

From Pensions to Personnel: The Incentive Effects of Retirement Benefits on Retention

October 2025

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Abstract: Private retirement plans are a crucial part of worker’s compensation in the U.S. and have long been thought to influence labor supply. This study uses a cohort-based regression discontinuity design to examine how a change in the retirement plan at the largest U.S. employer, the Federal Government, impacted the retention of employees over the entire life cycle. We find that workers with less valuable employer pensions but more portable retirement benefits were more likely to separate from the government around 15 and 30 years after beginning federal service. We find smaller, statistically insignificant effects in the first few years of employment. We also find evidence that the effects are driven by highly productive workers, identified through supplemental compensation or early promotions. Our results suggest that employees respond to changes in the value of retirement benefits by leaving employers for better outside options, but that employees may be inattentive or job-locked early in their careers. These findings demonstrate that non-wage compensation impacts labor supply decisions across a worker’s lifecycle and the distribution of human capital over time, particularly in labor markets where employers compete through diverse compensation structures.

¹We want to thank our advisors Alan Auerbach, Emi Nakamura, Emmanuel Saez, Jón Steinsson, Dmitry Taubinsky, and Danny Yagan for invaluable feedback across the many iterations of this paper. We would also like to thank Sarah Baker, David Card, Taha Choukhmane, Hilary Hoynes, Adam Leive, Cormac O’Dea, Charlie Rafkin, Benjamin Schoefer, and seminar attendees at UC Berkeley, BU Questrom, CBO, Treasury OTA, and the Federal Reserve Bank of Philadelphia for helpful comments and suggestions. We are grateful for the Center for Retirement Research at Boston College and the Social Security Administration for providing funding for this research.

1 Introduction

Over the past half century, U.S. employer-sponsored retirement benefits have shifted from guaranteed defined benefit (DB) pensions to portable defined contribution (DC) plans. Before the 1980s, most employer plans were DB, offering employees a monthly payment based on salary and tenure during retirement. After IRS Section 401(k) was introduced, DC plans, like individually-funded investment accounts, grew rapidly. Because DC plans reduce long-term liabilities and make costs more predictable, many firms had reduced their DB plans or froze them altogether.² From 1975 to 2020, active DB membership fell from 27 million to 12 million, while DC membership rose from 11 million to 85 million (Bureau of Labor Statistics).

Today, more than half of U.S. workers participate in some kind of employer-sponsored retirement plan, raising important questions about how the changing mix of DB and DC benefits shapes labor supply and human capital within firms. Because retirement benefits are a major component of total compensation and lifetime income, changes to plan design can meaningfully influence retention and workforce composition.

However, predicting these responses is difficult: incentives are non-linear and evolve with tenure and worker characteristics.³ Furthermore, empirical evidence has been limited, despite extensive economic and policy attention. Private-sector data are scarce, and causal estimates are hard to obtain absent of quasi-experimental variation: the observed labor supply differences between DB and DC plan participants (Munnell et al. (2006)) may reflect worker sorting rather than plan incentives (Goda et al. (2017)).

This paper isolates incentive effects by studying a representative retirement reform using 50 years of data at the largest U.S. employer, the federal government. We examine how the shift from DB to a mixed DB-DC plan affected retention and worker composition, leveraging a quasi-experimental setting in which a 1984 policy retroactively changed retirement coverage for newly hired federal workers.

Like many pension reforms, the new system reduced the DB annuity and increased portable retirement benefits. In our setting, this policy occurred without significant changes in the characteristics of new workers and wage compensation around the policy change. This institutional feature allows us to employ a regression discontinuity design with local randomization: we compare the last cohort under the old system to the first cohort under the new system, isolating the effect of the plan change on labor supply outcomes. The policy timing also lets us track effects over the life cycle, with up to 35 years of observations per worker.

²A “frozen” plan stops taking new participants or halts accruals for existing participants. By 2023, over 40% of DB participants were affected by freezes across all sectors.

³DB plans can encourage longer tenure—benefits depend on service and peak earnings—but may also prompt earlier exits once benefits vest. DC plans are portable and may ease job changes; because balances grow with current wages, they can also encourage longer careers to boost retirement income.

Our findings reveal that this policy change resulted in a sharp decline in DB pensions and a rise in portable benefits, reducing incentives to remain at the federal government. On average, these changes reduced average federal tenure by about three quarters and reduced the probability that a worker reaches retirement at the government by 3 percentage points. However, the effects were heterogeneous over the career: workers with less than 15 years of tenure showed little response, whereas those with 15 to 30 years were 2 to 3 percentage point more likely to be separated. This translated into workers in the 60th to the 78th percentiles of tenure shortening their federal careers by 1 to 3 years (a 3-16% reduction). In addition, these separations are concentrated among employees with stronger outside options: those with higher education or higher starting pay were more likely to leave mid- to late-career than their counterparts.

Productive workers were disproportionately affected. Using incentive pay and rapid promotion as proxies for productivity, we estimate that such workers are 3 to 5 percentage points more likely to separate mid- to late-career under the new system relative to similar coworkers, while less-productive workers show no meaningful change. This pattern suggests the government lost higher-value employees to outside opportunities after DB benefits were reduced.

Early-career differences in separation rates are small across systems. We posit early-career workers may be inattentive to retirement benefits at hire. We see no selection around the 1984 policy date or the 1986 announcement, and limited response to early-career incentives, consistent with inattention. However, responses strengthen as workers progress through their career: under the new system, separations spike after early vesting (around 10 years), indicating learning and a preference for the flexibility embedded in the new vesting schedule.

Despite higher mid to late-career separations under the new system, cumulative separations converge beyond 30 years of tenure due to “catch-up” effects. Late-career workers in the old system exited at higher rates once retirement eligibility is reached, driven by (1) more workers aging into retirement eligibility and (2) stronger sensitivity to retirement incentives. On the latter point, evidence from an event-study shows old-system workers intertemporally substitute labor toward periods with lower annuity values. As a result, the overall stock of separated workers converges across both systems near the end of the lifecycle. Essentially, old system workers remain longer in the firm but react strongly and early to retirement incentives, balancing out the separation rates at large tenure lengths.

Overall, reducing DB generosity and increasing portability raises separation rates in mid- and late-career, with the largest effects among more productive workers and those with better outside options. These insights suggest that although moving from DB to a mixed system may have saved the government money, it came at the cost of losing experienced personnel.

This paper is organized as follows. Section 2 discusses the broader literature. Section 3 explains the institutional details behind the retirement system for federal workers. In Section 4, we provide a conceptual framework, using a simple two-period discrete choice model, to guide predictions

of the change in labor supply. Section 5 describes the data, Section 6 will explain the empirical strategy, and Section 7 provide results. Section 8 presents some robustness analysis. We then conclude this paper in Section 9.

2 Literature Review

The contributions of this paper are twofold.

First, it provides quasi-experimental evidence on the impact of changes in an employer pension plan on labor supply to a firm. [Falk and Karamcheva \(2018\)](#) studied the same policy but focused on how the changes in the option value of the defined benefit pension affect separation rates, and found job tenure elasticity with respect to the employer's cost is low for DB pensions. In contrast, this paper utilizes a regression discontinuity approach to investigate heterogeneous retention effects resulting from the portability changes in incentives from DB to a mixed DB and DC plan. [Ippolito \(2002\)](#) also used the same policy change, but studied Department of Defense workers that have started 10 years apart and used a probit model to control for worker characteristics. Our analysis will compare all non-Department of Defense civilian workers under different retirement systems that started within a couple years of one another, to ensure there are not large differences in the sample. We will also have 35 years of observation of their federal government careers that will allow us to comment on the effects of the changes in benefits on the lifecycle of workers. [Goda et al. \(2017\)](#) studied a quasi-experimental setting where university employees were assigned to a default DB or DC plan depending on their age at a specific date. They found that exogenous default assignment into DC plans reduces short-term job mobility relative to DB plans around the age of 45. They also found positive selection effects exacerbating the difference. In our setting, we find no selection effects for entering into federal work after the retirement system changes, which allows us to directly estimate the incentive effects. Furthermore, we extend their findings because we can examine the retention effects at any age across the lifecycle of the employees.

Second, other papers have studied shifts from DB to DC plans using data on public programs and policy changes ([French et al. \(2022\)](#); [Lauletta and Bérgho \(2022\)](#)), and many others have studied the impact of DB reform, mainly changes to national plans ([Costa \(1995\)](#), [Asch et al. \(2005\)](#), [Friedberg and Webb \(2005\)](#), [Brown \(2013\)](#), [Biasi \(2024\)](#), [Fetter and Lockwood \(2018\)](#), [Staubli and Zweimüller \(2013\)](#), [Mastrobuoni \(2009\)](#), [Liebman et al. \(2009\)](#), [Lalive et al. \(2023\)](#), [Seibold \(2021\)](#)). However, we add to the broader literature on the shift in retirement plans by examining an important margin of response: exit for an outside employment option. Public or national plans often do not have this margin of response except for informality ([Bergolo and Cruces \(2014\)](#), [Lauletta and Bérgho \(2022\)](#), [Feinmann et al. \(2022\)](#)), migration, or labor force exit. We provide evidence from a private employer plan, where workers face a marketplace of other employment with various organizational structures of compensation. This setting has long thought to be important for labor supply ([Lumsdaine et al. \(1990\)](#); [Kotlikoff and Wise \(1987\)](#)) and job mobility.

Lastly, our paper adds to the literature on worker preferences for non-wage job attributes. In particular, we contribute to the large literature on the valuation of job amenities (some which include [Rosen \(1986\)](#), [Mas and Pallais \(2017\)](#), [Wiswall and Zafar \(2018\)](#), [Hall and Mueller \(2018\)](#), [Chen et al. \(2018\)](#), [Le Barbanchon et al. \(2021\)](#), [\(Cole and Taska \(2023\)\)](#), [Maestas et al. \(2023\)](#)) from a quasi-random variation in job attributes ([Lavetti and Schmutte \(2018\)](#), [Lee and Taylor \(2019\)](#)). We show how firm-specific job satisfaction may determine voluntary quits ([Akerlof et al. \(1988\)](#), [Clark \(2001\)](#), [Card et al. \(2012\)](#), [Sockin \(2021\)](#)) and heterogeneous turnover ([Ouimet and Tate \(2023\)](#)).

3 Institutional Details

3.1 History

Prior to 1984, all United States federal workers were covered by the Civil Service Retirement System (henceforth referred to as the “old system”). This system was established in 1920 and created a public pension fund which paid out retirement benefits to employees in a pay-as-you-go DB program: active employees paid some percentage of their wages towards the fund each month, and in turn, the government paid out a fixed benefit (or annuity) commensurate to one’s wage and tenure every month after retirement. Any individual covered by the old system was exempt from Social Security payroll taxes and benefits.⁴

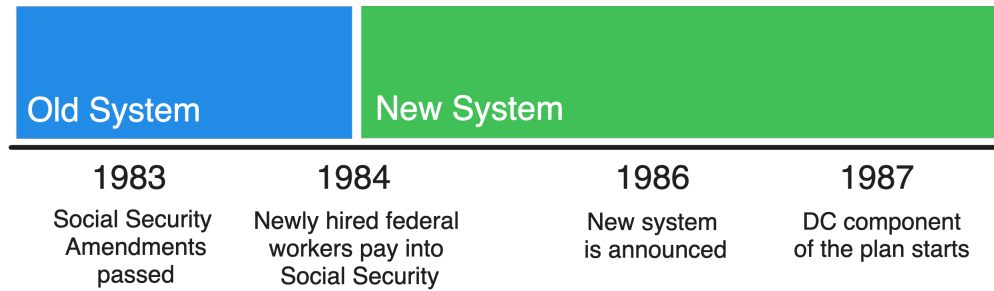
During 1983, the U.S. enacted a series of amendments to Social Security due to concerns over the solvency of the Social Security Trust Fund. These amendments reduced future expenditures and expanded the revenue base. One such provision expanded Social Security coverage to include all federal workers hired on or after January 1, 1984. This expansion necessitated a restructuring of the federal retirement system in order to cut back on the government’s cost as an employer and to prevent employees from undue burden of paying into two pension systems. Between 1984 and 1986, the Senate Committee on Governmental Affairs oversaw the development of the new retirement program that was modeled after non-federal retirement practices ([Finch \(1995\)](#)). In 1986, the Federal Employees Retirement System (henceforth referred to as the “new system”) was signed into law, replacing the old system with a mixed DB and DC system for employees that were newly hired on or after 1984. A visual timeline is represented in [Figure 1](#).

Crucially, the law applied retroactively for workers who began their federal career between 1984 and 1986. Publicly available action on the retirement plan was first proposed in October 1985 (S. 1527) by the Committee on Governmental Affairs, which outlined a preliminary plan that was ultimately rejected. Prior to this, little was known regarding the new retirement system.⁵ Hence,

⁴Social Security is a social insurance program in the U.S. that is largely funded by payroll taxes and pays out retirement, disability, and survivor benefits.

⁵The Office of Management and Budget (OMB) and the Office of Personnel Management (OPM) had considered two separate plans in 1984 ([Rich \(1984\)](#)). One was a pure DC system for new workers and another was a DB system that was as generous as the old system with the addition of Social Security benefits. Nei-

Figure 1: Historical Timeline



Note: This figure reports the timeline and key events surrounding the policy change regarding the retirement system for federal workers.

this research will exploit the 1.5 year window after 1984 where workers were unable to anticipate the exact components of the new system that were eventually established.

Since the 1984 policy change for federal employees, numerous employers have adopted similar reforms. Following the Great Recession, state governments, including Pennsylvania, South Carolina, and Tennessee, began transitioning to hybrid DB and DC retirement systems to mitigate long-term pension liabilities. Public and private university systems have also moved away from traditional DB pensions, with institutions like the University of California adopting hybrid plans and many private universities freezing DB benefits. Moreover, public teacher pensions have scaled back DB benefits in favor of more portable savings. These parallel reforms across a variety of sectors highlight a broader institutional movement toward more flexible retirement systems.

3.2 Comparing the Old and New System

In this section, we explore the similarities and differences between the two retirement systems. The new retirement system included several changes to align more closely with private sector practices: reduced pension benefits, increased portability through Social Security and a DC savings plan, and added incentives for extended careers. However, the two systems had the same employee contribution rate and similar eligibility criteria for retirement.

Similarities

Several aspects of the retirement system remained unchanged. First, the employee's contribution of pay for the annuities and social security under the old and new systems was nearly equivalent at 7%.⁶ Second, in order to receive one's annuity without a penalty (which we refer to as "full

ther plans included a hybrid component similar to the new system that was eventually enacted.

⁶Under the old system, workers paid 7% of their wages to the employer pension fund. Under the new system, workers paid 6.2% to Social Security and 0.8% to the employer pension fund. During the interim

Table 1: Differences between the Old and New System

		Old System	New System
PENSION REDUCTION	Annuity benefits	DB plan (1.5-2%)	DB plan (1-1.1%)
	Annuity penalty	2% per year for each year under 55	5% per year for each year under 62
	MRA	55 years	55-57 years, depending on birth year
INCREASED PORTABILITY	Social Security	No	Yes
	DC benefits	No match	Match up to 5%, agency automatically puts away 1%
ADDITIONAL OPTIONS	Deferments	Tenure of 5 years	Tenure of 5 years (to claim at 62) or 10 years (to claim at MRA)
	Annuity Bonus	N/A	Additional 0.1% after 20 years of service and at least 62 years old

Note: This table lists the differences between the old and new retirement system. The first column categorizes the changes. The second column lists the type of change. And the third column describes the policies under the old system, and the fourth column describes the policies under the new system.

retirement eligibility"), a worker must satisfy a tenure and age requirement. Under both systems, this would occur at the same three milestones:

1. 62 years old with 5 years of tenure,
2. 60 years old with 20 years of tenure, and
3. Your minimum retirement age (MRA) and 30 years of tenure.

Lastly, workers' retirement benefits vest after five years under both systems. If a worker does not reach full retirement eligibility after five years, then a worker may defer their benefit until they turn 62 years of age.

Differences

Table 1 reports the differences between the old and new system. We distill the changes into three categories: (1) pension reduction, (2) increased portability, and (3) additional options to incentivize extended careers.

Annuity reduction. The employees under the new system still receive an annuity, albeit at a much

period between 1984 and 1987, the Social Security employee contributions were 5.7% and workers paid 1.3% to the pension fund. Later, the federal government will increase the contributions to the new system (Social Security plus the employer pension fund) to 9.3% and 10.6% for workers who were hired in 2013 and 2014 and beyond, respectively.

lower rate. Under the new system, these annuities are calculated as 1% of an employee's average highest three years of salary ("high-3") for each year worked, as opposed to 1.5-2% per year under the old system. This translated into a 33-50% drop in the monthly benefit received from the government. Under the new system, if a worker reached at least 20 years of service and retires at the age of 62 or older, then their annuity is calculated with an additional 0.1% for all working years. To illustrate the differences in annuities, an employee in the old system who works for 30 years and retires at age 62 receives a pension benefit equal to about 56.25% of their high-3 average salary. An identical worker in the new system receives a pension benefit equal to only 32% of their average high-3 salary. Notably, these benefits are non-portable, meaning that the value of the pension benefit cannot be transferred to another employer. Pension benefits accrue based on wages and tenure with a specific employer. The full annuity formula can be found in Appendix A and B, and a graphical example is shown in Appendix C.

The new system also discouraged early retirement withdrawal: the penalties for an receiving early retirement benefits increased from 2% per year for each year under 55 years old to 5% per year for each year under 62 years old. In context, an employee under the old system who retires at age 50 with less than 30 years of service receives a 10% reduction in her annuity if the annuity is taken immediately, whereas the same employee under the new system receives a 60% reduction in her annuity. Additionally, the new system increased the minimum retirement age (MRA) from 55 to 55-57, depending on the birth year. Thus, workers under the new system who began their federal career earlier in their life, and would therefore be eligible for retirement at MRA, would have to wait 0-2 more years to receive their annuity without penalty compared to their old system counterparts. In our sample, the MRA increases by about 2 quarters on average.

Portability. In lock step with private sector retirement programs, the new system increased the portability of benefits with the addition of Social Security and a DC saving plan, known as the Thrift Savings Plan.⁷ A retirement benefit is portable if the value of the benefits from a current employer can be transferred to a new employer after leaving the current employer. Both Social Security and DC benefits are portable: Social Security calculates the benefits based on the past 35 years of work experience, regardless of the type of employer, and after an employee leaves federal work, DC contributions can (1) continue to grow in the DC account, (2) be transferred to a different employer retirement plan, or (3) withdrawn (but with significant penalties if under the minimum withdrawal age). All new system workers were enrolled for Social Security, while old system workers were not. Workers under the old and new system could opt in to the DC savings and investment plan;⁸ however, workers under the old system were not eligible for employer

⁷Under the new system, the agency would automatically contribute 1% of a worker's salary to the DC plan and then match at a one-to-one rate for the first 3% of contributions and then match 50 cents to a dollar for further contributions up to 5%. Hence, the agency would contribute up to 5% of an employee's salary to the DC plan. Those under the old system could still contribute to this DC plan, but the agency would not match or contribute at any rate.

