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

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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.

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1 Introduction

Over the last half century, employer-sponsored retirement benefits in the U.S. have shifted from guaranteed pensions to portable savings plans. Before the 1980s, most retirement plans were defined benefit (DB) plans, which provided guaranteed monthly payments based on salary and tenure. After the introduction of IRS Section 401(k), defined contribution (DC) plans, where employees and employers contribute to a retirement investment account, began to grow in popularity. DC plans offer employers lower long-term liabilities and predictable costs, leading many firms to reduce their DB benefits or freeze[4] them altogether. By 2023, over 40% of DB participants were impacted by plan freezes across all sectors. Overall, active DB membership fell from 27 million in 1975 to 12 million in 2020, while DC membership rose from 11 million to 85 million, according to the Bureau of Labor Statistics.

To what extent does this shift impact labor supply and productivity? Changes in the retirement programs can have significant implications for firm-specific labor supply and workforce composition as these benefits often make up a substantial part of a worker's total compensation and lifetime income. However, the non-linear, dynamic nature of these retirement structures make it difficult for researchers and firms to fully predict how and which employees will respond since the incentives vary significantly over a worker's tenure. DB plans may incentivize workers to stay at a single firm longer because the benefit depends on tenure and the highest wage earnings. Simultaneously, DB participants may be induced to leave earlier once eligible for benefits due to the opportunity cost of continued work. On the other hand, the portability of DC plans may encourage workers to leave a firm, as they can transfer and grow their retirement savings across different employers with potentially higher wage offerings. However, since DC plans grow based on current wages, employees may work longer to increase retirement income at old age.

Furthermore, there has been limited empirical evidence to address this question, despite extensive economic and policy attention. Data on private employer pensions are often scarce and typically cover only short periods rather than the full life cycle. Causal estimates of retirement plan changes are also challenging to obtain absent of large quasi-experimental settings.

This paper identifies the role of the shift from DB to DC plans on labor supply, using extensive data on the largest U.S, employer, the federal government, over the last 35 years. In particular, it studies how the shift away from employer-provided DB retirement benefits to portable and individually-funded DC retirement accounts have affected firms' abilities to retain workers. Other research has demonstrated differences in the labor supply of workers in DB vs DC settings (Munnell et al. (2006)); however, this in part may be driven by the selection of workers that the benefits attract (Goda et al. (2017)) and not the incentives set by different retirement plans.

We estimate the incentive effects, using a quasi-experimental setting in which a policy retroac-

[4]Frozen plans are defined as plans which have stopped taking new participants or have stopped benefit accrual for existing participants.

tively changed retirement benefit coverage for newly hired federal workers in the U.S. in 1984. For a year and a half, workers were unaware of the details of the new system, which was first proposed mid-1985 and finalized in mid-1986. The new retirement system simultaneously reduced annuity benefits tied to the employer and increased portable retirement benefits without significant changes in the characteristics of new workers and wage compensation around the policy change. This institutional setting allows us to employ a regression discontinuity design with local randomization to estimate the effects of the change in retirement systems on various labor supply outcomes. Because worker characteristics remain consistent across the policy timeline, we can essentially compare the last cohort under the old system with the first cohort under the new system, isolating the impact of retirement system changes. Additionally, the policy timing enables us to observe effects across the lifecycle, with up to 35 years of data.

Our findings reveal that this policy change led to a substantial reduction in employer-provided pensions and a large increase in portable retirement benefits, resulting in retirement benefits that are more front=loaded earlier in their career. The change in retirement benefit did not affect the average age at separation but slightly decreased average tenure with the federal government by 3 quarters. However, the change did not have an uniform effect across the lifecycle of workers. The new system had small effects early in the career and more pronounced effects later on in a worker's career. Workers with fewer than 15 years of tenure were not significantly impacted, while those with 15 to 30 years showed an increased likelihood of being separated by about 2 to 3 percentage points. When examining differences in tenure length percentiles between the two retirement systems, we find that these workers reduced their federal career length by 1 to 3 years, resulting in a 3 to 16 percent reduction in tenure length for those in the 60th to the 78th percentile. Further analysis suggests that the increase in separations are driven by the relative increase in the attractiveness of outside options: workers who face more competitive private sector wages, like those with higher education or starting salary, are much more likely to separate with the federal government mid-career or earlier than their counterparts.

Additionally, we find that productive workers are more likely to leave under the new system. We identify worker productivity by residualizing for standard factors that would determine pay and pay level, and taking those with residuals above the median as "productive" or "valuable" workers to retain. We find that these workers are more likely to be separated from federal work by 3 to 5 percentage points after the changes in retirement benefits, mid- to late-career. Less productive workers do not exhibit any changes in labor supply in response to the changes in retirement benefits. This suggests that the government may have lost some of its most valuable employees to better outside options after the loss of pension benefits.

We observe minimal differences in the percent of separated workers in their early and late careers across the two retirement systems. Late-career workers under the old system, exhibit higher separation rates compared to those in the new system once reaching retirement eligibility. 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. Using an event study design, we find that workers under the old system are more willing to intertemporally substitute work to when annuity values are low. As a result, while new system workers tend to separate earlier in their careers and are less responsive to retirement eligibility, the overall stock of separated workers converges across both systems over the lifecycle. In essence, old system workers remain longer in the labor force but react strongly to retirement incentives, balancing out the separation rates at large tenure lengths (around 30 years of service when most workers are eligible for immediate retirement without penalty).

Furthermore, our analysis highlights that early-career decisions may be influenced by inattention of retirement benefits at hire. We find no statistically significant effects on new hire characteristics in the short-term and no selection effects after the policy was realized in 1986. We find limited evidence that workers are responding to early career incentives as well. However, as workers progress through their careers, we find that they respond to later vesting schedules. Workers in the new system respond strongly to mid-career retirement benefit incentives: employees are significantly more likely to separate after realizing early benefits around 10 years, indicating evidence for learning and a preference for the flexibility offered by the new system's vesting schedule.

Overall, we find that a less generous employer-provided pension and greater portability of retirement benefits increased separation rates with small effects early in the career and more pronounced effects mid- to late-career. Workers who are affected are those with better outside options and those who are more productive. These insights suggest that retirement benefits play a crucial role in shaping firm-specific labor supply decisions and the retention of talent.

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 Bérgolo (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 Bérgolo (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)). Lastly, 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)).

This paper is organized as follows. Section 2 explains the institutional details behind the retirement system for federal workers. In Section 3, we provide a conceptual framework, using a simple two-period discrete choice model, to guide predictions of the change in labor supply. Section 4 describes the data, Section 5 will explain the empirical strategy, and Section 6 provide results. Section 7 presents some robustness analysis. We then conclude this paper in Section 8.

2 Institutional Details

2.1 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 as 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.[5]

Separately, the U.S. enacted a series of amendments to Social Security in 1983 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.[6] Hence, 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, 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.

2.2 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 defined contribution savings plan, and added incentives for extended careers. However, the two systems

[5] Social 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.

[6] The 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.

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%.[7] Second, in order to receive one's annuity without a penalty (which we refer to as "full 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 you do not reach full retirement eligibility after five years, then a worker may defer their benefit until the individual reaches 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 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. If a worker reached at least 20 years of service and retires at the age of 62 or older, then an extra 0.1% increase for all years worked is included in their annuity under the new system. 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

[7] Under 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 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.

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 defined contribution saving plan, known as the Thrift Savings Plan (TSP).[8] 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 TSP 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, TSP contributions can (1) continue to grow in the TSP account, (2) be transferred to a different employer retirement plan, or (3) withdrawn (but with significant penalties if under the minimum withdrawl 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 TSP savings and investment plan;[9] however, workers under the old system were not eligible for employer matching.[10] Under the new system, the agency where an employee worked would automatically contribute 1% of his or her wage to TSP, 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 TSP.

Career extension incentives. Under the new system, workers received two additional options

[8] Under the new system, the agency would automatically contribute 1% of a worker's salary to the Thrift Savings 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 Thrift Savings Plan. Those under the old system could still contribute to this DC plan, but the agency would not match or contribute at any rate.

[9] Under the Thrift Savings Plan Enhancement Act of 2009, newly hired employees were automatically enrolled into TSP with a contribution of 3%. In 2020, the Federal Retirement Thrift Investment Board increased this automatic enrollment to 5% for new hires.

[10] Old 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.

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.

3 Conceptual Framework

This section presents a parsimonious discrete choice model with three periods to examine how changes in the retirement system may affect labor supply choices of federal government employees. Traditional pension models often solve for the total labor supply of workers; however, we present a framework to conceptualize how labor supply choices to one employer may differ when faced with a marketplace of employers. The model analyzes an individual's choice between continuing employment in the federal sector and seeking alternative employment at a different employer, based on a comparison of wages and retirement benefits. Given the computational complexity in models featuring multiple periods and multiple discrete choices, we opt for a simplified framework here for tractability. A more complex analysis is provided in the appendix, that produces similar predictions as our simple 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 and grow pension benefits $\Delta\tau$, or (2) seek outside options for wage w^p.[11] In period three, all workers retire and claim their benefits. Workers receive a benefit from the federal government that is some replacement rate τ of their federal wages w_f. For working in period one, a worker receives a benefit of $\tau_1 w_f$ in retirement, and a worker who also works in period two will receive an additional $\Delta\tau w_f$.[12] In our setting, $\tau_1 w_f$ consists of benefits that received from employment, including Social Security, DC savings, and some portion of the annuity. On the other hand, $\Delta\tau$ is the benefit contingent on an additional year of federal work, or the annuity; this parameter captures the relative price of staying versus leaving the federal government.

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

[11] In Appendix F, we include a third option to retire early in our three period model. The predictions remain the same; thus, this version is relegated to the appendix for simplicity.

[12] Here, we do not explicitly model portable benefits as the DC savings and Social Security are not necessarily contingent upon federal employment. In addition, we abstract from the changes in savings behavior for simplicity as that is about the savings technology, which is not explicitly represented here. See Appendix G and D for more details.

period two. We have the following budget constraint:

$$c_2 + \frac{c_3}{1+r} = \begin{cases} w_f + a_1 + \frac{(\tau_1+\Delta\tau)w_f}{1+r} & \text{if continue to work for federal government} \\ w_p + a_1 + \frac{\tau_1 w_f + \delta w_p}{1+r} & \text{if seek an outside option} \end{cases}$$

The budget constraint is similar under the new and old system but with the following difference in benefit composition: (1) new system workers will receive a different benefit factor τ_1 and lower additional benefits $\Delta\tau$.

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

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

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 rule[13] of working at the federal government over working in the private sector as

$$U^f > U^p \Rightarrow w_f - w_p + \beta\Delta\tau w_f + \varepsilon_f - \varepsilon_p > 0.$$

Rearranging, we get

$$U^f > U^p \Rightarrow \beta\Delta\tau w_f > w_p - w_f + \varepsilon_p - \varepsilon_f.$$

An employee will remain in the federal workforce if the discounted value of the additional pension benefit $\Delta\tau w_f$ is greater than the wage premium of moving to other employment $w_p - w_f$ and the difference in idiosyncratic preferences $\varepsilon_p - \varepsilon_f$. For the remaining analysis, we assume ε has a mean of zero and focus on the change in benefit $\Delta\tau$ and outside option wage premium $w_p - w_f$. Hence, $U^f > U^p$ if

$$\underbrace{\beta\Delta\tau w_f}_{\text{federal employment benefit change}} > \underbrace{w_p - w_f}_{\text{outside option wage premium}}$$

Federal employment benefit change. The change in $\Delta\tau$, or the change in annuity benefit contingent on employment, will unambiguously decrease as a result of the change in retirement systems. Thus, this framework implies that the likelihood of employees remaining in federal employment

[13] The full solution can be found in Appendix E.

will generally decline. However, the extent of this decline will depend on the wage differential $wpwf$ and individual preferences, which we assume to be mean zero across the total population.

The outside option wage premium. The availability and attractiveness of outside employment options play a central role in shaping responses to the reduction in federal retirement benefits $\Delta\tau$. Workers with less favorable outside options—where the wage differential $w_p - w_f < 0$—are more likely to remain in federal employment, as their external opportunities do not offer a significant wage premium. 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.

By contrast, workers with more favorable outside options—where $w_p - w_f > 0$—are expected to be more sensitive to changes in retirement benefits. For this group, the wage premium offered by outside options employment presents a strong incentive to exit the federal workforce, particularly when coupled with a reduction in $\Delta\tau$. As the additional retirement benefit declines, the value of remaining in federal employment diminishes, making outside opportunities increasingly attractive.

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. Federal workers with a bachelor's degree or above earned about 10 to 29 percent less, on average, than similar workers in the private sector. Hence, we expect lower educated to be inframarginal and more highly educated workers to respond strongly to the reduction in benefits.

Summary. Overall, the theoretical framework implies the reduction in employer-provided benefits will decrease the likelihood workers will remain in federal service, and vice versa. However, responses should be concentrated among workers who face receive lower benefits from the federal government and better outside options. These workers tend to be higher paid and higher educated workers. Thus, we anticipate that the reduction in federal retirement benefits will lead to heterogeneous labor supply responses, driven by the wage differential between federal and outside employment and the magnitude of $\Delta\tau$.

In the Results section, we explore how changes in the annuity and portable benefits affect average total benefits and average tenure. Then, we examine different education levels and pay levels separately to validate the underlying mechanisms.

Other Considerations. We favor the above framework for simplicity and interpretation. Here, we do not explicitly model portable benefits. In addition, we abstract from the changes in savings behavior for simplicity as that is about the savings technology, which is not explicitly represented above.

We include two additional analysis in Appendix D and G to incorporate more complex and realistic components of the retirement system. In Appendix D, we redo the simple three-period model but explicitly include parameters for portable benefits (i.e. Social Security). Ultimately, this version simply decomposes the benefit into the (i) annuity and (ii) Social Security and DC savings; however, the predictions are the same. In Appendix G, we simulate a multiple period model to incorporate the dynamic features of the retirement system. We simulate a discrete choice model across multiple periods, where the choice is to (1) stay at the federal government, (2) leave for an outside option, or (3) retire. The multi-period simulation also accounts for the fact that portable benefits will grow faster in high wage environments and that employees will incur some cost for switching. Again, we find that higher-paid workers with better outside options reduce their labor supply to the federal government and increase supply to outside options.

4 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. Notably, 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) and using a transformer language model trained on record linkages of company aliases (Arora and Dell (2024)). 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. We do 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.

We create additional sample cuts to ensure accuracy of assignment into retirement regimes.

First, 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 examining the first observation in the data and when the binned tenure values change.[14] If the data does not include an employee's first two years of employment, then this employee is dropped.[15] We also

[14] We allow for workers to leave the government and return at a later date.

[15] This 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.

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.[16]

Next, 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.[17]

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 2.1.

4.1 Summary Statistics

Table 2 reports the summary statistics of our main sample. We take 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 40% of individuals have a Bachelor's degree or higher and approximately 22% eventually transition into a manager or supervisory role. The majority of federal workers are white-collar (88%) and approximately 8% are blue-collar workers. Under the new system, there are 2 percentage points fewer individuals that have separated from federal work, which is consistent with the average yearly separation rates (i.e. 2%).

We observe separation trends for federal employees from the data in Figure 2. This figure reports separation counts for the last cohort of workers covered under the old system (those who began employment in 1982 and 1983) and the first cohort of workers covered under the new system (those who began employment in 1984 and 1985).

Figure 2 illustrates that employees are responding to retirement incentives. At age and tenure eligibility (denoted by vertical gray lines), there is significant mass of separations. In the old system,

[16] To 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.

