Model to Include Incumbent Employees

The discussion so far is relevant to a population observed at entry at the beginning of a career. Our data included new entrants from 2010 to 2015 followed to 2019; however, such a sample provides no observations of years where individuals are retirement eligible. To augment the sample, we extended the DRM model to allow inclusion of employees who were incumbent in 2010, on whom we had longitudinal data from then forward to 2019. The extension assumed their taste distribution at entry was the same as the taste distribution of the 2010 – 2015 new entrants. Under this assumption, we expressed their conditional taste distribution as of 2010 in terms of the new entrant taste distribution and the cumulative probability that individuals of a given taste, who entered in years before 2010, stayed until 2010. Like 2010 – 2015 new entrants, they were then followed forward to 2019 and in each year could choose to stay or leave.

The density of taste, γ^c, at the start of year of service t conditional on staying continuously from entry to t is

$$p(\gamma^c | s_0, s_1, \dots, s_{t-1}) = p(\gamma^c, s_0, s_1, \dots, s_{t-1}) / p(s_0, s_1, \dots, s_{t-1})$$

$$= p(s_0, s_1, \dots, s_{t-1} | \gamma^c) g(\gamma^c) / p(s_0, s_1, \dots, s_{t-1}) \quad \text{(B.6)}$$

Here, $p(s_0, s_1, \ldots, s_{t-1}|\gamma^c)$ is the probability that an employee stays continuously to complete $t-1$ years of service (i.e., stays to the beginning of period *t*) given a particular value of taste drawn at entry into CPS. As before, the density of taste for new entrants is $g(\gamma^c)$. The denominator, $p(s_0, s_1, \ldots, s_{t-1})$, is the probability of staying continuously to complete $t-1$ years of service averaged over all values of taste, that is, taste is integrated out.

The DRM is a first-order Markov process, so the probability of staying in $t-1$ given that one has stayed continuously from entry through $t-2$ is just the probability of staying in $t-1$ given staying in $t-2$, and so forth. The expression in the numerator of (B.6) can then be written

$$p(s_0, s_1, \ldots, s_{t-1}|\gamma^c) = p(s_{t-1}|\gamma^c)p(s_{t-2}|\gamma^c) \ldots p(s_0|\gamma^c)$$

Also, the denominator in (B.6) is this probability averaged over taste:

$$p(s_0, s_1, \ldots, s_{t-1}) = \int_{-\infty}^{\infty} p(s_{t-1}|\gamma^c)p(s_{t-2}|\gamma^c) \ldots p(s_0|\gamma^c)g(\gamma^c)d\gamma^c$$

These results imply that (B.6) can be written as

$$p(\gamma^c|s_0, s_1, \ldots, s_{t-1}) = \frac{p(s_{t-1}|\gamma^c)p(s_{t-2}|\gamma^c) \ldots p(s_0|\gamma^c)g(\gamma^c)}{\int_{-\infty}^{\infty} p(s_{t-1}|\gamma^c)p(s_{t-2}|\gamma^c) \ldots p(s_0|\gamma^c)g(\gamma^c)d\gamma^c}$$

The usefulness of this expression for the conditional probability of taste given some period of stay (left-hand side) comes from breaking it into a product of per-period stay probabilities of known form times the a priori taste distribution, also of known form (assumed to be normal), divided by an average value that can be computed from the same expressions.

Using the conditional density for taste for an incumbent employee's years of service as of 2010, we can construct probability expressions for the incumbent's retention decisions in years from 2010 forward in the same fashion as done for new entrants, where the unconditional density of taste was used. For example, consider employees who served continuously from entry and were making a stay/leave decision at the beginning of year of service 20 in 2010. These employees began in 1991 and had already completed 19 years of service. The conditional taste distribution for these employees is

$$\frac{p(s_{19}|\gamma^c)p(s_{18}|\gamma^c) \ldots p(s_0|\gamma^c)g(\gamma^c)}{\int_{-\infty}^{\infty} p(s_{19}|\gamma^c)p(s_{18}|\gamma^c) \ldots p(s_0|\gamma^c)g(\gamma^c)d\gamma^c}$$

In developing the likelihood for these employees, this taste distribution was used in place of $g(\gamma^c)$ in (B.5) and their retention decisions were tracked from 2010 through 2019, the last period observed in the data set.