⁸Under the Thrift Savings Plan Enhancement Act of 2009, newly hired employees were automatically enrolled into the DC plan with a contribution of 3%. In 2020, the Federal Retirement Thrift Investment Board

matching.⁹ Under the new system, the agency where an employee worked would automatically contribute 1% of his or her wage to the DC plan, regardless of whether or not the employee had enrolled in the plan. The agency would match any employee contributions dollar-for-dollar up to 3%, and then 50 cents to the dollar for additional contributions up to 5%. Thus, a new system worker could receive up to 5% contribution by the employer if the worker contributed 5% or more to their DC plan.

Career extension incentives. Under the new system, workers received two additional options later into their tenure. If a worker has at least 20 years of service when filing for retirement at 62 or later, then an additional 0.1% of the high-3 wages per year is added to their pension. Thus, rather than receiving 1% of the high-3, this worker would receive 1.1% of their high-3. Furthermore, if a worker has 10 years of tenure and is not eligible for full retirement, then the worker may separate and defer their benefits to their MRA, instead of to 62. Claiming deferred benefits before full retirement eligibility is subject to the early retirement penalties.

4 Conceptual Framework

Retirement plans shape employer retention by embedding dynamic incentives throughout a worker's career. Traditional DB plans are typically backloaded, encouraging long tenures. However, in doing so they also generate sharp disincentives to work beyond retirement eligibility by imposing an implicit tax on working. By contrast, DC plans and Social Security provide portable benefits that weaken the relationship between retirement wealth and employment at a particular employer. Sections 4.1 and 4.2 outline these contrasting incentive structures and their implications for labor supply. Section 4.3 incorporates these concepts in a simple three period model.

4.1 Features of the DB Plan: Backloading

Traditional DB pensions typically exhibit a “backloaded” benefit structure (Kotlikoff and Wise (1988)). In such plans, the marginal benefit of each additional year of service increases with tenure. This occurs because of two reasons: (1) DB formulas often calculate benefits based on a worker's highest earning years, such as the average of the highest three years of pay, and (2) DB formulas typically apply a benefit factor that rises with total years of service. As a result, tenure raises both the benefit base and the multiplier applied to it, amplifying pension accruals late in one's career. This structure creates powerful incentives to remain with a specific workplace until key retirement milestones, discouraging mid-career exits.

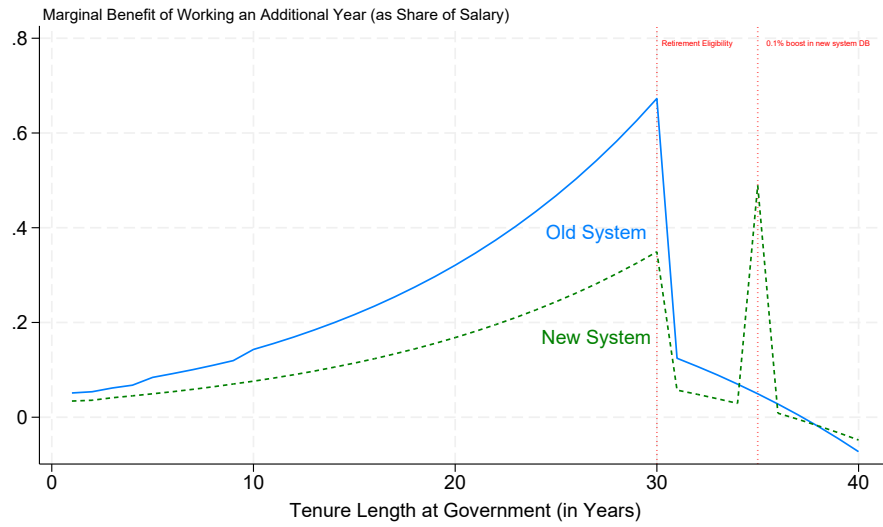
To illustrate this backloading effect in our setting, Figure 2 Panel (a) plots the present discounted

increased this automatic enrollment to 5% for new hires.

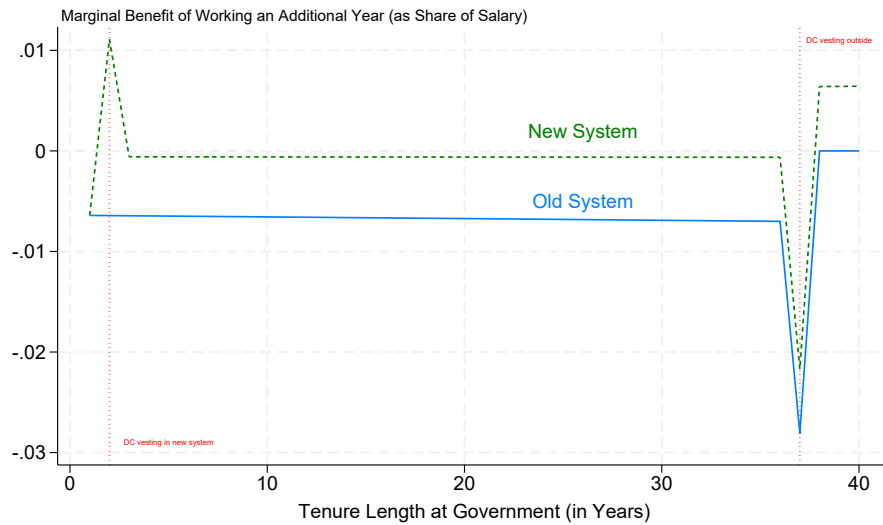
⁹Old system workers had two open seasons in 1987 and 1998 in which they were eligible to switch to the new system. Reportedly, less than 5% switched in 1987 and less than 1% switched in 1998.

Figure 2: Benefit of Working an Additional Year in the Federal Government

(a) Defined Benefit



(b) Defined Contribution



Note: This figure reports the marginal benefit to working at the federal government for an additional year ΔPDV_s for a sample worker that begins employment at 27 years old and has a career span of 40 years. We calculate the marginal benefit by estimating the present discounted value of the future stream of benefits, assuming that real wages stay constant and workers have a fixed labor supply of 40 years. Additionally, we assume that other employers have similar DC benefits, so that if a worker leaves the federal government, they can obtain similar portable benefits elsewhere. Panel (a) plots the PDV of the DB plan and Panel (b) plots the PDV of the DC plan.

value (PDV) of the DB benefit from one additional year of federal service as a share of salary. Formally, let $PDV_s^{DB}(a, s, w_f)$ be the present discounted value of the stream of DB benefits if the worker separates from the federal government at age a , tenure length s , and with wage w_f . The marginal benefit from staying an additional year is

$$\Delta PDV_s^{DB}(a, s, w_f) = PDV_s^{DB}(a+1, s+1, w_f) - PDV_s^{DB}(a, s, w_f).$$

Figure 2 Panel (a) plots ΔPDV_s^{DB} for a worker whose real wages do not change over time and who begins federal work at 27 years, so retirement eligibility occurs at 30 years of service. Panel (a) shows that the PDV marginal benefit increases steeply with tenure, demonstrating the backloaded nature of DB plans. Early in one's federal career, the gain from one more year is less than 5 percent of salary, but this climbs to 69 percent under the old system and 36 percent under the new system¹⁰ by retirement eligibility. At these thresholds, workers face strong incentives to remain until qualifying for large pension jumps. Note, this is only accounting for increases in the benefit factor; we do not account for the growth in the benefit base as real wages are held fixed.

Under the new system, the annuity reduction will lower the backloading effect, resulting in a flatter growth in benefits. This in turn generally lowers the retention incentives by tempering the marginal benefit to work.

However, while backloaded DB plans strongly incentivize workers to remain with an employer until retirement eligibility, it simultaneously creates strong incentives to leave once those benefits are available. Once a worker qualifies for benefits, continuing to work delays pension collection, effectively taxing additional labor. As shown in Panel (a), the marginal value of continued work drops sharply after eligibility and can even become negative when the incremental pension increase no longer compensates for the forgone annuity. Thus, backloading creates a cliff: the structure that encourages long service also triggers retirement spikes once eligibility is reached. This implicit tax on work at older ages may help explain the sharp increase in retirements upon DB or Social Security eligibility.

4.2 Features of the DC Plan and Social Security: Portability

In contrast to DB pensions, DC plans and Social Security lack the dynamic incentives that tie benefits to continued tenure. Their key feature is portability: employees can carry accrued balances or creditable years of service from one job to another. In a DC plan, retirement wealth equals the worker's account balance, such as in a 401(k), which can be transferred or rolled over across employers. Likewise, Social Security credits accumulate with any covered employment, so leav-

¹⁰The new system provides an additional benefit when turning 62 with at least 20 years of service (35 years of service in our example): the benefit factor increases from 1.0% to 1.1% for all years of service, creating an additional jump after retirement eligibility.

ing a particular employer does not forfeit future benefit growth. Because workers can continue to earn and grow benefits after switching jobs, portable systems do not generate the increasing, tenure-based incentives characteristic of DB plans.

To illustrate this difference, Figure 2 Panel (b) plots the marginal PDV gain from an additional year of federal work. We assumed that a worker has a fixed total career length of 40 years and that outside employers offer the same wages and DC benefits as the federal employer. Formally, let $PDV^{DC}(a, s, w|S)$ denote the present discounted value of DC wealth if separating at age a with government tenure s , wage w , and total working years S . The marginal benefit of an additional year of federal government work is

$$\Delta PDV_s^{DC}(a, s, w|S) = PDV_s^{DC}(a+1, s+1, w|S) - PDV_s^{DC}(a, s, w|S).$$

Panel (b) of Figure 2 shows that this marginal benefit is roughly flat over time, reflecting the absence of backloading. The only difference between staying and leaving arises because, under the old system, outside employers contributed to DC plans while the federal government did not. Consequently, working an extra year in federal service meant forgoing a year of outside DC contributions, making the marginal PDV slightly negative. Under the new system where we assume all employers contribute similarly, the marginal PDV is approximately zero, indicating no incremental advantage to remaining in federal employment.

Two sharp spikes appear around vesting thresholds. The upward spike occurs when the worker reaches the federal vesting requirement after 3 years of service, converting employer contributions into vested balances; the downward spike near 38 years of service reflects the need to re-vest at a new employer's DC plan after switching jobs. Beyond these brief discontinuities, the marginal PDV remains flat, underscoring the lack of dynamic incentives under portability. Portable benefits weaken employer-specific attachment by eliminating tenure-contingent gains.

Although portability does not affect dynamic incentives, it can amplify differences in outside options. If we relax our assumptions on homogeneous employers and allow other employers to offer higher pay or better DC matches for example, the marginal PDV of staying in federal service becomes negative; workers will gain from switching employers today versus tomorrow. If outside options are weaker or uncertain, the marginal PDV becomes slightly positive, providing a small incentive to stay. In this way, DB plans create internal, tenure-based incentives, whereas portable systems shift incentives to depend on external market opportunities.

4.3 A Simple Three-Period Model

Set-up. Consider a worker who worked for the federal government for wage w_f in the first period. In period two, they face a decision to (1) continue working for the federal government for wage w^f or (2) seek outside options for wage w^p . In period three, all workers retire and claim their benefits.

Workers receive a benefit from the federal government, which consists of benefits from working in period one, τ_1 , and additional DB benefits from working in period two, $\Delta\tau$. An employer will contribute $\lambda \in [0, 1]$ of a worker's wages to DC benefits (except the federal government under the old system).

In this set-up, we have two parameters of interest: $\Delta\tau$ and λ . The reduction in the degree of backloading on the benefits will decrease $\Delta\tau$. When benefits are less backloaded, the benefit of working an additional year does not grow as steeply. The effect of portable benefits will be reflected in λ .

Budget Constraint. We model a federal worker's lifetime budget that is composed of wages and retirement benefits. In parallel with our institutional setting, we take the worker's perspective in period two. We have the following budget constraint:

$$c_2 + c_3 = \begin{cases} w_f + a_1 + (\tau_1 + \Delta\tau)w_f + \lambda w_f(1+r)^2 + \lambda w_f(1+r) & \text{if working for the federal government} \\ w_p + a_1 + \tau_1 w_f + \lambda w_f(1+r)^2 + \lambda w_p(1+r) & \text{if working at an outside option} \end{cases}$$

The Worker's Problem. Consider a worker who has preferences in the following form:

$$\sum_{t=1}^T \beta^{t-1} [u(c_t) - \alpha \mathbb{1}\{\text{if working}\} + \varepsilon_j]$$

where β is the discount factor, c_t denotes consumption in period t , $u()$ is a CRRA utility function, and α is some disutility of working. The error term ε_j accounts for the fact that workers may have different preferences for working for the different employers j and is mean zero. Then given our budget constraint and objective function, we can write the decision rule¹¹ of working at the federal government over working in the private sector as

$$U^f > U^p \Rightarrow w_f - w_p + \beta\Delta\tau + \beta(\lambda w_f - \lambda w_p) > 0.$$

Rearranging, we get

$$\underbrace{\beta\Delta\tau w_f}_{\text{forgone benefits in period 2}} > \underbrace{w_p - w_f}_{\text{outside option wage premium}} (1 + \lambda)$$

An employee remains in federal service when the discounted value of forgone federal benefits $\beta\Delta\tau$ exceeds the outside wage premium $w_p - w_f$, adjusted by $(1 + \lambda)$. In other words, a worker stays if the future value of accumulated federal benefits outweighs the pay advantage of switching jobs.

¹¹The full solution can be found in Appendix D.

A reduction in $\Delta\tau$, or the reduction in the backloading of benefits, lowers this incentive, making early separation more likely. The magnitude of this response depends on the wage gap $w_p - w_f$. When outside pay is much higher, even modest declines in backloading can trigger exits. Portability further amplifies this effect through λ , since portable benefits allow workers to carry and grow their savings elsewhere, making differences in outside options more salient and weakening the tenure-based attachment to federal employment.

Workers with less favorable outside options, where $w_p - w_f < 0$, are more likely to remain in federal employment. For these workers, any positive value of $\Delta\tau$ overcomes the wage disadvantage they face in other employment since the benefit to working for the federal government is greater than the loss in wages for moving to outside options. As a result, we expect these employees to be inframarginal, with minimal changes in their labor supply decisions in response to the retirement benefit change.

5 Data

This project relies on payroll data made public by the Office of Personnel Management (OPM) under the Freedom of Information Act (FOIA). The primary dataset was compiled by BuzzFeed News and contains quarterly records of all federal government workers from 1973 to 2016. Using our own FOIA request to OPM, we extended the data until 2022. The data provides comprehensive information on salary, education level, tenure, age groups, agency, worker type, separations, and accessions at the employee level. Although the data originates from a single employer, the federal government employs a diverse set of workers, across different education groups, industries, salary ranges, and ages.

Due to a data breach in 2014, employee linkages are not provided beyond 2014, and thus employees are matched on names, education levels, and subagencies as done in [Spenkuch et al. \(2023\)](#). We also use a transformer large language model trained on record linkages of company aliases ([Arora and Dell \(2024\)](#)) to validate these matches.

We cut the sample to ensure we are able to accurately assign workers into their retirement plans.

First, we exclude workers who have ever worked in sensitive positions, like the Department of Defense, as their names and other personally-identifiable information are redacted from the data set and cannot be linked beyond 2014.

Second, we keep workers for whom we can infer their job start year. We obtain the precise quarter in which employees began employment with the federal government ("start quarter") by taking the minimum value of the first observation in the data and when the binned tenure values change. If the data does not include an employee's first two years of employment, then this employee is

dropped.¹² Beyond these years, we allow for workers to leave the government and return at a later date. We also use this bin-change method to infer the age of each worker. However, because OPM had released age bins with a noise-infusion algorithm, the inferred birth quarters are noisier, and we avoid using this variable extensively in our analysis.¹³

Third, we dropped individuals that may have unique retirement structures which deviate from the general old system or new system incentives. These individuals were those who were (1) employed as police, air traffic control, firefighters, or nuclear transporters and/or (2) seasonal or part-time workers. Thus, we only keep full-time, non-seasonal workers.¹⁴

Our full sample consists of 1,581,402 unique full-time workers across a sample period of 50 years. The main sample, which consists of individuals who began work between six quarters before and after the policy change, contains 99,251 unique individuals. The rationale for the construction of the main sample can be found in Section 3.1.

5.1 Summary Statistics

Table 2 reports the summary statistics of our main sample, using demographic characteristics at hire. Roughly half of the sample are under the old system while the other half are under the new system. Workers across the old and new system have similar demographic characteristics. More than half start employment with the federal government before the age of 30, with an average start age of about 31 years. The median nominal starting salary in this sample is \$13,903 with an average of \$17,467. Around 41% of individuals have a Bachelor's degree or higher and approximately 21% eventually transition into a manager or supervisory role. The majority of federal workers are white-collar (89%) and approximately 6% are blue-collar workers. Under the new system, there are 2.4 percentage points fewer individuals that have separated from federal work, which is consistent with the average yearly separation rates (i.e. 2%).

¹²This may occur for several reasons. First, these individuals may have worked in a sensitive position in the first few years and that information was not provided in the dataset. Second, OPM may have some data agreements with specific agencies to not disclose data. For example, the United States Postal Service workers are excluded from this dataset. To our knowledge, this is the only organization that is not included. Lastly, there may be some reporting errors in the dataset, and we assume this may occur randomly and rarely in the dataset.

¹³To combat the noisiness, we used two methods to infer birth quarters: (1) we calculated the midpoint of each age bin that appeared in the dataset and averaged them within person, and (2) we use bin changes to calculate the birth quarters and average that within person. For the main analysis, we use the first method; however, the results are consistent across both methods.

¹⁴Part time and seasonal or intermittent work may count towards the retirement eligibility. However, part time work results in a prorated annuity calculation and intermittent work may be calculated in more complex ways that are not shown in the data. If a worker has continuous full-time employment and transitions into non-full time employment, we can examine this in the dataset and will often keep workers that choose to do so.

Table 2: Sample Demographics

	Old System Col %	New System Col %	Total Col %
Start Age			
Less than 20	11.6	11.3	11.5
21-30	48.8	48.7	48.8
31-40	24.8	25.6	25.2
41-50	10.7	10.5	10.6
50+	4.1	3.9	4.0
Total	100.0	100.0	100.0
Education			
Less than Bachelor's	58.4	59.0	58.7
Bachelor's Degree	23.2	22.7	23.0
Higher Educ. Degree or More	18.4	18.3	18.3
Total	100.0	100.0	100.0
Supervisory Status			
Not Manager	78.9	79.1	79.0
Ever Manager	21.1	20.9	21.0
Total	100.0	100.0	100.0
Occ. Category			
White	89.5	89.0	89.3
Blue-Collar	6.0	5.6	5.8
Other	4.5	5.3	4.9
Total	100.0	100.0	100.0
Separations			
Still Working	4.2	6.6	5.4
Separated	95.8	93.4	94.6
N	49,750	49,501	99,251

Note: This table reports the demographic characteristics of the sample data which contains full-time federal workers from the third quarter of 1982 to the second quarter of 1985. The values are the percentages of the variable represented in a particular category, which is in bold.

