Mandatory Retirement for Judges Improved Performance on U.S. State Supreme Courts

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Abstract

Anecdotal evidence often points to aging as a cause for reduced work performance. This paper provides empirical evidence on this issue in a context where performance is measurable and there is variation in mandatory retirement policies: state supreme courts. We find that introducing mandatory retirement reduces the average age of working judges and improves court performance, both in the quantity and the quality of published decisions. To help explain these results, we find that older judges do about the same amount of work per case as younger judges, but that work is of lower quality as measured by forward citations.

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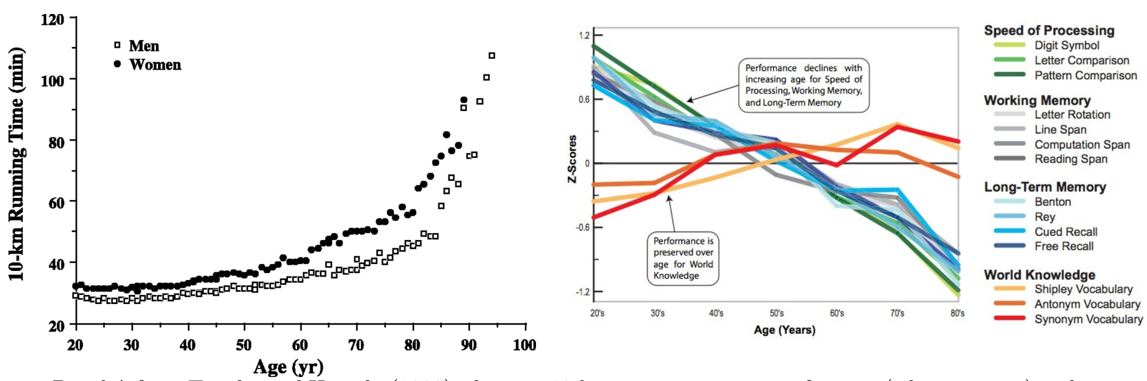
Figure 1: Performance vs. Age for Physical and Cognitive Tasks

(A) 10-K Running Time **(B) Cognitive Performance**



Notes. Panel A from Tanaka and Higuchi (1998), showing 10-km race running times for men (white squares) and women (black squares) by age. Panel B from Ballesteros et al. (2009) showing how measures of different factors of intelligence or cognitive performance from psychological tests vary by age. The green lines measure processing speed, the gray lines working memory, blue lines long-term memory, and red lines world knowledge. All are decreasing into old age except knowledge.

1 Introduction

At some point all good things must come an end, including our careers. A key factor in this decision to stop working is the inevitable depreciation in skills with age. Take the case of professional runners: As shown in Figure 1 Panel (A), the ability to run 10 kilometers falls continuously from about age 40, and there is a very steep decrease around age 85.[1] For any given professional runner, the decision to end his/her career is simple because running speed can be easily measured. The same goes for any job that depends on skills that can be cheaply and accurately measured.

Most jobs in a knowledge economy are not based on running or other one-dimensional physical tasks. But aging still takes its toll: As illustrated in Figure 1 Panel (B), cognitive processing ability declines continuously starting at age 20. The long-run decline in processing power is partly compensated by improvements in memory and knowledge. The presence of multiple countervailing factors reflects that the decision on when to end a cognitive career is more complicated than one based on running speed.

More generally, one cannot usually measure the productivity of skilled professionals. Age-related performance decline takes several years, and hence it may not be clear when

[1]This decline is in spite of a great deal of positive selection: individuals who are still able to run a 10-K at age 85 are a very selected group!

to step down. Moreover, if a professional is permanently employed, then dismissal must be with cause. In such a context, the employer must provide documentary evidence that performance is not sufficient, and naturally the employee might disagree, or may wish to bring an age discrimination claim.[2]

The process of ending careers is further complicated by the upward rigidity of wages. For many reasons, wage cuts are not usually an option for older workers. Part of this is personal: Few managers would relish telling a valued employee that his/her performance has declined to the point that the wage must go down or else regular employment must cease. Given the aforementioned performance measurement problems, employers will find it difficult to produce decisive evidence that a wage cut is warranted. Meanwhile, a predetermined age-based wage cut – even if it would be accepted by workers – would require an accurate estimation of age-related productivity decline (perhaps many years in the future), and would require (inefficiently) identical treatment of workers with highly heterogeneous performance trajectories. For these reasons, firms cannot bring the compensation of older workers in line with performance when performance declines.[3] As health choices and technologies improve, one could expect even more dramatic variation across workers in longevity and late-life productivity.[4]

A potential solution to these end-of-career conflicts is the use of mandatory retirement provisions. When parties have agreed in advance to a specified retirement date, then the employee's performance is not being called into question during the termination process. Hence, the employer does not need to provide evidence that an individual's performance is no longer acceptable. Beyond avoiding such conflicts, another benefit of such a rule is that it helps employees plan in advance their savings, so that they may best enjoy the fruits of a long working life. A potential cost is that many individuals are still productive into advanced age and would prefer to continue working in some capacity. Yet under mandatory retirement the employer can, at her discretion, continue to employ the retiree in a similar job, or in a job for which she is better suited.

[2]See MacLeod (2003) on how conflict can arise when employer and employee have different views regarding performance.

[3]Frederiksen and Flaherty Manchester (2019) provide evidence that firms have historically addressed the problem of varying performance trajectories by keeping base wages low and using more performance pay.

[4]In the United States in 2010, one could expect about 19 more years of life conditional upon reaching 65; this number was up from about 14 years in 1960. Appendix Figure A.1 Panel (a) shows the average retirement age by year, which has been stable for men but increasing significantly for women.

Regardless of the net benefits, mandatory retirement is prohibited (with some exceptions) in the United States under the Age Discrimination Act of 1967.[5] The justification for this prohibition is that mandatory retirement by age is facially discriminatory toward workers above that age. Instead, employers are required to evaluate the performance of the worker so that potentially high-productivity workers are retained. Economic theory provides little guidance on whether mandatory retirement dates should be allowed: under standard models, mandatory retirement would have no effect (due to costless renegotiation to reflect productivity changes), or, if it does have an effect, that private parties would themselves choose the optimal rule (see Frederiksen and Flaherty Manchester, 2019).

Separate from the question of legality, it is an open empirical question whether mandatory retirement improves work productivity. If performance declines with age, then reducing the average age of workers to some degree would improve productivity. On the other hand, if high-productivity older workers are removed during their prime due to the mandate, that could reduce productivity. In addition, with a looming mandatory retirement date workers might reduce investment in job-specific skills. To see which effects dominate, empirical evidence is needed.

The goal of this paper is to provide empirical evidence on how mandatory retirement rules influence work performance in high-skill occupations. The empirical setting is state supreme courts, the state-level equivalent to the federal-level U.S. Supreme Court. State supreme court judges are tasked with reviewing lower-court decisions and setting new legal rules in a common-law milieu. Researching, deciding, and justifying the law is a high-skilled constellation of tasks requiring expertise and professionalism (see Posner, 2008; Ash and MacLeod, 2015), comparable in technicality to physicians and scientists. Moreover, judges work alongside peer judges and supervise teams of clerks and other staff, meaning the job also entails significant social and managerial skills.

We measure judge performance over the lifespan using a database of all decisions published by state supreme courts for the years 1947-1994. Because these opinions comprise the near-entirety of a judge's work product, they can be used to produce cleaner measures of performance than is possible in other high-skill domains. More specifically, we measure work performance as the number of times a judge is cited (positively) by future judges (Choi et al., 2008). While forward citations do not identify a "correct" decision, they do index the degree to which a new interpretation or

[5]The Age Discrimination Act of 1967 is designed "to promote employment of older persons based on their ability rather than age". The text of the law is excerpted in Appendix D.

clarification of the law is helpful to future judges. Hence, citations provide a measure of performance that does not require a normative evaluation of the rule applied. In Ash and MacLeod (2015), we provide evidence that judges care about citations, and when given more time write longer and more detailed decisions that receive more citations. In Ash and MacLeod (2020), we provide further validation of citations as measuring quality and show that judges selected by less politicized processes (nonpartisan elections or merit commissions) provide higher-quality work than judges selected by more politicized processes (partisan elections).

Beyond the performance measurements, state supreme courts have a number of desirable features for our research objectives. First, the job of a judge has not changed substantially over time, nor does it change over the course of the career. Relative to other high-skill professions, such as medicine or management (Choudhry et al., 2005; Bloom and Reenen, 2007; Bloom et al., 2012), the skills relevant for good judging are relatively constant. Second, the workload for judges is held constant; it cannot be influenced by judges themselves, and does not vary according to age or experience. Third, compensation does not vary between judges, nor is it contingent on work performance (see Landes and Posner, 2009). Fourth, state supreme court judges have relatively strong tenure protections with little chance of termination (Kritzer, 2011). Fifth and finally, they are at the top of their profession without further opportunities for promotion. With these judges, therefore, we can track long-run changes in work performance over full careers in a high-skill setting. The resulting within-judge comparisons over time are different from those in most previous studies (e.g. Tanaka and Higuchi, 1998; Ballesteros et al., 2009), which use physical and cognitive metrics taken at single points in time and compare across individuals.

Appellate judging is a technically and professionally demanding career, at least on par with physicians, scientists, and managers. Our results will therefore be informative about how retirement policies would influence work productivity in these other high-skill professions. Beyond that, state supreme court judges are themselves an elite and powerful group. They have the authority to review not just the decisions of lower courts, but also legislation passed by state assemblies. Important common-law rules – such as contracts, real property, and torts – are made, applied, and distinguished in state supreme court decisions. These decisions have the force of binding precedent for all courts in a state and can even influence law in other states through a shared legal discourse and persuasive precedent.

Given the legal and social impacts, the quality of judge decisions is an important policy objective. In particular, the potential decline in performance due to aging could warrant a policy response. According to Posner (1995), "it is well-known within professional circles that some federal judges, including Supreme Court Justices, have continued to sit long after their judicial performance has become severely compromised by age-related disabilities" (p. 3). Recent news stories have highlighted anecdotal evidence of old age interfering with work performance in U.S. federal courts, where judges have life tenure and can stay on as long as they like. These accounts include some examples of older judges with dementia symptoms continuing with their work.[6]

In response to these concerns, many states have introduced maximum age constraints for full-time judges. Table 1 reports these rules and their reforms for the 1947-1994 period. In 1947 (the first year of our judge performance panel), 17 states had a mandatory retirement rule. By 1994 (the last year in the panel), an additional 14 states had adopted mandatory retirement. Besides the extensive-margin variation of having a rule or not, there is additional intensive-margin variation in the maximum age: 70, 72, or 75.

Our empirical strategy uses the introduction of mandatory retirement rules for judges as a natural experiment. We ask how introducing mandatory retirement affects court performance in a differences-in-differences regression framework. Court fixed effects adjust for time-invariant characteristics by court, while year fixed effects adjust for nationwide trends affecting all courts. Our identification assumption is parallel trends, for which we provide evidence using event-study regressions.

We first look for a first stage effect. Do mandatory retirement rules affect the judge age distribution? We find that introducing a retirement age decreases the age of working judges by 2-4 years. The effect is observed across the age distribution, with the oldest judges being replaced by younger judges than currently employed.

Next, we estimate the treatment effect of retirement rules on judge performance (as measured by citations to the court). We find a positive and statistically significant effect of mandatory retirement on judge performance. The effect is quantitatively large, at about a 25% proportional increase in positive citations to the court. The effect is robust to a number of alternative specifications, and we find similar effects using a less restrictive citation measure (all citations, not just positive ones) and a more restrictive

[6]See the 2011 *ProPublica* article, "Life Tenure for Federal Judges Raises Issues of Senility, Dementia," available at `https://www.propublica.org/article/life-tenure-for-federal-judges-raises-issues-of-senility-dementia`.

Table 1: Judge Retirement Rules and Reforms by State

A. Status Quo Rules at Period Start (1947)

Retirement Rule	List of States
No Mandatory Retirement	AR, CA, DE, GA, ID, KY, ME, MS, MT, ND, NE, NM, NV, OK, RI, TN, WI, WV, VT*
Retirement at Age 70	AK, HI, LA, MD, MA, MI,MO, NH, NJ, NY, OH
Retirement at Age 72	NC, SC
Retirement at Age 75	IL, IN, TX, UT

B. Retirement Rule Changes, 1948-1993

Mandatory Retirement Age		List of States (with Year Enacted)
Before	After	
None	70	AL (1973), AZ (1992), CT (1974), FL (1972), MN (1973), PA (1968), VA (1970), WI (1955), WY (1972)
None	72	CO (1962), IA (1965), WA (1952)
None	75	KS (1993), OR (1960)
70	None	WI (1984)

Notes. Initial retirement rules (in 1947, Panel A) and their reforms (Panel B), by state. * Vermont (VT) has mandatory retirement at age 90; we classify it as no mandatory retirement since there are just 2 judges in our entire sample (not in Vermont) who live that long.

one (just citations from other states, where a ruling is persuasive rather than binding precedent). In addition, we find that the effect is jointly driven by quantity (an increase in opinions produced) as well as quality (citations per opinion).

Why does mandatory retirement improve court performance? A salient possibility is that older judges do lower-quality work, so replacing them with younger judges would mechanically increase quality. In the second part of the analysis, we measure changes in judge performance over the lifespan. Our empirical strategy exploits the panel variation in our data across courts and across time. We first compare colleague judges by age within the same court, and second, looking at changes in performance within judge across the lifespan. We also compare judges based on starting age and ending age.

These regressions produce systematic evidence that performance falls with age. While judges do improve in performance over the first few years in the job, it is an experience rather than age effect. Holding experience constant, older judges provide lower-quality work. In addition, the effect of age is quadratic, consistent with an accelerating decline in work quality.