[17] Part 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.

there are jumps in separations at 55 years old, or the MRA in Figure 2 Panel (a). In the new system, the MRA extends to between 55 to 57, depending on birth year, and we see an appropriate shift in the jump in separations for new system employees–and virtually no response at 55 years old. Additionally, we see spikes in separations at two other statutory retirement ages, 60 and 62, where the latter has a slightly greater mass from new system employees. Figure 2 Panel (b) also illustrates similar trends for worker tenure length. Again, we see small spikes at statutory retirement goals of 20 and 30 years of service. Moreover, we also find a larger spike in separations at 20 years of service for new system employees, which suggests that workers may be responding to the extra 0.1% incentive. These figures provide a strong indication that the design of the federal retirement policy may have large impacts on employee decisions of when to retire or separate.

Notably, however, most workers separate from federal service at young ages and short tenure lengths. Around 72% of workers leave before reaching full retirement eligibility. Thus, a vast majority of the workers who are affected by this retirement change are those who would normally separate before they qualify for benefits and will therefore likely seek other employment. Hence, we examine labor supply responses to the federal government across the entire lifecycle of workers.

From the outset, workers who leave the federal government prior to full retirement eligibility do not seem to leave at differential rates across the new and old system. Figure 2 Panel (a) shows that the average separation rate for every year prior to age 55 under the new system seem to track closely to that under the old system. Figure 2 Panel (b) suggests that there may be some differences between the old and new system with early tenure lengths (less than 10 years of tenure). However, these summary figures do not capture underlying trends, like decreases in turnover, or seasonal differences.

To precisely test these labor supply responses to changes in pension design, our analysis will utilize the institutional setting from Section 2 to guide the regression discontinuity empirical strategy in the following section.

5 Empirical Strategy

5.1 Regression Discontinuity Design

To empirically 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 (within a year and a half, or 6 quarters) around the policy change in which new hires were unaware of the terms of the new retirement system. This timing, as described in Section 2, provides an ideal setting to employ a regression disconti-

nuity 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 6, 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 Q.

6 Results

6.1 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 5 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 many 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 seasonal changes,

this difference becomes insignificant, as shown in Column (2). In fact, seasonally adjusted estimates relay a similar story as our main analysis: there are no significant changes in observables for new hires before and after the policy change. Lastly, the difference in magnitudes of these characteristics are small and not economically meaningful. 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.

6.2 Changes in benefits

Potential Benefits. We illustrate the effects of the policy change on retirement benefits in Figure 3. 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 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 3 Panel (a) illustrates that non-portable benefits, or the annuity benefits tied to federal employment, decrease steeply as a worker progresses through federal service as a result of the change in retirement benefits. By 35 years of service, a new system worker will receive more than $300,000 less in annuity benefits than a comparable old system worker. In contrast, Panel (b) reports that portable benefits, or Social Security and the automatic DC savings contributions, increases as a result of the benefit changes. By 35 years of service, a new system worker will receive about $300,000 more in portable benefits than an old system worker.

Taken together, we examine the net benefits by combining Panels (a) and (b) in Panel (c). This figure suggests that with more portability, the retirement benefits become more front-loaded in a worker's career. However, the difference in benefits between the new and old system shrink for a full career worker. 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 employment-tied annuities in Panel (a). According to our framework, this reduction should guide the labor supply responses.

Actualized Benefits. By contrast, Figure 4 reports the average present discounted value (PDV) of retirement benefits (in 2022 dollars) of workers in our sample who have separated from the

government. This figure notably incorporates real separation behaviors—that is, employees who leave earlier or do not complete a full career. Once these exits are accounted for, workers under the new system receive approximately $11,000 less in annual annuity, or a 55% reduction, per year. This amounts to a $150,000 reduction in the PDV of the annuity, shown in Panel (a). In addition, new system workers gained portable benefits: Figure 4 Panel (b) reports an approximately $167,000 difference in the PDV of portable benefits from social security and the automatic 1% DC contributions from the agency with a generous 9% growth rate.[18] Taken all together in Figure 4 (c), this resulted in a $16,000 increase in the PDV of total benefits, although not statistically significant.

Overall, the policy change had a net positive effect for workers with tenure lengths less than 25 years. However, accounting for separation behaviors, new system workers received fewer pension benefits and a slightly larger increase in portable retirement benefits, resulting in similar retirement benefit accrual from the federal government. This suggests workers under the new system may be experiencing greater turnover and shorter tenures that reduce expected benefits in the new system. We examine how labor supply responses have shifted between the new and old system across the lifecycle in the next section.

6.3 Labor Supply

Despite a change in the retirement benefit package and limited evidence in selection effects, Figure 5 shows that the change in retirement systems did not have a statistically significant effect on the average age at separation. Panel (a) demonstrates that the average age at separation remained relatively stable across the policy change.

However, the reduction in pension benefits and increase in portability has a marginally significant impact on the tenure of workers. Figure 5 Panel (b) shows that the average tenure at separation dropped by three quarters on average following the introduction of the new system. These findings suggest that employees slightly adjust their separation timing or job tenure in response to the changes in benefits on average.

However, examining lifecycle responses across different tenure lengths reveals a more complex and rich response. Figure 6 plots 35 different RD coefficients of cumulative separation rates across different tenure lengths, similar to Figure 3. 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

[18] The 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.

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. This figure 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. Notably, workers who leave with less than 10 years of service constitutes more than half of the sample, explaining the muted tenure responses across all workers in Figure 5 Panel (b).

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 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, this analysis highlights that the policy change had heterogeneous effects across the lifecycle, 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 I.

Quantifying the reduction in tenure

How much do workers adjust their tenure? We examine the intensive margin effects of the change in benefits by analyzing the average length of tenure across different tenure length percentiles in Figure 7. This illustrates 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. Thus, the change in benefits from the new

system has reduced the 65th percentile tenure length by 16 percent. 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 8 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. This approach accounts for the possibility that some low-wage workers may receive more generous federal benefits across the lifecycle after the policy change, given the progressive nature of Social Security, and that private sector work may be relatively more attractive to high-wage workers following the drop in pension benefits. By examining workers with starting pay above and below the median, we aim to discern whether higher initial pay, which determines the change in the relative attractiveness of outside opportunities, correlates with increased likelihood of being separated from federal service. In Figure 8 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 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. These findings underscore the significance of retirement incentives in shaping labor supply decisions among federal employees. First, 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 on average were higher for tenure lengths under 25 years. Next, the new system did not statistically affect the average age at separation. However, we find shorter tenure at separation, with a detailed analysis reveals heterogeneous effects. Workers with fewer than 15 years of tenure showed no significant differences across the old and 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.

6.4 Who responds

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 using the following regression. 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 $k = 1, 2, ..., K$ 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 $k = 1, 2, ..., K$ 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 running average residual value for each person i at time t:

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

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 Ts 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 6. The results are shown in Figure 9.

We find workers with higher supplementary pay are more likely to be separated from federal work by 3 to 5 percentage points after the changes in retirement benefits, particularly after 8 years of tenure, in Figure 9 Panel (a). The magnitude of the effect is twice as large as the average effect across all new system workers as reported in Section 6, and starts much earlier in the tenure. Workers with lower supplementary pay, on the other hand, do not seem to be affected by the changes in the retirement benefit across all years. In fact, these workers seem less likely to separate after the benefit change–although this is not statistically significant.

These results further validate the prediction that workers with better outside options respond to the benefit change. This analysis compares individuals from similar occupations, education groups, etc. ensuring that they are comparable across key characteristics. The only distinction is that some receive supplementary pay, which results in slight pay differences within the same pay band. Workers who receive supplementary pay are typically in more "valuable" positions but also likely exhibit lower attachment to the federal sector due to competitive outside offers. Their need for retention pay indicates stronger outside options, and these are the exact type of workers that respond strongly to the changes in the retirement system. In Appendix J, we split these groups by high vs low education and find that the group most affected by the policy are highly educated workers that receive supplementary pay. We find no effects for workers with less than a Bachelor's degree but with high supplementary pay, further emphasizing the important of outside wage offers.

Workers who are promoted faster reveal a similar story in Figure 9 Panel (b). 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. While "less productive" workers were unaffected by the retirement policy change, "more productive" workers are more likely to separate at longer tenure periods. Workers who quickly advance through the pay scale are about 3 to 4 percentage points more likely to be separated from the federal government after 10 years of service.

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.

6.5 Dynamic Selection

We examine dynamic selection among federal workers following changes in retirement benefits. Because supplementary pay is denominated in dollars, we can track the composition of human capital each cohort by computing the average residual from our pay analysis for workers at each tenure length. In other words, we can estimate the difference in the average value of a worker

under the old and new system over time, as valuated by supplementary pay. As mentioned above, these residuals capture deviations from expected pay and serve as a proxy for underlying productivity and outside opportunities. This approach quantifies the selective attrition within the cohort.

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

We begin by normalizing the average supplementary pay for each cohort to zero at the start of their tenure. Then, we plot these normalized values for workers under both the old and new retirement systems in Figure 10. Over the first five years, the lines track closely, indicating that attrition patterns with respect to residual pay are broadly similar across both systems initially. As tenure increases and "more valuable" workers exit under the new system, the average residual pay among those who remain under the new system grows slower relative to the old system. By around five to seven years, selective attrition amplifies the gap: old-system workers, on average, earn about $251 more in supplementary pay–equivalent to roughly one to three months' worth of typical experience-based pay increases (which range from $1,000 to $4,000 per year). Note that because the new system experiences higher overall separations, this figure reflects only those who remain, and thus likely understates the full compounding effect of differential attrition.

6.6 Who doesn't respond: early and late career workers

Throughout our exploration of the changes in retirement benefits on tenure across the lifecycle of workers, 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 incentives. 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. These workers are eligible to receive their annuity benefits without any penalty. Figure 11 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:

$$Y_{it} = \alpha + \beta_1 \text{Post}_i + \beta_2 \text{NS}_i + \beta_3 \text{Post}_i \times \text{NS}_i + \gamma D_i + \epsilon_{it} \tag{2}$$

where Post_i is a dummy variable for if person i is at or beyond full retirement eligibility; NS_i is a dummy variable for whether the worker is under the new system; D_i is a person fixed effect; Y_{it} is whether or not person i separates at t; 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 L.

We plot the difference in separation rates, or the β_2 coefficients, in Figure 12. 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. Table 4 compares the workers at hire before and after the announcement of the new retirement policy in the second quarter of 1986. The coefficients reported are from the RD specification from equation 1 but with the announcement date as the threshold instead of the effective policy date. In other words, we compare the characteristics of new hires 6 quarters before the announcement of the new system to those hired 6 quarters after the announcement. Again, we find limited evidence for selection effects, indicating that the policy change may not have influenced workers' decisions at the onset of their employment.

Furthermore, we find no responses to vesting schedules for the DC contributions. Figure 13 illustrates the RD for separating at and after 3 years of service, after employee contributions to the DC component of the retirement system vests. Workers under the new system are no more likely to separate at or after realizing employee retirement contributions than old system workers who do not receive the DC match.

However, we find responses to retirement incentives later in a worker's career, suggesting employees are learning about their retirement benefits over time. After several years, workers under the old and new system appear to highly value the pension and deliberately stay until the minimum eligibility for some benefits before leaving for better outside options, a phenomenon known as "job lock" or "golden shackles." Prior literature has shown individuals to be highly responsive to structural changes in pension designs (Lumsdaine et al. (1990), Kotlikoff and Wise (1987)). However, the studies on the responses to benefit vesting schedules is mixed, with the literature on equity compensation showing strong retention effects but the research on on 401(k) vesting schedules revealing null effects (Carranza and Goodman (2024)).

We find evidence that employees might be strategically timing their mid-career departures to realize some benefit before exiting the federal workforce.

Although the standard vesting schedule for the pension does not change between the two systems, we can examine an additional vesting schedule that applied to new system workers. The old and new system had a vesting schedule in which a worker who has at least five years of tenure may defer their benefits until 62. Under the new system, federal workers have an additional vesting schedule at 10 years of service. When a worker has at least ten years of tenure, they are eligible to defer that benefit until their MRA (55-57 years) or later, with appropriate penalties applied. Figure 14 Panel (a) show that employees are strongly responsive to this incentive: on average, new system employers are more likely to separate between 10 to 15 years of tenure by 0.7 percentage points, or a 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), according to Panel (b) and (c) respectively. 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.

In Appendix M, 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 M.

However, this analysis is only suggestive of the possible mechanisms that drive the behavior of short-term workers under the old and new system. Further research is needed to understand the learning mechanism.

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.

7 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. Finally, we conduct a placebo test to address concerns of potential mechanical effects. 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 N. 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 P. 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 O. The results of this placebo analysis suggests that mechanical effects are not driving our main results.

8 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 and compare similar workers who started under different retirement systems.

The RD results revealed that on average, there was a large decrease in the pension and a large increase in portable retirement benefits, resulting in an overall net wash of benefits for full-career workers but larger benefits earlier in their career. This translated to a reduction in tenure of a few quarters overall. 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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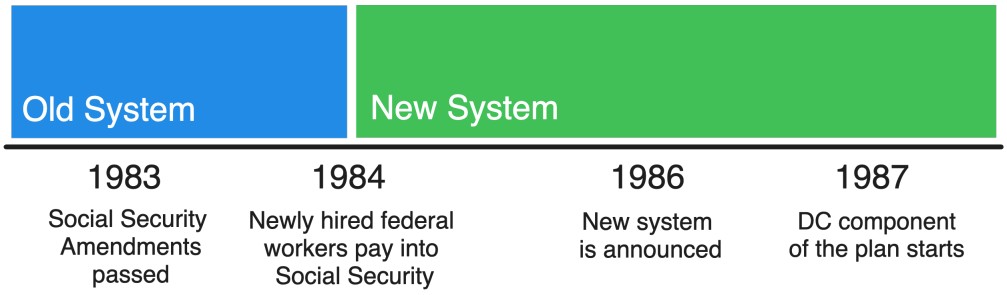
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Figures and Tables

Figure 1: Historical Timeline



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

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.