6 Empirical Strategy

6.1 Regression Discontinuity Design

To investigate the impact of the change in retirement benefits on the labor supply of federal government workers, we examine the differences in retirement benefits, hiring characteristics, and labor supply to the firm between the employees who began federal work just before the policy change and employees who began right after the policy change. Because the new system applied retroactively, we exploit the window around the policy change in which new hires were unaware of the terms of the new retirement system (a year and a half or 6 quarters). This timing, as described in Section 3, provides an ideal setting to employ a regression discontinuity design with local randomization. We employ a local randomization technique for inference because (1) the start dates

for federal work around the policy change resemble a treatment mechanism in a randomized control trial, and (2) our running variable is discrete and traditional RD techniques impose continuity assumptions (Cattaneo et al. (2016)). Our specification is as follows:

$$Y_{it} = \beta_0 + \beta_1 NS_{it} + \delta_1(start_i - 1984Q1) + \delta_2 NS_{it}(start_i - 1984Q1) + \epsilon_{it} \quad (1)$$

where $start_i$ is the start quarter for person i and Y_{it} is the outcome for person i at quarter t . The coefficient β_1 is the local average treatment effect of switching from the old DB system to the new mixed DB and DC system (i.e. when there is a reduction in retirement benefits tied to the employer and increase of portability). Essentially, the effect is measured by approximating a line before and after the policy change and taking the difference of the average at the time of the change. Our main analysis includes this parametric assumption to absorb approximately linear trends in aging and compensation.

In the Section 7, we illustrate the effects of the retirement benefit change on the pension, or non-portable benefits, and portable retirement benefits. We check any concerns about selection or changes in hiring characteristics around the policy change. Additionally, we examine if an announcement of the benefit change in 1986 caused changes in recruitment on observables. Lastly, we examine how worker tenure responds to the retirement policy change. Balance checks for additional sample splits, described later in the results, can be found in Appendix O.

7 Results

7.1 Selection and Hiring Characteristics

Before analyzing the effects of the change in retirement benefits on worker behavior, we first show that there were limited changes in hiring characteristics of federal government new hires around the policy threshold. This will allow us to reasonably infer if the sample before and after the policy change is comparable, such that we have a valid RD for labor supply outcomes.

Table 3 Column (1) suggests there is limited evidence that the change in retirement systems impacted the selection of new hires around the policy change. We examine the following observable characteristics in our data: time needed until full retirement, log of the starting salary, start age, educational variables, and occupational categories. Across these factors, there is no meaningful difference between those under the old system and new system in our main sample. Moreover, there is limited evidence that subagencies hired at differential rates before and after the policy change. The percent of workers with a bachelor's degree is marginally significant at the 10 percent level after the retirement policy change. However, when controlling for quarter fixed effects, this difference becomes insignificant, as shown in Column (2). In fact, seasonally adjusted estimates relay a similar story as our main analysis. In Column (3), we seasonally adjust our estimates us-

Table 3: Changes in Hiring Characteristics

	Baseline Mean	(1) Main Sample	(2) Main Sample w/ Quarter FE	(3) Main Sample Seasonally-Adj
Quarters Needed for Full Retirement	110.61	0.09 (1.79)	1.08 (1.69)	-0.10 (0.39)
ln(Starting Salary)	10.74	-0.01 (0.02)	0.04 (0.04)	-0.01 (0.02)
Starting Age (in Quarters)	121.22	2.09 (2.76)	0.26 (1.60)	0.08 (0.57)
No. Hires in Subagency	35.15	-2.06 (15.97)	-2.98 (5.72)	19.62 (23.50)
Education				
High School or More	0.98	-0.00 (0.00)	-0.00 (0.00)	-0.02 (0.02)
Bachelor's Degree or More	0.41	-0.04* (0.02)	0.03 (0.09)	-0.01 (0.01)
Higher Educ. Degree or More	0.18	0.01 (0.03)	0.01 (0.06)	-0.02 (0.02)
Years of Educ.	14.74	-0.13 (0.09)	0.21 (0.45)	-0.26 (0.23)
Occupation Category				
White-Collar	0.90	-0.01 (0.02)	-0.00 (0.00)	0.01** (0.00)
Blue-Collar	0.06	0.00 (0.00)	0.01 (0.02)	-0.00 (0.00)
Other	0.04	0.01 (0.02)	-0.01 (0.07)	-0.01 (0.01)

Note: This figure reports the RD coefficients that relate to the change in hiring characteristics under the new retirement system. The running variable is the quarter in which an employee begins federal government work, and the regression contains the six quarters before and after the policy change. Column (1) reports the coefficients using the main sample. Column (2) reports the RD coefficients with quarter fixed effects. Column (3) reports the coefficients where we seasonally adjust the series using X-13ARIMA-SEATS (U.S. Census Bureau). Standard errors are reported in parenthesis. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

ing the U.S. Census' X-13ARIMA program. There are no significant changes in observables for new hires before and after the policy change, with the exception of white-collar workers. This difference is small in magnitude. These results are consistent with the timeline of the policy announcement and its retroactive application to workers who had already began employment at the federal government.

Lastly, the government did not change starting wage levels despite changes in the retirement benefit, which we show in the next section.

7.2 Changes in benefits

Figure 3 reports the average PDV (in 2022 dollars) of retirement benefits for workers who actually separated, thus incorporating realized separation timing. Under the new system, annual annu-

ities are about \$11,000 lower (55% reduction), implying a \$150,000 decline in their PDV, as shown in Panel (a). Offsetting this, portable wealth rises: Panel (b) shows roughly a \$167,000 increase in the PDV of Social Security and the agency's mandatory 1% DC contribution.¹⁵ Netting the two in Panel (c) yields a \$16,000 increase in total PDV, which is not statistically significant.

For analysis on the retirement benefit changes across the lifecycle, we plot the difference in DB, portable, and net benefits between the old system and the new system workers in Appendix E. After interpolating wages and assuming no prior employment, the new system can frontload benefits due to Social Security; however, on net the differences are a wash for a full career.

7.3 Labor Supply

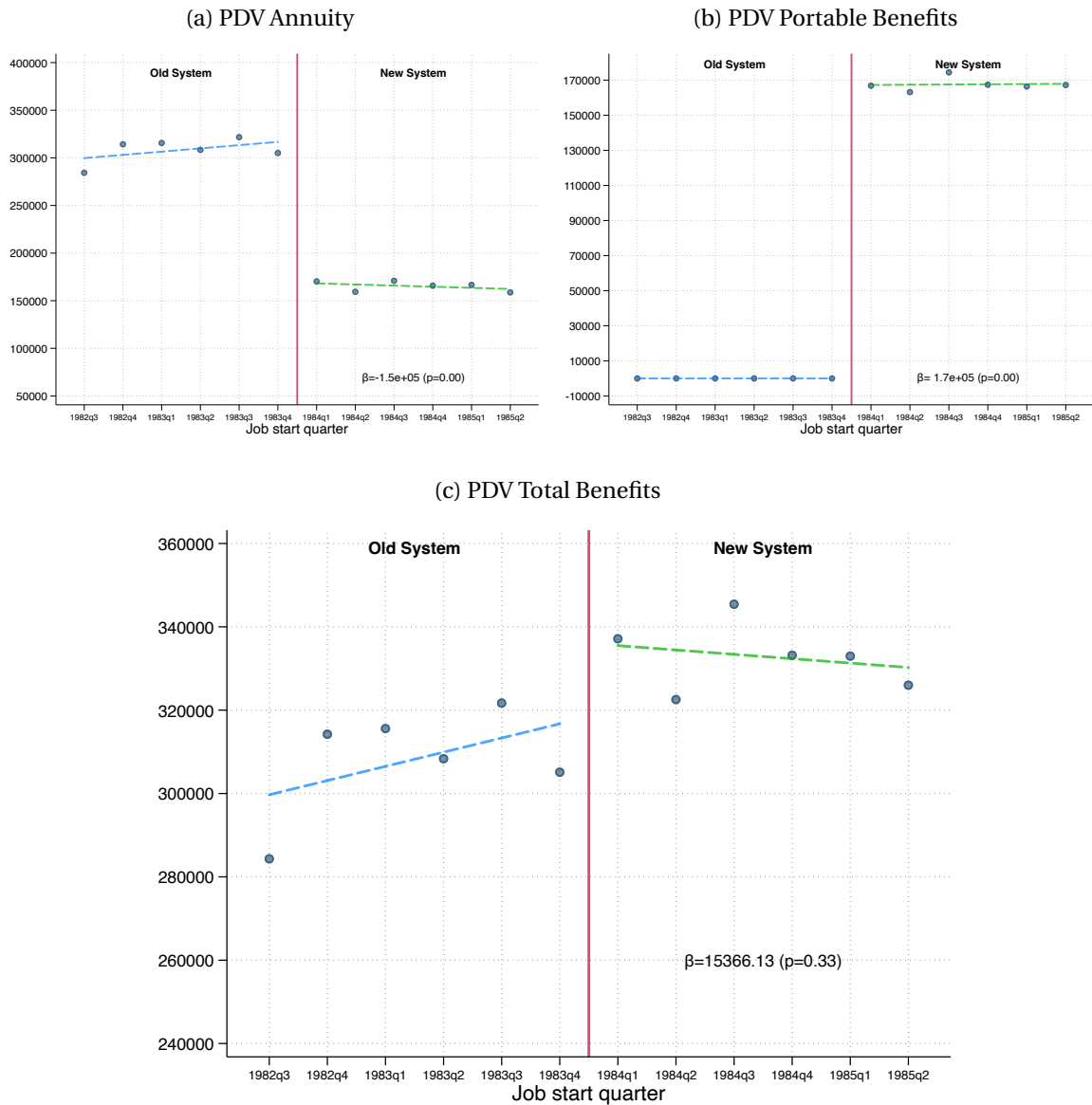
Figure 4 shows that the change in retirement systems had a small negative effect on the average tenure lengths and the probability of reaching retirement eligibility at separation. Panel (a) shows that the average tenure at separation dropped by three quarters on average following the introduction of the new system. In addition, workers under the new system were 3 percentage points less likely to reach full retirement eligibility. These findings suggest that employees only slightly adjust their separation timing or job tenure in response to the changes in benefits on average.

Examining lifecycle responses across different tenure lengths reveals a more complex and rich response. Figure 5 plots 35 different RD coefficients of cumulative separation rates across different tenure lengths, similar to Figure 13. For each point, we are reporting the results of the RD regression where the outcome is the probability of working x years (i.e. separate by 1 year, 2 years, etc.). In other words, it reports the additional probability of a new system worker being separated at a given tenure length relative to an old system worker. For example, the figure states that the change in retirement benefits resulted in a 2.5 percentage point increase in the stock of workers separated by 16 years of service.

Figure 5 reveals several key implications of the effects of the change in retirement benefits on retention. First, early and medium career workers (or workers who have less than 10 years of tenure at the federal government) are not significantly affected by the change in retirement benefits. Although these workers separated at higher rates on average, the retirement systems did not have a statistically significant effect on the tenure of these workers. Second, late career workers (or workers who have 15 years of tenure or more at the federal government) are about 2 to 3 percentage points more likely to be separated at any given year. This indicates that the reduction in retirement

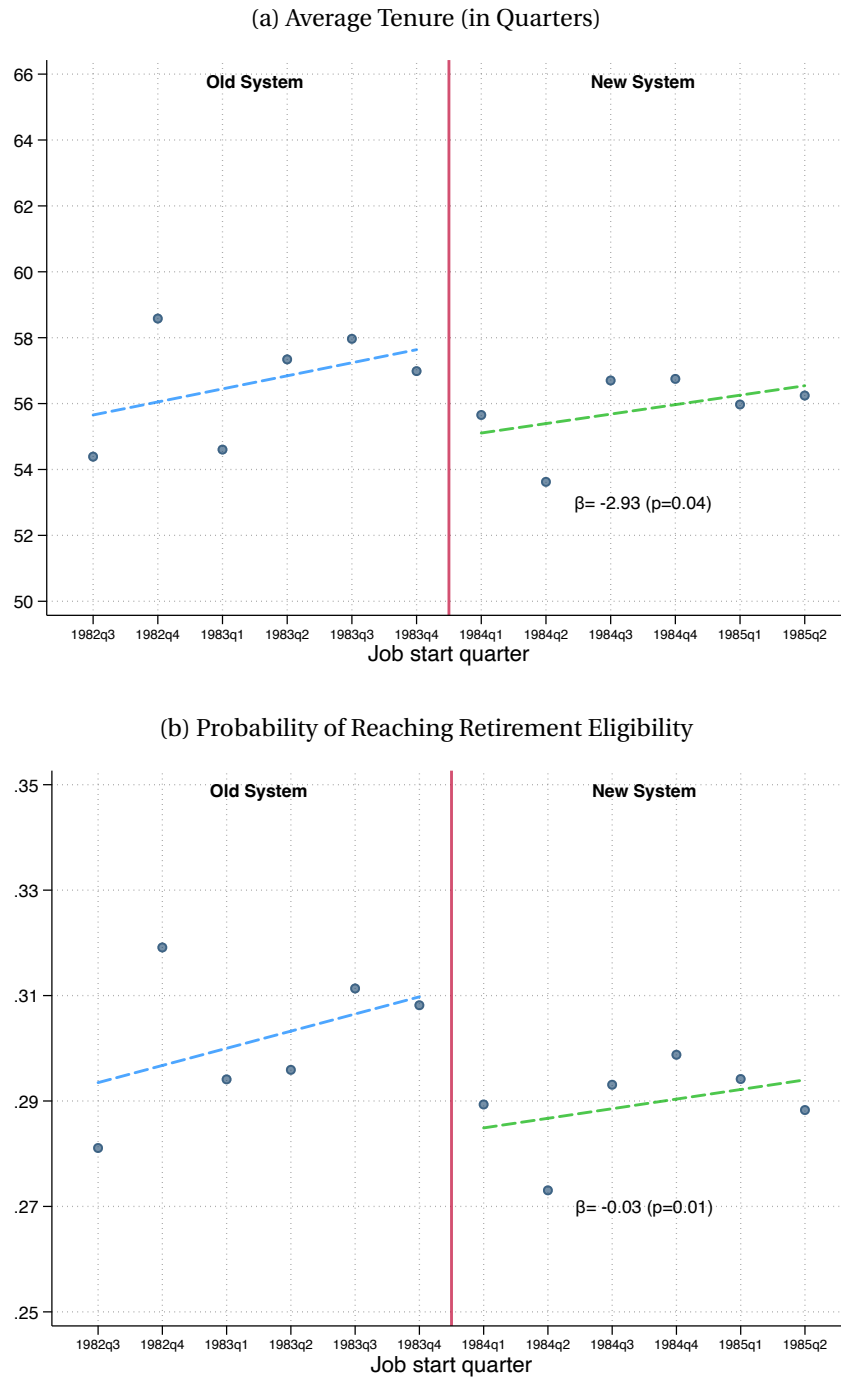
¹⁵The assumptions are as follows. For Social Security, we assume that the wages earned will contribute towards the first dollar of social security. For the DC contributions, we only account for the mandatory 1% yearly contribution by the employer and do not include employee savings information, as that information is unavailable publicly. A generous 9% yearly return is included for DC contributions. We also assume a 3% discount rate across all PDV calculations. Note that in the main analysis we only include mandatory contributions by the employer because we do not have information on the employees' voluntary contributions.

Figure 3: Change in PDV Retirement Benefits



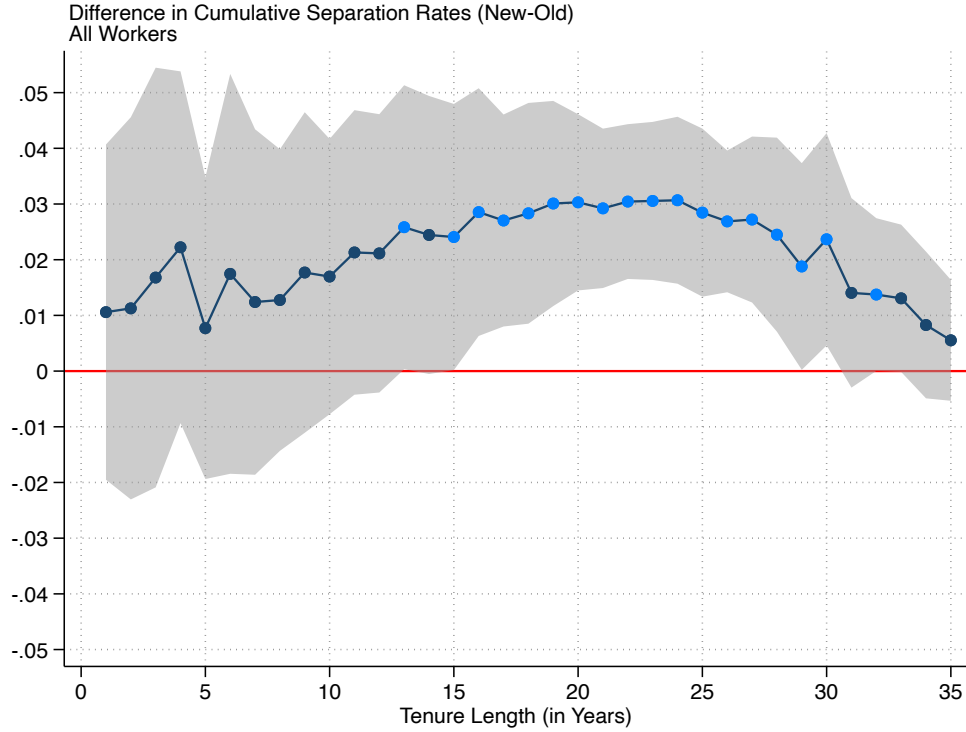
Note: This figure reports the RD coefficients on the changes in PDV of portable benefits, which is composed of Social Security and employer's DC contributions, after the new system is introduced. We assume the employer will contribute 1% of the worker's wages in the DC savings plan and that this account will have a generous yearly growth rate of 10%. We also assume that the wages will contribute to the first dollar of social security. The running variable is the quarter in which an employee begins federal government work. Thus, each point in the plots represents the sample of people who have started federal work at a given quarter. Panel (a) plots the average PDV annuity for those who have separated from the federal government in our data. Panel (b) plots the average PDV of the portable benefits (employer's mandatory contribution to TSP and social security). Panel (c) plots the average total benefits, summing Panel (a) and (b). The RD coefficients are reported as the β and p-values are given in parenthesis.

Figure 4: Tenure and Reaching Retirement Eligibility at Separation



Note: This figure reports the RD outcomes for tenure and the probability of reaching retirement eligibility at separation. Each point represents the sample of people that began federal government work in the quarter shown in the x-axis and have separated in our sample period. Panel (a) plots the average tenure in quarters at separation. Panel (b) plots the percent of workers who reach retirement eligibility at separation. The RD coefficients are reported as the β and p-values are given in parenthesis.