The effect is robust to an array of specifications for performance, including in rank percentiles within court-year (as in Ash and MacLeod, 2020). There are only minimal effects on the amount of work that older judges do in terms of number of decisions or volume of text produced, consistent with being helped by clerks to maintain quantity (Posner, 1995). The effects are not driven by the types of cases that judges review.

To summarize, we find that the introduction of mandatory retirement reduces judges age and increases court-level work quality. We document a connection between these effects in that judge-level work quality is decreasing with age. Overall, these results support the view that the effects of mandatory retirement on quality are due to the replacement of older judges with younger ones, who tend to provide higher-quality work on average.

These results add to the significant and active literature on the economics of aging and retirement (e.g. Lumsdaine and Mitchell, 1999). One of the closest papers is Ashenfelter and Card (2002), who find that a mandatory retirement age for university faculty was binding in the sense that it significantly reduced the number of older academics. The structural literature on retirement choice, beginning with Gustman and Steinmeier (1986) and Stock and Wise (1990), has produced counterfactual estimates for worker responses to pensions and other retirement incentives (see also Gustman and Steinmeier, 1991, 2005). In political economy, Diermeier et al. (2005) and Keane and Merlo (2010) derive structural estimates of the parameters underlying retirement choices of U.S. Congressmen.

A major theme in the economics of retirement choices is diminishing productivity in the later years of life (see Figure 1). Although cognitive abilities begin to fall early in life (Desjardins and Warnke, 2012), workers also learn and enhance their skills.[7] Thus, wages and employment continue to rise after the start of physical and cognitive decline and only begin to fall for individuals older than fifty years (Medoff and Abraham, 1980; Abraham and Farber, 1987). These stylized facts underlie the standard economic model, where younger individuals invest in human capital that depreciates over the lifespan (e.g., Blundell and Macurdy, 1999). Empirically, a concave relationship between age and productivity has been found for scientists (Levin and Stephan, 1991), economists (Oster and Hamermesh, 1998), and physicians (Choudhry et al., 2005).[8] However, within-person and between-person studies have found very different age-skill profiles; Small et al. (2011), for example, report a within-person study where episodic/semantic memory demonstrated no decline before the age of 75.

The issues of aging, retirement, and work performance have special policy relevance in the case of judges, who make important social decisions and tend to stay in their jobs into advanced age. The previous evidence on variation in judge performance over the lifespan is mixed. In an early and detailed study of U.S. federal judges, Posner (1995, ch. 8) finds that opinion quality (citations per opinion) is maintained into advanced age (into the 80s) before decreasing. In a sample of twenty judges on the Australia High Court, Smyth and Bhattacharya (2003) find that quality (as measured by citations) peaks at age 64. Teitelbaum (2006) provides descriptive time-series evidence that the U.S. Supreme Court produces about the same number of cases regardless of the average age of the justices. Dimitrova-Grajzl et al. (2012) compared performance by age in three Slovenian trial courts; in one court, there was a concave relationship between productivity (number of cases resolved) and age, and in the other two courts, there

[7]In the words of cognitive psychology: While pattern recognition and logic skills (fluid intelligence) begin diminishing at a young age, verbal skills (i.e. writing skills) and knowledge (crystallized intelligence) improve into relatively advanced ages (Desjardins and Warnke, 2012). Another way of saying this, from Ramscar et al. (2014), is that as people age they have a larger data set in their mind. This in turn leads to slower processing speeds as they search larger data sets.

[8]Choudhry et al. (2005) conclude that "older physicians possess less factual knowledge, are less likely to adhere to appropriate standards of care, and may also have poorer patient outcomes." In the case of assembly-line workers, Borsch-Supan and Weiss (2016) find no evidence of a performance decline before the age of 60.

was no relationship.

Posner (1995, ch.8) discusses some reasons that judges might be able to maintain a high level of work quality into advanced age. In Posner's words, judging is a "late peak, sustained" career, where productivity increases into advanced age and then sustained until near death. In particular, many of the tasks facing judges draw on crystallized intelligence, which is maintained into advanced age. Similarly, Grossmann et al. (2010) show that reasoning about social conflicts – the raison d'être of judges - improves into old age, as indicated by higher-order reasoning emphasizing the need for multiple perspectives and compromise. Meanwhile, Lindenberger (2014) suggests that frequent participation in intellectual challenges and social engagement – both salient features of appellate judging – may mitigate cognitive decline.

These factors of job performance as well as professional engagement are both important determinants of the judge retirement decision, which tends to come later than that for the average U.S. worker (see Appendix Figure A.1). The lengthy career reflects in part a high intrinsic professional motivation on the part of the judges (Ash and MacLeod, 2015), indicated for example by the fact that a small minority of federal judges take senior status (a reduced caseload a full salary) as soon as it becomes available (Posner 1995, pg. 186; see also Choi et al. 2013). Meanwhile, a related literature in political science has shown evidence of strategic retirement – judges timing their retirement based on the party of the appointing governor or president to influence the political ideology of the successor judge (e.g. Nixon and Haskin, 2000).[9]

The rest of the paper is organized into the following parts. Section 2 provides some background and describes the data. Section 3 provides the empirical analysis of how mandatory retirement reforms affect judge performance. In Section 4, we analyze variation in performance over the judge life cycle. Section 5 connects these analyses and concludes.

[9]Retirement choices have also been used for identification of electoral-retention effects. For jurisdictions with competitive reappointment processes, judges planning to retire do not face the same retention-related incentives as judges who intend to stay in office (Shepherd, 2009a; Gordon and Huber, 2007; Shepherd, 2009b).

2 Background and Data

2.1 Institutional Context

Our empirical setting is state supreme courts. While judicial systems do vary from state to state, they share major characteristics and structures. The fundamental role of a state supreme court judge is to rule on questions of state law (rather than federal law). These questions arise in cases appealed from lower state courts. A case begins when a plaintiff files a lawsuit or a prosecutor indicts a criminal. At trial, facts are litigated and a judge/jury gives a verdict, which the losing party can appeal. If the state has an intermediate appeals court (as most do), that court will then take the case and may affirm, reverse, or modify the trial verdict. After this intermediate court's decision (or after the trial decision when the state does not have an intermediate appellate court), the ruling can be appealed to the state supreme court, which is the last appeal on matters of state law.[10]

If the state supreme court accepts a case for review, the judges will rehear the case at oral argument and then review the submitted briefs for legal error. Each judge votes whether to affirm or reverse the lower decision. One of the majority judges then researches and writes an opinion explaining the decision (with the help of clerk staff). In our data we cannot directly disentangle a judge's work from that of their clerks. For now, we note that our observed effects of age and conditions could include changes in how judges hire or manage their staff.

2.2 Judge Age and Retirement Decisions

The starting point for data collection is the existing data on state supreme courts from Ash and MacLeod (2015) and Ash and MacLeod (2020). A team of research assistants collected these data from a range of sources and built biographies for each judge in the sample. The key sources include state court web sites, judge obituaries, and Marquis Who's Who. Items that were unavailable from these sources were obtained through records requests or interviews of state court administration staff.

The dataset includes 1,558 state supreme court judges, for which we were able to obtain birth date information for all but 12 individuals. Beyond birth, we collected

[10]In rare cases when federal law (rather than state law) is pivotal, state supreme court decisions can be appealed to the U.S. Supreme Court. In two states (Texas and Oklahoma), there are separate high courts for criminal and civil matters.

Figure 2: Summary Histograms on Judge Age

Notes. Distributions of judge age, starting age, ending age, and career length, as indicated. Vertical dashed line at median.

date information on judgeship starts, judgeship terminations, and judge deaths. We also collected information on how judgeships ended and previous and subsequent career information.

Figure 2 provides some visual descriptives on the age and retirement decisions of state supreme court judges. These graphs only include states that do not have a mandatory retirement age. First, Panel A shows the age distribution for all state supreme court judges working between 1947 and 1994. We can see a wide range of ages of active working state supreme court judges. The other panels show the distributions of the starting age (Panel B), ending age (Panel C), and career length (Panel D). Judges tend to start in their position late in life (in their 50s) and work late as well (into their 70s).

The average retirement age of judges has not changed much over the time period 1947-1994 (Appendix Figure A.1, Panel B). This is somewhat different from the long-run changes in the broader economy which include an aging work force (Appendix Figure A.1, Panel A). The retirement age for judges has been consistently 4-5 years higher than the average worker over this time period. Meanwhile, the proportion of judges working in the private sector after leaving the court also increased over this time period (Appendix Figure A.2).

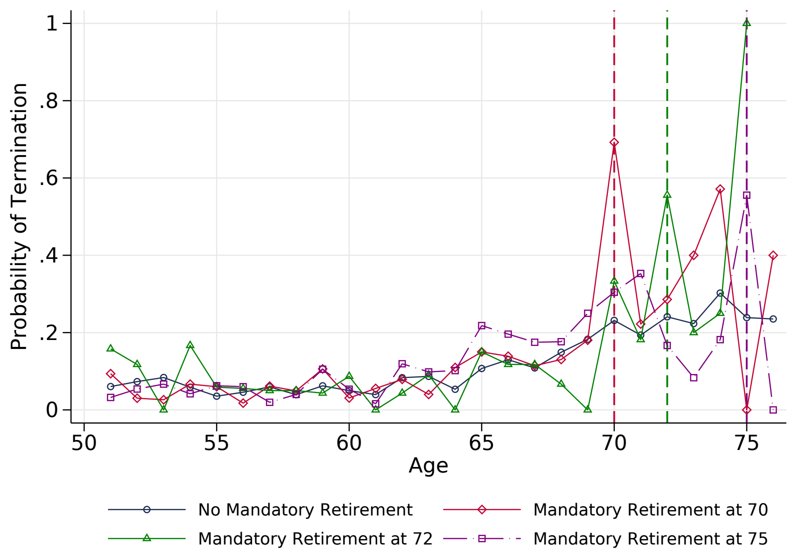
2.3 Mandatory Retirement Rules

The second data collection performed is on the rules on mandatory retirement. Table 1 reports these rules and records on their reforms in the 1947-1994 period. As discussed already in the introduction, we have 14 reforms to analyze in the empirical part. These include maximum ages of 70, 72, or 75.

In some states, the chief justice has the right to keep on a retired judge in what the federal courts call "senior status" or "active retirement status". Appendix Table A.3 presents some information on how these rules work by state. When senior status is available under mandatory retirement, the control rights on the retirement decision switch to the court, which can decide to keep a high-performing judge.

One practical implication of senior status is that we do see some judges in our data working past the official retirement age. This can be seen in Figure 3, showing the probability of retirement at any given age, separately by the mandatory retirement rule. The blue line, with no mandatory retirement, is relatively smooth, peaking in the early 70s. The red line, with mandatory retirement at age 70, shows big increases

Figure 3: Retirement Rates by Age, by Mandatory Retirement Age



Notes. Probability that a judge retires at a particular age, conditional on working at that age. Plotted separately by mandatory retirement rule.

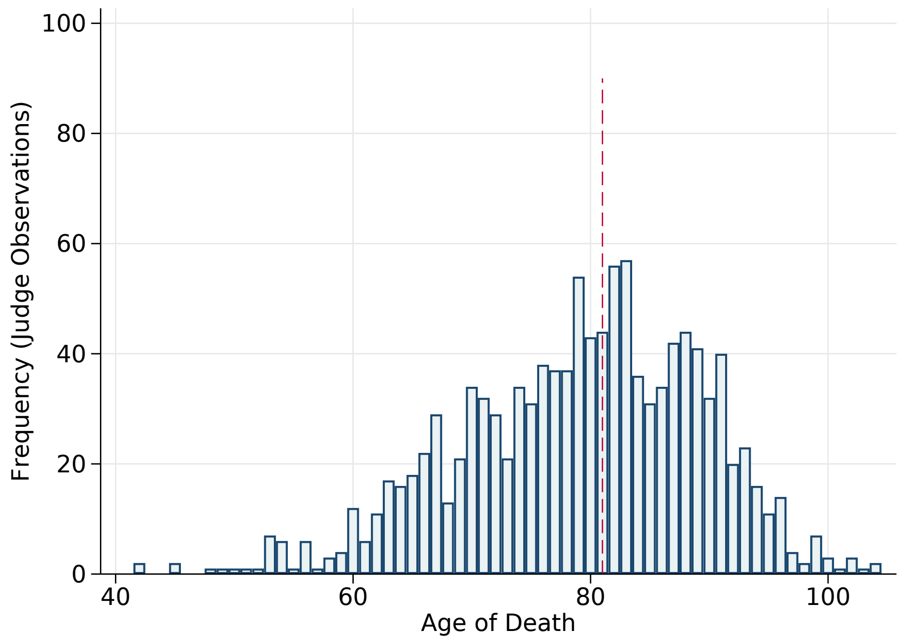
for ages 69 and 70. We see corresponding jumps for retirement at 72 (green line) and 75 (purple line). We do see, however, that the rules are not perfectly enforced. Some judges stay on past the mandatory retirement age due to senior judge status. Since the maximum age rule is not 100% binding, our estimates from the rule changes should be interpreted as intention-to-treat effects.[11]

To round out our view of the judge life cycle, Figure 4 provides some statistics on the timing of judge deaths. Panel A shows that the judges have relatively long lifespans, with most living into the eighties. Panel B looks at how judge retirement is related to judge longevity, separately for mandatory retirement (left panel) and voluntary retirement (right panel). The figure shows that with voluntary retirement, judges are much more likely to die within a year of leaving office. This difference supports the idea that mandatory retirement is an impactful policy: judges are more likely to stay in their jobs until death under voluntary retirement. On the other hand, there is still a relatively high chance of death in the first year out of office under mandatory retirement (left panel), which may hint at a causal impact of retirement on mortality (as found in Sullivan and von Wachter, 2009). This is a promising area for future work.