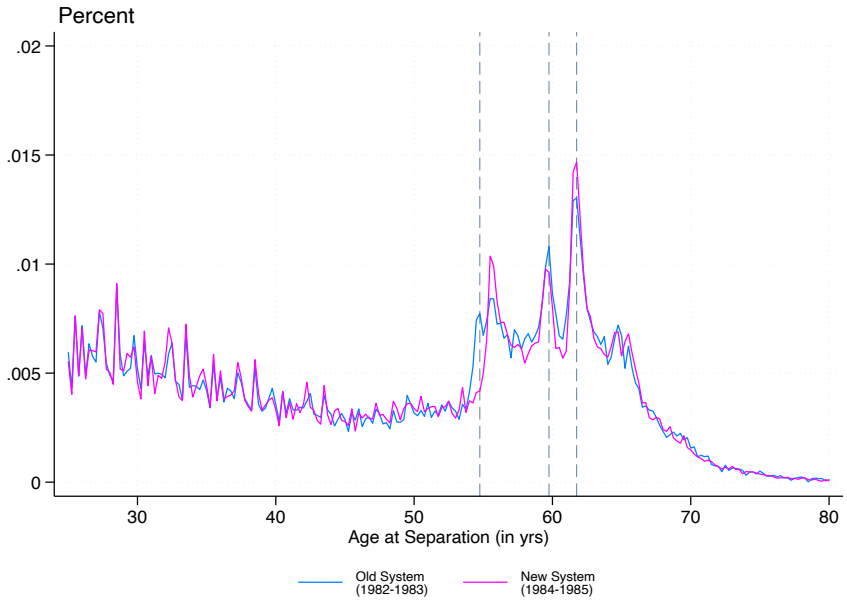
Table 2: Sample Demographics

	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

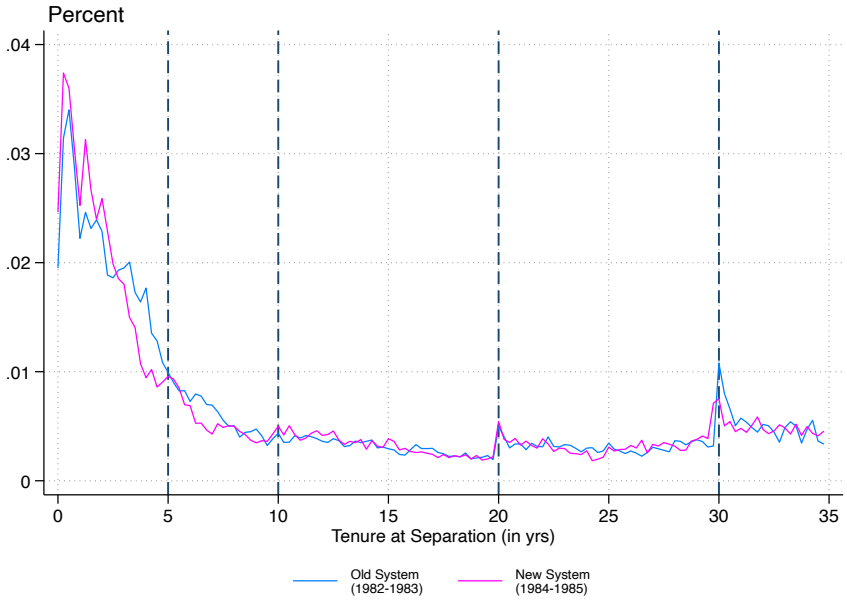
Note: This table reports the demographic characteristics of the sample data which contains full-time federal workers from the third quarter of 1982 to the second quarter of 1985. The values are the percentages of the variable represented in a particular category, which is in bold.

Figure 2: Percent Separated by Age and Tenure

(a) Age



(b) Tenure



Note: This figure reports the percent of people who have separated under the old system (1982-1983) and the new system (1984-1985). Panel (a) reports the percent of people who have separated at a given age (in quarters), and Panel (b) reports the percent of people who have separated at a given tenure (in quarters).

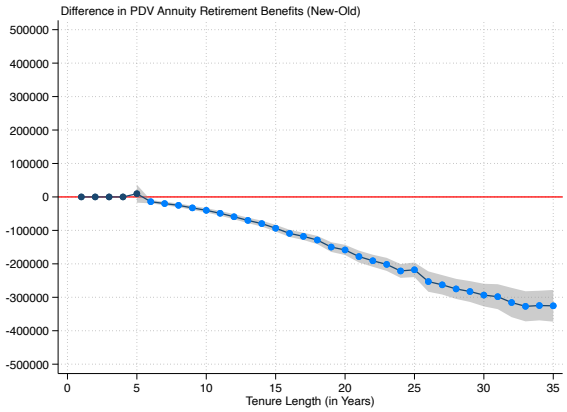
Table 3: Changes in Hiring Characteristics

	(1) Main Sample	(2) Main Sample w/Quarter FE
Quarters Needed for Full Retirement	0.09	1.08
	(1.79)	(1.69)
ln(Starting Salary)	-0.01	0.04
	(0.02)	(0.04)
Starting Age (in Quarters)	2.09	0.26
	(2.76)	(1.60)
No. Hires in Subagency	-2.06	-2.98
	(15.97)	(5.72)
Education		
High School or More	-0.00	-0.00
	(0.00)	(0.00)
Bachelor's Degree or More	-0.04*	0.03
	(0.02)	(0.09)
Higher Educ. Degree or More	0.01	0.01
	(0.03)	(0.06)
Years of Educ.	-0.13	0.21
	(0.09)	(0.45)
Occupation Category		
White-Collar	-0.01	-0.00
	(0.02)	(0.00)
Blue-Collar	0.00	0.01
	(0.00)	(0.02)
Other	0.01	-0.01
	(0.02)	(0.07)

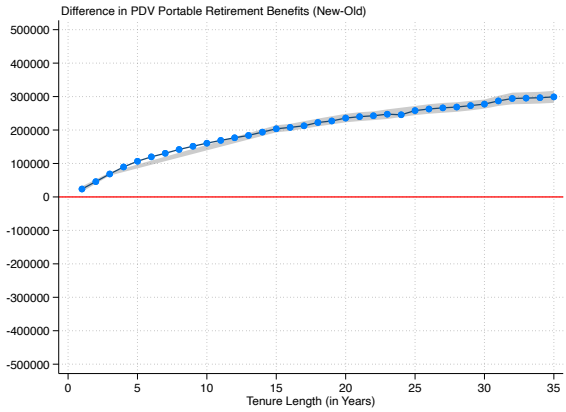
Note: This figure reports the RD coefficients that relate to the change in hiring characteristics under the new retirement system. The running variable is the quarter in which an employee begins federal government work, and the regression contains the six quarters before and after the policy change.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

Figure 3: Difference in Retirement Benefits by Tenure Length in the Old vs. New System

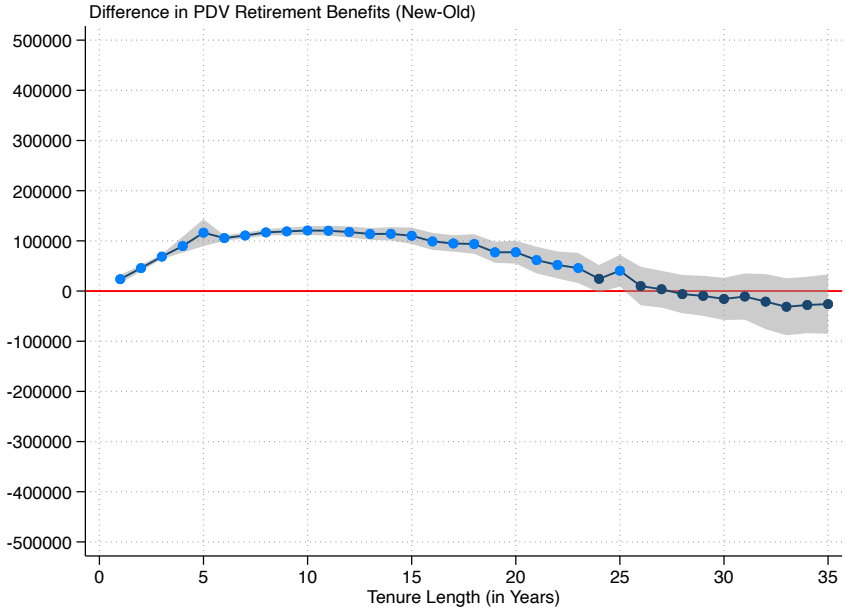
(a) Non-Portable Benefits



(b) Portable Benefits



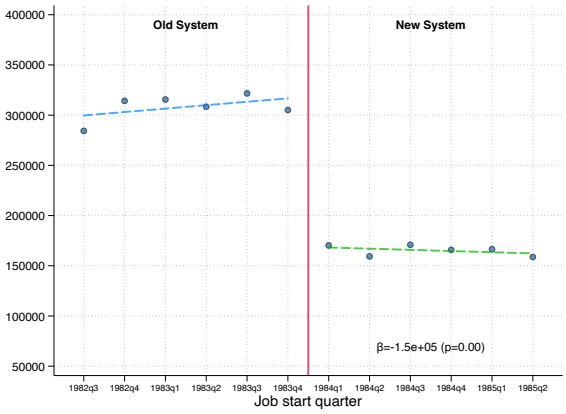
(c) Total Benefits



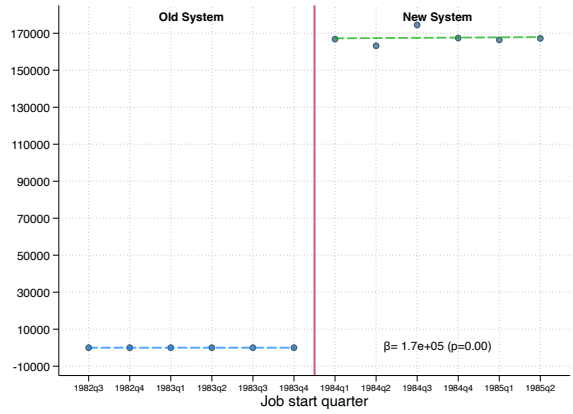
Note: This figure plots the RD coefficients on the benefit amount for 35 years of tenure, using interpolated wages to project benefits for workers who have separated prior to 35 years in our sample. Each point represents the difference in the benefits between old system workers and new system workers. 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.

Figure 4: Change in PDV Retirement Benefits

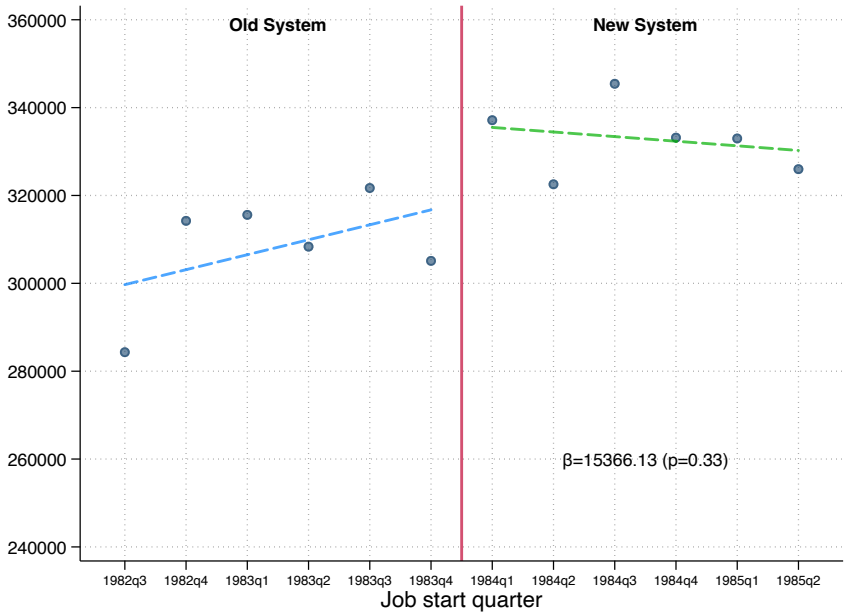
(a) PDV Annuity



(b) PDV Portable Benefits



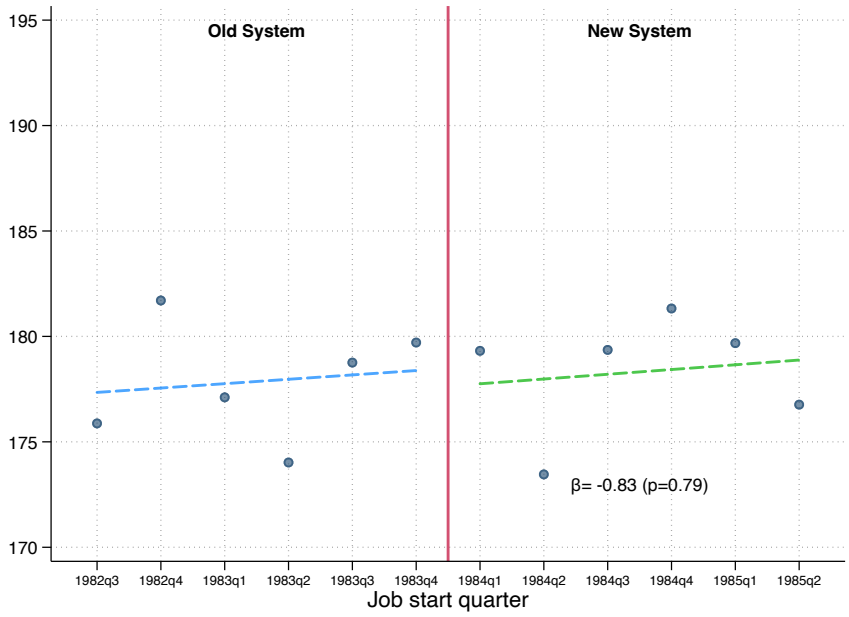
(c) PDV Total Benefits



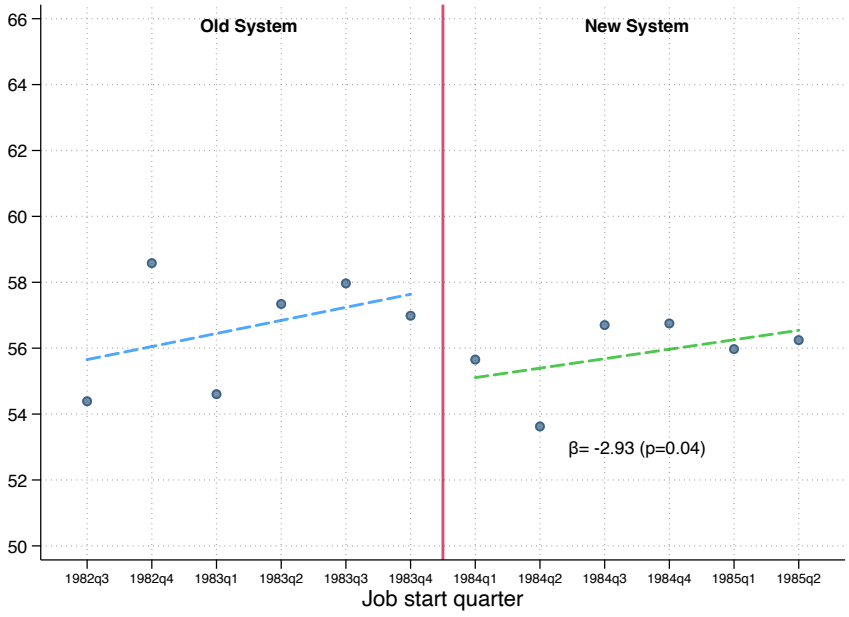
Note: This figure reports the RD coefficients on the changes in PDV of portable benefits, which is composed of Social Security and employer's DC contributions, after the new system is introduced. We assume the employer will contribute 1% of the worker's wages in the DC savings plan and that this account 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 5: Average Age and Tenure at Separation

(a) Average Age (in Quarters)

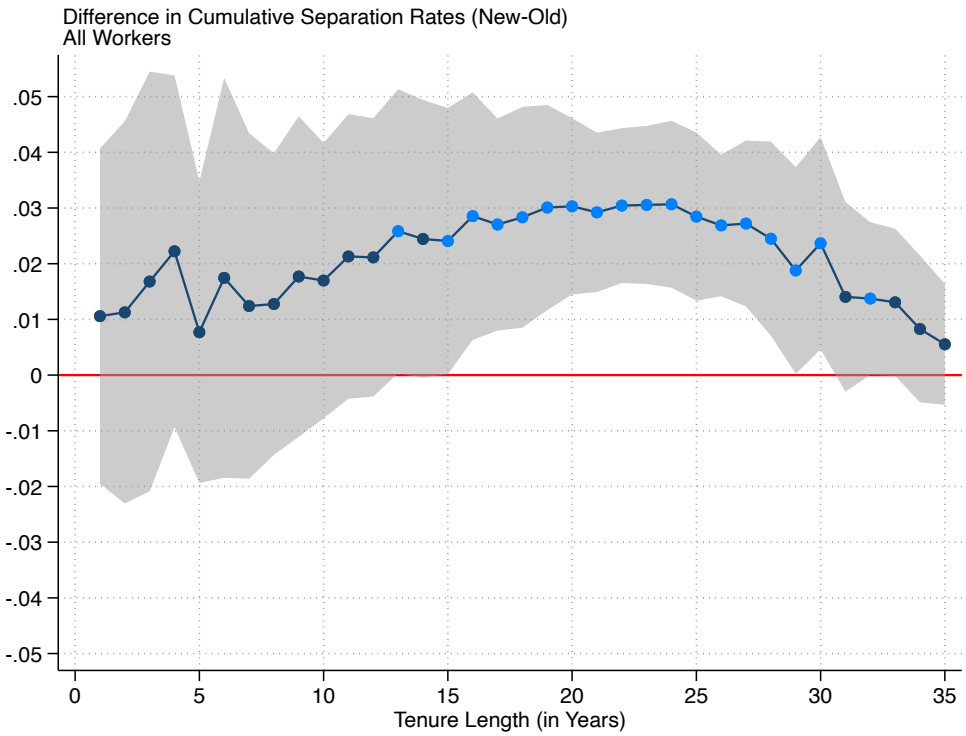


(b) Average Tenure (in Quarters)