Figure 5: Difference in Cumulative Separations by Tenure Length in the Old vs. New System

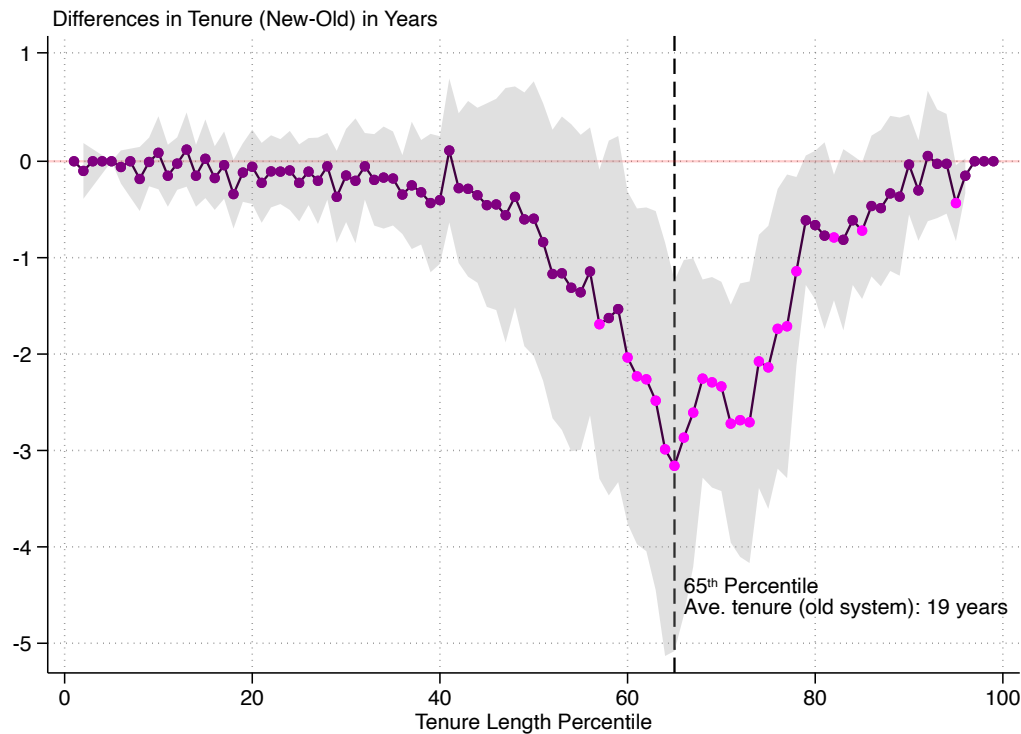


Note: This figure plots the RD coefficients on the cumulative separation rates for 35 years of tenure. Each point represents the difference in the cumulative separation rates between old system workers and new system workers. The 95% confidence interval is shaded in gray. Light blue points represent coefficients which are statistically significant from zero at the 95% level.

benefits had a more pronounced effect on those with longer tenure, influencing their decision to retire or separate earlier than they might have under the old system. Third, the change in benefit did not affect the workers beyond large retirement milestones. In part, this is due to a large number of workers under the old system retiring at their full retirement eligibility quarter around 30 years of service, essentially “catching up” to the total separation rates of the new system workers. We discuss early and late career workers in more detail in later sections.

Overall, our analysis highlights that the policy change had heterogeneous effects across the life-cycle, with more pronounced impacts on workers with longer tenures. Using a similar analysis looking at the cumulative separation rates at each age, we find no heterogeneous effects, however. We report this finding in Appendix F.

Figure 6: Differences in Tenure Centiles



Note: This figure reports the differences in years of tenure centiles. Lighter colored points represent coefficients which are statistically significant from zero at the 95% level. The gray shaded area are the 95% confidence intervals.

Quantifying the reduction in tenure

How much do workers adjust their tenure? We examine the intensive margin effects of the benefit changes by analyzing the average length of tenure across different tenure length percentiles in Figure 6. This figure reports the differences in average tenure between workers under the new retirement system compared to the old system, across various tenure length percentiles. Consistent with the previous results, we find negative effects for workers in the higher, above-median percentile ranges of tenure, but no significant effects on the lower percentile ranges or percentile ranges that extend beyond full retirement eligibility. Approximately the 60th to the 78th percentile of workers have a statistically significant reduction of career length by 1 to 3 years, resulting from 3 to 16 percent reduction in tenure length at the given percentile ranges. For example, the 65th percentile worker under the old system has 19 years of tenure. Under the new system, the 65th percentile worker has about 3 fewer years of tenure. These responses are significantly larger than what the change average tenure length across the two systems would suggest.

Outside Options

Our model suggested that workers with better outside options should leave the government as a result of the reduction in benefits tied to federal employment. This is particularly true for those who face higher wages in the private sector. According to a CBO report on comparing the compensation of federal and private-sector employees in 2022, federal workers with no more than a high school education earned about 17 percent more, on average, than their private-sector counterparts. Those with a bachelor's degree or above earned about 10 to 29 percent less, on average, than similar workers in the private sector. To validate this prediction, we compare workers who start with a below a Bachelor's degree to workers who have at least a Bachelor's degree in Figure 7 Panel (a). We find that workers with less than a Bachelor's degree, who face lower wages in the private sector on average, do not adjust their labor supply across all tenure lengths. In contrast, those with a Bachelor's degree or more are more likely to be separated after 7 years under the new benefit system. Not only do these effects begin much earlier than the average of the sample, we find that the magnitude of these effects are about twice as large for this sub-population: workers with a Bachelor's degree or more are 3 to 5 percentage points more likely to be separated under the new system after 7 years of tenure.

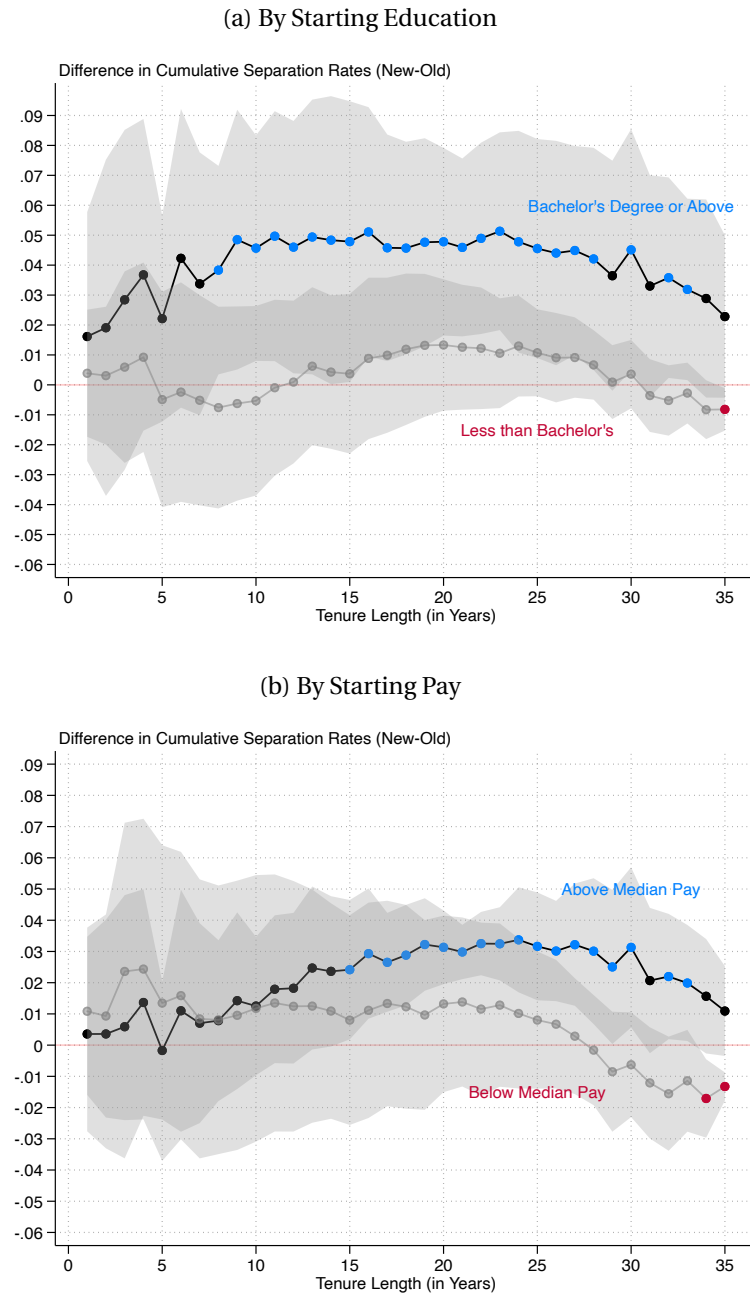
To further explore whether the average tenure result is influenced by outside options, we analyze another split based on median pay in the quarter in which employees start employment, a measure highly correlated with education. In Figure 7 Panel (b) reports the RD coefficients for the two subgroups. In line with our model predictions, we find that workers who start with above median pay are 2 to 3 percentage points more likely to be separated after 14 years of tenure, similar to our average result. On the other hand, workers who start with below median pay do not seem to change their separation behavior due to the change in benefits.

Our findings indicate that the increase in the attractiveness of outside employment drove lower retention. Workers with better outside options, particularly those with higher education levels and starting pay, are more likely to leave the government due to the reduction in federal retirement benefits and increased portability, compounded with the potentially higher wage opportunities elsewhere.

Summary

To investigate the impact of the change in retirement benefits on the recruitment and retention of federal government workers, we employ a regression discontinuity design, examining employees who began work just before and after the policy change. We find that the policy change resulted in a reduction in employer-provided pensions and an increase in portable retirement benefits, with no significant impact on hiring characteristics. On net, benefits under the new system were less backloaded. Next, the new system did not statistically affect the average age at separation. However, we find shorter tenure at separation, with a detailed analysis revealing heterogeneous effects. Workers with fewer than 15 years of tenure showed no significant differences across the old and

Figure 7: Difference in Cumulative Separations by Tenure Length



Note: This figure plots the RD coefficients on the cumulative separation rates for the tenure lengths in the x axis. Each point represents the difference in the cumulative separation rates between old system workers and new system workers. Panel (a) plots the RD coefficients by starting education: those with a Bachelor's degree or above vs. those with less than a Bachelor's. Panel (b) plots the RD coefficients by starting pay: those with above-median starting pay vs. those with below-median. The 95% confidence interval is shaded in gray. Light blue and red points represent coefficients which are statistically significant from zero at the 95% level.

new system, while those with 15 or more years were about 2 to 3 percentage points more likely to separate annually, with an average reduction of 1 to 3 years. These effects were more pronounced among workers who faced higher lifetime consumption by working elsewhere, further indicating that outside options play an important role in changes in tenure as our framework suggested.

7.4 Productivity

According to the CRS Report in 2019, the change in the retirement system reduced the employer's cost by nearly half, from 30% of employee wages to 17% of employee wages. Despite the significant reduction in costs, an important concern is whether the government lost productive workers who left for better outside options. We identify these workers using information in their pay. In the US, federal employee pay scales are structured into grades and steps, with each grade reflecting a level of responsibility and each step indicating a level of seniority or performance within that grade. Pay increases as employees move up in grade or step, and the scales are periodically adjusted for inflation and cost of living. Using this information, we employ two methods to parse out more "productive" workers:

1. **Workers who receive supplementary pay (non-overtime, regular, fixed payments) within their pay scales.** Workers receiving supplementary pay are given additional wages within their pay steps for retention and recruitment purposes, indicating that these positions and workers are valuable for the government to retain. In addition, this specify workers with better outside options: workers who need greater pay to continue federal employment.
2. **Workers who advance through pay steps and promotions a year prior to the event.** Government pay steps and promotions are often the primary mechanisms through which workers advance their careers. By examining how quickly workers advance through the pay scales, we can identify those who may have been particularly valuable to the government and assess the potential trade-offs of the retirement policy change.

Specifically, we identify these employees by removing standard factors which would determine pay level and pay grade. For supplementary pay:

$$\text{pay}_{i,t} = \beta_0 + \sum_{k=1}^K \delta_{k,t} z_{k,i,t} + \sum_{t=1}^T \gamma_t D_{i,t} + \varepsilon_{i,t}$$

where $\text{pay}_{i,t}$ is the salary of person i at time t , $z_{k,i,t}$ are the value of $k = 1, 2, \dots, K$ job characteristics for person i at time t (i.e. pay grade, pay plan, supervisory status, tenure, age, location, education, subagency, occupation, quarter); and $D_{i,t}$ is a dummy variable for time t . Essentially, this is a hedonic regression with characteristics that determine pay and step.

For promotion advancement:

$$\text{grade}_{i,t} = \beta_0 + \sum_{k=1}^K \delta_{k,t-1} z_{k,i,t-1} + \sum_{t=1}^T \gamma_{t-1} D_{i,t-1} + \varepsilon_{i,t-1}$$

where $\text{grade}_{i,t}$ is the pay grade of person i at time t , $z_{k,i,t-1}$ are the value of $k = 1, 2, \dots, K$ job characteristics for person i at time $t - 1$ (i.e. pay grade, pay plan, supervisory status, tenure, age, location, education, subagency, occupation, quarter); and $D_{i,t-1}$ is a dummy variable for time $t - 1$. We are regressing pay levels on lagged job characteristics.

Then we take the average residual pay and grade level for each person i at time t :

$$R_{i,t} = \frac{1}{t} \sum_{p=1}^t [y_{i,p} - \hat{y}_{i,p}]$$

where $y_{i,t}$ is current pay or current pay grade. The size of the residuals provide some information on whether a salary or pay grade are smaller or larger than typically associated with their experience and job characteristics.

For analysis on those who receive supplemental pay, we take the average of the residuals across all period T s for each worker. We assume those with above-median residuals, or those with a large portion of pay that is non-attributable to typical factors, are workers that are more productive and may have low attachment to federal work; and those with below-median residuals are workers that are less productive and with high attachment to federal work.

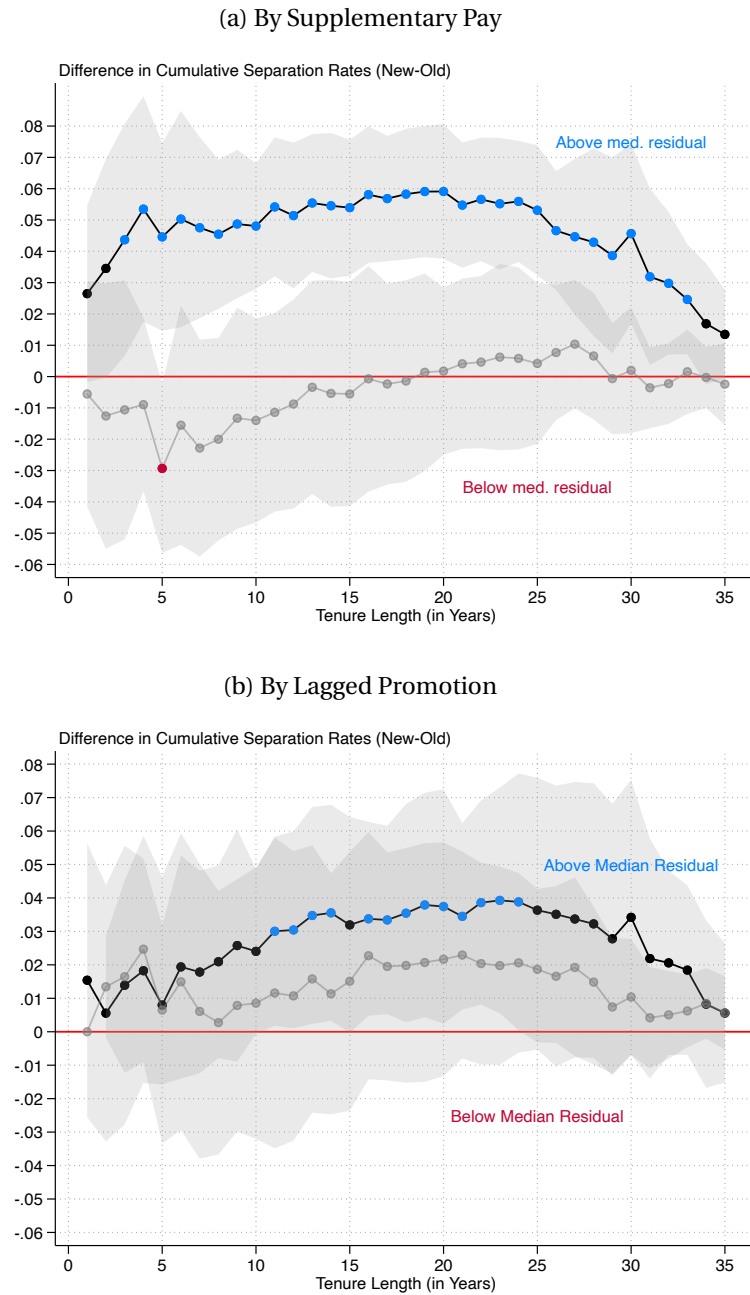
For analysis on those who advance through federal career faster, we take the running average of the residuals lagged by one year. We assume those with above-median residuals are those who advance quicker and are more productive, and workers with below-median residuals are workers who advance slower and are less productive. We take the lagged indicator to lessen endogeneity concerns over career advancement and separation behaviors.

We then plot RD coefficients of cumulative separation rates at 35 different tenure lengths for these two splits, analogous to Figure 5. The results are shown in Figure 8.

Figure 8 Panel (a) shows that workers receiving supplementary pay are 3 to 5 percentage points more likely to separate under the new system, with effects emerging by year 8. This is approximately twice the average effect reported in Section 7. Workers without supplementary pay show no detectable response; if anything, separations fall slightly, but not significantly.

These patterns align with the outside-options mechanism. Comparisons are within occupation, education group, and other covariates; the key distinction is receiving supplementary pay, which may signal productivity but also likely lower attachment to the federal sector due to competitive outside offers. Consistent with the story of outside options, the effect is concentrated among

Figure 8: Difference in Cumulative Separations by Tenure Length



Note: This figure plots the RD coefficients on the cumulative separation rates for the tenure lengths in the x axis. Each point represents the difference in the cumulative separation rates between old system workers and new system workers. Panel (a) plots the RD coefficients by supplementary pay: those that receive extra wages within their pay bands vs. those that do not or receive less. Panel (b) plots the RD coefficients by lagged promotion speed: those with above-median promotion speed in the year prior vs. those with below-median promotion speed. The 95% confidence interval is shaded in gray. Light blue and red points represent coefficients which are statistically significant from zero at the 95% level.

highly educated workers with supplementary pay (Appendix G); we find no effect for workers without a bachelor's degree even when they receive supplementary pay.

Productivity measured through promotions tells a similar story in Figure 8 Panel (b). Using a lagged promotion indicator, workers who are promoted faster are 3 to 4 percentage points more likely to separate after about 10 years, while workers who are promoted slower are unaffected. Note that because we use the lag indicator at each tenure length, the sample is not balanced, and so each point represents a different sample split.

Together this suggests that the change in retirement benefits, resulting from the loss in pension benefits and increase of portability, disproportionately affected productive or valuable workers. Notably, the effect of the policy change on productive workers is more pronounced than the main results, indicating that the average change from retirement benefits are driven by productive workers. Further studies may be interested in researching the impact on the loss of valuable personnel on performance of the agency.

7.5 Dynamic Selection

We study how dynamic separations affect the human capital composition by tracking the mean of the supplementary pay in a cohort over time. This approach quantifies the selective attrition within the cohort.

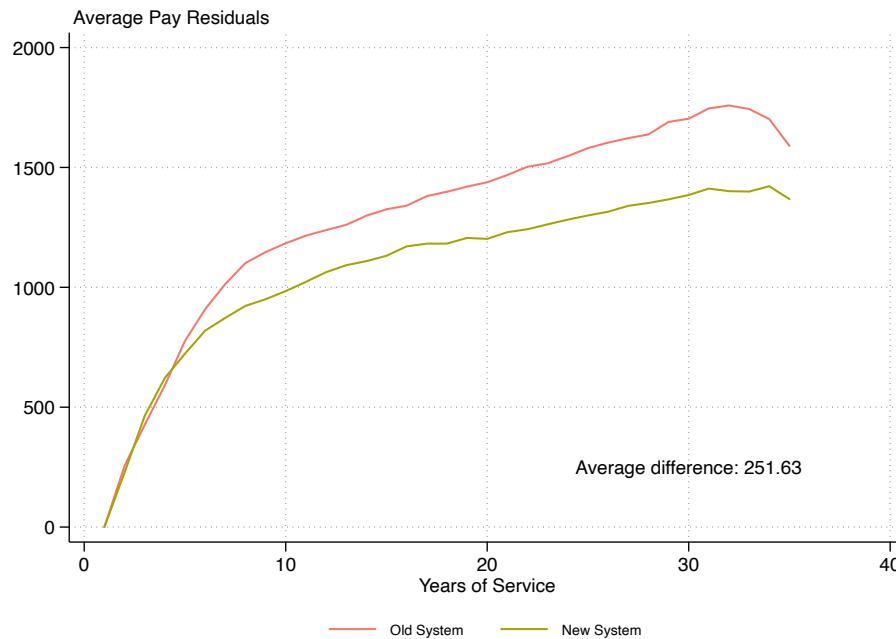
In the previous section, we found that “more productive” workers, or those with attractive alternative employment options, are more likely to exit the workforce. Hence, we should expect a declining average residual over time.