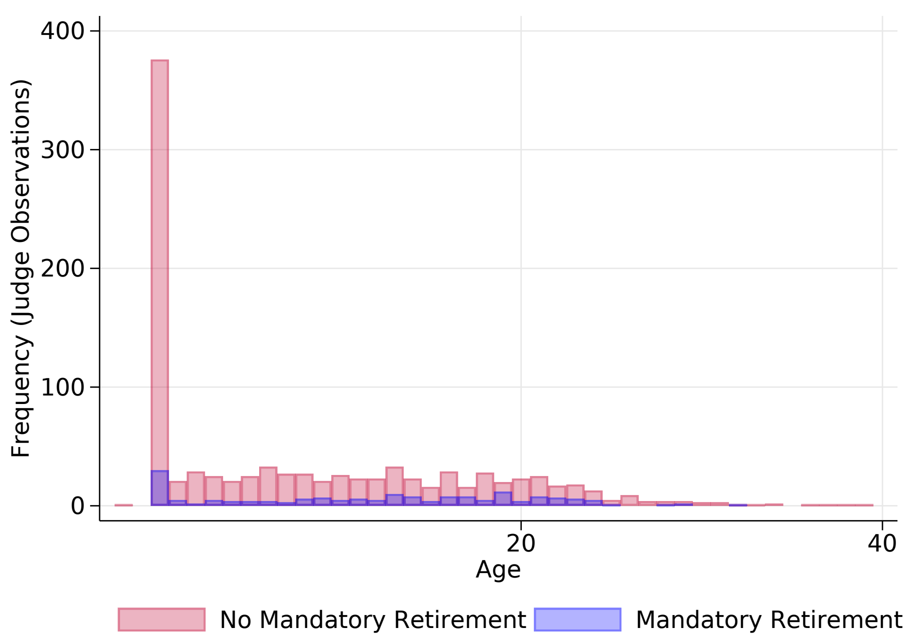
[11] Results using variation in senior status rules are reported in Appendix Table A.5. We did not find differential impacts of reforms in states with formal senior-status policies.

Figure 4: Mandatory Retirement and Deaths on the Job

(A) Judge Age-at-Death Distribution



(B) Distribution of Years Between Termination and Death, With/Without Mandatory Retirement



Notes. Distributions of judge age at death (panel A, vertical dashed line at median) and death year minus year judgeship ended (panel B).

2.4 Measuring Judge Performance

Our performance measures are constructed from published state supreme court opinions for the years 1947 through 1994, obtained (along with some annotated meta-data) from Bloomberg Law. The full sample includes 1,024,261 cases. We drop opinions that do not have a named author (per curium decisions), resulting in a sample of 404,928 majority opinions. In the final sample we have an average 25.7 cases per judge per year. Data collection and processing are described in more detail by Ash and MacLeod (2015) and Ash and MacLeod (2020).

As mentioned in the introduction, a special feature of appellate judging is that one can obtain useful measures of individual work performance. While there is a collaborative element of judging, almost all significant decisions have a single authoring judge who is individually responsible. This is different from many other occupations, such as science/innovation, which are inextricably collaborative and it is technically challenging to disentangle the contributions of individual team members.

Another nice feature of judging is that the quantity of assigned work is constant. When scientists or inventors get more papers or patents, that is the result of a joint choice on the number of projects and work quality on those projects. So one cannot disentangle the work quality choice from the extensive margin. In the courts, judges have to do the same number of cases as every other judge, so it is possible to extract the work quality factor.

Our preferred measure of judge performance is *work impact*. This is the total number of positive forward citations to a judge in a year. Judges in a common-law system cite previous cases that are useful to their decision, and therefore citations can be seen as an expert evaluation of peer decision quality (Posner, 2008; Choi et al., 2010; Epstein et al., 2013; Ash and MacLeod, 2015). Note that this is not a measure of whether the decision is correct or not, which we do not observe. But more citations means that a case was useful to a future judge and thereby makes a stronger influence on the path of the law. Ash and MacLeod (2020) show that a judge's citation count is correlated with bar association evaluations of his/her quality.

Citations are annotated as positive, negative, or distinguishing by the data provider. For the baseline, we look only at positive citations. As a more inclusive measure of performance that does not rely on subjective annotations about "positive", we use all cites (including negative and distinguishing). As more restrictive measures of performance, we use discussion cites (where the case was discussed at length by the citing court) and

Table 2: Summary Statistics on Outcomes

Outcome	Mean	S.D.
Log Positive Cites	5.360	0.954
Log All Cites	5.521	0.982
Log Out-State Cites	3.297	0.998
Log Discussion Cites	3.912	0.878
Log # of Opinions	3.131	0.565
Log Cites per Opinion	2.419	0.668
Log # of Words Written	10.77	0.622
Log Addendum Opinions	1.492	0.995

Notes. Summary statistics (mean and standard deviation) on judicial opinion outcomes, at the judge-year level.

out-of-state cites (only citations in other jurisdictions). Because state supreme court precedents are not binding in other states, out-of-state citations serve as an especially strong signal of legal usefulness or influence (Choi et al., 2010). In addition, while older judges might have time to network and influence colleagues in their own court to earn cites, this concern is less pronounced for out-of-state cites.

Our measure of work impact is a combination of quantity (number of opinions) and quality (number of citations per opinion). For analyzing the impacts of reforms, such as mandatory retirement, we feel that the impact measure is the most policy-relevant. To the extent that the number of opinions is invariant, work impact is a measure of work quality. Still, to decompose the importance of quantity and quality, we report as additional outcomes the number of opinions written (quantity), and the number of position citations per opinion (work quality). In addition, as a measure of *work output* we report effects on the total number of words written in opinions during a year. The appendix includes analysis for a range of other outcomes, including measures of caselaw research and number of discretionary opinions written.

For all these variables, the baseline measure is the log of the average value for the judge in a year. Summary statistics for all of our outcome measures are reported in Table 2. The main outcome is the log of positive citations, with additional measures meant to provide additional dimensions of performance, quantity, and quality.

We report a range of alternative specifications for the outcomes in the appendix.

When comparing judges to their colleagues, we also highlight the use of a rank percentile specification (as in Ash and MacLeod, 2020). These transformations are discussed further below.

2.5 Case Assignment and Characteristics

The citation count for a decision is a joint product of both the type of case and the judge's efforts. For example, cases that review the constitutionality of statutes will generally get more citations than summary habeas denials. When looking at the effects of reforms or aging on quality, we have to check whether that is driven by changes in the composition of the caseload, rather than changes in judge work quality.

A relevant institutional rule is how cases are assigned to judges, especially when comparing judges to their colleagues. There are three systems for case assignment, collected by Brace and Hall (2007) and updated by Christensen et al. (2012).[12] Appendix Table A.3 lists the state supreme courts by rule. Discretionary assignment by the chief justice (the rule at the U.S. Supreme Court) is the minority rule followed in just 15 states. In 13 states, cases are randomly assigned by lottery to authoring judges. In the remaining 22 states, cases are assigned on a rotating system, with cases arbitrarily assigned to judges based on their order on the docket.[13] Christensen et al. (2012) found that in state supreme courts, case characteristics and judge characteristics are correlated even under random/rotation assignment. This is important for interpreting any effects, which could be due to changes in case types.

At the decision level, we have data on the area of law of a case, as well as the related industries of a case. These are coded for each case by the data provider, and there may be up to three legal areas and three related industrial sectors for any particular case. Appendix Table A.2 reports summary tabulations of these characteristics. In the data, we include a vector of dummy variables for each area and sector, equaling one if the case is annotated as that area or sector. Because there are so many of these categories, including separate covariates for every category would almost saturate the dataset. Instead, we construct the first five principal components of this matrix of

[12] These rules were confirmed by Brace and Hall in the early 1990s and late 2000s. We tried to check the rules for earlier years. We could not get comprehensive information, but for those states where we could find information, it comported with the Christensen et al. (2012) information.

[13] There are complex rules across states that affect the rotation. Senior judges have fewer cases. Judges can occasionally recuse themselves. On appeal after remand, the same panel normally reviews a case. There can be exceptions for specialized cases such as those involving the death penalty.

categorical variables, which explains 65% of the variance.[14] We will uses these factors as controls, but also look at how they respond to the treatments.

3 Mandatory Retirement and Court Performance

3.1 Empirical Approach

The main estimating equation is

$$y_{ist} = \alpha_s + \alpha_t + \rho M_{st} + \alpha_s \cdot t + X_s^0 \cdot \alpha_t + X'_{ist}\beta + \epsilon_{ist} \tag{1}$$

where y_{ist} is an annual performance metric (e.g. log citations, described in Subsection 2.4 above) for judge i working in court s during year t. Coefficients are estimated by ordinary least squares regression with standard errors clustered by state. The right-hand side items in the equation are described as follows.

The empirical approach is generalized differences-in-differences. To control for time-invariant court characteristics that may be correlated with the retirement system and with performance, we include court fixed effects α_s. To control for national trends in performance, we include year fixed effects α_t. Standard errors are clustered by state to allow correlation in the residuals over time across judges and within time in the same state.

The treatment indicator M_{st} equals one for years after introducing mandatory retirement. Fourteen states introduced a mandatory retirement age during the time period of our data (see Table 1). The coefficient ρ measures the corresponding causal effect of interest. Due to the length of the panel, in the baseline specification we estimate effects in a ten-year window before and after the reforms (as in Ash and MacLeod, 2015).[15] Formally, X_{ist} includes an indicator equaling one for the baseline time window of ten years before and ten years after a change to the retention system. In turn, M_{st} is a dummy for the ten years after the change. Thus, as y_{ist} is specified in logs, the estimates can be interpreted as the average proportional difference in within-court performance for the ten years after the policy change relative to the ten years before the policy change. For additional flexibility, we also allow for state-specific treatment

[14] Using more or fewer components does not change anything.

[15] In Appendix Table A.4 we use a six-year window, fourteen-year window, or no window (all years). The main effects are robust across these specifications.

windows.

The introduction of mandatory retirement is not an exogenous event, given that the reform is likely to be implemented in response to (the perception of) older judges not performing as expected.[16] On the other hand, there have been some recent moves to repeal mandatory retirement rules, so the pressure to change operates in both directions.[17] In any case, random assignment of treatment is not needed for identification. Consistent estimation of ρ requires parallel trends between treated states and comparison states (Bertrand et al., 2004). Put differently, the comparison states should provide a counterfactual for the trend in the treated states in the absence of the rule change. Still, the standard assumption of parallel trends is strong in this setting if the reforms are implemented in response to pre-existing trends in performance. In our regressions, we allow for pre-existing state trends in performance that may be confounded with the reforms by including state-specific linear trends $\alpha_s \cdot t$. Further, the term $X_s^0 \cdot \alpha_t$ includes initial-period court characteristics – institutional rules, case types, and judge age distribution – interacted with year fixed effects. These covariates allow for different trends along these different dimensions of state court characteristics.

To formally test for parallel trends and assess the dynamics of the effect, we use a panel event-study specification. Formally, we estimate

$$y_{ist} = \alpha_s + \alpha_t + \sum_{k=-6, k\neq -1}^{12} \rho_k M_{st}^k + \alpha_s \cdot t + X_s^0 \cdot \alpha_t + X'_{ist}\beta + \epsilon_{ist} \tag{2}$$

where all of the items are as above, except the singular treatment indicator M_{st} is replaced with a sequence of event-study year indicators M_{st}^k. We let k index the years before and after treatment, with the year before treatment being left out as the comparison year. Then $\hat{\rho}_k$ give the dynamic effects on performance k years before/after the reform. Parallel trends are consistent with $\hat{\rho}_k = 0$ for $k < -1$. For $k >= 0$, $\hat{\rho}_k$ will elucidate the dynamics of the difference-in-differences effect measured by $\hat{\rho}$ from Equation (1).

[16] See (Posner, 1995, ch.8) and Goldstein (2011) for discussions of the issue with respect to federal judges.

[17] See `http://ncsc.contentdm.oclc.org/cdm/ref/collection/judicial/id/440` for an update on the state situation.

Table 3: Effect of Mandatory Retirement Reform, First Stage

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Age (Mean)		Age (Min)	Age (Q25)	Age (Median)	Age (Q75)	Age (Max)
Ret. Reform	-2.065*	-3.924**	-3.444**	-3.804**	-4.386**	-3.956**	-3.381*
	(0.886)	(0.796)	(1.239)	(1.287)	(0.833)	(1.098)	(1.312)
Year FE, Court FE	X	X	X	X	X	X	X
Windows/Trends		X	X	X	X	X	X
N	14775	14775	14775	14775	14775	14775	14775
R-sq	0.494	0.648	0.598	0.569	0.614	0.616	0.638

Notes. DD effect of mandatory retirement reform on judge age statistics in ten years after reform, relative to ten years before reform. Observation is a judge working in a year. "Ret. Reform" is a treatment indicator for the ten years after the introduction of mandatory retirement. Dependent variables are computed at the court-year level. In particular, "Age (Mean)" is the average age of judges in each court and year, "Age (Min)" the minimum age, "Age (Q25)" the age at the 25th percentile, "Age (Median)" the median age, "Age (Q75)" the age at the 75th percentile and "Age (Max)" the maximum age. Court Treat Windows means court-specific treatment windows (ten years before and after reform). Standard errors clustered by state in parentheses. + p<.0.1, * p<0.05, ** p<0.01.