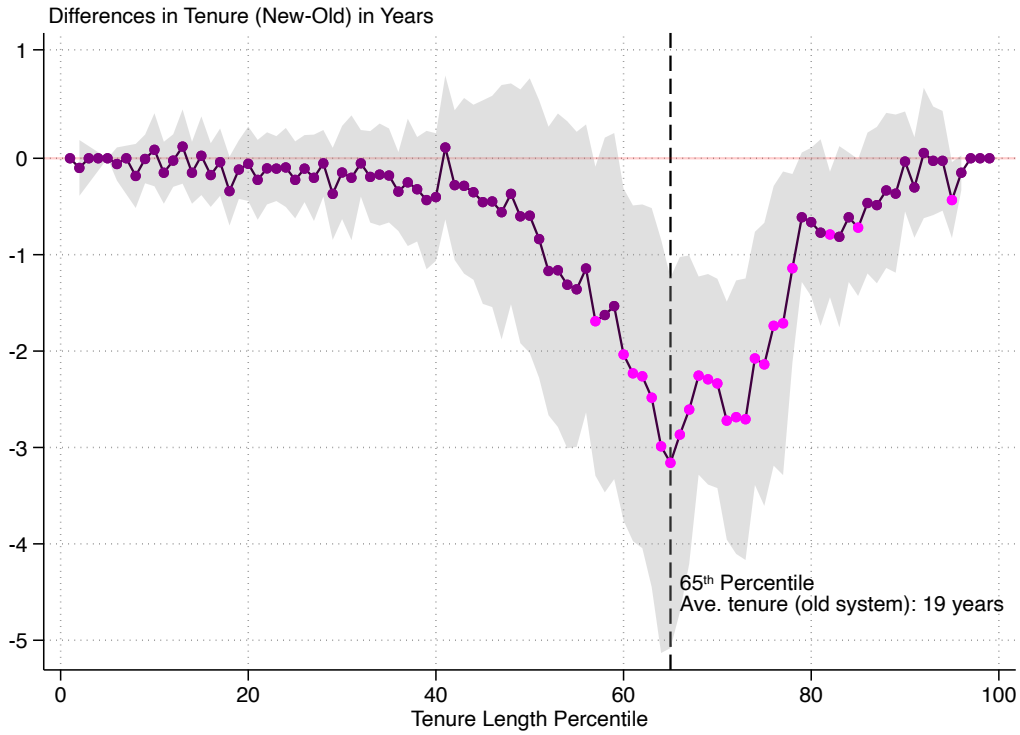
Note: This figure reports the RD outcomes for age and tenure at separation. Each point represents the sample of people that began federal government work in the quarter shown in the x-axis and have separated in our sample period. Panel (a) plots the average age in quarters at separation for each quarter around the 1984 policy change. Panel (b) plots the average tenure in quarters at separation. The RD coefficients are reported as the β and p-values are given in parenthesis.

Figure 6: 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.

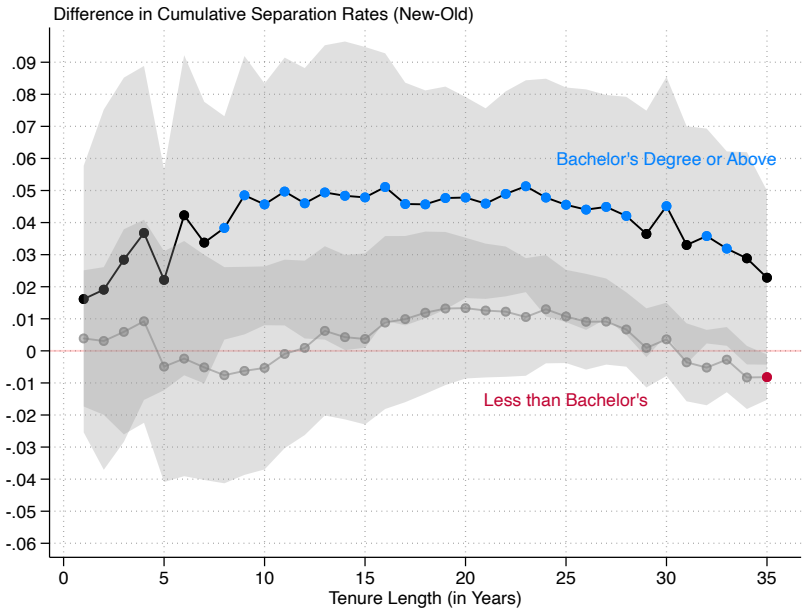
Figure 7: Differences in Tenure Centiles



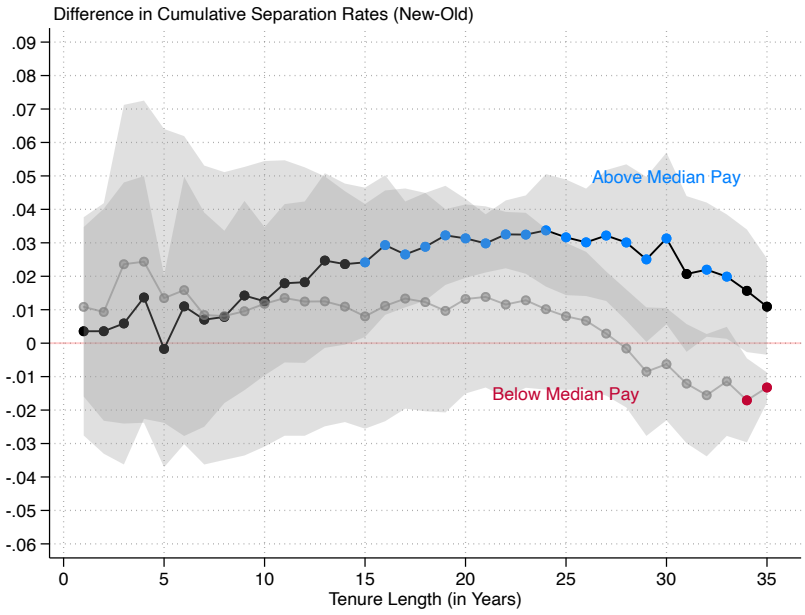
Note: This figure reports the differences in years of tenure centiles. Lighter colored points represent coefficients which are statistically significant from zero at the 95% level. The gray shaded area are the 95% confidence intervals.

Figure 8: Difference in Cumulative Separations by Tenure Length

(a) By Starting Education



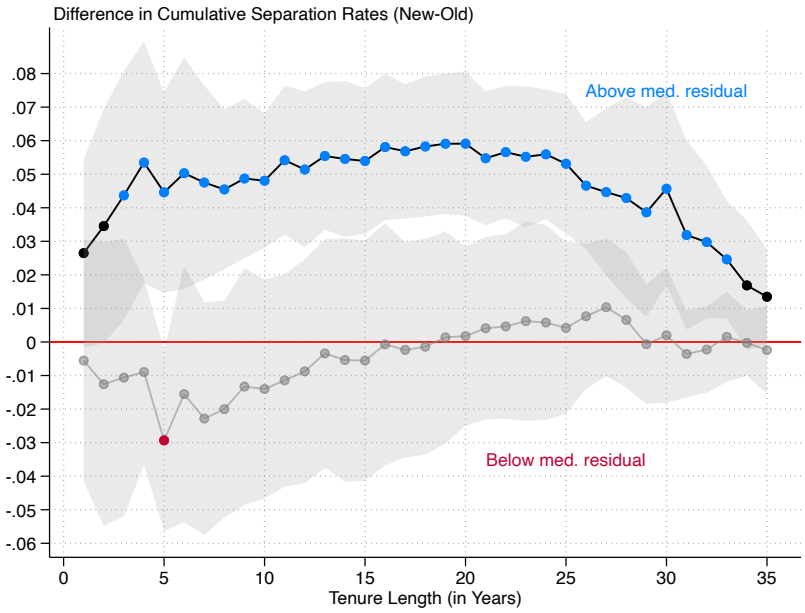
(b) By Starting Pay



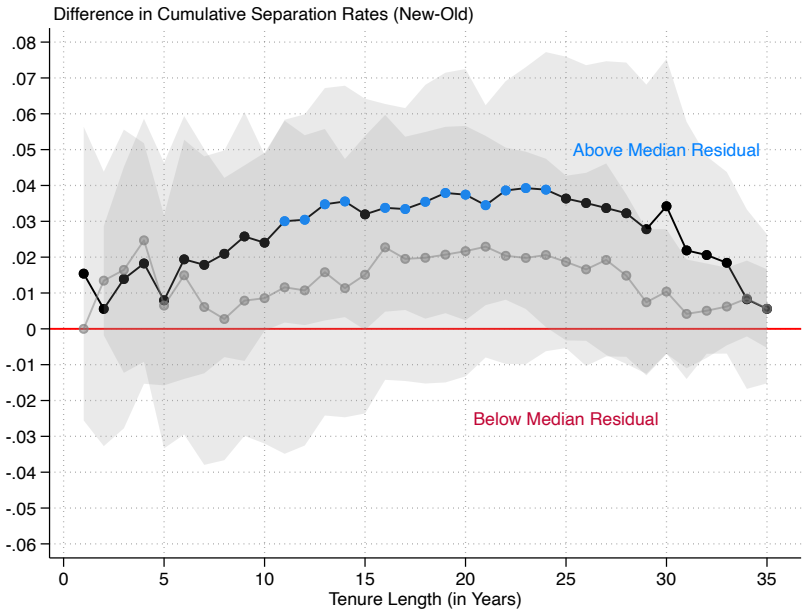
Note: This figure plots the RD coefficients on the cumulative separation rates for the tenure lengths in the x axis. Each point represents the difference in the cumulative separation rates between old system workers and new system workers. Panel (a) plots the RD coefficients by starting education: those 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.

Figure 9: Difference in Cumulative Separations by Tenure Length

(a) By Supplementary Pay

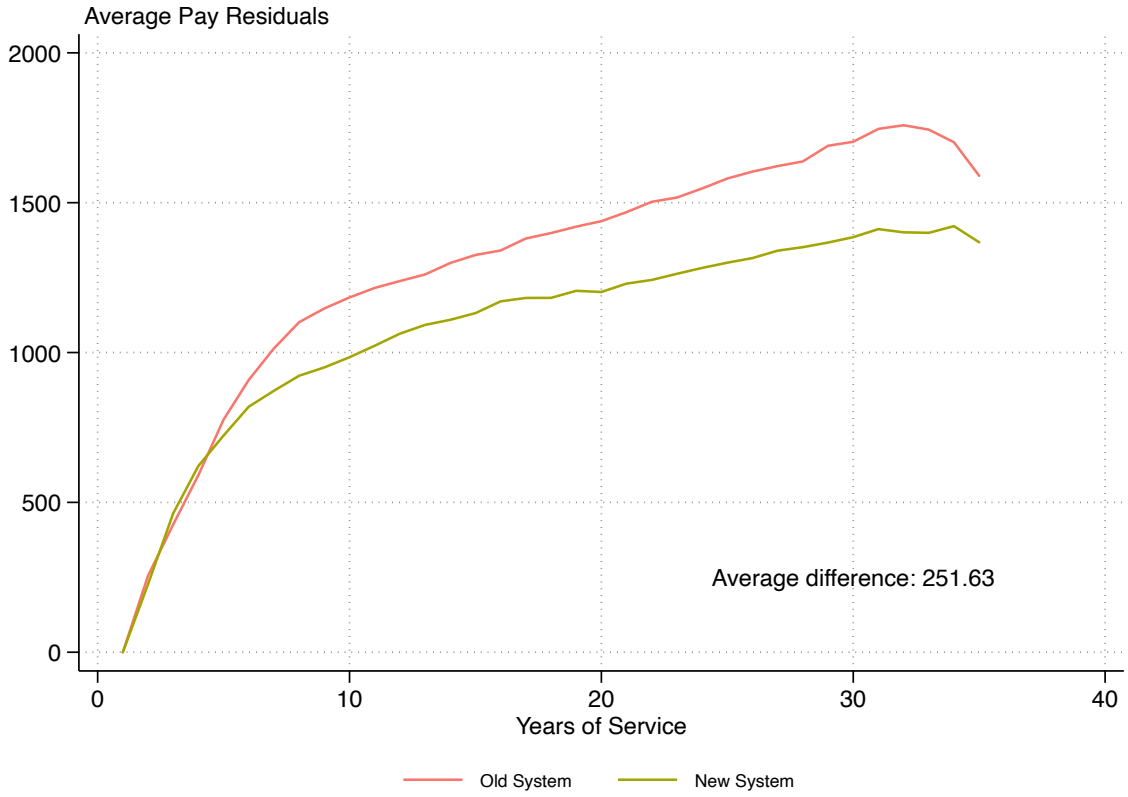


(b) By Lagged Promotion



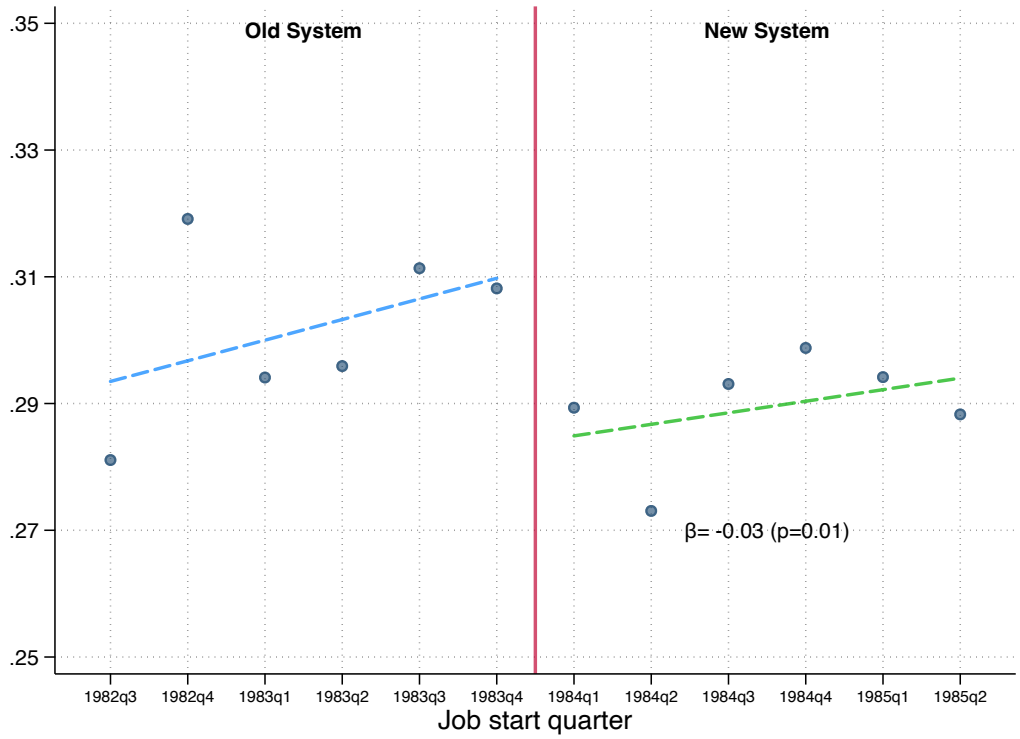
Note: This figure plots the RD coefficients on the cumulative separation rates for the tenure lengths in the x axis. Each point represents the difference in the cumulative separation rates between old system workers and new system workers. Panel (a) plots the RD coefficients by supplementary pay: those 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.