We first normalize each cohort's average supplementary pay to zero at entry and plot its evolution for both systems in Figure 9. For the first five years the paths are similar. Thereafter, as more productive workers leave under the new system, its mean residual grows more slowly than under the old system. By roughly 5 to 7 years, the average worker in the old system has \$251 more in supplementary pay. This is equivalent to roughly one to three months of typical experience-based raises (\$1,000 which is \$4,000 per year on the General Schedule). Because the new system also has higher overall separations, these stayers' averages likely understate the full compounding effect of differential attrition.

7.6 Early and Late Career Workers

Throughout our exploration of the changes in retirement benefits on tenure across the lifecycle, the responses towards the retirement benefit change have predominantly occurred in the mid-career range for federal workers, e.g. between 10 to 30 years of service. In this section, we focus on late- and early-career federal workers to understand the factors underlying the absence of statistically significant differences in the stock of separated workers, especially given the changes in

Figure 9: Dynamic Selection



Note: This figure reports the average normalized supplementary pay, by years of service, for workers under the old and new retirement systems. To construct this measure, we first set each cohort's average supplementary pay to zero at the start date, then track how the mean evolves over time. The resulting lines capture differences in dynamic selection.

incentives across all tenure years. By zooming in these distinct career stages, we create a full image of the DB to DC retirement benefit change across the employment lifecycle and to identify potential mechanisms driving the observed patterns of labor supply adjustment.

Discussion on late career workers

Despite old and new system workers having different labor supply responses mid-career, we find a catch-up effect for the stock of old system workers who have separated near or at retirement ages. This is largely driven by two factors: (1) the increasing number of old system workers reaching retirement age, and (2) their heightened sensitivity to retirement eligibility. Regarding the former, this is due to fewer workers reaching full retirement eligibility under the new system, around 30 years of service. Figure 4 Panel (b) reports that workers under the new system are 3 percentage points less likely to reach their eligibility age at separation.

Regarding the latter, we find that workers under the new system are less elastic to retirement benefits. Using the variation in the annuity growth before and after retirement eligibility, we can utilize an event study to examine how labor supply responds to changes in financial incentives around

full retirement eligibility:

$$\text{Separation}_{it} = \alpha + \beta_1 \text{Post}_{it} + \beta_2 \text{NS}_i + \beta_3 \text{Post}_{it} \times \text{NS}_i + \gamma D_i + \omega Z_t + \epsilon_{it}$$

where Post_{it} is a dummy variable for if person i is at or beyond full retirement eligibility at quarter t ; NS_i is a dummy variable for whether the worker is under the new system; D_i is a person fixed effect; Separation_{it} is whether or not person i separates at t ; γ and ω are individual and time fixed effects; and β_3 is the difference in the effect of retirement eligibility between individuals in the old and new system. Because we see individuals reacting to the retirement eligibility a quarter prior to the event, we include the quarter prior to eligibility in our Post_i variable. Furthermore, we condition to workers within 5 years of retirement eligibility. For the separate event studies with the baseline separation for the old and new system, see Appendix I.

We plot the difference in separation rates, or the β_2 coefficients, in Figure 10. The figure highlights two facts about old versus new retirement system workers: old and new system workers are separating at similar rates prior to retirement eligibility, but old system workers are more willing to intertemporally substitute work to when (retirement) benefits are low. Prior to eligibility, workers are separating at a 1 percentage point rate per quarter. After eligibility, workers separate at higher rates. However, that rate is larger and remains at a higher rate for old system workers. The event study estimate suggests that workers are 0.3 percentage points more likely to leave after eligibility under the old system. This is about 33% of baseline separation rates.

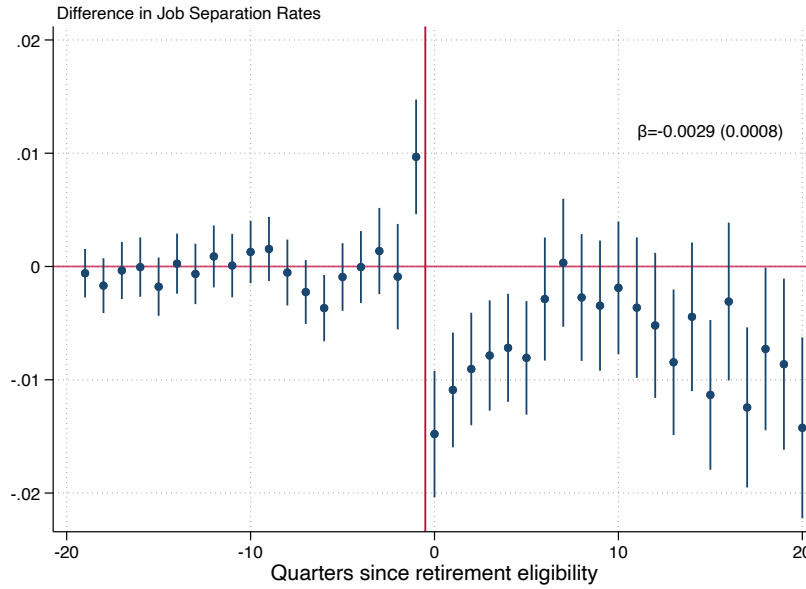
In conclusion, we find a significant catch-up effect driven by the increasing number of old system workers reaching retirement eligibility and their greater intertemporal sensitivity to retirement incentives. This suggests that old system workers may drive more of their behavior to the changes retirement benefits, while new system workers respond less to these financial incentives near retirement.

Discussion on early career workers

Our analysis revealed that short-term workers do not respond to changes in retirement benefits, despite larger net benefits. We find that, at hire, workers are inattentive to retirement benefits or lack financial literacy early in their careers. Numerous studies support this theory, suggesting that early-career employees may not prioritize or fully understand the long-term implications of retirement plans (for a review of the literature, see [Lusardi and Mitchell \(2023\)](#)).

We bolster this argument by showing that even the announcement of the changes in retirement benefits did not affect hiring characteristics. Appendix Table 4 re-estimates the RD in equation 1 using the 1986Q2 announcement as the cutoff, comparing hires six quarters before vs. after. Hiring characteristics are similar, indicating the policy had limited effects on selection into federal work.

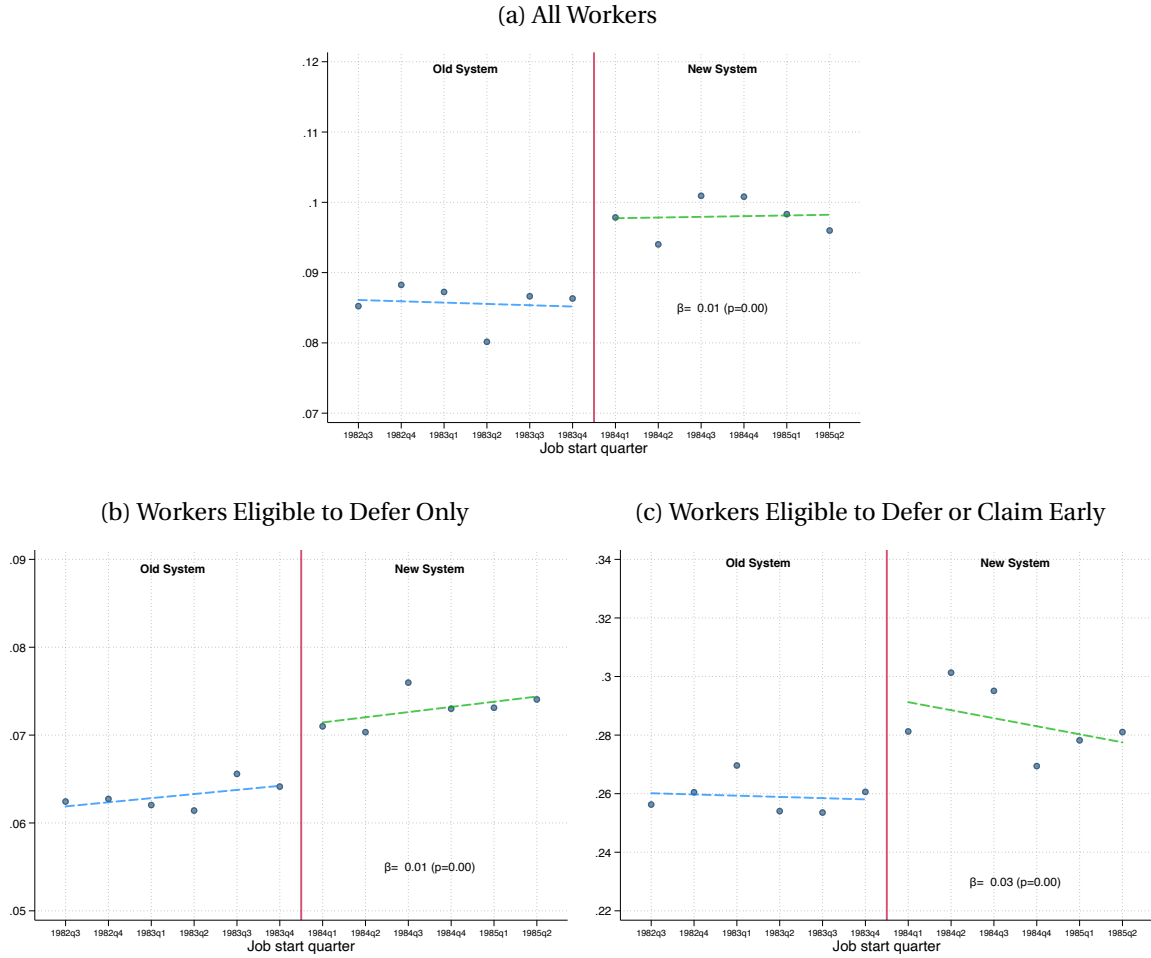
Figure 10: Event study - differences in separations around full retirement eligibility



Note: This figure presents the event study provided in equation 2 for our RD sample. The coefficient is reported as β with standard errors in parenthesis. We include the quarter prior to eligibility in the $Post_i$ coefficient as workers seem to be responding to retirement benefits prior to the event. The sample is restricted to workers who work within 5 years of their full retirement eligibility. The red vertical line signifies the time in which workers become eligible. The navy dots are differences in worker separation rates between the old and new system. Vertical bars represent the 95% confidence interval, which is clustered at the individual level.

We find responses to retirement incentives a little after the start of a worker's career, suggesting employees are learning about their retirement benefits over time. Consistent with "job lock" or "golden shackles," workers in both systems delay exit to meet minimum retirement eligibility thresholds (Lumsdaine et al. (1990), Kotlikoff and Wise (1987)). We test whether workers respond to new incentives under the new system's additional 10-year vesting milestone: with at least 10 years of tenure, workers can claim their annuity earlier at their MRA, with penalties. Figure 11 shows sharp behavioral responses at this threshold: separations increased by 0.7 percentage points between 10 to 15 years, or an 11% increase. This applies for workers who would only be eligible for deferred retirement (i.e. workers who separate before their MRA) and workers who may be eligible for early retirement (i.e. workers who can separate immediately at MRA). We interpret this as individuals valuing the option to claim future annuity benefits earlier and to claim reduced annuities immediately. The former may be young workers who value the option value of future wages, as they seek outside options for employment. The latter may be a story about how early availability of liquid retirement accounts may induce more workers to retire early, especially as the returns to working shrink under the new system.

Figure 11: Separating at 10-15 Years



Note: This figure reports the RD outcomes for separating at 10 to 15 years of tenure. Panel (a) plots the percent separated with 10 to 15 years of service across the total sample, for each quarter around the 1984 policy change. Panel (b) plots the percent separated between 10 to 15 years of service for those who begin work under 40 years old and are thus only eligible to defer their benefits. Panel (c) plots the percent separated between 10 to 15 years of service for those who begin work at 45 years old or above and are thus eligible to claim their benefits early or defer their benefits until later. The RD coefficients are reported as the β and p-values are given in parenthesis.

In Appendix J, we show the analogous results, focusing on separations at 10 years of tenure. We find similar effects that are driven by older workers that are eligible to retire early upon separation. We find no effects on the probability of separating at 10 years of service for younger workers that can only defer the benefit. This likely reflects the time required for younger workers to secure alternative employment, delaying their ability to respond immediately to the change in benefits. Instead, their separations are spread over the subsequent years. Additionally, we show that there is no evidence of differential separation patterns at 9 years of tenure in Appendix J.

Summary

We investigate the possible channels surrounding the lack of late and early career responses. More late career workers approach retirement eligibility under the old system than under the new system. This, combined with the fact that these workers are more sensitive to the annuity eligibility, explains why we don't see much of a divergence in separation rates for older workers. For early career workers, we posit that some workers may be inattentive at hire while others may wait to accrue retirement benefits. We illustrate some evidence of early responsiveness: the new system's early retirement incentives led to a 11% increase in separations for workers with 10-15 years of tenure.

8 Robustness Checks

In this section, we present several robustness checks to validate our findings. First, we assess the sensitivity of our RD design by varying the bandwidth, testing both larger and smaller windows. We also account for potential seasonal effects by adjusting for quarter fixed effects. Additionally, we conduct a placebo test to address concerns of potential mechanical effects. Then finally, we also run a donut-RD to further address potential selection concerns regarding those hired around the policy threshold. These alternative specifications yield results that are consistent with our main analysis, suggesting the bin sizes, seasonality, and mechanical effects do not bias our estimates.

Bin sizes. We conducted a sensitivity analysis by varying the bandwidth used in our RD design. While the window in the primary analysis is determined by the institutional setting, we tested both larger (10 quarters) and smaller (4 quarters) bandwidths to ensure the robustness of our findings in Appendix K. Across these different specifications, we observe results consistent with our main analysis, suggesting that our estimates are robust to variations in the window size.

Seasonal effects. Hiring may have seasonal effects, stemming from job-specific characteristics or applicant profiles. For example, the influx of new graduates typically entering the workforce in the third quarter post-graduation may skew the educational composition of hires during this period; new hires in that quarter tend to be more educated relative to those in other quarters. Since our RD is centered around the start of 1984, this asymmetry may skew our results. To account for this seasonality, we conduct a robustness check by residualizing quarter fixed effects from labor supply outcomes in Appendix M. We find consistent results between the primary analysis and fixed effects-adjusted estimates, suggesting that seasonal variation does not significantly influence the results.

Placebo test. Although the primary analysis accommodates linear trends across start quarters, there may be potential concerns that our estimates are sensitive to some mechanical lagged effect because we are comparing workers who started their federal career at different times. While our

relatively narrow study period likely precludes such effects, this robustness check serves to further validate our findings. We conduct a placebo test that re-centers our RD design around the second quarter of 1985, such that we are comparing two cohorts under the new system. The figure is shown in Appendix L. The results of this placebo analysis suggests that mechanical effects are not driving our main results.

Donut regression discontinuity. To address concerns that the timing of hires may have been influenced by uncertainty around the policy threshold—such as pessimism about the new system potentially leading employers or employees to shift hiring into December—we conduct a donut regression discontinuity design using detailed personnel data. This dataset includes hires and separation event dates of employees, which we partially use in constructing our main sample. For approximately 70% of the sample (over 68,000 employees), the recorded start quarter aligns with a precise hire date.

Using the subsample of employees with precise hiring dates, we observe a greater increase in December hires relative to January between 1983 and 1984, compared to surrounding years. To mitigate potential bias from this, we construct two donut RD analysis: (1) drop only those hired in December and January from the main sample, and (2) restrict to the subset with matched start and accession dates and then remove December and January hires. Across both specifications, found in Appendix Figure 25, the results remain consistent with our main findings: employees under the new retirement system separate mid- to late-career at higher rates than those under the old retirement system. As expected with a smaller sample, the results are noisier, however, than our main specification.

Finally, using the subsample with precise start dates, we replicate the main analysis at the monthly level and again find similar effects. We use the month level to smooth hires that are more likely to occur in the beginning of the week and at the start of a pay period (typically bi-monthly). Appendix Figure 26 plots 35 different RD coefficients of cumulative separation rates across different tenure lengths, similar to Figure 5 but using monthly-level data. Panel (a) plots the coefficients using all months in the RD bandwidth, and Panel (b) excludes December 1983 and January 1984. Again, we find the employees are 2-3 percentage points more likely to leave federal service mid- to late- career under the new system.

9 Conclusion

In this project, we employed a regression discontinuity design to characterize labor supply in response to the change the U.S. federal retirement systems. This project provides one of the first and largest pieces of empirical evidence for labor supply responses to the shift from DB to DC private employer benefits. We leverage our institutional setting to compare similar workers who started under different retirement systems.

The RD results revealed that there was a large decrease in the DB pension and a large increase in portable retirement benefits, resulting in less benefit backloading and hence reducing retention incentives. This translated to a reduction in average tenure of a few quarters and a lower probability that a worker stays with the federal government for their full career. However, the effects were mostly concentrated among mid- to late-career workers. The new retirement system led workers with 15 or more years of tenure to separate at a 2-3 percentage point higher rate than old system workers. Workers in this range reduced their labor supply by 1 to 3 years. Moreover, the responsive workers were more educated, had a higher base pay, were more likely to be receiving retention pay, and were promoted faster than the median worker, suggesting that a large driver of the separation responses were workers who were more productive and sought better outside options. The new system's less generous pension benefits may have driven valuable employees to seek opportunities elsewhere.

In contrast, employees with fewer than 15 years of tenure were not significantly affected, and by 30 years of tenure, workers seemed to separate at similar levels. We find evidence that the convergence of the stock of separated workers under the two systems are driven by workers in the old DB system who are much more sensitive to the retirement benefit eligibility age. On the other hand, the lack of change in short-term workers may be driven by a mix of inattention and job locking for vesting schedules. A more thorough analysis may be warranted to investigate early separation behavior.

These findings emphasize that workers are responsive to changes in retirement benefits. While the shift to a mixed DB and DC system achieved cost savings, it also influenced employee retention patterns, particularly among long-tenured and highly productive workers.

Similar reforms have occurred throughout the country, with employers increasingly moving away from traditional DB pensions. Many state governments, including Pennsylvania, South Carolina, and Tennessee, converted to hybrid DB-DC systems in response to fiscal challenges after the Great Recession. University systems have also restructured their retirement offerings, with mostly public institutions like the University of California system adopting a mixed system (as opposed to eliminating the DB portion altogether); public teacher pensions have seen similar rollbacks. Today, the topic remains relevant as major unions, including those representing autoworkers and Boeing employees, are negotiating over the return of the traditional DB program. This study contributes to a deeper understanding of these dynamics, informing future policy and economic understanding of labor supply responses to the evolving retirement landscape.