3.2 Effect on Judge Age Distribution

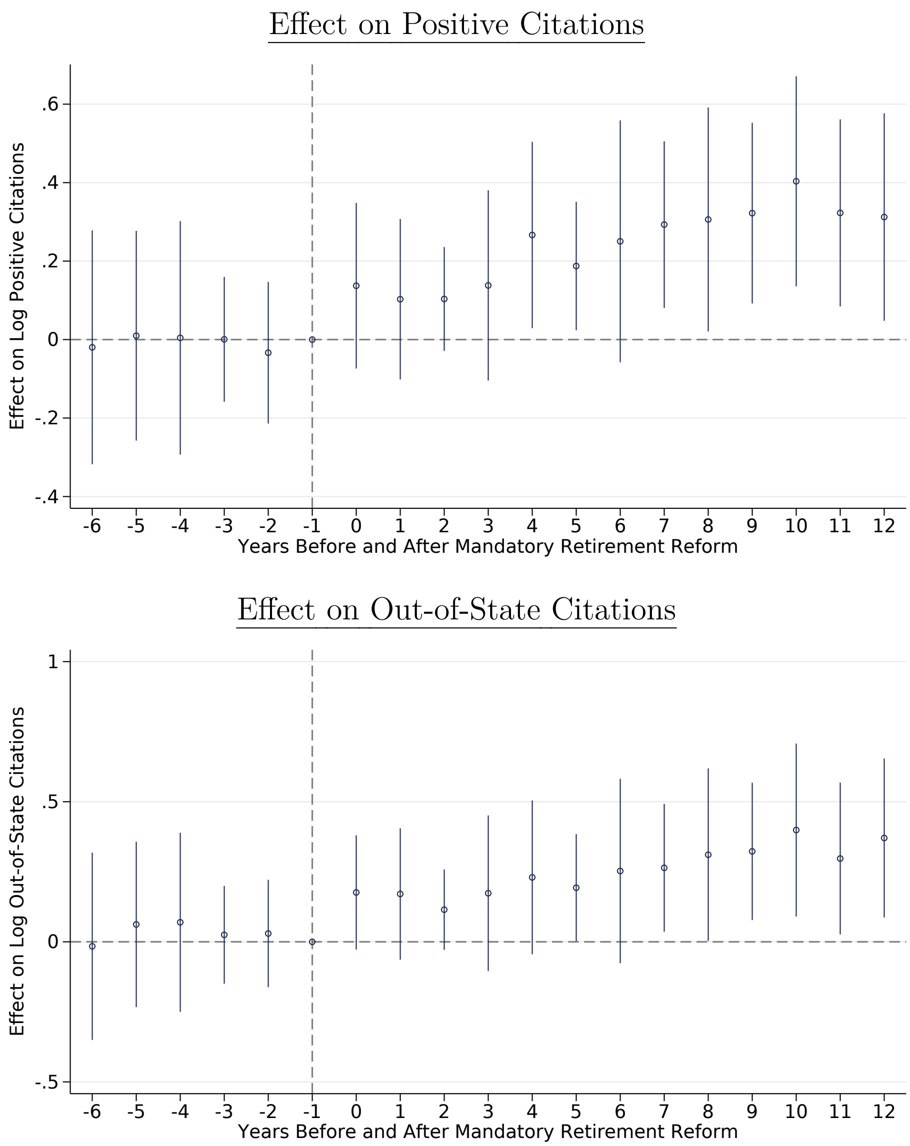
An initial question is whether mandatory retirement reforms have an effect on the age distribution in the courts. To add to the descriptive statistics presented earlier, we report the causal treatment effect using the reforms. This can be seen as a "first stage" to see if the "instrument" (mandatory retirement) is affecting the relevant "treatment variable" (judge age).

Regression estimates for Equation (1) with age statistics as the outcome are reported in Table 3. Relative to the ten years before the reform, judges after the reform are on average between 2 and 4 years younger. Columns 3 through 7 show that this effect is present across the age distribution. Both the youngest and oldest ends of the distribution are shifting down. This is consistent with the replacement of the oldest judges with overall younger judges. Presumably, this result is what the reforms were meant to achieve.

3.3 Effect on Judge Performance

Figure 5 shows event-study estimates (Equation 2) with log citations per judge as the outcome. We use six years before the reform, up until twelve years after, as the event window. In the top panel, the outcome includes all positive citations. In the bottom

Figure 5: Event-Study Effect of Retirement Reform on Judge Performance



Notes. Judge performance before and after reforms implementing retirement ages of 70, 72 or 75. Top panel outcome is log positive citations for a judge in a year; bottom panel is only citations from courts in other states. Time series is a coefficient plot from the event study regression (2), with coefficents estimated relative to the year before the reform. Regression includes court and year fixed effects and court-specific event windows. 95% confidence intervals constructed with standard errors clustered by state.

Table 4: Effect of Mandatory Retirement Reform on Log Citations

	(1)	(2)	(3)	(4)	(5)
	Effect on Log Positive Cites per Judge				
Retirement Reform	0.228**	0.253**	0.237**	0.322**	0.328**
	(0.0756)	(0.0836)	(0.0818)	(0.0899)	(0.0880)
Court FE, Year FE	X	X	X	X	X
Court Trends/Windows		X	X	X	X
Init Court Rules × Year FE			X	X	X
Init Case Types × Year FE				X	X
Init Age × Year FE					X
N	15010	15010	15010	15010	15010
R-sq	0.460	0.526	0.538	0.555	0.565

Notes. DD effect of mandatory retirement reform on log positive citations to a judge's opinions in ten years after reform, relative to ten years before reform. Observation is a judge working in a year. "Ret. Reform" is a treatment indicator for the ten years after the introduction of mandatory retirement. Court Treat Windows means court-specific treatment windows (ten years before and after reform). "Init X" × year FE means initial values are interacted with year. "Init Court Rules" includes a state's 1947 rules for judge selection/retention system, admin office, intermediate appellate court, number of judges, and term length. "Init Case Types" includes a court's 1947 average values for case characteristics (legal area and related industries). "Init Age" includes the initial mean and standard deviation for judge age on the court. Standard errors clustered by state in parentheses. + $p<.0.1$, * $p<0.05$, ** $p<0.01$.

panel, the citation count is limited to citations from other states. Out-of-state citations may better reflect quality because they proxy for the persuasive influence of an opinion as rulings are not binding in other states (Choi et al., 2010). For both outcomes, we can see a clear break and increase after treatment. The effect increases over a number of years, peaking at about a 40 percent increase (relative to counterfactual) ten years after the reform. Meanwhile, the precise zeros before the reform support our identification assumption of parallel trends.

The results for the differences-in-differences regressions for Equation (1) are reported in Table 4. Across a range of specifications, there is a positive and significant effect of introducing a mandatory retirement age on a court's influence, as measured by citations. The result is consistently significant when adding controls for initial court rules, case types, and the age distribution, interacted with year. Appendix Figure A.5 shows the event study when adding these interacted covariates.

We undertook an array of checks to assess the robustness of the effect of the retirement reform on judge work quality. First, Table 5 shows that the effect holds for a number of alternative quality measures besides positive citations. The result is robust

Table 5: Effect of Mandatory Retirement Reform, Other Quality Measures

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Cites in Levels		Within 10 years		All Cites		Discuss Cites		Out-of-State Cites	
Ret. Reform	57.51*	60.50*	0.333**	0.338**	0.224**	0.249**	0.183**	0.175*	0.154	0.208*
	(23.27)	(25.41)	(0.0921)	(0.102)	(0.0715)	(0.0806)	(0.0569)	(0.0654)	(0.0920)	(0.0846)
Year / Court FE	X	X	X	X	X	X	X	X	X	X
Trends/Windows		X		X		X		X		X
N	15010	15010	15010	15010	15010	15010	15010	15010	15010	15010
R-sq	0.351	0.415	0.537	0.613	0.470	0.530	0.463	0.523	0.471	0.520

Notes. Observation is a judge working in a year. “Retirement Reform” is an indicator for the ten years after the introduction of mandatory retirement. “Cites in Levels” means the outcome is not logged. “Within 10 years” is the log positive cites within ten years of an opinion. “All Cites” is the log number of all citations (positive, negative, and distinguishing) to a judge in a year. “Discuss Cites” is only the positive cites where the latter judge discussed the cited opinion. “Out-of-State Cites” is the count of number of positive citations from courts in other states. “Positive Cites” is the number of positive cites (in levels). Court Treat Windows means court-specific treatment windows (ten years before and after reform). Standard errors clustered by state in parentheses. + p<.0.1, * p<0.05, ** p<0.01.

to using levels rather than logs (Columns 1 and 2; see also Appendix Figure A.6) or limiting only to citations within ten years of an opinion (Columns 3 and 4; Appendix Figure A.7). We report effects on a more inclusive measure of quality (all cites, not just positive) in Columns 5 and 6 (and Appendix Figure A.8). We use a more restrictive measure (discussion cites, where the previous case was specifically discussed and applied) in Columns 7 and 8 (Appendix Figure A.9). Finally, we report DD estimates for out-of-state citations (Columns 9 and 10). We see positive effects for all of these alternative measures.

The appendix reports robustness checks along a number of additional margins. Appendix Figure A.10 shows robustness to only using treated states in the sample, while Appendix Figure A.11 shows a stronger effect when limiting the sample only to the event study window. Appendix Figure A.12 adds more pre-periods and shows there is no sign of a pre-trend even ten years before the reform. Appendix Figure A.4 shows robustness to dropping each treated state individually. Appendix Table A.13 shows that a qualitatively similar effect on judge performance is observed when each of the specified maximum judge ages (70, 72, or 75) are analyzed separately.

Next, in Appendix Table A.11 we add additional time-varying controls to X_{ist} , which are probably “bad controls” or “colliders” in the sense that they could be affected by the retirement reforms. We include controls for the case characteristics, time-varying

Table 6: Disentangling the Reform Effect on Quantity and Quality

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	# of Opinions			Cites per Case			Out-State Cites / Case		
Retirement Reform	0.169**	0.142**	0.188**	0.0368	0.0751	0.102+	0.154	0.208*	0.296**
	(0.0415)	(0.0467)	(0.0553)	(0.0456)	(0.0497)	(0.0511)	(0.0920)	(0.0846)	(0.0884)
Year FE, Court FE	X	X	X	X	X	X	X	X	X
Court Trends/Windows		X	X		X	X		X	X
Init Covars × Year FE			X			X			X
N	15010	15010	15010	15010	15010	15010	15010	15010	15010
R-sq	0.326	0.510	0.557	0.649	0.710	0.735	0.471	0.520	0.557

Observation is a judge working in a year. "Retirement Reform" is an indicator for the ten years after the introduction of mandatory retirement. "# of Opinions" is the number of majority opinions written by a judge in a year. "Cites per Case" is number of citations per published opinion. "Out-of-State Cites / Case" is number of out-of-state citations per published opinion. Court Treat Windows means court-specific treatment windows (ten years before and after reform). Init Covars × Year FE includes initial rule, case type, and age statistics of a court interacted with year. Standard errors clustered by state in parentheses. + p<.0.1, * p<0.05, ** p<0.01.

court rules (election system, number of judges, and government expenditures on the judiciary) from Ash and MacLeod (2020), and fixed effects for the number of years a judge has been on the court. Finally, we include the lagged dependent variable (Appendix Table A.12), which can perform better in panel data models with persistent shocks (Gentzkow et al., 2011; Caughey and Warshaw, 2018).

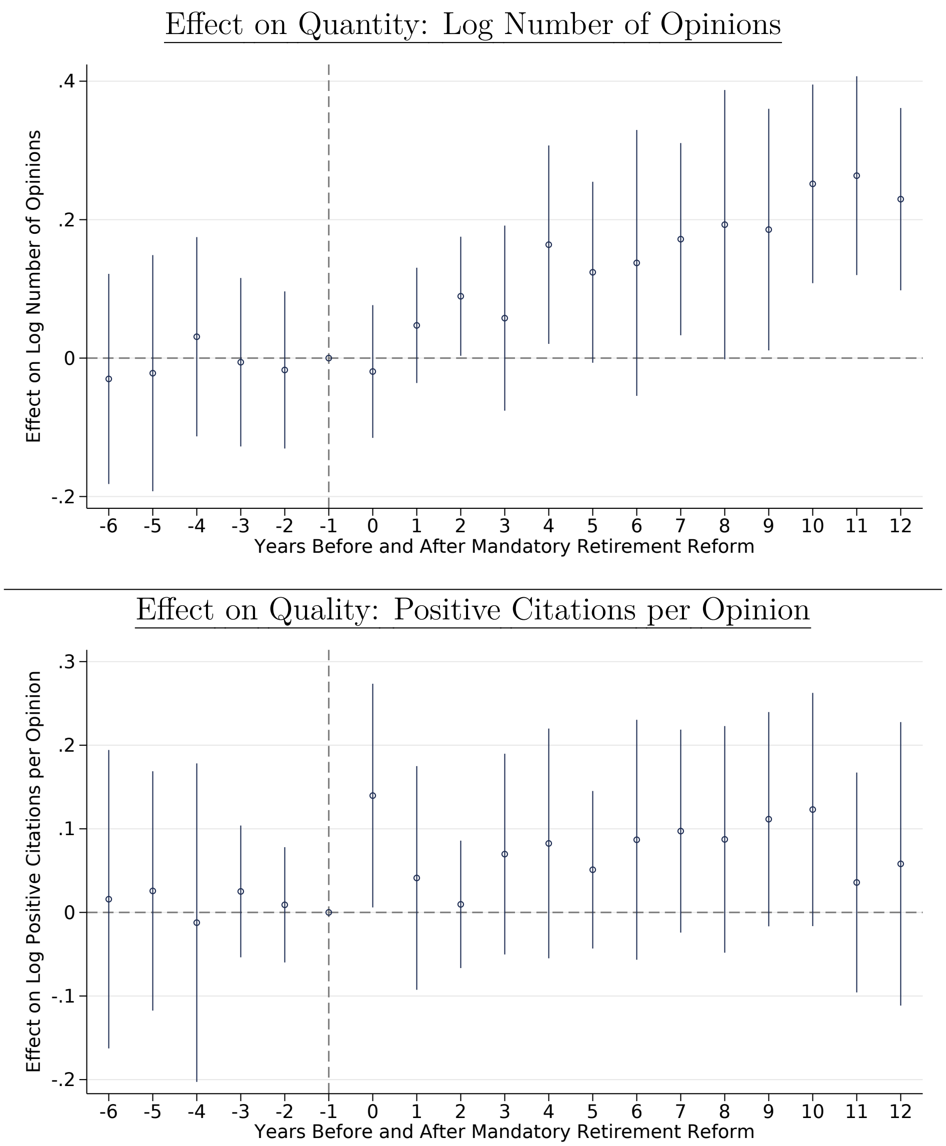
3.4 Is it Quality or Quantity?