Figure 10: Dynamic Selection



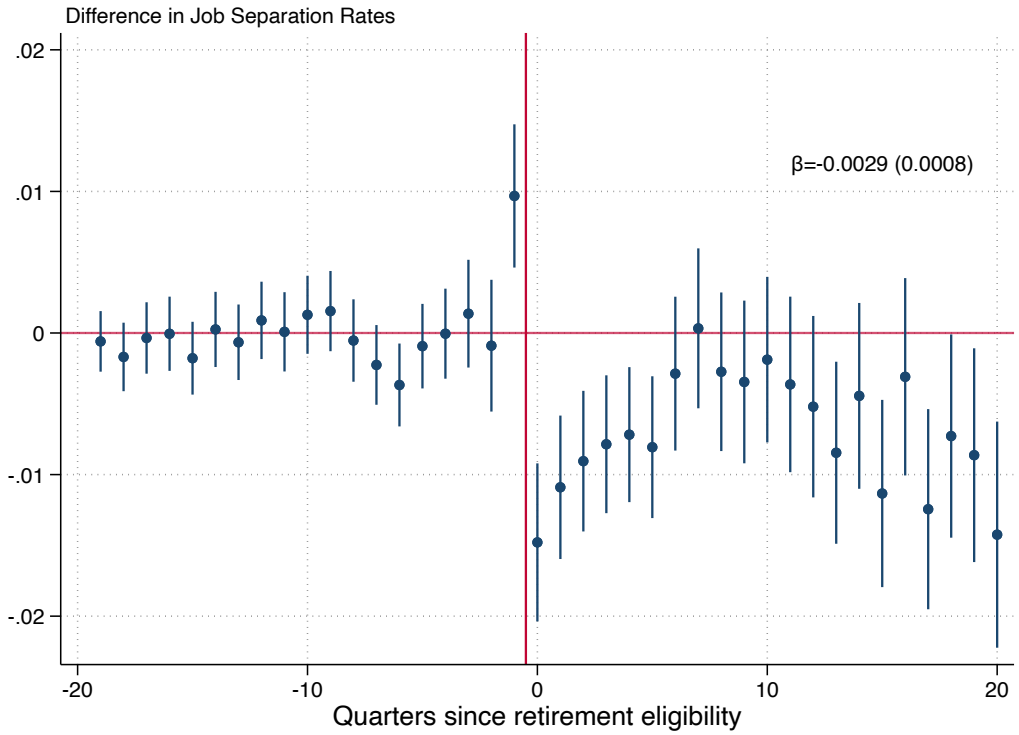
Note: This figure reports the average normalized supplementary pay, by years of service, for workers under the old and new retirement systems. To construct this measure, we first set each cohort's average supplementary pay to zero at the start date, then track how the mean evolves over time. The resulting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

Figure 11: Probability of reaching full retirement eligibility



Note: This figure reports the RD coefficient on the probability of reaching full retirement eligibility. 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. The RD coefficients are reported as the β and p-values are given in parenthesis.

Figure 12: Event study - differences in separations around full retirement eligibility



Note: This figure presents the event study provided in equation 3 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.

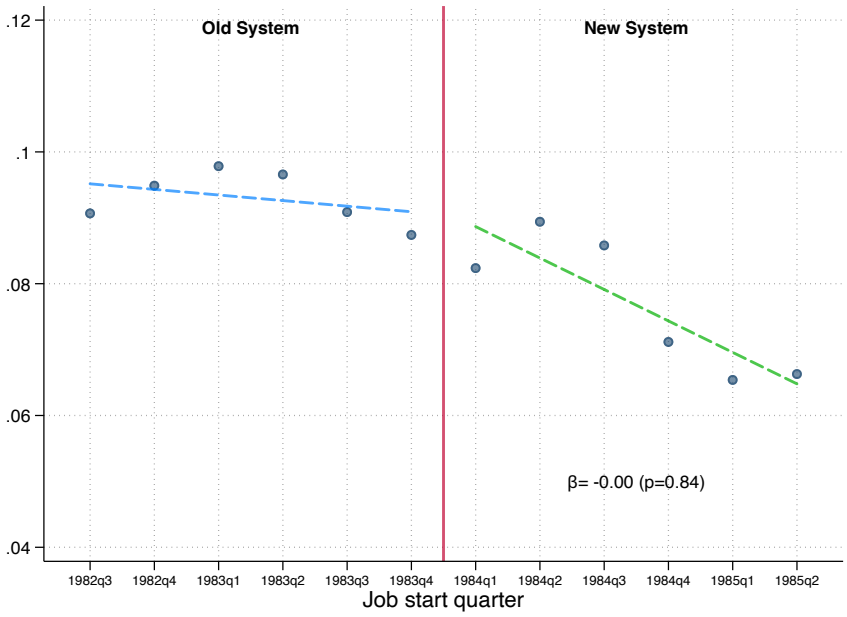
Table 4: Changes in Hiring Characteristics Around New System Announcement

	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)

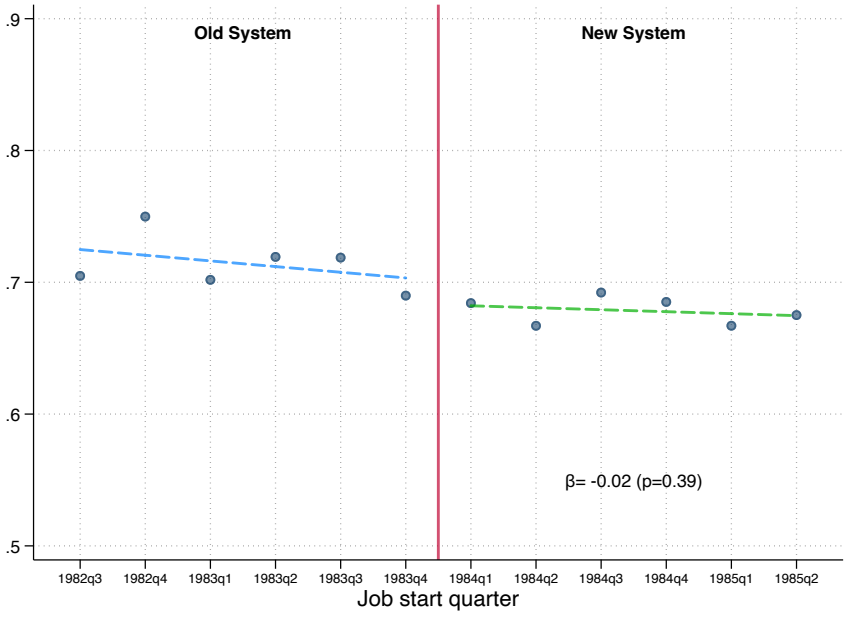
Note: This figure reports the RD coefficients that relate to the change in hiring characteristics after the announcement of the new system. The running variable is the quarter in which an employee begins federal government work, and the regression contains the six quarters before and after the announcement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

Figure 13: Separating after DC Vesting

(a) Separate at 3 years



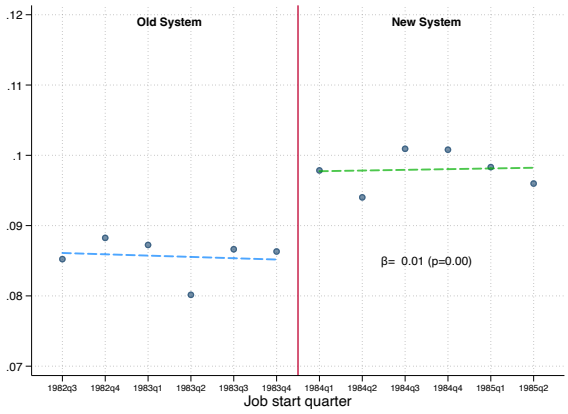
(b) Separate after 3 years



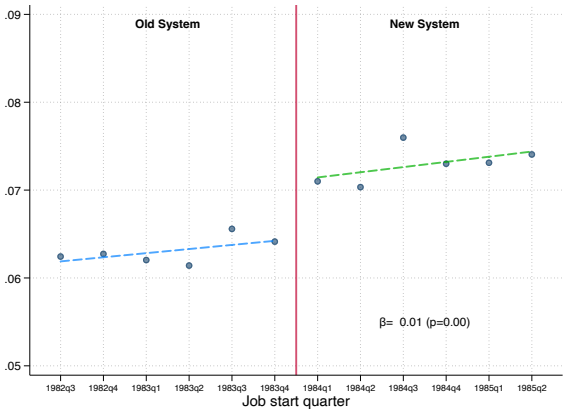
Note: This figure reports the RD outcomes for separating after the DC vesting schedule. Panel (a) plots the percent separated at 3 years of service across the total sample, for each quarter around the 1984 policy change. Panel (b) plots the percent separated after 3 years of service across the total sample, for each quarter around the 1984 policy change. The RD coefficients are reported as the β and p-values are given in parenthesis.

Figure 14: Separating at 10-15 Years

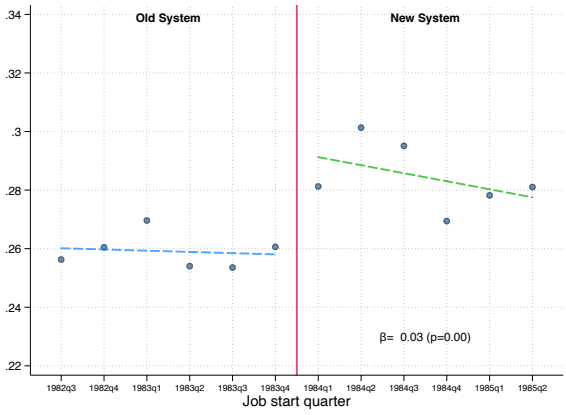
(a) All Workers



(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 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.

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:

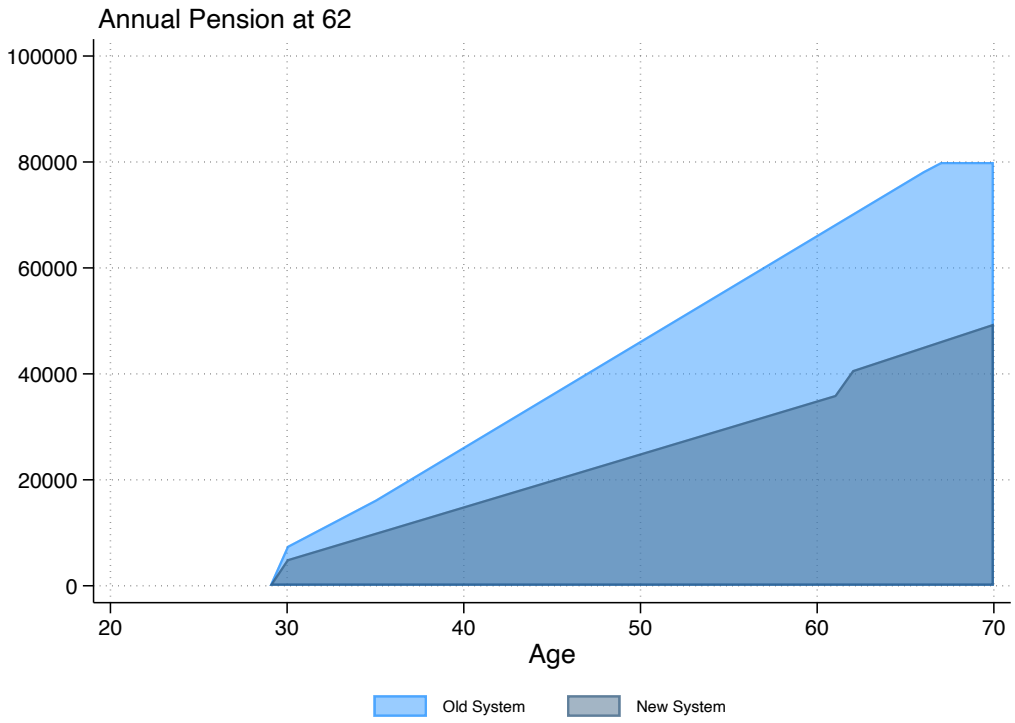
$$b_{it}^{FERS} = \underbrace{1\% \times h_{it} \times \delta_{it}}_{\text{basic benefit}} + \underbrace{\mathbb{1}\{t \geq 62 \wedge \delta_{it} \geq 20\}}_{\text{eligibility for extra benefits}} \times \underbrace{0.1\% \times h_{it} \times \delta_{it}}_{\text{extra 0.1\% bump}}$$

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 15: 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 15 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 fazed out at the MRA. In our analysis, we consider the trade-offs of early retirement penalities 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 Conceptual Framework with Portability

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 and grow pension benefits $\Delta\tau$, or (2) seek outside options for wage w^p.[19] In period three, all workers retire and claim their benefits. Workers receive an annuity from the federal government that is some replacement rate τ of their federal wages w_f. For working in period one, a worker receives $\tau_1 w_f$ in retirement, and a worker who also works in period two will receive an additional $\Delta\tau w_f$ in benefits. Under the old system, a worker earns δ of their outside wages as a portable retirement benefit, like Social Security.[20] Under the new system, a worker earns δ of their wages as a portable benefit, regardless of where they work.

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

[19] In Appendix F, we include a third option to retire early in our three period model. The predictions remain the same; thus, this version is relegated to the appendix for simplicity.

[20] We abstract from the changes in savings behavior as that is about the savings technology, which is not explicitly represented here.

period two. Under the old system,

$$c_2^{old} + \frac{c_3^{old}}{1+r} = \begin{cases} w_f + a_1 + \frac{(\tau_1+\Delta\tau)w_f}{1+r} & \text{if continue to work for federal government} \\ w_p + a_1 + \frac{\tau_1 w_f + \delta_p w_p}{1+r} & \text{if seek an outside option} \end{cases}$$

Under the new system,

$$c_2^{new} + \frac{c_3^{new}}{1+r} = \begin{cases} w_f + a_1 + \frac{(\tau_1+\Delta\tau+\delta_f+\Delta\delta_f)w_f}{1+r} & \text{if continue to work for federal government} \\ w_p + a_1 + \frac{\tau_1 w_f + \delta_f w_f + \delta_p w_p}{1+r} & \text{if seek an outside option} \end{cases}$$

The budget constraint is similar under the new and old system but with two notable differences in benefit composition: new system workers will earn portable benefits δ_f for working at the federal government and will receive a lower annuity $\Delta\tau$.