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Appendix Figures and Tables

Appendix A Old System Annuity Formula

The computation for the annuities involve age, tenure and salary. The full retirement benefit is calculated by averaging the high-3 salaries and multiplying it by 1.5% for each year of service in the first five years of one's tenure, 1.75% for each year of service in the next five years of one's tenure, and 2% for each year of service after the first ten years of one's tenure. Specifically, the formula for the annuities (without any penalty) is as follows:

$$b_{it}^{CSRS} = \underbrace{1.5\% \times h_{it} \times 5}_{\text{first 5 years of service}} + \underbrace{1.75\% \times h_{it} \times \max(0, \min(5, \delta_{it} - 5))}_{\text{next 5 years of service}} + \underbrace{2\% \times h_{it} \times \max(0, \delta_{it} - 10)}_{\text{years of service over 10 years}}$$

where b_{it} is the yearly annuity benefits person i receives for retiring at age t ; h_{it} is the high-3 average salary of person i at age t ; and δ_{it} is the number of years person i has worked by age t ("years of service").

Federal workers under the old system are eligible for the immediate disbursement of the full retirement annuity as long as they have worked under the old system within the two years before retirement and have either (1) reached the MRA of 55 years and at least 30 years of service, or (2) reached 60 years of age and at least 20 years of service, or (3) reached 62 years of age and at least 5 years of service. Those who opt to retire under the MRA will receive a penalty amounting to one-sixth of 1 percent for each full month under the age 55. For example, if an employee decides to retire 12 months prior to her 55th birthday, then her annual annuity will be reduced by 2%.

Appendix B New System Annuity Formula

The full retirement benefit under the new system is calculated by averaging the high-3 salaries and multiplying it by 1% or 1.1% for each year of service. Those who retire at or above the age 62 with at least 20 years of service are eligible for the additional 0.1% benefit. Specifically, the formula for the annuities (without any penalty) is as follows:

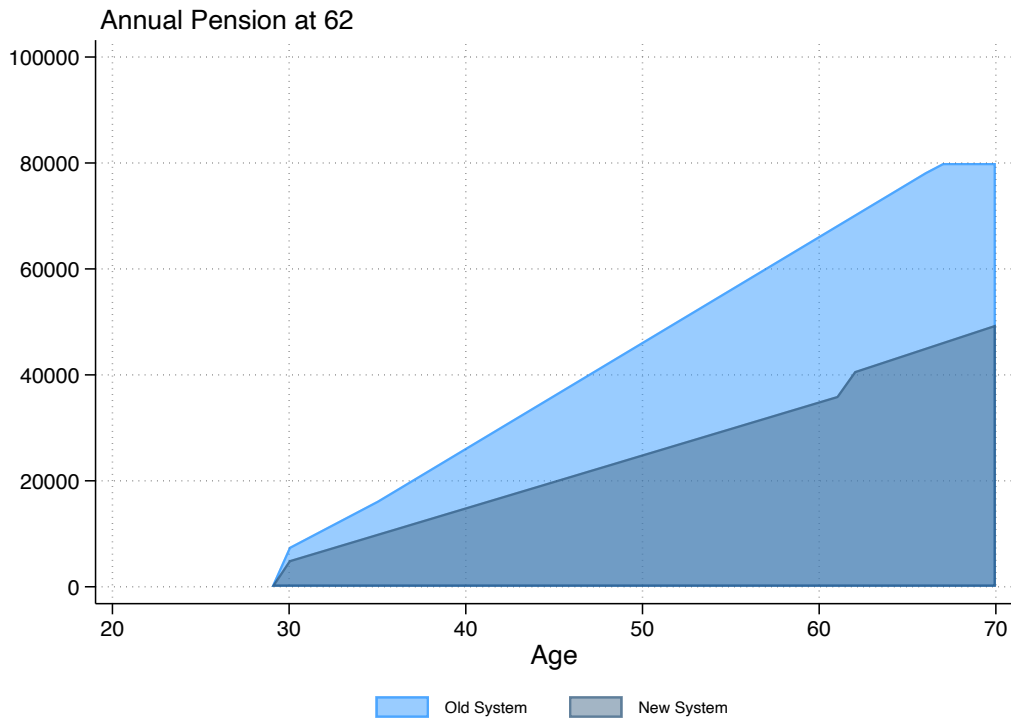
$$b_{it}^{FERS} = \underbrace{1\% \times h_{it} \times \delta_{it}}_{\text{basic benefit}} + \underbrace{\mathbb{1}\{t \geq 62 \wedge \delta_{it} \geq 20\}}_{\text{eligibility for extra benefits}} \times \underbrace{0.1\% \times h_{it} \times \delta_{it}}_{\text{extra 0.1\% bump}}$$

Federal workers under the new system are eligible for the immediate disbursement of the full retirement annuity as long as they have worked under the new system within the two years before retirement and have either (1) reached the MRA and at least 30 years of service, or (2) reached 60 years of age and at least 20 years of service, or (3) reached 62 years of age and at least 5 years of service. If an employee retires at the MRA with at least 10, but less than 30 years of service, their benefit will be reduced by 5% a year for each year under 62, unless she is eligible for retirement under a different age-service year cut off. In contrast to the old system, the MRA under FERS will

depend on one's birth year. The full schedule of MRAs can be found [here](#).

Appendix C Illustrative Example of Pension Growth

Figure 12: Example of Annuity Growth



Note: This is an example of an employer pension growth of a federal worker under both retirement systems. We assume this worker begins work at the age of 25 years and has an MRA of 55 years under both systems. We also assume static annual wages at \$100,000. For ages under the MRA, we assume the annuity would be claimed at 62.

Figure 12 provides an illustrative example of the pension growth of a worker who begins full-time federal work at the age of 25 and receives their annuity at separation or 62 years old if under the MRA. For simplicity, we assume a worker whose wages amount to \$100,000 annually and whose MRA occurs at 55 years old under both systems. Under the old system, the benefits vest at 5 years of tenure and grow at a steeper rate, facing a larger benefit factor after 5 and 10 years of service. Our example worker reaches MRA at 55 years old and obtains full retirement eligibility because they have reached 30 years of tenure simultaneously. Then the pension flattens after 42 years of service because the old system caps annuities at 80% of the high-3 wages. Under the new system, this individual also vests after 5 years but faces a slower growth in pension, by a magnitude of around half of the benefit factor under the old system. This pension steadily grows

until the worker completes at least 20 years of tenure at 62 years old, in which case they are eligible for an extra 0.1% boost in their annuity formula. This will cause an additional jump for the value of pension benefits for this worker.

In comparison to the old system, the new system pension is significantly less generous across a given tenure length. For example, our worker at 55 years old faces approximately a \$56,000 annual annuity under the old system and a \$30,000 annual annuity under the new system. This amounts to a little over half of the annuity for the same age, tenure, and wage combination. Furthermore, the worker faces jumps in their annuity growth if they achieve full retirement eligibility before 62 and at the additional 0.1% boost in annuity.

This figure does not account for penalties for early withdrawal. If we account for those who may claim benefits early, the pension growth may contain kinks or jumps at key milestones, especially those under the new system. Workers under the old system tend to face a smoother growth in benefits because penalties are processed gradually faded out at the MRA. In our analysis, we consider the trade-offs of early retirement penalties and assume workers choose benefits based on the largest present discounted value of the benefits.

In summary, the restructuring of the retirement system did not affect key age or tenure milestones in the retirement benefit accrual; however, it introduced significant changes in the level and the type of benefit. The new system reduced the pension benefit, enhanced the portability of retirement savings with the inclusion of Social Security and the Thrift Savings Plan (TSP), and introduced new incentives for extending careers.

Appendix D Solving for the Decision Rules

We have a generalized CRRA utility in the form:

$$\sum_{t=0}^T \beta^t \left[\frac{c_t^{1-\sigma}}{1-\sigma} - \alpha 1_{\{\text{working}\}} \right]$$

Thus our first order conditions are: $c_3 = k c_2$ where $k = (\beta(1+r))^{\frac{1}{\sigma}}$

We can solve for optimal consumption under the three different choices through the first order conditions above:

$$c_2^f = \frac{w_f + a_2 + \frac{(\tau_1 + \Delta\tau)w_f}{1+r}}{1 + \frac{k}{1+r}}$$

$$c_2^p = \frac{w_p + a_2 + \frac{\tau_1 w_f}{1+r}}{1 + \frac{k}{1+r}}$$

Thus, the decision rule to Work for the federal government over going to an outside employer is $U^f > U^p$:

$$\frac{c_2^{f1-\sigma} - c_2^{p1-\sigma}}{1-\sigma} (1 + \beta k^{1-\sigma}) > 0$$

If $c_2^f > c_2^p$ then $U^f > U^p$ regardless of σ , and vice versa. Hence, we can just compare if $c_2^f > c_2^p$. Since they contain the same denominator, we can simply compare the budget constraints. We have intertemporal substitution in consumption σ , but the trade off in consuming today vs tomorrow is the same across the choices of different employment options.

Appendix E Potential Benefits

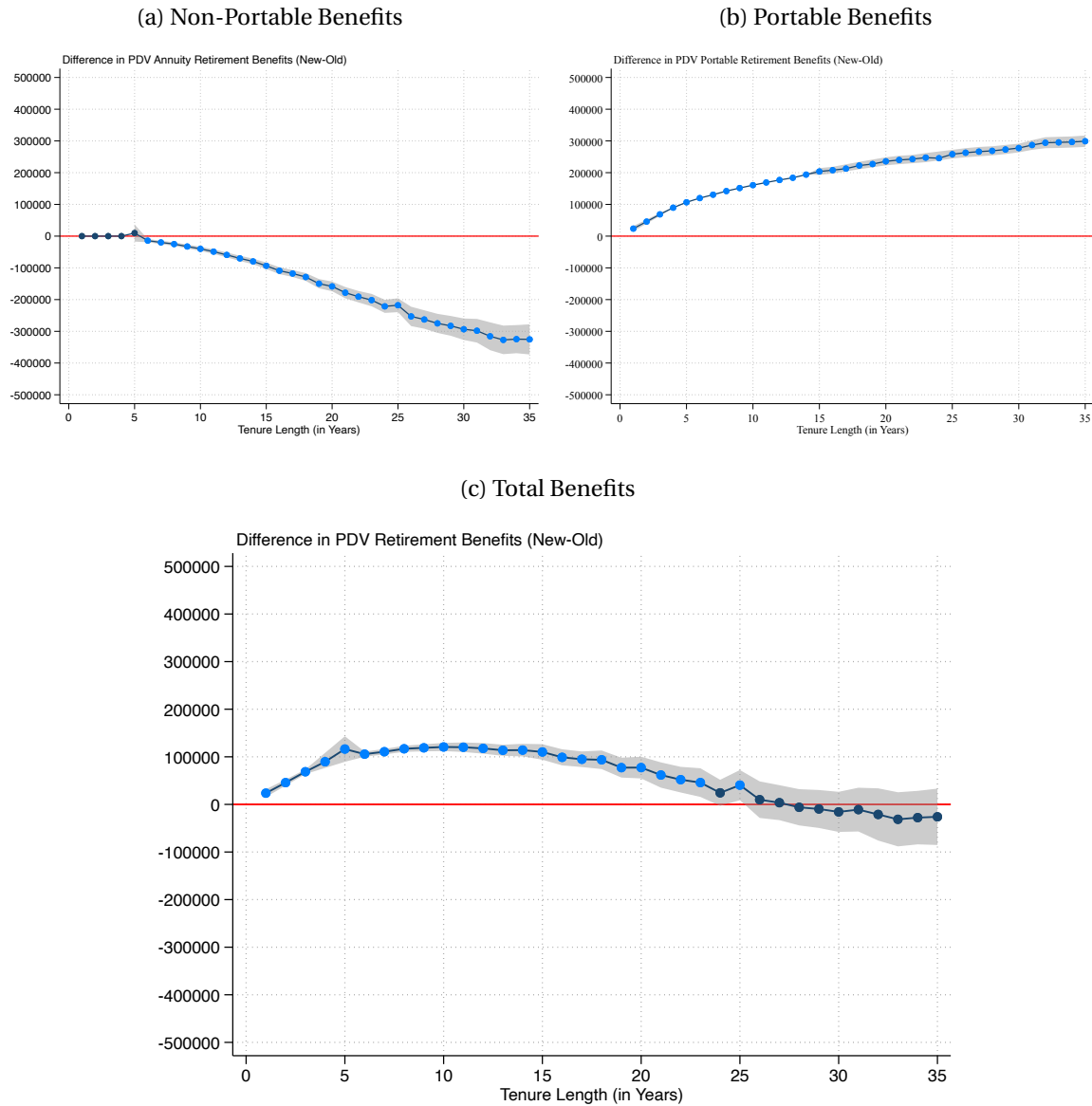
We illustrate the effects of the policy change on retirement benefits in Figure 13. This figure displays 35 separate regression discontinuity (RD) estimates of retirement benefit differentials across 35 years of tenure. For each year (from 1 to 35), we estimate the total retirement benefits under the new system relative to the old system. Specifically, for each point on the graph, we run the RD regression using interpolated wages for all workers to project both the annual annuity and the portable benefits, assuming a 35-year career. Thus, these estimates do not reflect actual separation behavior but instead illustrate the hypothetical net change in benefits at each potential tenure length.

Figure 13 quantifies how the policy change trades off back-loaded, employment-tied annuities against portable wealth. Panel (a) shows that the back-loaded (non-portable) component falls sharply under the new system: by 35 years, annuity wealth is more than \$300,000 lower than under the old plan. Panel (b) shows the mirror image for portability. Social Security plus automatic DC contributions rise, yielding roughly \$300,000 more portable wealth by 35 years.

Taken together in Panel (c), portability reduces the backloadedness the benefit profile by increasing front-loaded benefits. New-system workers receive more early in the career, but the advantage diminishes with tenure. Beyond 25 years of tenure, the old system provides larger benefits, although the estimates are not statistically significant. If we adjust the benefits for risk aversion, the old system can provide statistically significant larger benefits for a long career.

However, unambiguously, the new system will reduce the price of staying at the federal government across the lifecycle, as shown with the reduction in tenure-contingent, non-portable in Panel (a). According to our framework, this reduction should guide the labor supply to exit.

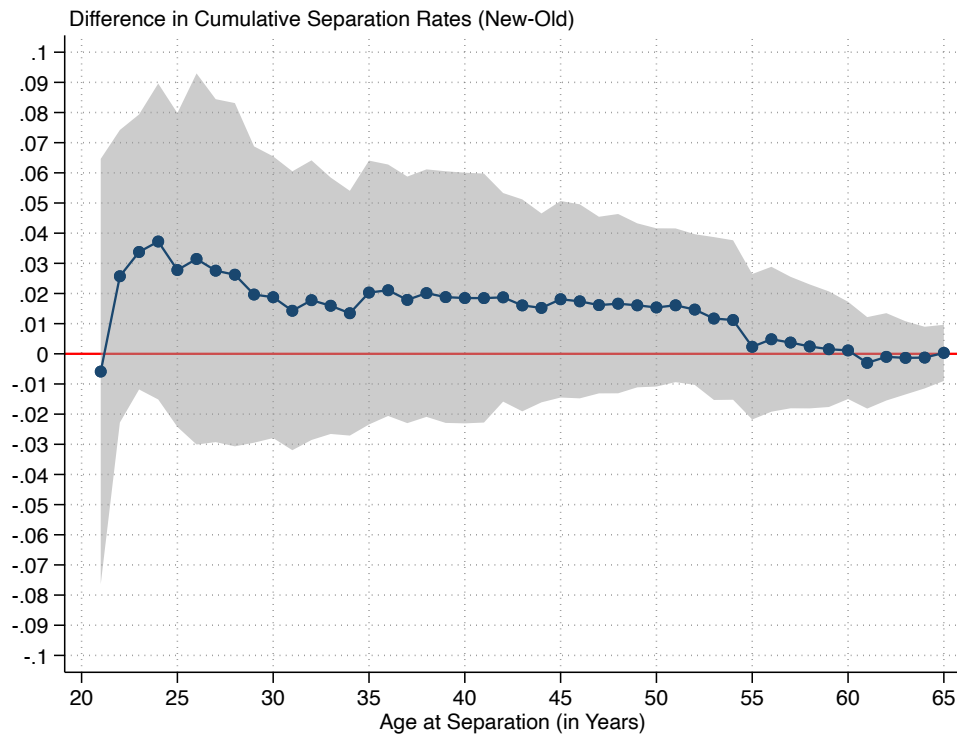
Figure 13: Difference in Retirement Benefits by Tenure Length in the Old vs. New System



Note: This figure plots the RD coefficients on the benefit amount for 35 years of tenure, using interpolated wages to project benefits for workers who have separated prior to 35 years in our sample. Each point represents the difference in the benefits between old system workers and new system workers. Panel (a) displays the change in total retirement benefits, Panel (b) displays the change in non-portable retirement benefits (i.e. the annuity), and panel (c) displays the change in portable retirement benefits (i.e. Social Security and DC savings match). The 95% confidence interval is shaded in gray. Light blue points represent coefficients which are statistically significant from zero at the 95% level.

Appendix F Heterogeneity Analysis on Separation Rates by Ages

Figure 14: Difference in Cumulative Separations by Age in the Old vs. New System

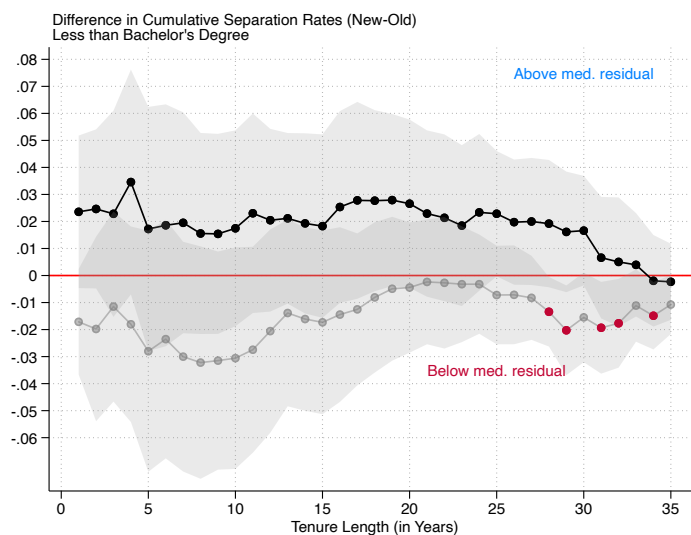


Note: This figure plots the RD coefficients of the cumulative separation rates for different ages in the x axis. Each point represents the difference in the cumulative separation rates between old system workers and new system workers. The 95% confidence interval is shaded in gray. Light blue points represent coefficients which are statistically significant from zero at the 95% level.