As discussed, the main outcome, total citations to a judge or court per year, is a combined measure of quantity and quality. Posner (1995) suggests that older judges often maintain high quality levels by reducing quantity in terms of the number of opinions they write. Ash and MacLeod (2015) provide evidence that these are separate choices in a judge's work and that judges tend to care more about quality at the margin. A clearly important question, then, is whether the effect on total citations is driven by total number of opinions, or citations per opinion.

We provide some evidence in this direction by running our analysis with these separated quantity and quality measures. Figure 6 shows the event study estimates. We can see a clear positive effect of the reform on both outcomes.

Table 6 provides the differences-in-differences estimates. We see that there is an

Figure 6: Disentangling the Reform Effect on Quantity and Quality



Notes. Judge performance effects before and after reforms implementing retirement ages of 70, 72 or 75. Top panel outcome is log number of opinions by a judge in a year; bottom panel is average log positive citations per opinon. Time series is a coefficient plot from the event study regression (2), with coefficents estimated relative to the year before the reform. Regression includes court and year fixed effects and court-specific event windows. 95% confidence intervals constructed with standard errors clustered by state.

Table 7: Effect of Retirement Reform on Case Characteristics

	(1)	(2)	(3)	(4)
	Share Criminal Cases		Case Importance	
Retirement Reform	0.0400*	0.0301*	0.0570	0.0350
	(0.0157)	(0.0133)	(0.0376)	(0.0300)
Year FE, Court FE	X	X	X	X
Court Treat Windows		X		X
N	15010	15010	15010	15010
R-sq	0.596	0.649	0.394	0.472

Observation is a judge working in a year. "Retirement Reform" is an indicator for the ten years after the introduction of mandatory retirement. Court Treat Windows means court-specific treatment windows (ten years before and after reform). "Share Criinal Cases" is the share on criminal law. "Case Importance" is the predicted citations to a case based on case characteristics (legal area and related industries). Standard errors clustered by state in parentheses. + p<.0.1, * p<0.05, ** p<0.01.

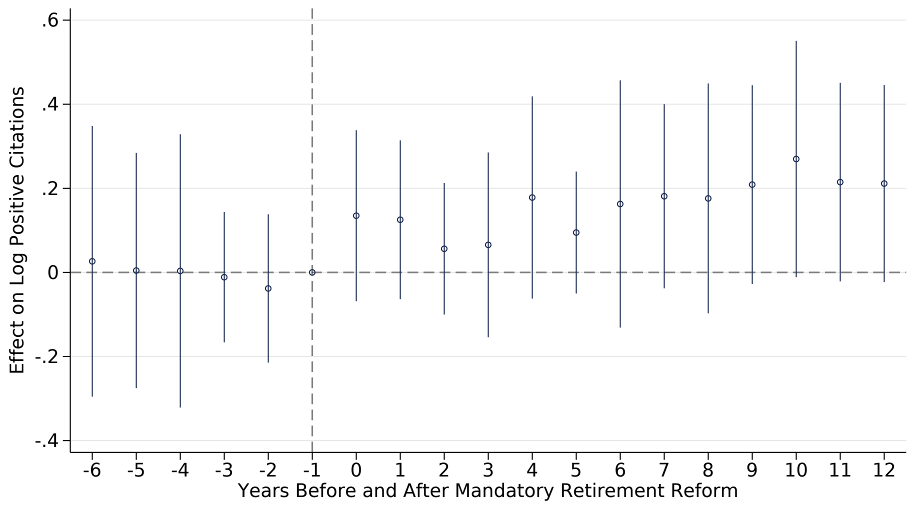
increase in the number of opinions (Columns 1-3), reflecting an increase in quantity. In addition, there is a positive effect on positive cites per opinion (Columns 4-6), even when limiting to out-of-state cites (Columns 7-9). Thus, the effect on total cites is a combination of both quantity and quality effects.

3.5 Further Unpacking the Effect

To further unpack the effect, we look at how the types of cases that the judges review changed after the reform. The estimates are reported in Table 7. First, in Columns 1 and 2 we see that the share of criminal cases increased after the reform, reflecting a change in the composition of the caseload that judges review. However, in Columns 3 and 4, we do not see a significant change in the importance of opinions, as predicted from the case characteristics (see Ash and MacLeod, 2020). Therefore it appears that the types of cases that the court accepts for appeal is not a major factor in the increase in court citations.

The next question is whether the effect is driven by selection or incentives. On the selection side, the performance gain comes from the replacement of older judges with new, younger, better-performing judges. On the incentive side, mandatory retirement might increase quality for sitting judges by changing their incentives or their work environment. Incentive effects could include the need to impress the chief justice so

Figure 7: Event-Study Effect of Reform on Performance, with Judge Fixed Effects



Judge performance before and after reforms implementing retirement ages of 70, 72 or 75. Outcome is log positive citations for a judge in a year. Time series is a coefficient plot from the event study regression (2), with coefficents estimated relative to the year before the reform. Regression includes court and year fixed effects and court-specific event windows, plus judge fixed effects. 95% confidence intervals constructed with standard errors clustered by state.

that one can stay on as a senior justice, or else to maintain skills for obtaining non-judicial employment outside the court. Work-environment changes could be due to spillovers from the replacement of older judges with younger judges, so judges that stay on have to do less to support the older judges. Our previous estimates have not disentangled the across-judge from the within-judge effects of retirement reforms.

To net out selection and look only at within-judge impacts, we add judge fixed effects to Equation 2. Figure 7 shows the corresponding event study estimates (see Appendix Table A.7 for the DD estimates). There is a positive and marginally significant effect, about half of the magnitude of the full effect measures from Figure 5. This result shows that our main effects are a combination of selection effects and incentive effects. The effect is driven partly by older judges being replaced, but also from a positive effect on the younger judges who are working before and after the reform.

To get at selection, we use the same approach as Ash and MacLeod (2020) and compare judges working on the same court at the same time, but selected before/after the reforms. These regressions use court-year fixed effects so hold time-varying factors constant. The results, reported in Appendix Table A.8, show that the reforms did not significantly affect the starting age of judges. However, the judges selected after the reforms tended to be high-quality, as measured by citations per opinion.

We look at additional outcomes in Appendix Table A.15. We report effects on work output (log number of words written), caselaw research, the rate of being overruled by the U.S. Supreme Court, and number of addendum opinions (log of the count of dissents and concurrences). There is no effect on any of these additional dimensions of judge behavior.

Appendix Table A.14 provides some estimates of the effects on related institutional factors. We find that the effect on judge experience (years on the court) also decreases (mechanically), but not quite as much as by judge age. We see no immediate causal effect (comparing the ten years before and after a reform) on how judgeships ended (whether by retirement, death in office, etc).

4 Aging and Judge Performance

Next we provide a descriptive analysis of how differences in ages are related to differences in performance. We show that work quality decreases with age. This helps explain our previous result, that reducing judge age through mandatory retirement increases the performance of the court.

4.1 Empirical Approach

For examining the effects of aging on judicial performance, again we use a panel data model with fixed effects. Formally, we assume a quadratic age model of performance variable y_{ist} for judge i working in court s at year t:

$$y_{ist} = \alpha_{st} + \alpha_i^0 + \gamma_1 A_{ist} + \gamma_2 A_{ist}^2 + X_{ist}'\beta + \epsilon_{ist} \tag{3}$$

where A_{ist} is the age (in years) for judge i in court s at t. The main source of bias comes from the time-varying changes in the court work environment which are systematically correlated with age. Thus, we include a full set of court-year fixed effects. Therefore any estimated coefficients are also relative to the court average in each year. The regressions effectively compare judges sitting on the same court, working at the same time, but who are of different ages. Again, standard errors are clustered by state.

The other key element in the regression is α_i^0, which gives the judge-level outcome for their first year on the court. This provides a judge-specific baseline value such that our estimates for the effect of age, $\hat{\gamma}_1$, are relative to the individual's baseline.

X_{ist} includes a number of additional items which we add in follow-up specifications. First, we have cohort fixed effects – indicators for each decade that the judge started on the court. This covariate is meant to rule out mechanical variation due to cohort differences across the time period. In the same vein, we have court-specific linear trends in judge starting cohort: formally, judge starting-year interacted with court fixed effect. This allows for judges in different states to have a different confounding trend in starting year and performance.

In the baseline specification, we specify y_{ist} in logs (as above) and the age variable is in levels. This means that the coefficients can be interpreted as the proportional change in performance due to a one-year increase in judge age. In follow-up results, we report results with y_{ist} in levels and in rank percentiles by court-year. That is, the judge with the highest measure in a year is given a 1, the lowest a zero, and all other judges uniformly distributed on that interval according to rank. In this specification, the level differences do not matter, and the measure is more robust to outliers (Chetty et al., 2014; Ash and MacLeod, 2020). The interpretation of coefficients is similar to median (quantile) regression.

In addition to the quadratic model regressions, we plot out the dynamic changes in performance over the lifespan by estimating

$$y_{ist} = \alpha_{st} + \alpha_i^0 + \sum_{g \in G} \gamma_g A_{ist}^g + X_{ist}'\beta + \epsilon_{ist} \tag{4}$$

where now instead of a quadratic specification for age, we have a vector of indicator variables A_{ist}^g, $g \in G$, equaling one when judge i is in age group g. The age groups, chosen for convenience, are 0-44, 45-49, 50-54, 55-59, 60-64, 65-60, 61-64, 65-69, 70-74, and 75+. Appendix Figure A.13 shows the distribution in our data for these age groups. The qualitative results of the dynamic age analysis are not sensitive to how these groups are defined.

In addition, for the dynamic analysis we drop the first and last years of each judge career. This is because in the first and last years, judges will have a partial caseload by construction. In the quadratic age model, this sample adjustment does not make a big difference in estimates. But it can shift estimates around a lot for younger and older judges when estimating the age group effects.

It is important to note why we do not report a specification with judge fixed effects. Age (in years) is perfectly linear within judge. Therefore, γ is not identified when including both judge fixed effects and year (or court-year) fixed effects. There is no straight-forward estimation approach that would allow judge fixed effects and also account for the large global variation in citations over time across all courts. Further, with judge fixed effects the age and experience effect cannot be distinguished.

Since judge fixed effects are not an option, a potential issue with the previous specifications is that they are applied to an unbalanced sample of judges. Judges start and end at different ages, so the estimated effects could be driven by selection of different types of judges into different starting and ending ages. To address this issue, we produce a set of regressions using balanced samples of judges. First, we take overlapping ten-year age groups across the lifespan (45-54, 50-59, 55-64, 60-69, 65-74) and limit to judges that worked continuously in that age group. The distribution over these groups is shown in Appendix Figure A.14. Next, we produce estimates from Equation 3 restricting to those balanced samples. This is similar econometrically to using judge fixed effects as we are keeping the set of judges constant. On the other hand, the judges come from many different courts and years, and there could be confounding variation in citations across courts over time. Therefore for the balanced-sample analysis, the preferred outcome is the rank percentile in citations. The rank percentile provides a performance measure that is comparable across courts and over time.

4.2 Main Results on Judge Age and Judge Performance

Now we report the main results for variation of judge performance by age. The regression estimates from Equation (3) are reported in Table 8. There is a highly significant negative relationship between age and judge performance as measured by positive citations to a judge's opinions in a year. The estimate doesn't change that much when adding the judge's first-year as a baseline to the regression (Column 2), or when adding cohort fixed effects and state-specific cohort trends (Column 3). As seen in Column 5, the effect also holds using a rank percentile specification in work performance.

Columns 4 and 6 assume a quadratic model for age. Both of these columns show that the negative linear estimates from the other columns conceal a concave relationship, where the linear term is actually positive. The quadratic term is negative and significant, indicating that the negative relationship between age and performance accelerates at later ages. Taking the quadratic model at face value, the coefficient estimates indicate that judge performance is maximized around age 40. Thus despite

Table 8: Judge Age and Judge Performance

	(1)	(2)	(3)	(4)	(5)	(6)
		Log Positive Cites			Rank Percentile Cites	
Judge Age (Years)	-0.00797**	-0.00790**	-0.00702**	0.0351*	-0.00428**	0.0185+
	(0.00140)	(0.00114)	(0.00127)	(0.0133)	(0.000833)	(0.00939)
Age Squared				-0.000356**		-0.000192*
				(0.000118)		(0.0000824)
Court-Year FE	X	X	X	X	X	X
First-Year Baseline		X	X	X	X	X
Cohort FE / Trends			X	X	X	X
N	13655	13655	13655	13655	13646	13646
R-sq	0.674	0.694	0.701	0.702	0.112	0.115

Observation is a judge working in a year. "Log Positive Cites" is log of positive cites to a judge in a year. "Rank Percentile Cites" means judges are uniformly distributed between zero and one based on number of positive citations within court-year (0 is lowest, 1 is highest). Court-Year FE is interacted court-year fixed effects. First-Year Baseline means a judge's value for the outcome in their first year on the court is included as a control. Cohort FE means fixed effect for decade that the judge started on the court. Cohort Trends means judge starting-year interacted with court fixed effect. Standard errors clustered by state in parentheses. + p<.0.1, * p<0.05, ** p<0.01.