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

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

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_i accounts for the fact that workers may have different preferences for working for the federal government versus other employers. Then given our budget constraint and objective function, we can write the decision rule[21] of working at the federal government over working in the private sector as

$$U^f > U^p \Rightarrow \begin{cases} w_f - w_p + \beta(\Delta\tau w_f - \delta_p w_p) > 0 & \text{under the old system} \\ w_f - w_p + \beta(\Delta\tau w_f - \delta_p w_p + \Delta\delta_f w_f) > 0 & \text{under the new system} \end{cases}$$

The likelihood that an employee remains in federal employment is primarily determined by the net changes in total benefits. The change in total benefits will depend on the changes in the benefit factors of the annuity and portable benefit, and also the wage differential of federal vs. other wages (i.e. w_f and w_p).

Changes in the benefit factor. The changes in annuity benefit $\Delta\tau$ will discourage federal work while the addition of portable benefits $\Delta\delta_f$ will increase the value of staying, all else equal.

- **Annuity Reduction**. The annuity reduction of the new system will decrease the additional benefits received from working at the federal government $\Delta\tau$. Holding fixed the changes in portability, the annuity reduction will reduce the likelihood of working at the federal

[21] The full solution can be found in Appendix E.

government over working at an outside option.

- **Portability**. Portability changes the budget constraint by changing how δ interacts with the different choices. In the old system, δ was only relevant for non-federal work; however, δ becomes relevant for all work history under the new system. In this view, portable benefits add to the value of federal work, and thus increases the probability of continue working for the federal government relative to working at an outside option.

If the reduction in the annuity is offset by increases in portable benefits, employees may not adjust their labor supply to the firm. On the other hand, a negative net change may incentivize employees to seek alternative employment. Importantly, this mechanism is influenced not only by the changes in the two types of benefits, $\Delta\tau$ and δ, but also by the wage differential between the government and outside employment.

The Role of Outside Options. Wage differentials shape potential responses to changes in retirement benefits. For lower-wage federal employees, typically those with a high school education or less, lower outside options may reduce their inclination to seek other employment on the outset. Furthermore, the progressiveness of Social Security mitigates the reduction in the annuity for this group. Consequently, lower-wage federal workers may be somewhat inframarginal in their decision-making process, with benefit changes potentially having a small effect on their labor supply decisions.

Federal employees with higher education levels, and thus higher wages, are presented with a different scenario. These workers tend to have larger compensation potential for their outside option. Thus, reducing the annuity and adding in a more progressive portable benefit may decrease the attractiveness of staying at the federal government. Furthermore, workers with a bachelor's degree or above tend to face steeper wage profiles[22] than those with less than a bachelor's degree. Hence, the change in benefits negatively affects this group, as reduction in the annuity will put fewer dependency on the highest wages and more weight on wage levels across all years.

Based on these observations, we anticipate heterogeneous responses to the retirement policy changes across education groups and salary levels. Specifically, we expect that employees with a bachelor's degree or higher and those with larger salaries are more likely to reduce their tenure in federal government as a result of large reductions in the benefit. Competitive outside options available to these workers and steep wage profiles may drive them to leave earlier under the new system.

Since the annuity, DC, and Social Security components follow different schedules, we also simulate a multiple period model to incorporate more realistic features of the retirement system. We simulate a discrete choice model across multiple periods, where the choice is to (1) stay at the federal government, (2) leave for an outside option, or (3) retire. The multi-period simulation also

[22] See Appendix K.

accounts for the fact that portable benefits will grow faster in high wage environments. The results are shown in Appendix G. We find similar results where workers reduce their labor supply to the federal government and increase supply to outside options, especially those who face higher wages in other employment.

Appendix E Solving for the Decision Rules

We have a generalized CRRA utility in the form:

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

Thus our first order conditions are: $c_3 = kc_2$ 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 $U^f > U^p$:

$$\frac{c_2^{f\,1-\sigma} - c_2^{p\,1-\sigma}}{1-\sigma}(1+\beta k^{1-\sigma}) > 0$$

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 F Three Choices in the 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 and grow pension benefits $\Delta\tau$, (2) seek outside options for wage w^p, or (3) retire and claim

early benefits with a penalty γ. In period three, all workers retire and claim their benefits. Workers receive an annuity from the federal government that is some replacement rate τ of their federal wages w_f. For working in period one, a worker receives $\tau_1 w_f$ in retirement, and a worker who also works in period two will receive an additional $\Delta\tau w_f$ in benefits. Under the old system, a worker earns δ of their outside wages as a portable retirement benefit. Under the new system, a worker earns δ of their total wages, regardless of where they work.

Budget Constraint. We model a federal worker's lifetime budget that is composed of wages and retirement benefits. We take the worker's perspective in period two. Under the old system,

$$c_2^{old} + \frac{c_3^{old}}{1+r} = \begin{cases} w_f + a_1 + \frac{(\tau_1+\Delta\tau)w_f}{1+r} & \text{if continue to work for federal government} \\ w_p + a_1 + \frac{\tau_1 w_f}{1+r} + \frac{\delta_p w_p}{1+r} & \text{if seek an outside option} \\ (1-\gamma)\tau_1 w_f + a_1 + \frac{(1-\gamma)\tau_1 w_f}{1+r} & \text{if retire early} \end{cases}$$

Under the new system,

$$c_2^{new} + \frac{c_3^{new}}{1+r} = \begin{cases} w_f + a_1 + \frac{(\tau_1+\Delta\tau+\delta_f+\Delta\delta_f)w_f}{1+r} & \text{if continue to work for federal government} \\ w_p + a_1 + \frac{\tau_1 w_f}{1+r} + \frac{\delta_f w_f+\delta_p w_p}{1+r} & \text{if seek an outside option} \\ (1-\gamma)(\tau_1+\delta_f)w_f + a_1 + \frac{(1-\gamma)(\tau_1+\delta_f)w_f}{1+r} & \text{if retire early} \end{cases}$$

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

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

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. Then given our budget constraint and objective function, we can write the decision rule of working at the federal government over working in the private sector as

$$U^f > U^p \Rightarrow \begin{cases} w_f - w_p + \beta(\Delta\tau w_f - \delta_p w_p) > 0 & \text{under the old system} \\ w_f - w_p + \beta(\Delta\tau w_f - \delta_p w_p + \Delta\delta_f w_f) > 0 & \text{under the new system} \end{cases}$$

and the decision rule of working at the federal government over retiring early as

$$U^f > U^r \Rightarrow \begin{cases} w_f - (1-\gamma)\tau_1 w_f + \beta(\Delta\tau + \gamma\tau_1)w_f > 0 & \text{under the old system} \\ w_f - (1-\gamma)(\tau_1+\delta_f)w_f + \beta(\Delta\tau + \gamma\tau_1 + \gamma\delta_f + \Delta\delta_f)w_f > 0 & \text{under the new system} \end{cases}$$

and the decision rule of working at an outside option over retiring early as

$$U^p > U^r \Rightarrow \begin{cases} w_p - (1-\gamma)\tau_1 w_f + \beta(\delta_p w_p + \gamma\tau_1 w_f) > 0 & \text{under the old system} \\ w_p - (1-\gamma)(\tau_1 + \delta_f) w_f + \beta(\delta_p w_p + \gamma\tau_1 w_f + \gamma\delta_f w_f) > 0 & \text{under the new system} \end{cases}$$

Annuity Reduction. The annuity reduction of the new system will decrease the additional benefits received from working at the federal government $\Delta\tau$ and increase the penalty associated with claiming retirement benefits early γ. Holding fixed the changes in portability, the annuity reduction will increase the likelihood of retiring early over working in the federal government or some outside option. However, the increase in penalty of early retirement will increase the likelihood of staying at work or going to the private sector.

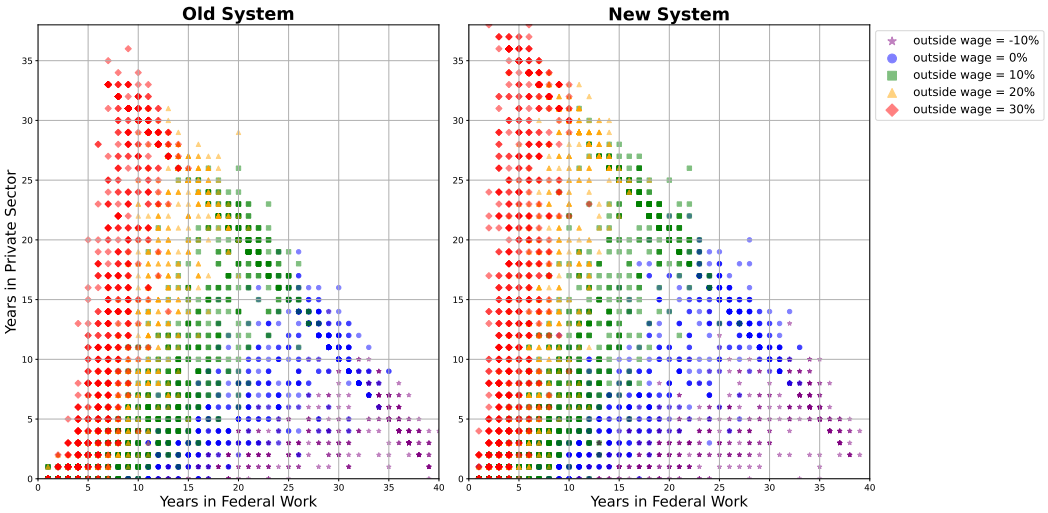
Portability. Portability changes the budget constraint by changing how δ interacts with the different choices. In the old system, δ was only relevant for non-federal work; however, δ becomes relevant for all work history under the new system. In this view, portable benefits add to the value of work, and thus reduces the probability of retiring early.

Appendix G Simulation of a Multi-Period Discrete Choice Model

To simulate a multiple period model, we ran the following simulation:

1. Workers start at the federal government with a wage drawn from a normal distribution;
2. At each period, we draw an outside offer that is $[0, 10, 20, 30]$% better in wages, based on the type of worker that is pre-determined; we simulate 1,000 workers of each type;
3. With new information, workers evaluate the highest expected utility of (1) staying, (2) taking the outside option, and (3) retiring;
4. Choose the highest expected value;
5. If they switch jobs, they incur a fixed cost;
6. If they retire, it is irreversible;
7. To simplify the simulation, there is no uncertainty in this model.

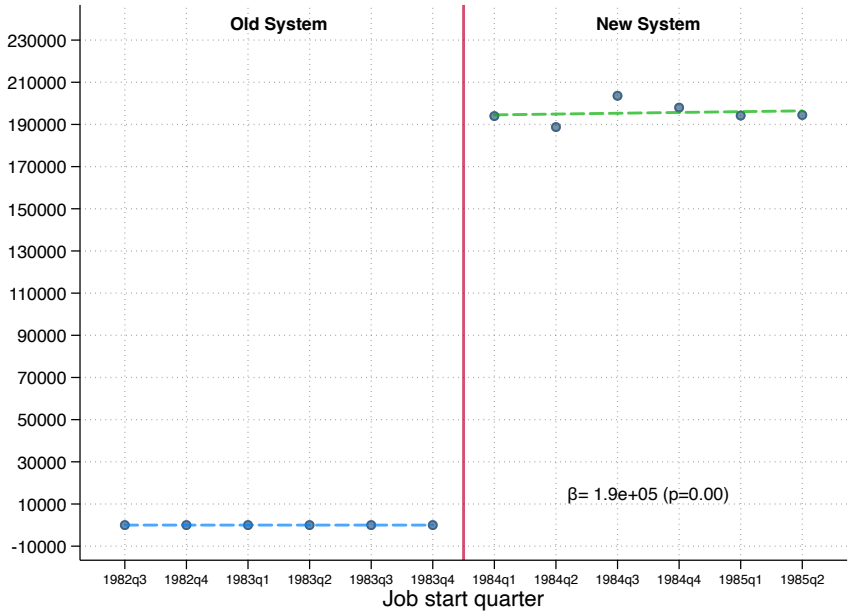
Figure 16: Simulation: Private vs. Public Sector Years



Note: This figure simulates workers' decisions to work in the private sector, work in an outside option, or retire. The y-axis shows the number of years in the private, or outside, sector from the simulation. The x-axis shows the number of years in the federal government. The different colors represent the possible outside options that each worker faced.

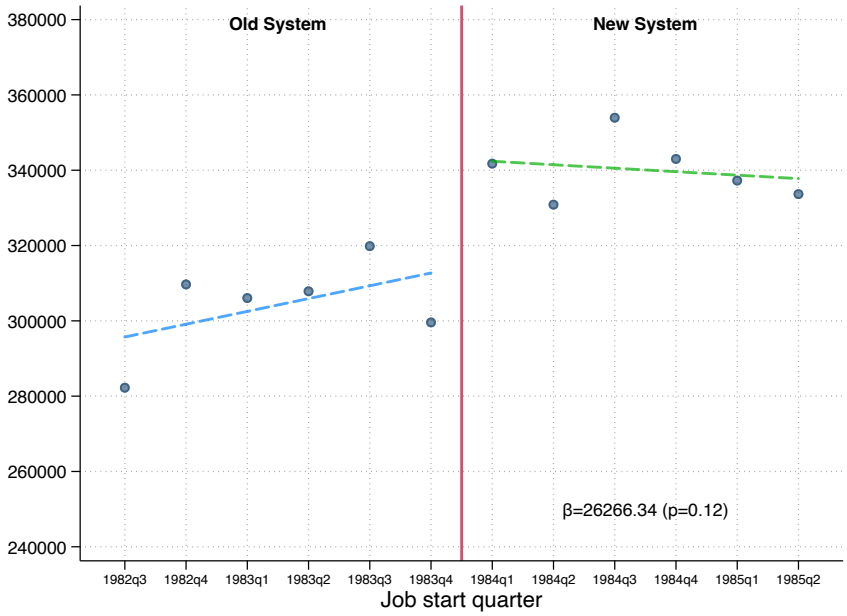
Appendix H Changes in Portable Benefits

Figure 17: Change in PDV of Portable Benefits, assuming 5% yearly match



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 5% 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. The RD coefficients are reported as the β and p-values are given in parenthesis.

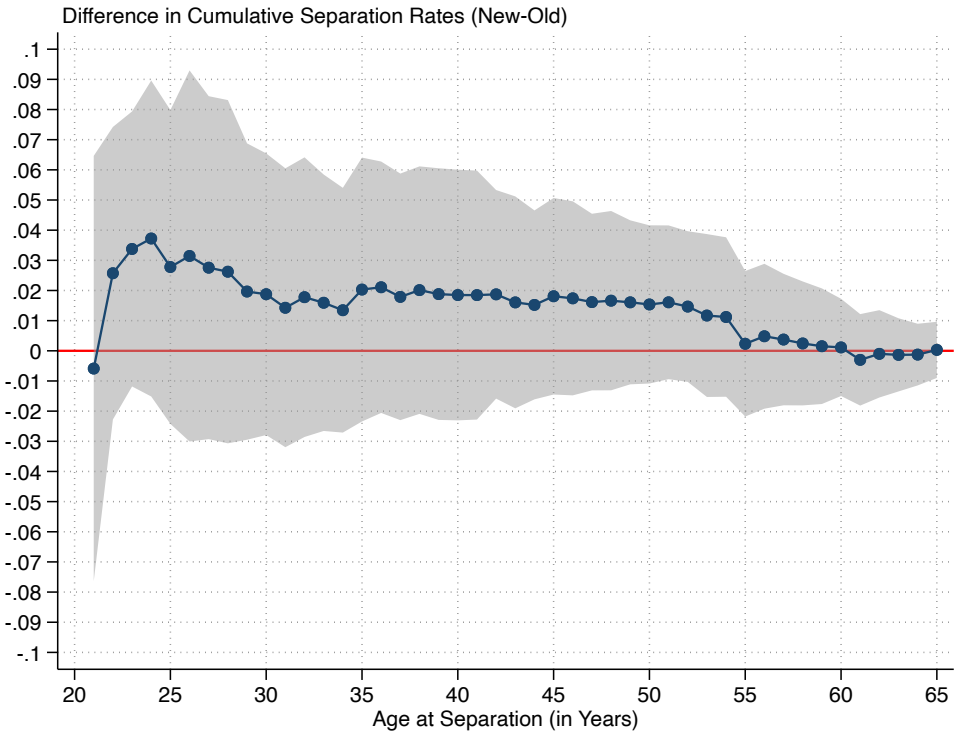
Figure 18: Change in PDV of Total Retirement Benefits, assuming 5% yearly match



Note: This figure reports the RD coefficients on the changes in PDV of total retirement benefits, which is composed of the annuity, Social Security and employer's DC contributions, after the new system is introduced. We assume the employer will contribute 5% 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. The RD coefficients are reported as the β and p-values are given in parenthesis.