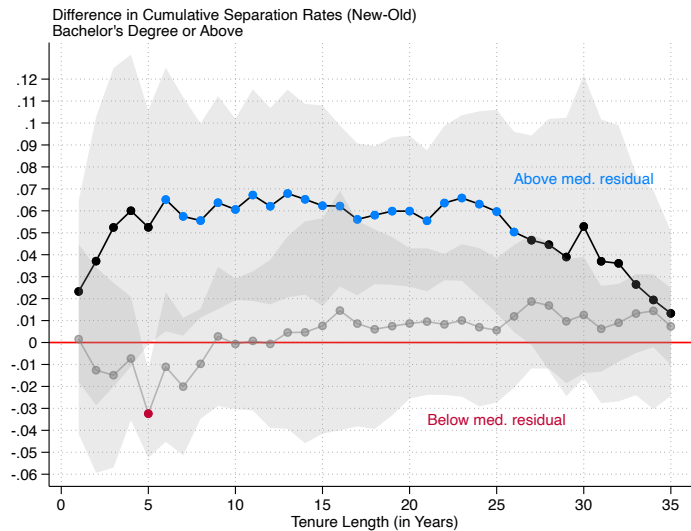
Appendix G Productive Workers: High vs. Low Education

Figure 15: Difference in Cumulative Separations by Supplementary Pay

(a) Less than a Bachelor's Degree



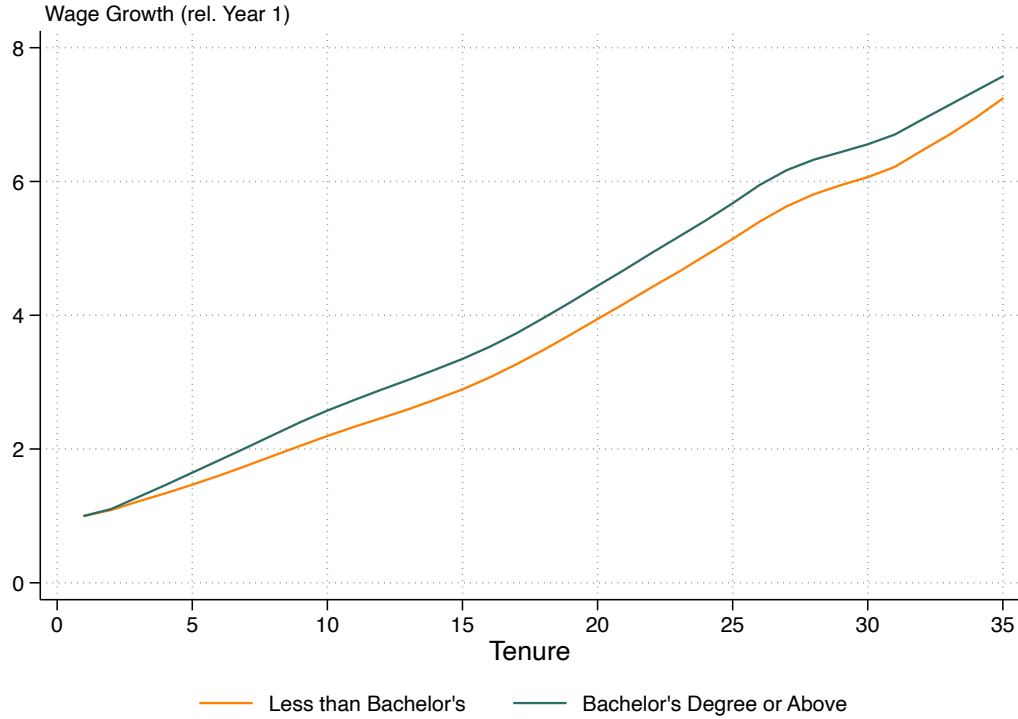
(b) Bachelor's Degree or Above



Note: This figure plots the RD coefficients on the cumulative separation rates for the tenure lengths in the x axis. Each point represents the difference in the cumulative separation rates between old system workers and new system workers. Both figures plot the RD coefficients by supplementary pay: those that receive extra wages within their pay bands vs. those that do not or receive less. Panel (a) restricts the sample to the subset of workers that start with less than a Bachelor's degree. Panel (b) restricts the sample to the subset of workers that start with a Bachelor's degree or higher. Light blue and red points represent coefficients which are statistically significant from zero at the 95% level.

Appendix H Wage Growth by Education Level

Figure 16: Wage Growth relative to year 1 salary



Note: This figure plots the wage growth relative to the first year of employment. The orange line represents those who started with less than a Bachelor's degree, and the teal line represents those who started with a Bachelor's degree or more.

Appendix I Separation Event Studies

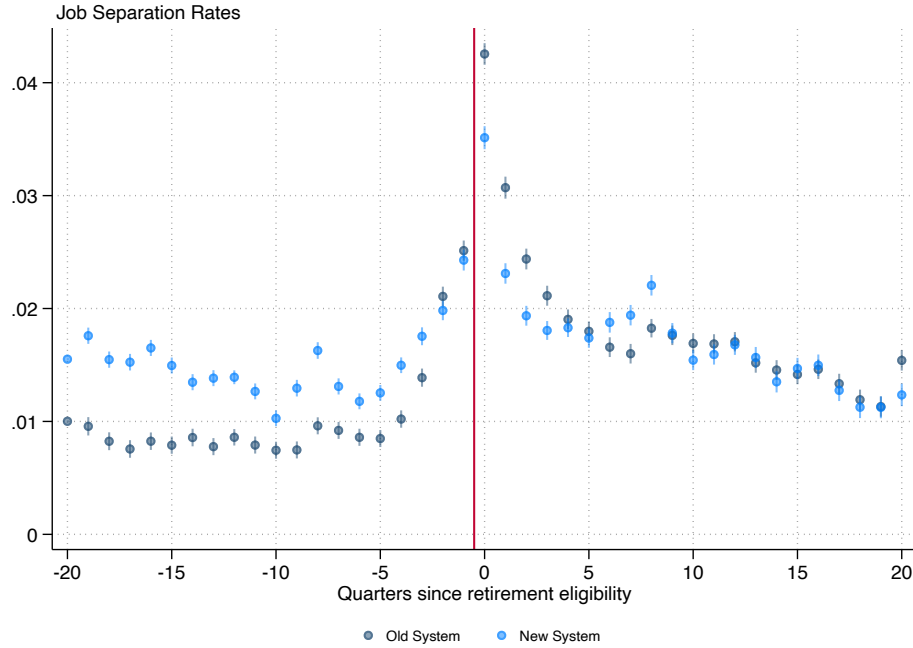
Using the variation in the annuity growth before and after retirement eligibility, we can utilize an event study to examine how labor supply responds to changes in financial incentives around full retirement eligibility:

$$Y_{it} = \alpha + \sum_{n=k}^K \beta_n X_{in} + \gamma D_{it} + \epsilon_{it} \quad (2)$$

where X_{in} is a dummy variable for if person i is n quarters away from full retirement eligibility; D_{it} is a vector of rich fixed effects (i.e. subagency, occupation category, location, education level, pay status, appointment status, and age); Y_{it} is whether or not person i separates at quarter t ; and β_n is the average separation rate when n quarters away from full retirement eligibility. We condition to workers within 5 years of retirement eligibility. Because we are able to control for a variety of

characteristics and time, we include all workers that have started between 1980 and 2000. For the event study on our RD sample, see Appendix I, which show similar but noisier effects.

Figure 17: Event study: separations around full retirement eligibility

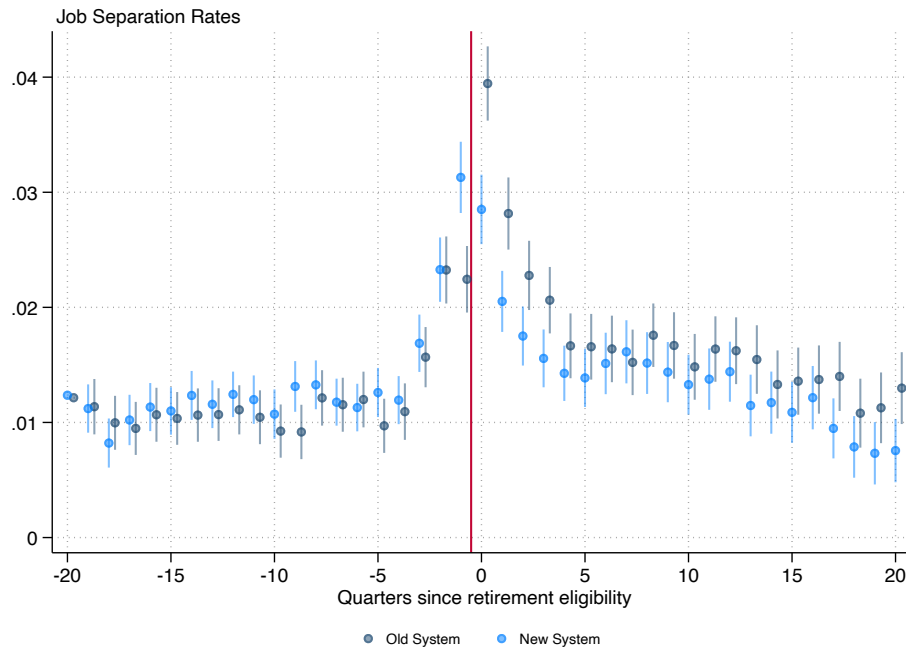


Note: This figure presents the event study coefficients provided in equation 2, for all workers who began between 1980-2000. The sample is restricted to workers who work within 5 years of their full retirement eligibility. The red vertical line signifies the time in which workers become eligible. The navy dots are workers under the old system and the light blue dots are workers under the new system. Vertical bars represent the 95% confidence interval.

The figure highlights two facts about old versus new retirement system workers: old system workers are much more sensitive to retirement eligibility, and they are also more willing to intertemporally substitute work to when (retirement) benefits are low. Under the old system, workers are separating at a 1 percentage point rate prior to eligibility; however, following retirement eligibility, that rate increases four fold to 4 percentage points. Then, workers remain at a higher 1.5 percentage point separation rate following the event. The new system workers, on the other hand, leave at a rate of 1.5 percentage points before and after eligibility. At eligibility, they separate at a rate of 3.5 percentage points, or about two to three fold of the baseline.

Below we run the same event study but for our RD sample.

Figure 18: Event study: separations around full retirement eligibility



Note: This figure presents the event study coefficients provided in equation 2. The sample is restricted to workers who work within 5 years of their full retirement eligibility. The red vertical line signifies the time in which workers become eligible. The navy dots are workers under the old system and the light blue dots are workers under the new system. Vertical bars represent the 95% confidence interval.

Under the old and new system, workers are separating at a 1 percentage point rate prior to eligibility; however, following retirement eligibility, that rate increases four fold to 4 percentage points for old system workers and three fold to 3 percentage points for new system workers. Then, old system workers remain at a higher 1.5 percentage point separation rate on average following the event. The new system workers, on the other hand, separate at a rate closer to baseline around 1 percentage point after eligibility. This highlights two facts about old versus new retirement system workers: old system workers are more sensitive to retirement eligibility, and they are also more willing to intertemporally substitute work to when (retirement) benefits are low.

Appendix J Early career workers

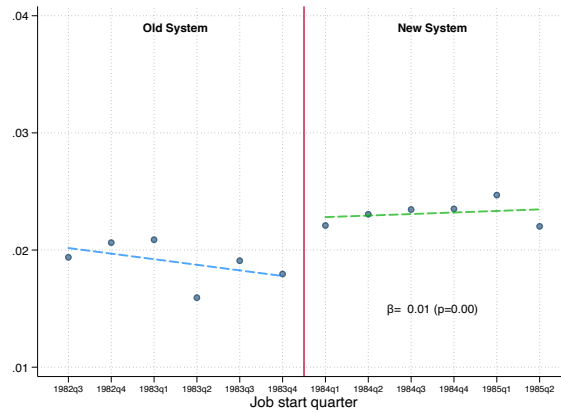
Table 4: Changes in Hiring Characteristics Around New System Announcement

	Announcement 1986Q2
Quarters Needed for Full Retirement	-0.14 (1.72)
ln(Starting Salary)	0.03 (0.02)
Starting Age (in Quarters)	0.13 (2.22)
No. Hires in Subagency	4.52 (15.22)
Education	
High School or More	-0.00 (0.00)
Bachelor's Degree or More	0.02 (0.02)
Higher Educ. Degree or More	0.02 (0.02)
Years of Educ.	0.04 (0.09)
Occupation Category	
White-Collar	-0.00 (0.00)
Blue-Collar	0.00 (0.00)
Other	-0.01 (0.02)

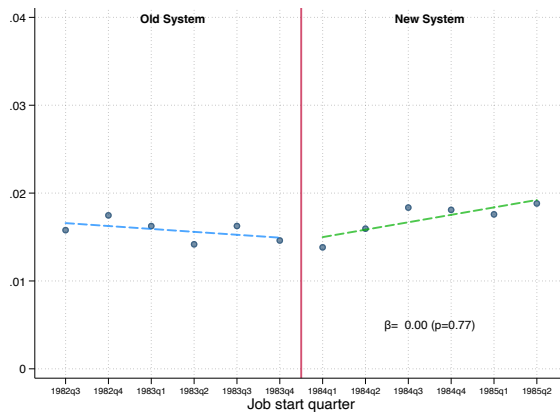
Note: This figure reports the RD coefficients that relate to the change in hiring characteristics after the announcement of the new system. The running variable is the quarter in which an employee begins federal government work, and the regression contains the six quarters before and after the announcement (second quarter in 1986). Standard errors are reported in parenthesis. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Figure 19: Separating at 10 Years

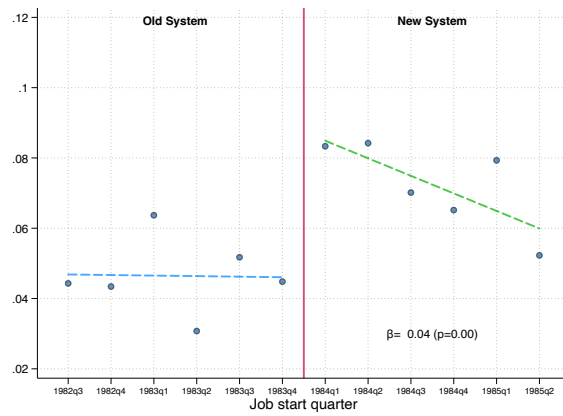
(a) All Workers



(b) Workers Eligible to Defer Only

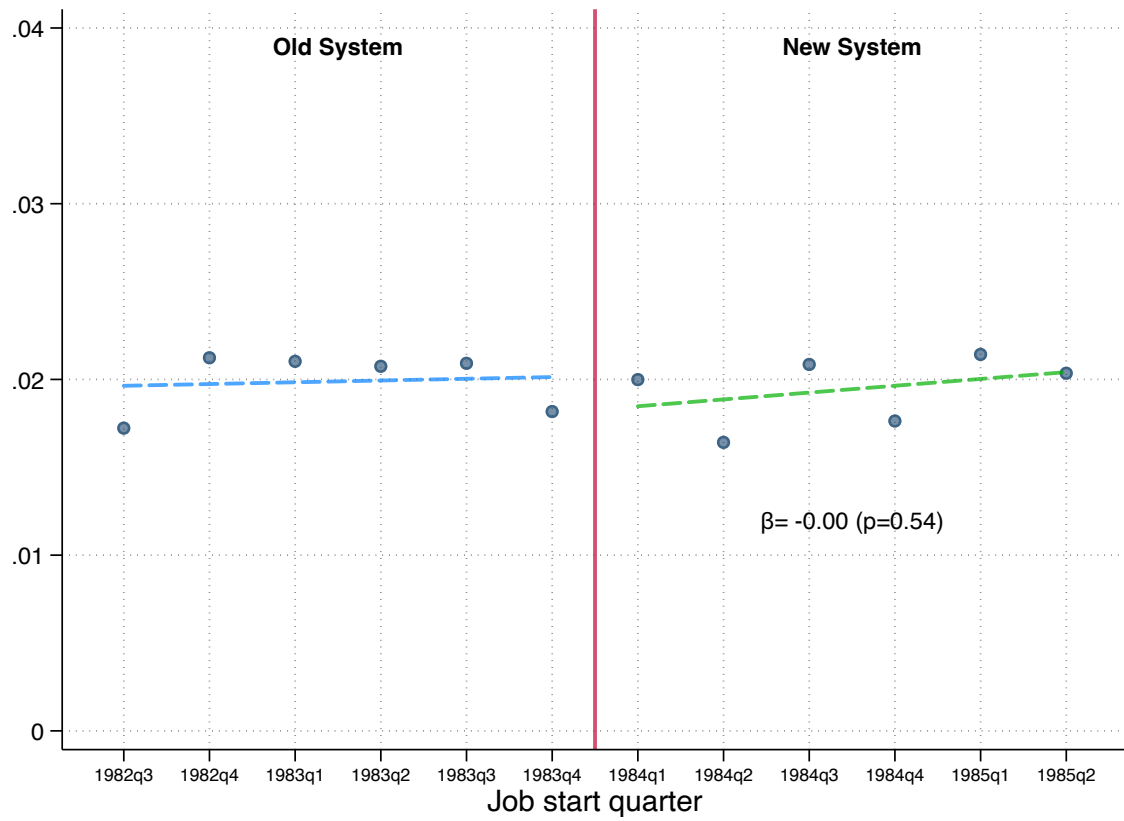


(c) Workers Eligible to Defer or Claim Early



Note: This figure reports the RD outcomes for separating at 10 of tenure. Panel (a) plots the percent separated with 10 years of service across the total sample, for each quarter around the 1984 policy change. Panel (b) plots the percent separated at 10 years of service for those who begin work under 40 years old and are thus only eligible to defer their benefits. Panel (c) plots the percent separated at 10 years of service for those who begin work at 45 years old or above and are thus eligible to claim their benefits early or defer their benefits until later. The RD coefficients are reported as the β and p-values are given in parenthesis.

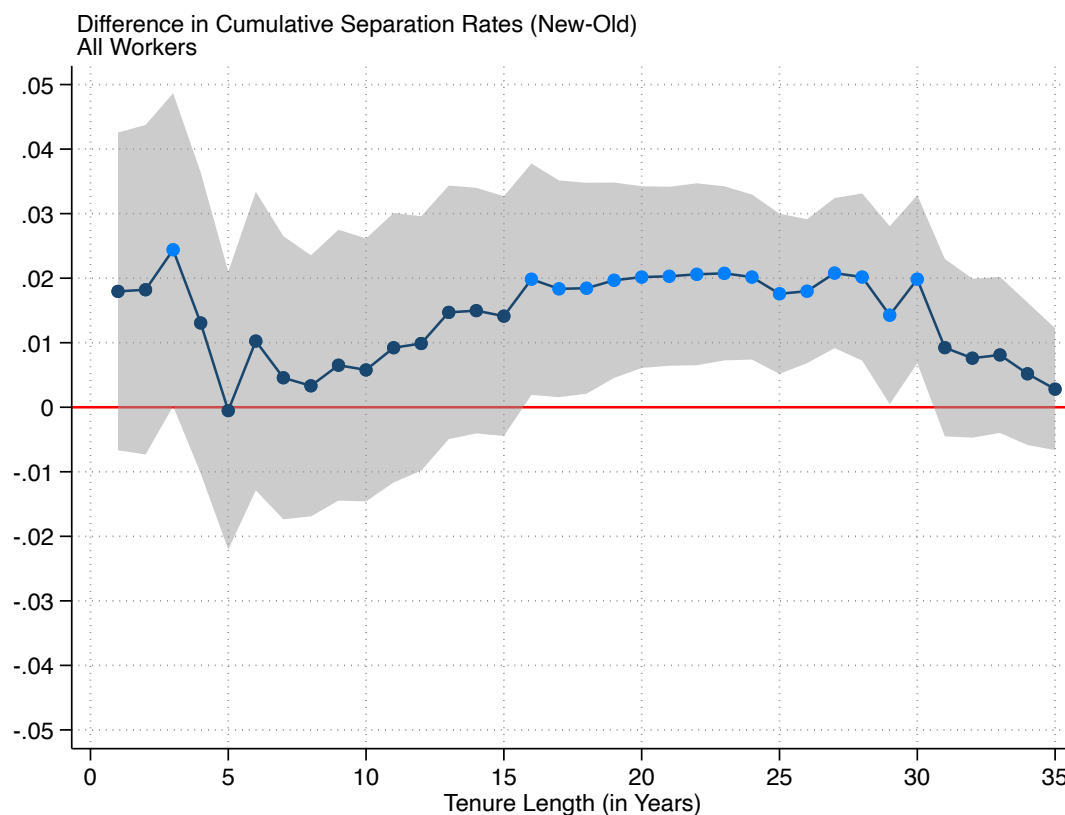
Figure 20: Separating at 9 Years



Note: This figure reports the RD outcomes for separating at 9 of tenure across the total sample, for each quarter around the 1984 policy change. The RD coefficients are reported as the β and p-values are given in parenthesis.