Appendix C. Estimating Earnings Trajectories

In Chapter 3, we report estimated earnings trajectories for South Carolina public sector workers used as input into the DRM. This appendix documents the model used to estimate those trajectories, reports the model estimates and documents the additional earnings trajectories for workers with less than a bachelor's degree that are used when estimating the model in Chapter 4 for groups with less than a bachelor's degree (as reported in Appendix A).

There are two data sources we use when estimating earnings trajectories. We use the 2018 ACS when estimating the earnings trajectories because it is a large cross-sectional survey that collects information on a workers, age and education, which are important factors in the model presented in Chapter 4. This data is used to estimate the earnings trajectories by educational achievement for: South Carolina private sector workers, state and local public sector workers, and public school teachers. Because we were able to access administrative earnings data for teachers but not public sector employees, we also use administrative data on teacher salaries from SCDE to estimate South Carolina teacher earnings trajectories.

Estimating Earnings Trajectories Using the ACS

ACS data is censored above the 99.5 percentile for the respective population of interest. We use an upper-censored Tobit model to estimate earnings in South Carolina. The specification is $\boldsymbol{ln(earnings) = X\beta + \epsilon}$ where $\boldsymbol{ln(earnings)}$ represents continuous outcomes and the error is normally distributed and independent across observations, $\epsilon \sim N(\mathbf{0}, \sigma^2 \boldsymbol{I})$. We observe individual *i*'s log earnings, $ln(earnings)_i$, for observations $i \in \mathcal{C}$. Observations $i \in \mathcal{R}$ are right-censored; we know only that they are greater than or equal to the known threshold $y_{\mathcal{R}i}$. The log likelihood is

$$\ln L = -\frac{1}{2}\sum_{i\in\mathcal{C}} w_i \left\{\left(\frac{ln(earnings_i) - \boldsymbol{X_i\beta}}{\sigma}\right)^2 + log2\pi\sigma^2\right\} + \sum_{i\in\mathcal{R}} w_i \log\left\{1 - \Phi\left(\frac{y_{\mathcal{R}i} - \boldsymbol{X_i\beta}}{\sigma}\right)\right\}$$

where $\Phi()$ is the standard cumulative normal and w_i it the weight for the *i*th observation.

We use a piecewise linear specification where the knots depend on age, i.e., $Age_a(age_i)$, a = 1,…,K represents K variables to be created and k_a, a = 1,…, K–1 are the corresponding knots. We set knots at five-year age groups between 22 (age 18 for those with less than a BA) and 65, though with the first age group being 3 years, 22 to 24, and the last age group being 6 years, 60 to 65. The omitted group is a male with a BA degree (sample is restricted to BA+) who is not a veteran.

$$Age_a() = age_i \;\; if\; a = 1$$
$$Age_a() = \max(0, age_i - k_{a-1}) \;\; if\; a = 2 \ldots K$$

The explanatory variables include the age piecewise linear specification and indicator variables for female and veteran status. The baseline regression is:

$$\ln(earnings_i) = \beta_{intercept} + \beta_{a=1} Age_{a=1}() + \beta_2 Age_2() + \cdots + \beta_K Age_K() + \beta_{female}\, female_i + \beta_{VET} veteran_i$$