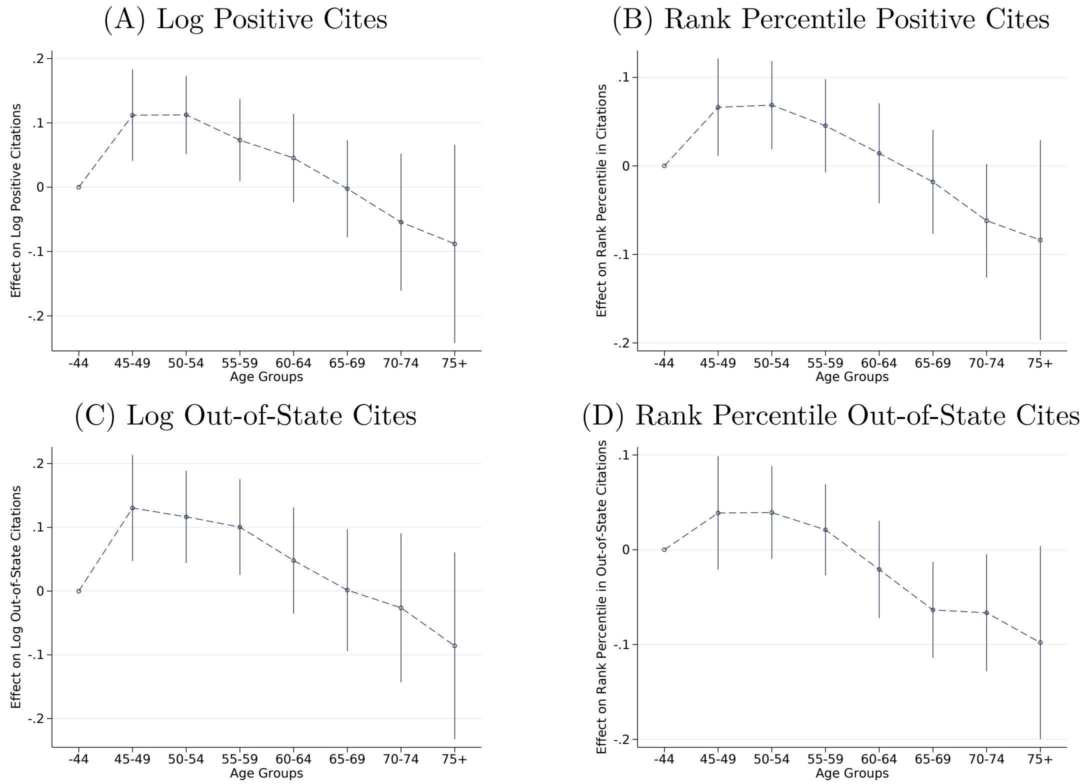
the positive linear-term coefficient, these estimates suggest a consistently negative relationship in our dataset, as state supreme court judges rarely start before the age of 40.

To show further the dynamics of the effect, Figure 8 reports the age-group estimates from Equation (4). These regressions are consistent with the quadratic model, showing an initial increase in performance and then a steady decrease. This trend holds for both positive citations and out-of-state citations, and for the log outcome as well as the within-court-year percentile rank.

As seen in Table 9, this effect holds for alternative quality measures: cites within ten years of an opinion, all cites (not just positive), discussion cites, and out-of-state cites. For each of these variables, moreover, the relationship is concave in the quadratic specification. Appendix Table A.16 reports qualitatively equivalent results using the rank percentiles in outcomes (rather than logs). Appendix Figure A.15 shows the dynamic estimates for these additional performance measures.

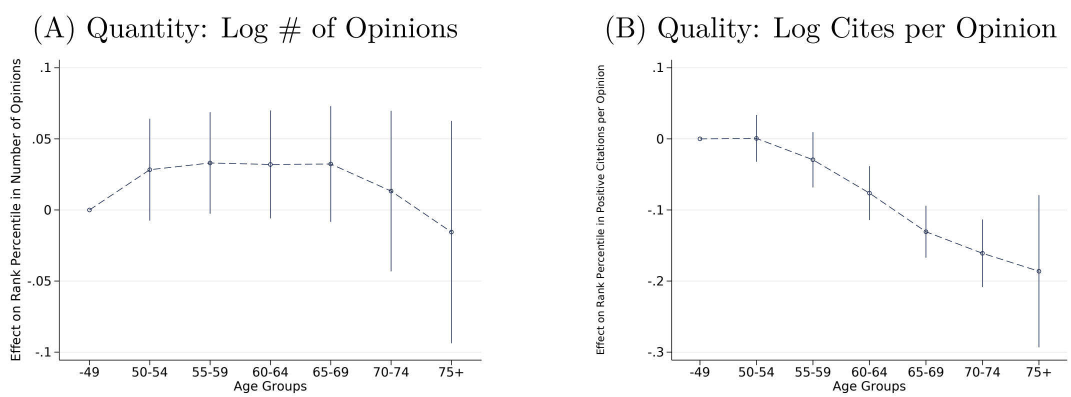
Figure 9 breaks out the age effect by quantity (Panel A) and quality (Panel B). Complementary regression estimates are reported in Appendix Tables A.17 and A.18.

Figure 8: Dynamic Analysis of Judge Age and Judge Performance



Dynamic coefficient plots for estimates of five-year age group differences, relative to the age < 45 group. Observation is a judge working in a year. All graphs contain court-year interacted fixed effects, first year baselines, and cohort fixed effects. Outcomes are in logs or rank percentiles, as indicated. 95% confidence intervals constructed using standard errors clustered by state.

Figure 9: Dynamic Analysis: Quantity vs. Quality



Dynamic coefficient plots for estimates of five-year age group differences, relative to the age < 45 group. Observation is a judge working in a year. All graphs contain court-year interacted fixed effects, first year baselines, and cohort fixed effects. 95% confidence intervals constructed using standard errors clustered by state.

Table 9: Judge Age and Additional Measures of Performance

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Cites in 10 Years		All Cites		Discuss Cites		Out-of-State Cites	
Judge Age	-0.00693**	0.0375**	-0.00739**	0.0348*	-0.00836**	0.0373**	-0.00885**	0.0323*
	(0.00135)	(0.0127)	(0.00129)	(0.0138)	(0.00116)	(0.0119)	(0.00143)	(0.0139)
Age Squared		-0.000375**		-0.000356**		-0.000386**		-0.000348**
		(0.000112)		(0.000122)		(0.000105)		(0.000123)
Court-Year FE	X	X	X	X	X	X	X	X
1st-Year Base	X	X	X	X	X	X	X	X
Cohort FE/Trend	X	X	X	X	X	X	X	X
N	13655	13655	13655	13655	13655	13655	13655	13655
R-sq	0.768	0.769	0.697	0.698	0.698	0.690	0.691	0.674

Observation is a judge working in a year. Outcomes are in logs. “Cites in 10 years” is log of positive cites to a judge in a year, within ten years of a case. “All Cites” includes negative and distinguishing (not just positive) cites. “Discuss cites” means the case was positively discussed and applied. “Out-of-state cites” means citations from courts in other states. Court-Year FE is interacted court-year fixed effects. 1st-Year Base means a judge’s value for the outcome in their first year on the court is included as a control. Cohort FE means fixed effect for decade that the judge started on the court. Cohort Trends means judge starting-year interacted with court fixed effect. Standard errors clustered by state in parentheses. + p<.0.1, * p<0.05, ** p<0.01.

As can be seen in the figure, there is not much of an age trend for the caseload, but a large and significant negative effect on citations per opinion. This result suggests that the aging effect on performance is driven by changes in work quality, rather than by changes in work quantity. This is somewhat different from the retirement reforms results, where the effect of mandatory retirement was driven both by quantity and by quality.

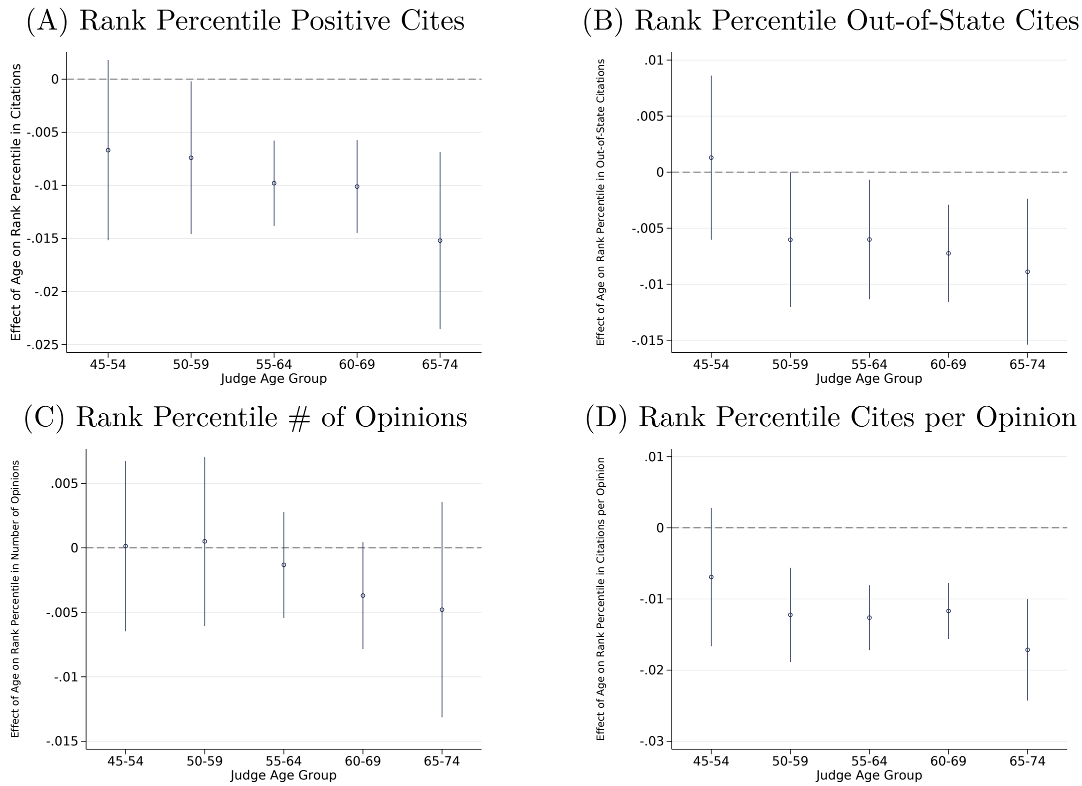
To help interpret our results, we look for evidence for whether older judges are assigned different types of cases to work on. The analysis is reported in Appendix Table A.19 and Appendix Figure A.16. Case categories and case importance are not significantly related to judge age. Overall, these statistics suggest that observed differences in work quality across the lifespan are not mainly driven by changes in the types of cases that older judges rule on.

The effect of age on performance is robust to a variety of alternative specifications. Appendix Figure A.17 shows that the results look very similar without any fixed effects (Panel A), or instead adding experience fixed effects (Panel B). We include results separately by mandatory and voluntary retirement (Appendix Table A.20). We also separate our results before/after 1970, when legal research databases such as WestLaw were introduced (Appendix Figure A.18). The main results on quality hold across subsamples. The results are robust to alternative weighting (Appendix Figure A.19) and alternative clustering of standard errors (Appendix Figure A.20).

We analyze a number of alternative outcomes (see Appendix Table A.21). Judges tend to do about the same amount of total work, as indicated by total words written. Judges tend to affirm (rather than reverse) cases at about the same rate as they age, but do less caselaw research. Older judges tend to dissent less often and are overruled more often by the U.S. Supreme Court.

For completeness, Appendix Table A.22 reports a two-stage least-squares (2SLS) specification where we instrument for judge age using the mandatory retirement treatment indicators. This specification relies on unrealistic exogeneity assumptions, as the reforms affect performance through other channels besides age. That said, we get a strong first stage and estimate a significantly negative 2SLS effect of age on performance. The 2SLS coefficient is about ten times as large as the OLS coefficient, probably reflecting violation of the exclusion restriction.

Figure 10: Effect of Age on Performance in Balanced Judge Samples



Performance-Age estimates for separate balanced samples of judges based on age group. Observation is a judge working in a year. Outcomes are in rank percentiles, regressed on age (in years) for the specified group. 95% confidence intervals constructed using standard errors clustered by state.

4.3 Analysis of Balanced Judge Samples

As discussed in Section 4.1 above, an issue with the previous results is that they are made on unbalanced samples of judges. Judges are entering and leaving the sample at different ages. It could very well be that the negative effect of aging on performance is driven by this attrition bias. To address this issue, we construct balanced samples of judges by age group across the lifespan.

The regression results using balanced samples are visualized by the coefficient plots in Figure 10. Each of these coefficient plots reports the estimate for $\hat{\gamma}$ (with 95% confidence interval) from Equation 3 (the linear model, without the quadratic age term) using a sample of judges that work continuously for the ten years of the age group indicated in the horizontal axis. The plots go from left to right starting from 45-54, to 50-59, and so on, up until 65-74. Because the judges are working continuously, the estimates give within-judge changes over time and are not biased by selective entry or exit. Because the outcomes are within-court-year rank percentiles, no fixed effects are needed and the performance measures are comparable across courts and years.