Appendix I Heterogeneity Analysis on Separation Rates by Ages

Figure 19: Difference in Cumulative Separations by Age in the Old vs. New System

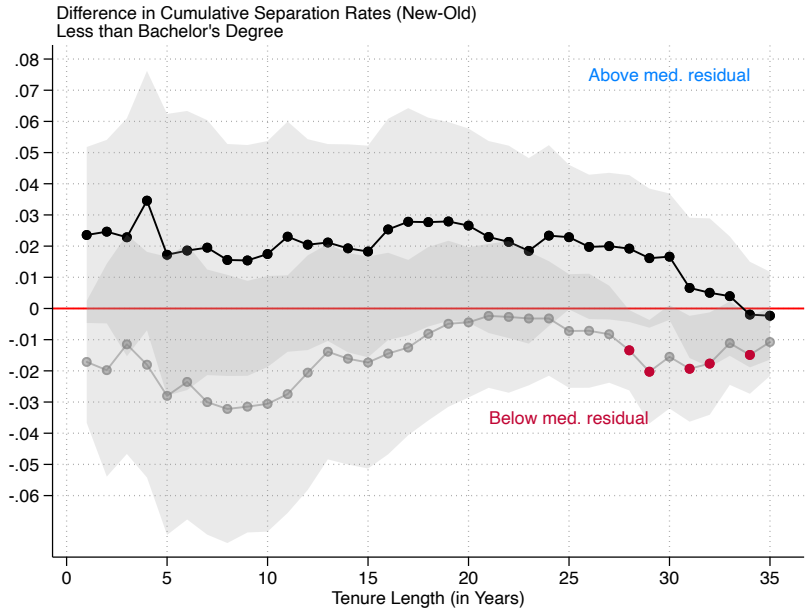


Note: This figure plots the RD coefficients of the cumulative separation rates for different ages in the x axis. Each point represents the difference in the cumulative separation rates between old system workers and new system workers. The 95% confidence interval is shaded in gray. Light blue points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

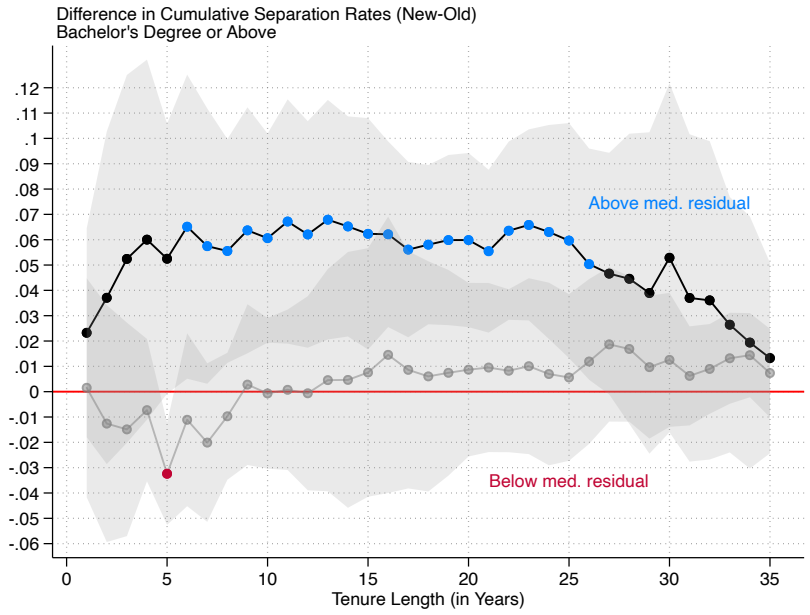
Appendix J Productive Workers: High vs. Low Education

Figure 20: Difference in Cumulative Separations by Supplementary Pay

(a) Less than a Bachelor's Degree



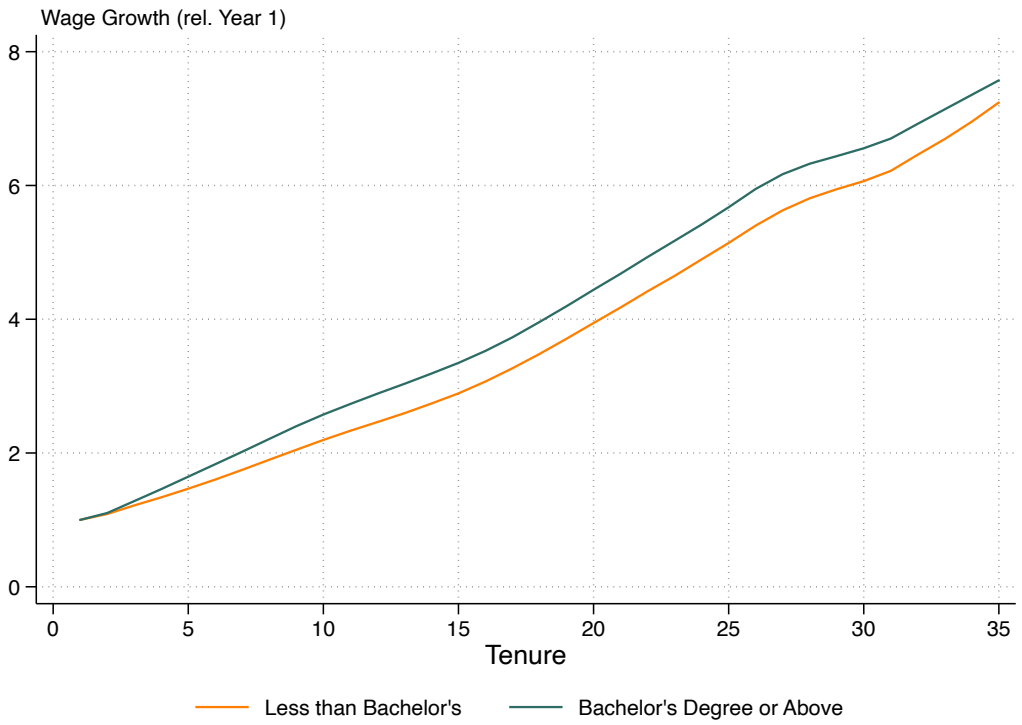
(b) Bachelor's Degree or Above



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 K Wage Growth by Education Level

Figure 21: 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 L Separation Event Studies

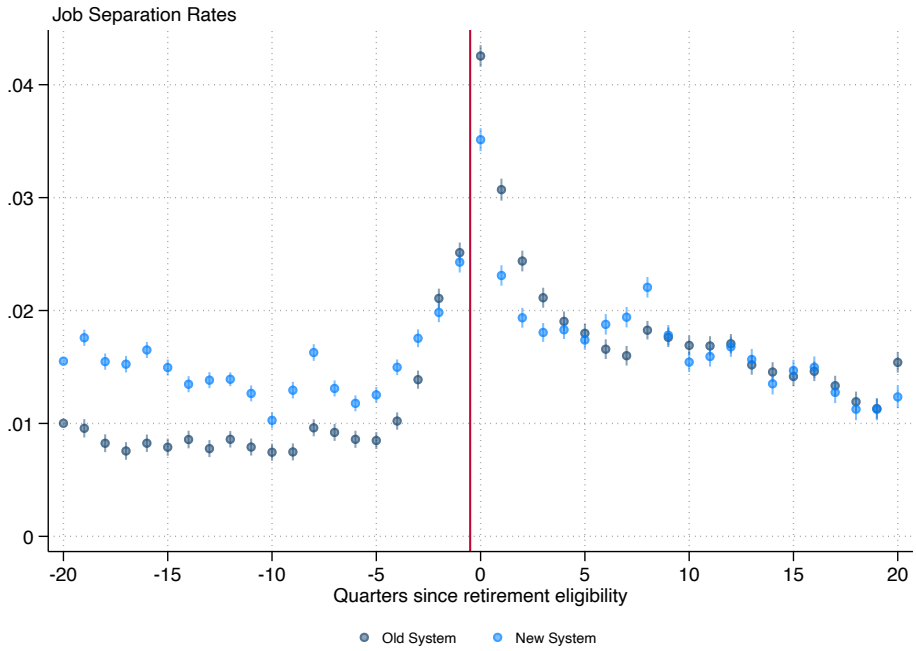
Using the variation in the annuity growth before and after retirement eligibility, we can utilize an event study to examine how labor supply responds to changes in financial incentives around full retirement eligibility:

$$Y_{it} = \alpha + \Sigma_{n=k}^{K} \beta_n X_{in} + \gamma D_{it} + \epsilon_{it} \tag{3}$$

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 L, which show similar but noisier effects.

Figure 22: Event study: separations around full retirement eligibility

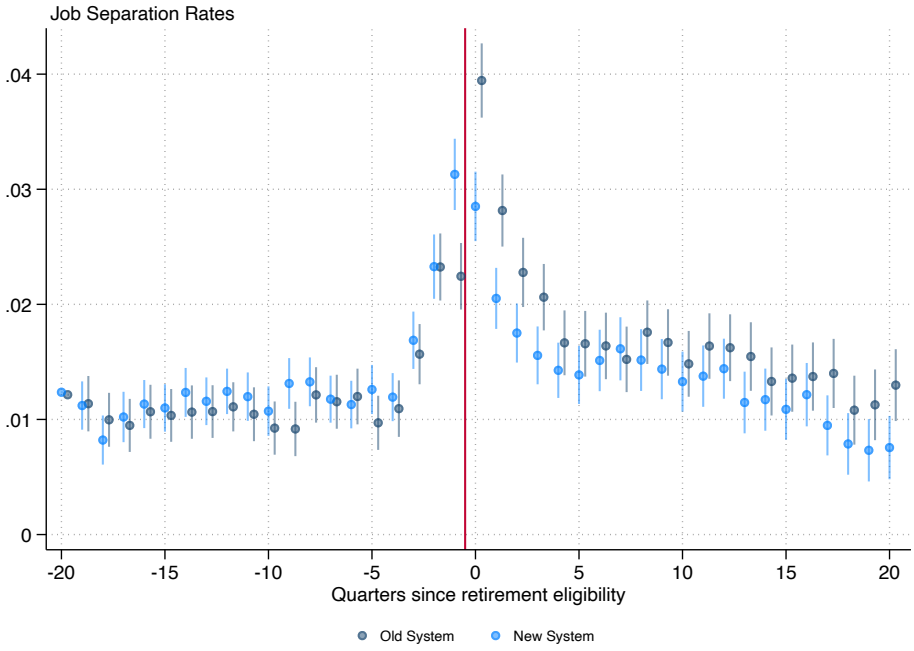


Note: This figure presents the event study coefficients provided in equation 3, for all workers who began between 1980-2000. The sample is restricted to workers who work within 5 years of their full retirement eligibility. The red vertical line signifies the time in which workers become eligible. The 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 23: Event study: separations around full retirement eligibility



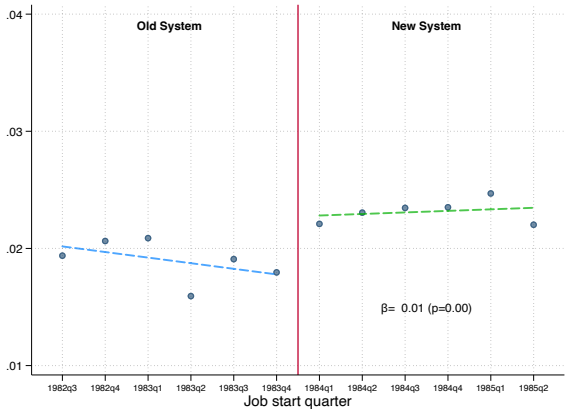
Note: This figure presents the event study coefficients provided in equation 3. The sample is restricted to workers who work within 5 years of their full retirement eligibility. The red vertical line signifies the time in which workers become eligible. The navy dots are workers under the old system and 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.

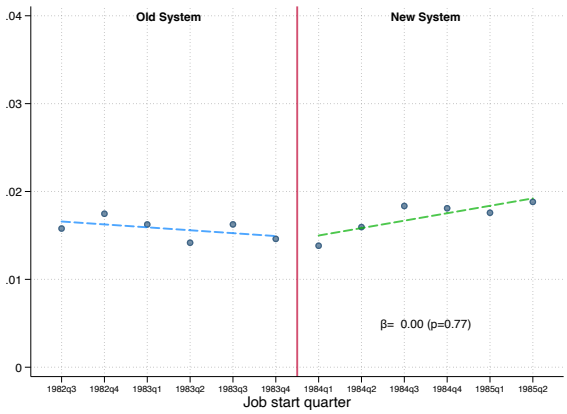
Appendix M Early career workers

Figure 24: Separating at 10 Years

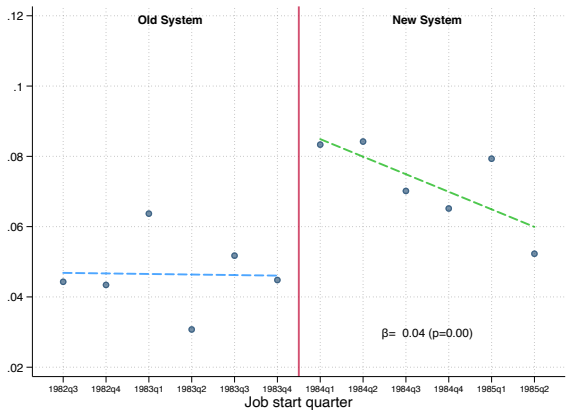
(a) All Workers



(b) Workers Eligible to Defer Only

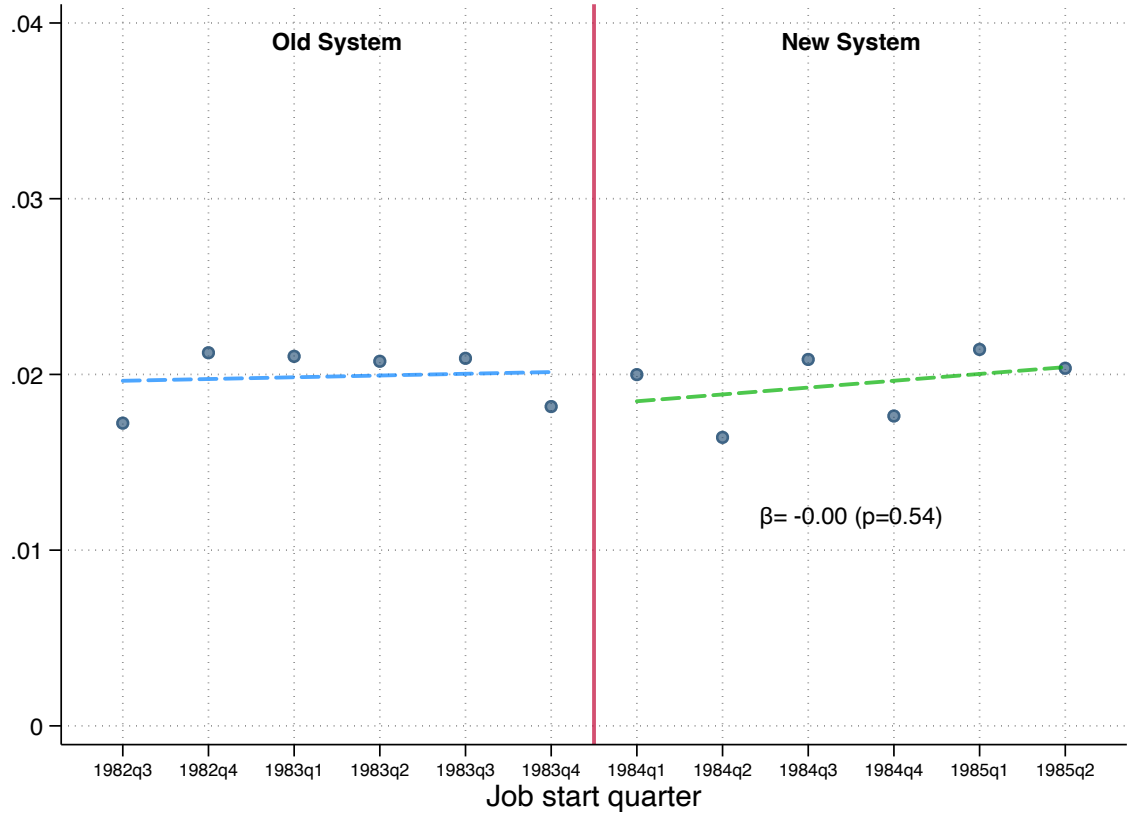


(c) Workers Eligible to Defer or Claim Early



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.