The age-earnings profile for a male with a BA degree, who is not a veteran and who lives in South Carolina is:

$$\ln(earnings_i) = \begin{cases} \beta_{intercept} + \beta_{a=1} Age_{a=1} & age_i \in [22,24] \\ \beta_{intercept} + \beta_{a=1} Age_{a=1} + \beta_2 Age_2 & age_i \in [25,29] \\ \vdots \quad \vdots & \\ \beta_{intercept} + \beta_{a=1} Age_{a=1} + \beta_2 Age_2 + \cdots + \beta_9 Age_9 & age_i \in [60,65] \end{cases}$$

The marginal effect of age is

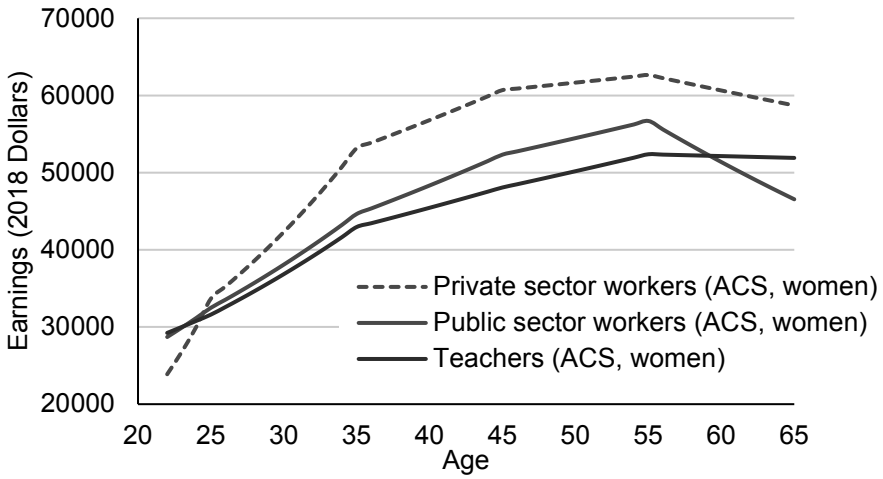
$$\frac{d(\ln(earnings_i))}{d(age)} = \begin{cases} \beta_{a=1} & age_i \in [22,24] \\ \beta_{a=1} + \beta_{a=2} & age_i \in [25,29] \\ \vdots \quad \vdots & \\ \beta_{a=1} + \beta_{a=2} + \cdots + \beta_{a=9} & age_i \in [60,65] \end{cases}$$

The 2018 earnings profiles were then simulated using the model estimates. We assumed the following variable values:

- Is a Veteran = No
- Gender = Female

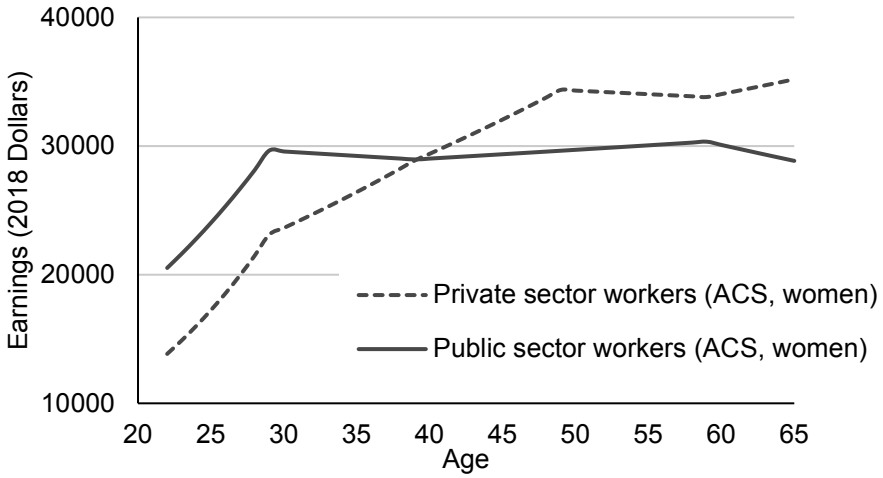
Figure C.1 presents the earning trajectories for respective groups with at least a bachelor's degree and then in Figure C.2 the exercise is repeated for groups with less than a bachelor's degree (omitting teachers, who almost always have a bachelor's degree).