We can see in Panel A that there is a negative effect of age on performance across the samples. The effect in the earliest cohort is not significant. As we move to later samples, the effect becomes more negative and more statistically significant. This is consistent with an increasingly negative effect of age on performance later in the lifespan. In Panel B, we see a similar trend for out-of-state cites.

In Panel C and Panel D, we look at quantity (number of opinions) and quality (citations per opinion) respectively, in the balanced samples of judges. We see no significant effect on the workload (number of opinions) for any of the samples. Meanwhile, there is a large negative effect for citations per opinion starting in the 50-59 sample. These results provide additional support for the view that the age-performance effect is driven by work quality (rather than quantity).

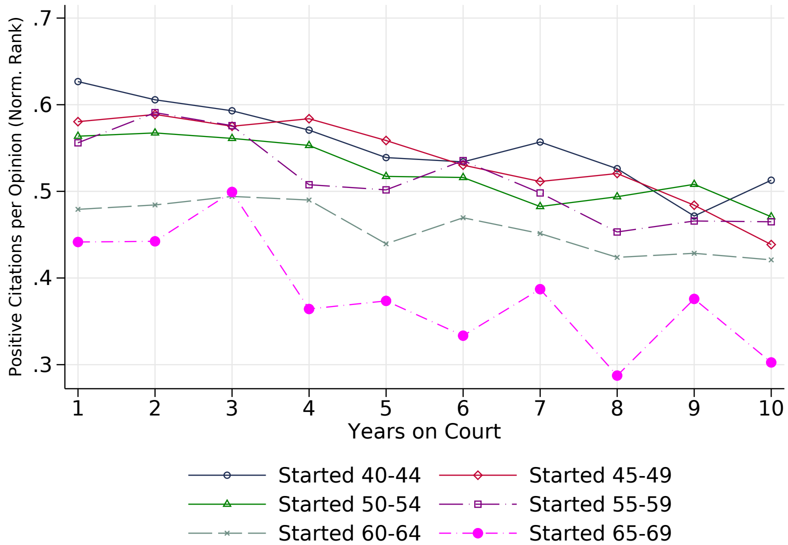
Qualitatively similar results using log outcomes are reported in Appendix Figure A.21. We also report some robustness checks on the main specification. The results are robust to alternative weighting and alternative clustering of standard errors (Appendix Figure A.22). Appendix Figure A.23 shows that there is a negative age-performance trend both before and after 1970, but there appears to be an earlier onset of a negative trend pre-1970, perhaps reflecting better judge health in the later period .

4.4 Age, performance, and years (left) on the court

This section provides some additional supporting analysis relating age, performance, and the timing of entry and exit to the court. First, a lingering question has been how much our age effect is driven by differences in experience as a state supreme court judge. To get at this issue, we look at how judge performance evolves over the first ten years on the court, but comparing judges by their starting age. We can see this variation in Figure 11. The judges in the different time series have the same amount of experience (years on the state supreme court), but they started at different ages. As before, we see a generally negative trend in quality over time. Moreover, we can see clearly that younger starting judges begin at a higher quality level than older starting judges. This difference is maintained over time. Therefore, increased age reduces work performance even holding experience constant.

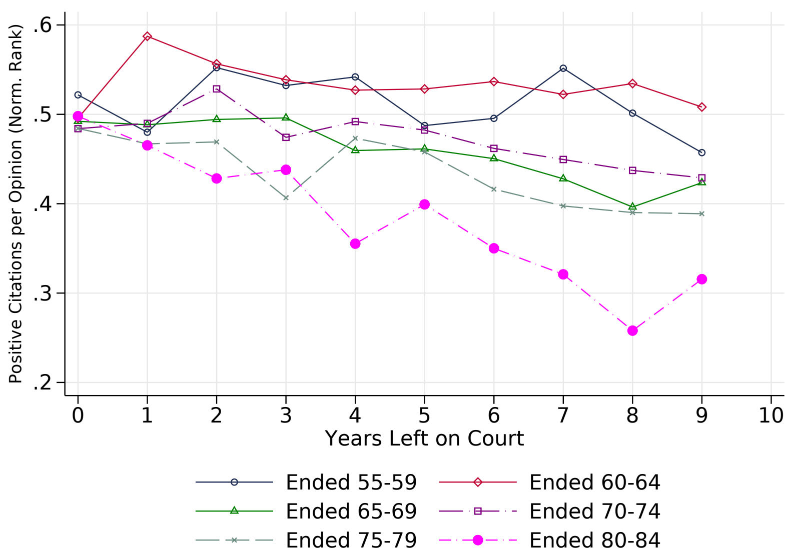
Figure 12 takes the inverse perspective and looks at the final nine years of the

Figure 11: Judge Performance in First Years of Career, by Starting Age



Notes. Time series for average rank percentile (within court year) in positive citations for the first ten years of a judge career, separately by starting age (indicated in legend).

Figure 12: Judge Performance in Last Years of Career, by Ending Age



Notes. Time series for average rank percentile (within court year) in positive citations for the last nine years of a judge career, separately by ending age (indicated in legend).

Table 10: Effects of Starting Age and Ending Age

	(1)	(2)	(3)	(4)	(5)
	Effect on Log Positive Cites				
Judge Start Age	-0.00700**	-0.000885			-0.00147
	(0.00155)	(0.00232)			(0.00222)
Judge End Age			-0.000612	0.0151**	0.0152**
			(0.00132)	(0.00177)	(0.00181)
Court-Year FE	X	X	X	X	X
Age FE		X		X	X
N	13655	13643	14618	13643	13643
adj. R-sq	0.672	0.678	0.668	0.682	0.682

Effect of judge start age and end age on judge performance. Observation is a judge working in a year. Standard errors clustered by state in parentheses. + p<.0.1, * p<0.05, ** p<0.01.

judge career. Instead of grouping by starting age, we group by ending age. These time series groups have the same number of years left in the career at any given point. Again, we see a negative trend, and again, we see that judge age is distinctive in its effect on performance. The judges that retire later are also relatively less impactful in their decisions in the latter years of their career. Holding the timing of the exit choice constant, increased age reduces work performance.

Table 10 further examines how age and performance relate to career transition choices. We hold judge age constant (by adding age fixed effects) and regress judge performance (positive cites) on starting age (Columns 1-2) or ending age (Columns 3-4). We can see in Column 2 that holding age fixed, the start age has no effect. This result again supports the view that there is no important experience effect relative to the aging effect.

In Column 4, we look at how performance is related to the ending age, holding current age constant. We see a significant positive effect. At a given age, judges who will end up working longer have relatively high performance in their job. This means that there is positive selection in terms of judges staying on the court. Lower-performing judges tend to leave the court at younger ages.

5 Conclusion

The goal of this paper has been to measure the effects of aging on judicial behavior. Given that judges have low-powered incentives that do not explicitly link pay to performance, these factors likely have a significant impact on judge behavior. We find that mandatory retirement rules increase the performance of courts as a whole. We can explain this effect in that physical aging is associated with a reduction in work quality over the lifespan.

We found a different age-performance profile than the previous work on federal circuit judges (Posner, 1995) and Australia High Court judges (Smyth and Bhattacharya, 2003). There could be many reasons for this difference, starting with our much larger sample of judges. The U.S. federal courts (and the Australia High Court) are consistently professionalized and selective, while state supreme courts have much more variance in the types of individuals who become judges.

These results will be useful to policymakers seeking to design better retirement policies for judges and other high-skill jobs. When productivity decreases with age, mandatory retirement can increase productivity on average. In particular, the results are useful in an era where an aging workforce is resulting in large structural changes to the economy (Acemoglu and Restrepo, 2017).

In the case of federal judges, our results are especially relevant given that imposing mandatory retirement is unconstitutional (Posner, 1995).[18] While the use of senior status and other incentives can put pressure on older judges (Choi et al., 2013), it is still the case that many federal judges stay on the bench past their prime (e.g. Goldstein, 2011). Our evidence provides more support for proposed reforms (including a constitutional amendment) to mandate retirement for the oldest federal judges.

This research highlights the usefulness of direct measures of employee performance. A major challenge is that it is difficult to evaluate employees over long periods of time. In particular, in the last century there have been transformative changes in the nature of work. Computers are much more important, and jobs are more complex and include "soft" factors such as the ability to manage employees (e.g. Autor et al., 2008). A second challenge is that even if one could measure these factors, using them in hiring and promotion decisions could have unexpected agency effects.

A final open question is the role of health in expert decision-making. While judges are working longer and getting more citations, it is still an open question how much this

[18] Federal judges "shall hold their offices during good behavior" (U.S. Const. Art. III Sec. 1).

is due to differences in health. Future work can explore whether changes in quality over the lifespan are due to cognitive effects of aging, changes in reputational incentives, or some other aging mechanism.

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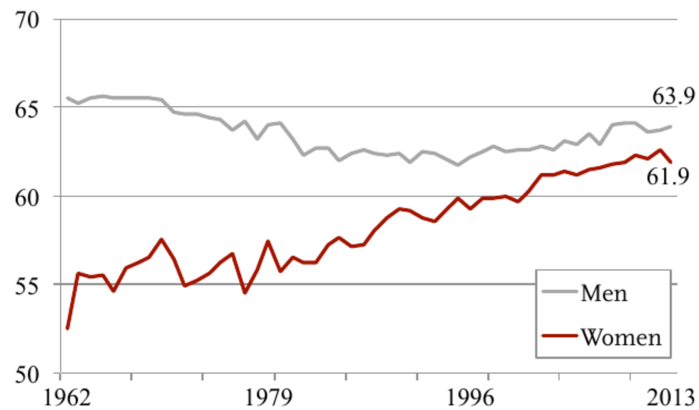
Figure A.1: Average Retirement Age for U.S. Workers and Judges,

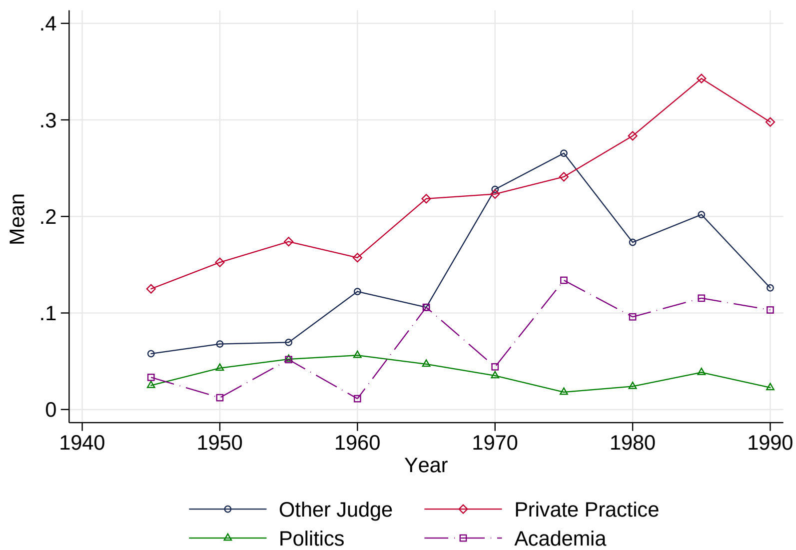
(A) Average Retirement Age for U.S. Workers, by Gender, 1962-2013



(B) Average Retirement Age for State Supreme Court Judges, 1948-1994

Panel (A): Average retirement age by gender for U.S. workers, computed from CPS by Munnell (2015). Panel (B): Average retirement age of state supreme court judges, by year. Error spikes give 25th and 75th percentiles.

Figure A.2: Post-Judgeship Careers



Proportion of judges with documented careers after their state supreme court judgeship, including other judgeship, private practice, politics, and academia. Plotted by five-year bins.

Appendix

A Background and Data

A.1 Aging and Retirement Decisions

What do judges do after retirement? Figure A.2 shows the trends in these career choices. At the beginning of the sample, few judges took on more work after their judgeship. That has become more common in recent years. If they do take another career, it is usually in private practice as an attorney.

A.2 Mandatory Retirement

Appendix Table A.1 provides tabulations on the relevant treatment variation in the data for mandatory retirement reforms. The first column of numbers gives the number of court-years where at least one treated (selected post-reform) and one control judge (selected pre-reform) is on the court that year. The second set of columns gives the number of judge-year observations in the control and treatment groups (and total). The

Table A.1: Tabulations on Treatment and Control Judges

Reform	Number of Courts with Treatment Variation	Number of Obs (Judge-Year)			Number of Judges		
		Controls	Treated	Total	Controls	Treated	Total
Retirement Age 70	9	11265	1390	12655	1240	172	1368
Retirement Age 72	3	12373	884	13257	1348	88	1421
Retirement Age 75	2	10584	259	12373	1191	34	1219

Notes. Summary tabulations on Retirement Reform Judges. The column gives the number of courts that experience a change in the retirement rule. The second set of columns gives the number of judge-year observations in the control and treatment groups (and total) when a change in retirement rule occurs in that year. The third list of columns gives the number of judges in these respective groups.

third list of columns gives the number of distinct judges in these respective groups.