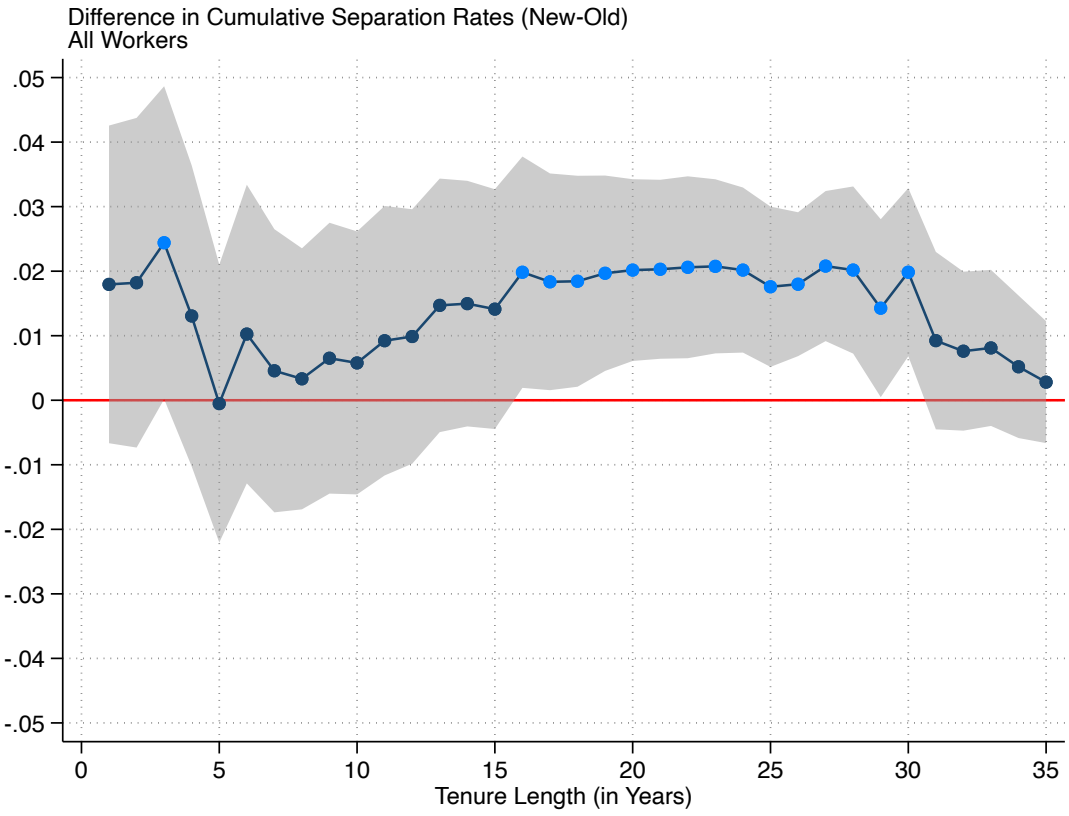
Figure 25: Separating at 9 Years



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.

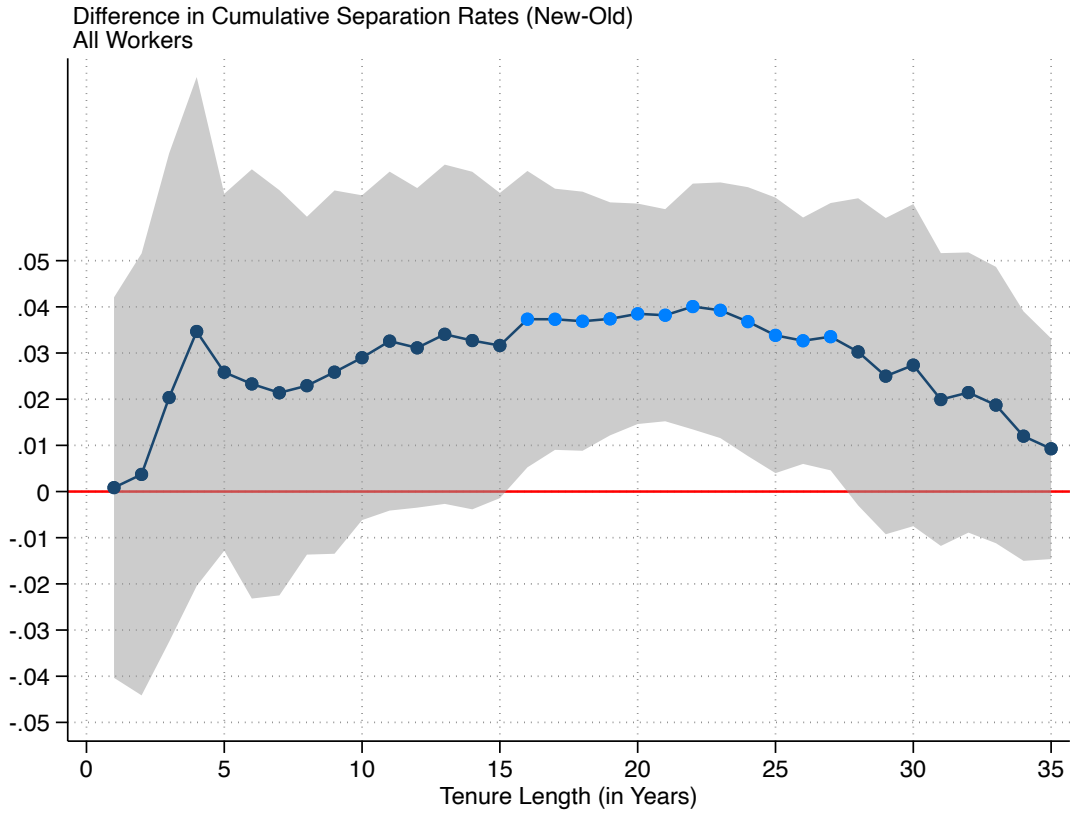
Appendix N Different RD Bandwidths

Figure 26: 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.

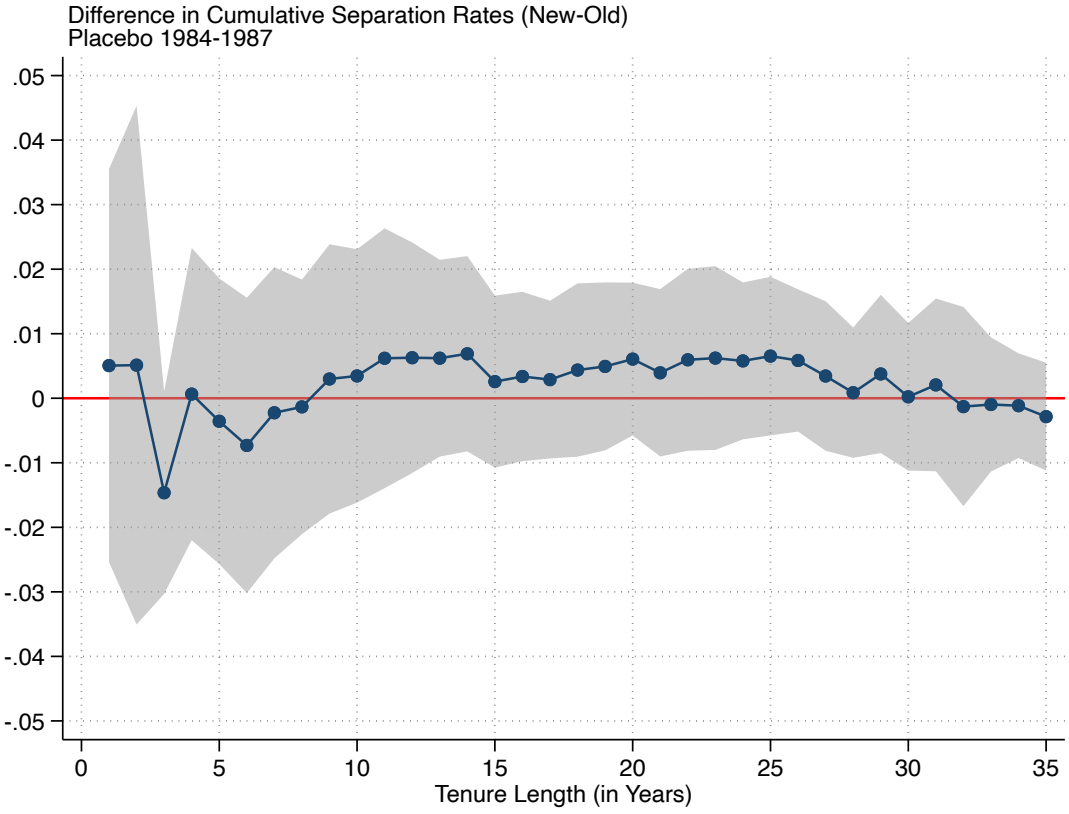
Figure 27: Short Window - Difference in Cumulative Separations by Tenure Length in the Old vs. New System



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 O Placebo Test

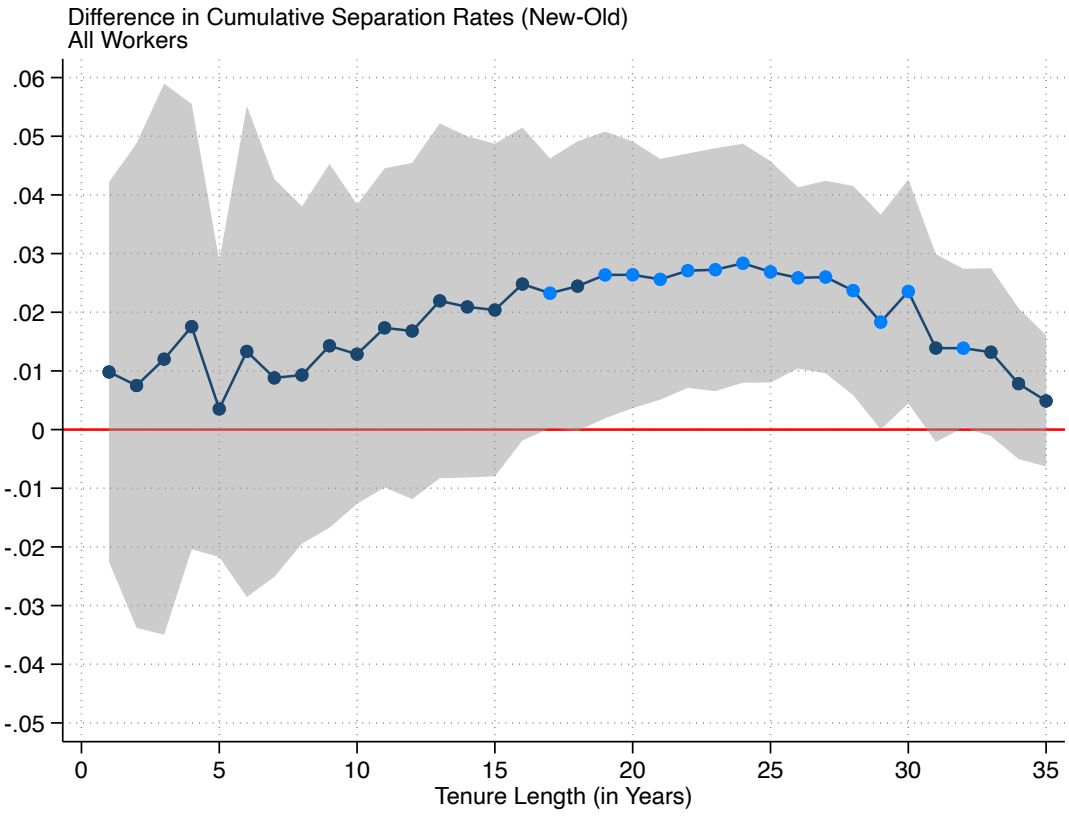
Figure 28: Placebo: Difference in Cumulative Separations by Tenure Length in the Old vs. New System



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 P Seasonal Effects

Figure 29: 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 Q 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	-1.40	0.04	0.11	1.46	-0.45	0.38	-0.38
	(2.07)	(1.97)	(2.40)	(1.44)	(1.42)	(0.75)	(2.10)	(1.65)
ln(Starting Salary)	0.02	0.04	0.01	-0.00	0.01	-0.02	0.01	0.01
	(0.02)	(0.03)	(0.01)	(0.00)	(0.04)	(0.02)	(0.03)	(0.02)
Starting Age (in Quarters)	0.74	3.93	2.18	2.04	0.65	1.81**	1.71	2.52
	(2.63)	(2.90)	(3.65)	(2.03)	(1.96)	(0.78)	(2.99)	(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**	-0.03	-0.05*	-0.02	-0.04	-0.05***
			(0.02)	(0.04)	(0.03)	(0.02)	(0.04)	(0.02)
Higher Educ. Degree or More		0.06*	0.00	0.02	0.01	0.00	0.02	-0.00
		(0.03)	(0.00)	(0.04)	(0.03)	(0.00)	(0.04)	(0.00)
Years of Educ.	-0.04	0.11	-0.18***	-0.07	-0.16	-0.05	-0.12	-0.17***
	(0.06)	(0.08)	(0.07)	(0.14)	(0.10)	(0.12)	(0.14)	(0.06)
Occupation Category								
White-Collar	-0.01	-0.00	-0.02	-0.01	-0.02	0.00	-0.01	-0.02
	(0.03)	(0.00)	(0.04)	(0.01)	(0.03)	(0.00)	(0.02)	(0.03)
Blue-Collar	-0.00	0.00	-0.00	0.01*	0.00	-0.00	0.00	0.01
	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.01)
Other	0.01	0.00	0.02	-0.00	0.01	-0.00	0.01	0.01
	(0.03)	(0.00)	(0.04)	(0.00)	(0.02)	(0.00)	(0.02)	(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. $*p < 0.1, **p < 0.05, ***p < 0.01$.