Figure C.1. Earnings Trajectories for South Carolina Workers With At Least a Bachelor's Degree (2018 dollars)



NOTES: Earnings trajectories reflect workers will at least a bachelor's degree. In estimating the model in Chapter 4, earnings are assumed to be constant after age 55.

Figure C.2. Earnings Trajectories for South Carolina Workers With Less Than a Bachelor's Degree (2018 dollars)



NOTES: Earnings trajectories reflect workers will less than a bachelor's degree. In estimating the model in Chapter 4, earnings are assumed to be constant after age 30 for the public sector and after age 50 for the private sector.

Estimating Earnings Trajectories for South Carolina Teachers

The model used for estimating the earnings trajectories for South Carolina teachers is similar to model used for the ACS with three key differences:

1. No censoring, so a Tobit model is not required
2. No data on veteran status, so this variable is omitted

3. Data from multiple years permits the inclusion of year indicators into the model

The explanatory variables include the age piecewise linear specification and indicator variables for female. Year fixed effects are also included. The baseline regression specification includes these variables.

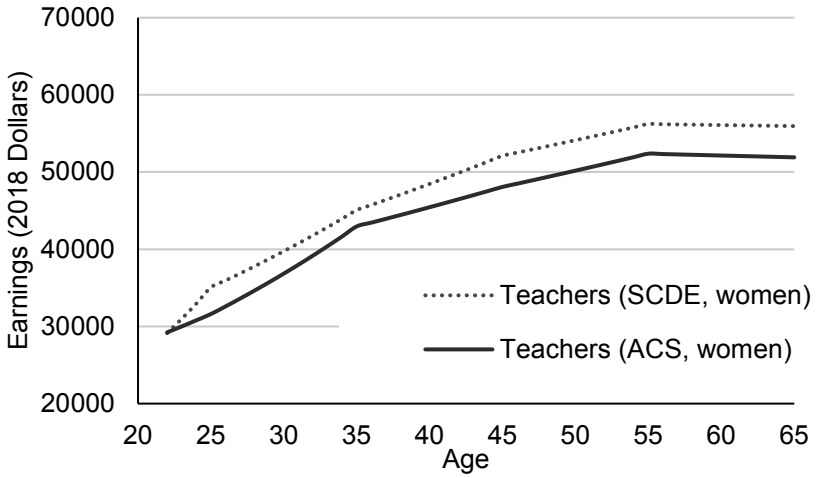
$$\ln(earnings) = \beta_{intercept} + \beta_{a=1} Age_{a=1}() + \beta_2 Age_2() + \cdots + \beta_K Age_K() + \beta_{female}\, female_i + \sum_{\substack{y=[2008,2020] \\ y \neq 2008}} \{\beta_y \boldsymbol{I}[year_i = y]\}$$

Figure C.3 presents the earning trajectories simulated using the model estimated with SCDE annual pay data and compares them to the estimates from the ACS model. We assumed the following variable values:

- Gender = Female
- Year=2018

Earnings predictions using SCDE data are generally 7 to 8 percent higher for a particular age than predictions using the ACS. In our model estimation in Chapter 4, we use the earnings trajectories for teachers predicted from using the SCDE data. In practice, given the consistency of the earnings trajectories between the two data sets, the permanent difference in salary between the two approaches will be largely absorbed into the mean of the taste distribution. Consequently, the impact of this choice on the simulations in Chapter 5 and Appendix A should be minimal.

Figure C.3. Earnings Trajectories for South Carolina Teachers (2018 dollars)



NOTES: Earnings trajectories reflect workers will at least a bachelor's degree. In estimating the model in Chapter 4, earnings are assumed to be constant after age 55.

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