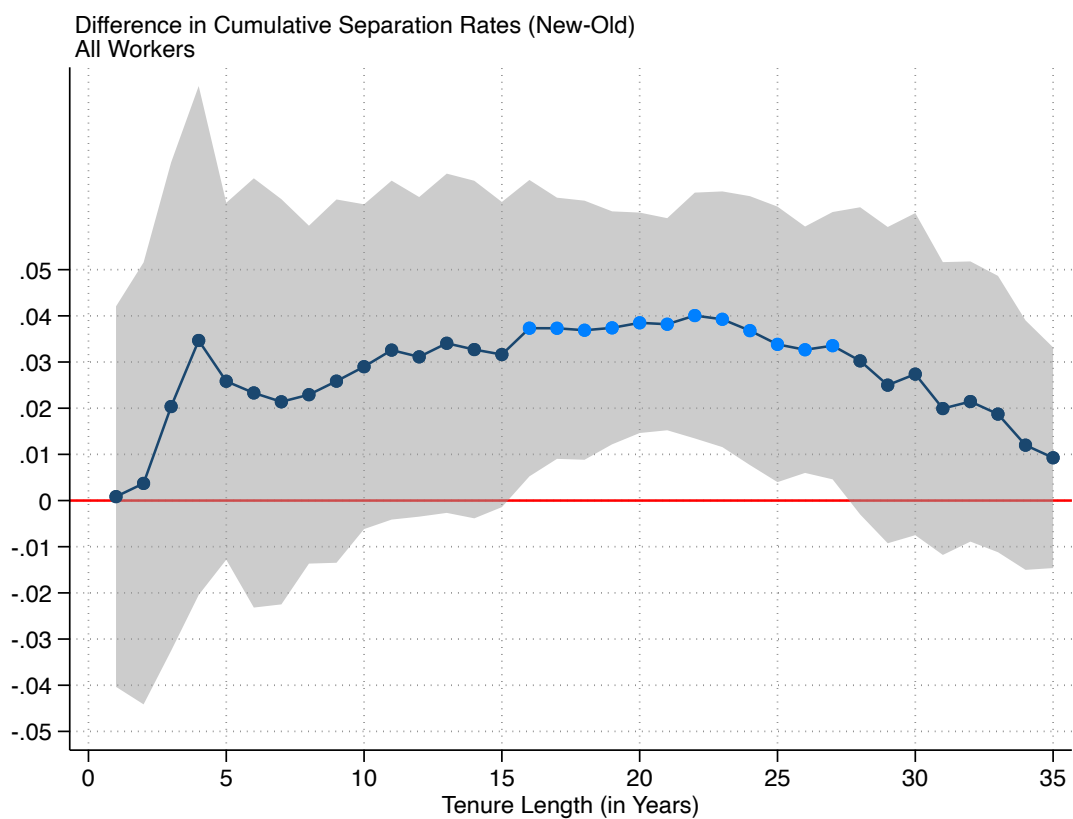
Appendix K Different RD Bandwidths

Figure 21: Long Window - Difference in Cumulative Separations by Tenure Length in the Old vs. New System



Note: This figure plots the RD coefficients, using 10 quarters before and after the policy change, on the cumulative separation rates for the tenure lengths in the x axis. Each point represents the difference in the cumulative separation rates between old system workers and new system workers. The 95% confidence interval is shaded in gray. Light blue points represent coefficients which are statistically significant from zero at the 95% level.

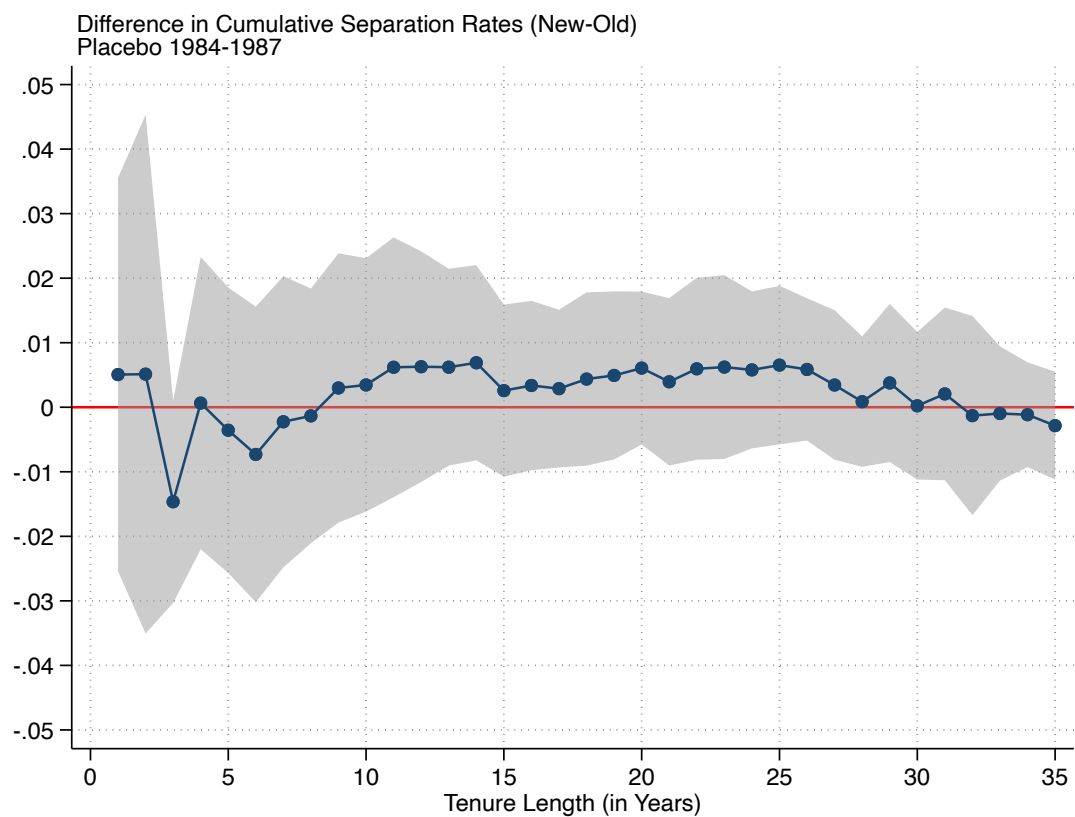
Figure 22: Short Window - Difference in Cumulative Separations by Tenure Length in the Old vs. New System



Note: This figure plots the RD coefficients, using 4 quarters before and after the policy change, on the cumulative separation rates for the tenure lengths in the x axis. Each point represents the difference in the cumulative separation rates between old system workers and new system workers. The 95% confidence interval is shaded in gray. Light blue points represent coefficients which are statistically significant from zero at the 95% level.

Appendix L Placebo Test

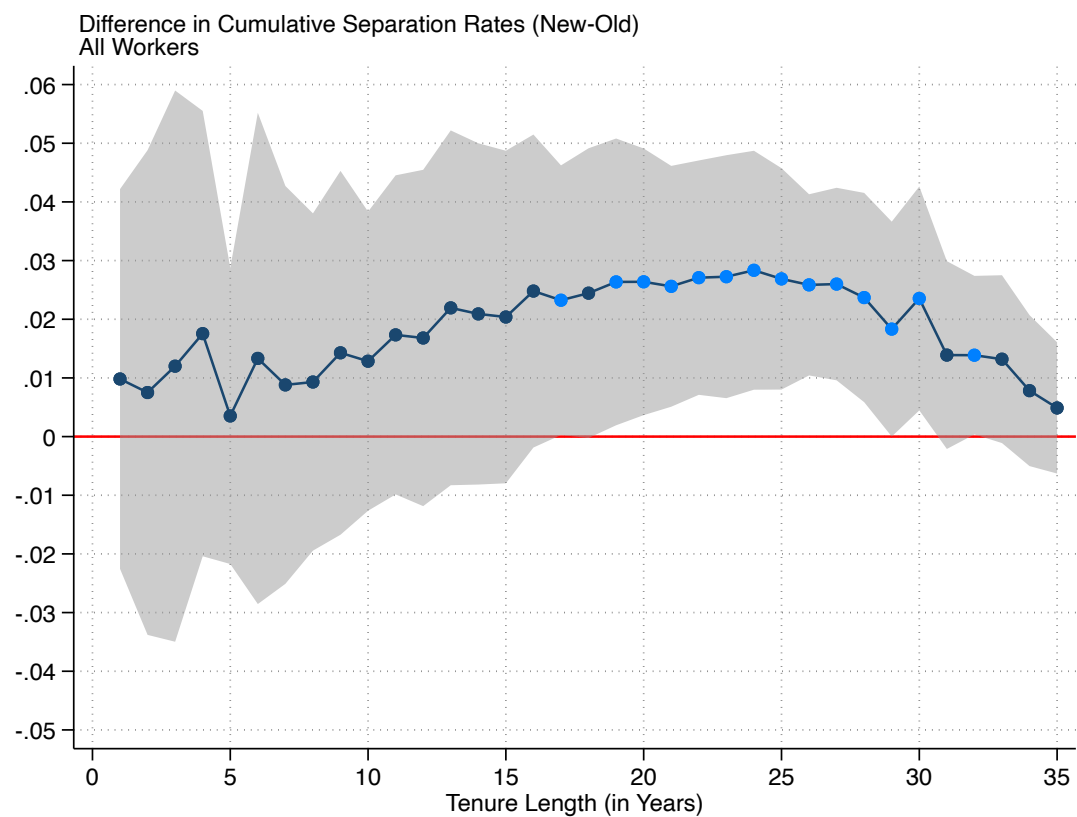
Figure 23: Placebo: Difference in Cumulative Separations by Tenure Length in the Old vs. New System



Note: This figure plots the RD coefficients of a placebo threshold (second quarter of 1985) on the cumulative separation rates for the tenure lengths in the x axis. Each point represents the difference in the cumulative separation rates between old system workers and new system workers. The 95% confidence interval is shaded in gray. Light blue points represent coefficients which are statistically significant from zero at the 95% level.

Appendix M Seasonal Effects

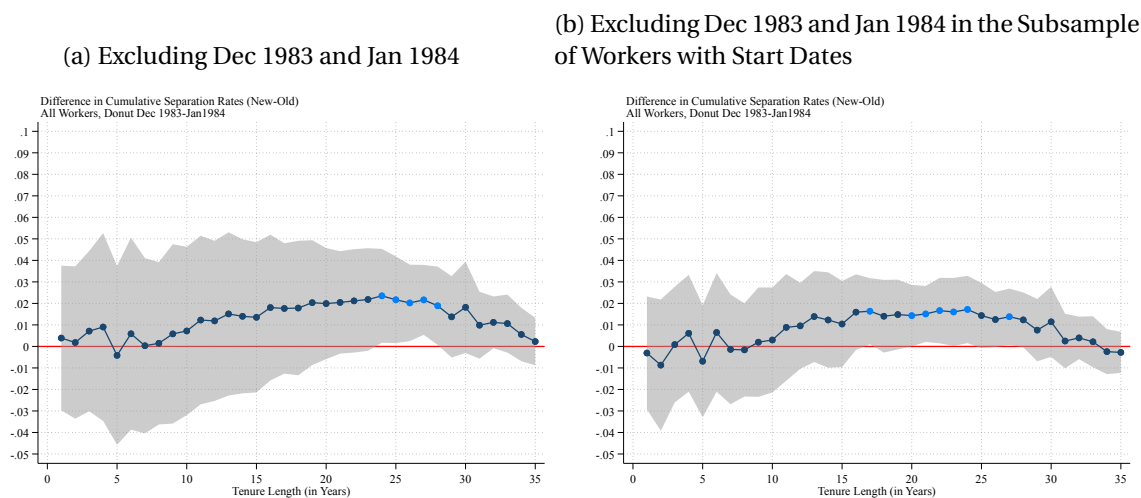
Figure 24: Removing Seasonal Effects: Difference in Cumulative Separations by Tenure Length in the Old vs. New System



Note: This figure plots the RD coefficients, after residualizing for quarter fixed effects, on the cumulative separation rates for the tenure lengths in the x axis. Each point represents the difference in the cumulative separation rates between old system workers and new system workers. The 95% confidence interval is shaded in gray. Light blue points represent coefficients which are statistically significant from zero at the 95% level.

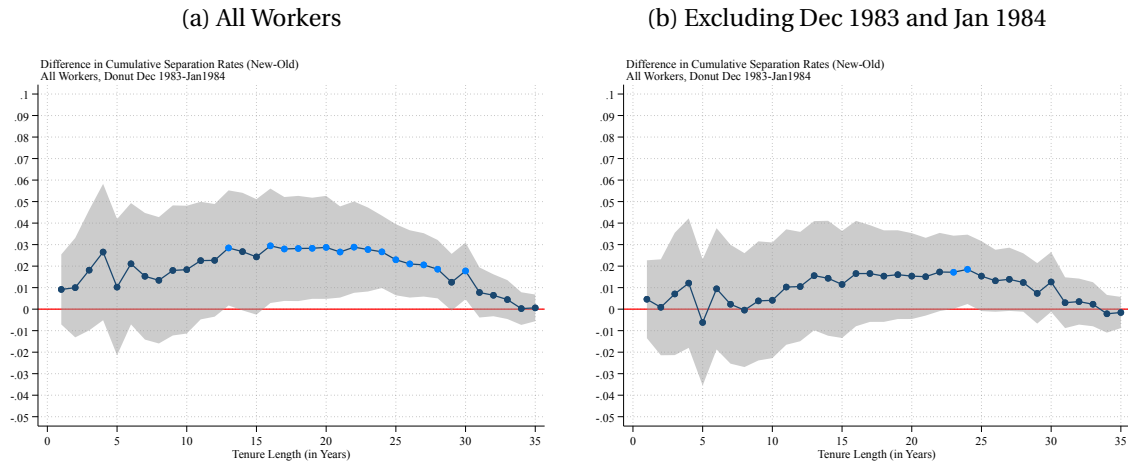
Appendix N Donut Analysis

Figure 25: Donutted Difference in Cumulative Separations by Tenure Length in the Old vs. New System



Note: This figure plots the donut RD coefficients on the cumulative separation rates for 35 years of tenure. Each point represents the difference in the cumulative separation rates between old system workers and new system workers. The 95% confidence interval is shaded in gray. Light blue points represent coefficients which are statistically significant from zero at the 95% level. Panel (a) displays the coefficients from our main sample but excluding those with a start date in December 1983 to January 1984. Panel (b) displays the coefficients from the subsample of employees that have start dates and excludes those with a start date in December 1983 to January 1984.

Figure 26: Donutted Difference in Cumulative Separations by Tenure Length in the Old vs. New System (by Month)



Note: This figure plots the RD coefficients on the cumulative separation rates for 35 years of tenure, at the month level. Each point represents the difference in the cumulative separation rates between old system workers and new system workers. The 95% confidence interval is shaded in gray. Light blue points represent coefficients which are statistically significant from zero at the 95% level. Panel (a) reports the coefficients for the subsample that have start dates. Panel (b) reports the coefficients for the subsample that have start dates and does not contain hires in December 1983 to January 1984.

Appendix O Selection on Sample Splits

Below are the balance tests for sample splits from the main analysis. We include all the sample splits with the exception of the promotion analysis because the sample is cut differently for each tenure length. We find marginal differences in education for some samples, most notably in the above median supplementary pay analysis.

Table 5: Changes in Hiring Characteristics

	(1) Starting Educ. Less than Bachelor's	(2) Starting Educ. Bachelor's or More	(3) Starting Pay Below Median	(4) Starting Pay Above Median	(5) Starting Age Below 40	(6) Starting Age 45 or Above	(7) Suppl. Pay Below Median	(8) Suppl. Pay Above Median
Quarters Needed for Full Retirement	1.16 (2.07)	-1.40 (1.97)	0.04 (2.40)	0.11 (1.44)	1.46 (1.42)	-0.45 (0.75)	0.38 (2.10)	-0.38 (1.65)
ln(Starting Salary)	0.02 (0.02)	0.04 (0.03)	0.01 (0.01)	-0.00 (0.00)	0.01 (0.04)	-0.02 (0.02)	0.01 (0.03)	0.01 (0.02)
Starting Age (in Quarters)	0.74 (2.63)	3.93 (2.90)	2.18 (3.65)	2.04 (2.03)	0.65 (1.96)	1.81** (0.78)	1.71 (2.99)	2.52 (2.57)
No. Hires in Subagency								
Education								
High School or More	-0.00 (0.00)		-0.00 (0.00)	-0.00 (0.00)	-0.00 (0.00)	-0.00 (0.00)	-0.00 (0.00)	-0.00 (0.00)
Bachelor's Degree or More			-0.05** (0.02)	-0.03 (0.04)	-0.05* (0.03)	-0.02 (0.02)	-0.04 (0.04)	-0.05*** (0.02)
Higher Educ. Degree or More		0.06* (0.03)	0.00 (0.00)	0.02 (0.04)	0.01 (0.03)	0.00 (0.00)	0.02 (0.04)	-0.00 (0.00)
Years of Educ.	-0.04 (0.06)	0.11 (0.08)	-0.18*** (0.07)	-0.07 (0.14)	-0.16 (0.10)	-0.05 (0.12)	-0.12 (0.14)	-0.17*** (0.06)
Occupation Category								
White-Collar	-0.01 (0.03)	-0.00 (0.00)	-0.02 (0.04)	-0.01 (0.01)	-0.02 (0.03)	0.00 (0.00)	-0.01 (0.02)	-0.02 (0.03)
Blue-Collar	-0.00 (0.00)	0.00 (0.00)	-0.00 (0.00)	0.01* (0.01)	0.00 (0.00)	-0.00 (0.00)	0.00 (0.00)	0.01 (0.01)
Other	0.01 (0.03)	0.00 (0.00)	0.02 (0.04)	-0.00 (0.00)	0.01 (0.02)	-0.00 (0.00)	0.01 (0.02)	0.01 (0.04)

Note: This figure reports the RD coefficients that relate to the change in hiring characteristics under the new retirement system. The running variable is the quarter in which an employee begins federal government work, and the regression contains the six quarters before and after the policy change. Column (1) and (2) report the coefficients, splitting the sample by starting education. Column (3) and (4) report the RD coefficients, splitting by starting salary. Column (5) and (6) report the coefficients when restricting by starting age. Column (7) and (8) report the RD coefficients, splitting by supplementary pay. Standard errors are reported in parenthesis. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.