A.3 Case Assignment

B Additional Analysis of Mandatory Retirement Reforms

C Additional Material on Aging and Performance

Figure A.3: Rules on Judge Senior Status, by State

State	Retirement age	Seniority	Note
Alabama	70	✓	*Supernumerary judge*
Alaska	70	✗	*Only to work on temporary assignments*
Arizona	70	✗	*Only to work on temporary assignments*
Arkansas	none	-	*No retirement benefits if seek re-election past age 70*
California	none	-	
Colorado	72	✗	
Connecticut	70	✓	*State referee*
Delaware	none	-	
Florida	75	✗	*Allows temporary assignments*
Georgia	none	-	
Hawaii	70	✗	
Idaho	none	-	
Illinois	none	-	*Retirement Act for age 75, declared unconstitutional in 2009*
Indiana	75	✗	
Iowa	72	✓	
Kansas	75	✗	
Kentucky	none	-	
Louisiana	70	✗	
Maine	none	-	
Maryland	70	✗	
Massachusetts	70	✗	
Michigan	70	✗	
Minnesota	70	✗	
Mississippi	none	-	
Missouri	70	✓	*Senior judge*
Montana	none	-	
Nebraska	none	-	
Nevada	none	-	
New Hampshire	70	✗	
New Jersey	70	✗	
New Mexico	none	-	
New York	70	✓	*May serve after 70 until 76*
North Carolina	72	✗	*Only to work on temporary assignments*
North Dakota	none	-	
Ohio	70	✗	
Oklahoma	none	-	
Oregon	75	✗	*Legislature may ask retired judges to work on temporary assignments*
Pennsylvania	75	✓	*Senior judge*
Rhode Island	none	-	
South Carolina	72	-	
South Dakota	70	✗	
Tennessee	none	-	
Texas	75	✗	*Conditions may vary based on Art.5 of Texas Consistution*
Utah	75	✗	
Vermont	90	✗	
Virginia	73	✗	
Washington	75	✗	
West Virginia	none	-	
Wisconsin	70	✓	*Can serve as a judge on a temporary basis*
Wyoming	70	✓	

Table A.2: Summary Statistics on Area of Law and Related Industries

Area of Law	Freq.	Percent	Related Industrial Sector	Freq.	Percent
Criminal Law	191810	21.85	Real Estate	28527	13.64
Civil Procedure	74757	8.52	Law Enforcement	10758	5.14
Evidence	66377	7.56	Automobiles	10206	4.88
Torts	57915	6.6	Insurance	9158	4.38
Damages & Remedies	45073	5.14	Tax	8509	4.07
Contracts	40888	4.66	Construction & Engineering	6332	3.03
Real Property	36408	4.15	Workers' Compensation	5397	2.58
Constitutional Law	34038	3.88	Banking	4917	2.35
Family Law	32191	3.67	Legal & Compliance Services	4682	2.24
Workers' Compensation	22955	2.62	Automobile Insurance	4124	1.97
Insurance Law	19375	2.21	Property Management	4108	1.96
Administrative Law	18264	2.08	Transportation	3890	1.86
Wills, Trusts & Estates	18179	2.07	Child Welfare	3689	1.76
Tax & Accounting	16978	1.93	Employment Services	3679	1.76
Employment Law	14601	1.66	Health & Medical	3478	1.66
Habeas Corpus	13426	1.53	Oil & Gas	3189	1.52
Appellate Procedure	13140	1.5	Railroads	2777	1.33
Professional Responsibility	12052	1.37	Hospitals	2719	1.3
Motor Vehicles & Traffic Law	9644	1.1	Education	2586	1.24
Land Use Planning & Zoning	9122	1.04	Trucking	2097	1
Government	8942	1.02	Bridges & Roads	1751	0.84
Mortgages & Liens	7531	0.86	Agriculture & Farming	1729	0.83
Landlord & Tenant	5499	0.63	Mortgage Lending	1680	0.8
Construction Law	4997	0.57	Manufacturing	1612	0.77
Elections & Politics	4972	0.57	Real Estate Agents & Brokers	1573	0.75
Eminent Domain	4943	0.56	Unions	1485	0.71
Labor Law	4790	0.55	Financial Services	1469	0.7
Government Employees	4773	0.54	Judiciary	1448	0.69
Debtor Creditor	4260	0.49	Politics	1336	0.64
Employee Benefits	4208	0.48	Teachers	1300	0.62
Medical Malpractice	4113	0.47	Medical Procedures	1273	0.61
Personal Property	3994	0.46	Public Works	1223	0.58
Corporate Law	3958	0.45	Life Insurance & Annuities	1155	0.55
Negotiable Instruments	3843	0.44	Apartment Leasing	1127	0.54
Education Law	3803	0.43	Mining & Natural Resources	1115	0.53
Banking & Finance	3380	0.39	Drug Trafficking	1105	0.53
Alcohol & Beverage	3213	0.37	Sewer & Water	990	0.47
Civil Rights	3138	0.36	Electric	985	0.47
Health Law	2950	0.34	Water & Sewer	972	0.46
Transportation Law	2839	0.32	Physicians	966	0.46
Partnerships	2333	0.27	Firearms & Weapons	962	0.46
Natural Resources	2301	0.26	Motorcycles	919	0.44
Legal Malpractice	2285	0.26	Water	904	0.43
Products Liability	2280	0.26	Food & Beverage	888	0.42
Alternative Dispute Resolution	2144	0.24	Commercial Real Estate	883	0.42
Communications & Media	2048	0.23	Property & Casualty Insurance	854	0.41
Environmental Law	1857	0.21	Administration	837	0.4

Table A.3: Case Assignment Rules on State Supreme Courts

Discretionary	Random	Rotating
Arizona	Idaho	Alaska
California	Louisiana	Alabama
Colorado	Mississippi	Arkansas
Connecticut	New Hampshire	Florida
Delaware	New York	Georgia
Hawaii	Ohio	Iowa
Indiana	South Dakota	Illinois
Kansas	Tennessee	Maine
Kentucky	Texas	Minnesota
Massachusetts	Virginia	Missouri
Maryland	Washington	Montana
New Jersey	Wisconsin	North Carolina
Oregon		North Dakota
Pennsylvania		Nebraska
Wyoming		New Mexico
		Nevada
		Oklahoma
		Rhode Island
		South Carolina
		Utah
		Vermont
		West Virginia

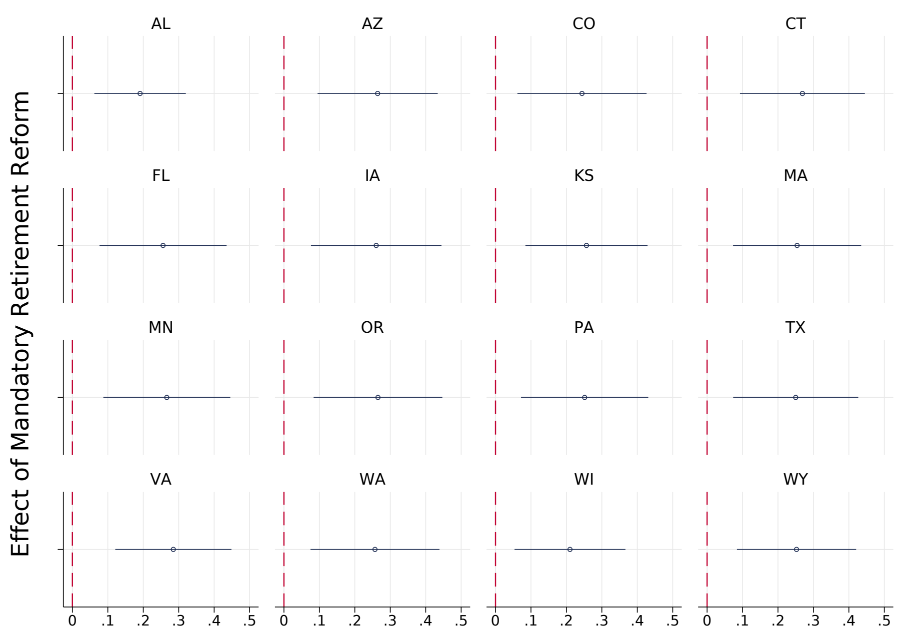
List of states by rules for case assignment in state supreme courts. Rules collected by Christensen et al. (2012).

Table A.4: Effect of Reform on Citations: Different Windows

	(1)	(2)	(3)	(4)	(5)	(6)
Treatment Window	6		14		All	
Retirement Reform	0.164*	0.173*	0.220**	0.232**	0.0403	0.338**
	(0.0662)	(0.0709)	(0.0716)	(0.0793)	(0.0993)	(0.103)
Year FE, Court FE	X	X	X	X	X	X
Court Trends/Windows		X		X		X
N	15010	15010	15010	15010	15010	15010
R-sq	0.458	0.523	0.460	0.525	0.458	0.519

Notes. Observation is a judge working in a year. "Retirement Reform" is an indicator for the ten years after the introduction of mandatory retirement. Court Treat Windows means court-specific treatment windows (ten years before and after reform). Standard errors clustered by state in parentheses. + p<.0.1, * p<0.05, ** p<0.01.

Figure A.4: DD Effect of Retirement Reform, Dropping each Treated State Individually



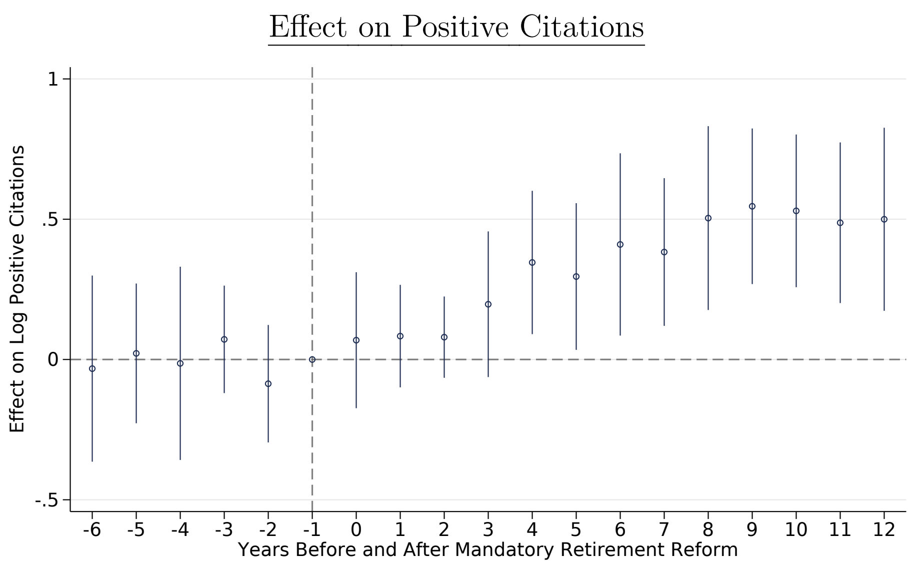
Coefficient for the effect of mandatory retirement at ages of 70, 72 or 75 on judge performance. The outcome is the log positive citations of a judge in a year. Each subfigure plots the coefficient from regression 1 excluding one treated state at a time. Includes court and year fixed effects, court-specific windows and trends.

Table A.5: Effect of Reform on Citations: Senior Status Rules

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Retirement Reform	0.209*	0.282*	0.245**	0.246*	0.251**	0.243*	0.202*	0.270*
	(0.0879)	(0.119)	(0.0809)	(0.0904)	(0.0799)	(0.0896)	(0.0904)	(0.103)
× Grandfather Rule	0.0657	-0.127						
	(0.111)	(0.146)						
× Finish Term			-0.115	-0.0939				
			(0.0762)	(0.0983)				
× Finish Term Half					-0.355**	-0.0573		
					(0.0749)	(0.109)		
× Finish Year							0.134	-0.135
							(0.120)	(0.115)
Year FE, Court FE	X	X	X	X	X	X	X	X
Court Trends/Windows		X		X		X		X
N	9868	9868	9868	9868	9868	9868	9868	9868
R-sq	0.370	0.438	0.370	0.438	0.371	0.438	0.370	0.438

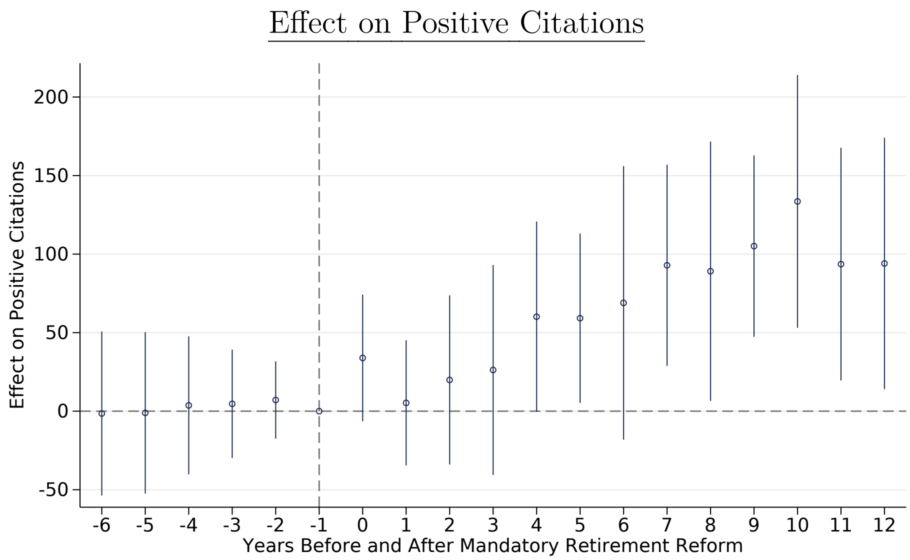
Observation is a judge working in a year. “Retirement Reform” is an indicator for the ten years after the introduction of mandatory retirement. Coefficients are interacted with respective senior status rules (respectively: the rule not applying to sitting judges, being allowed to finish the term, being allowed to finish terms that are over halfway finished, and being able to finish out the year). Court Treat Windows means court-specific treatment windows (ten years before and after reform). Standard errors clustered by state in parentheses. + p<.0.1, * p<0.05, ** p<0.01.

Figure A.5: Event-Study Effect of Retirement Reform on Judge Performance: Initial Covariates



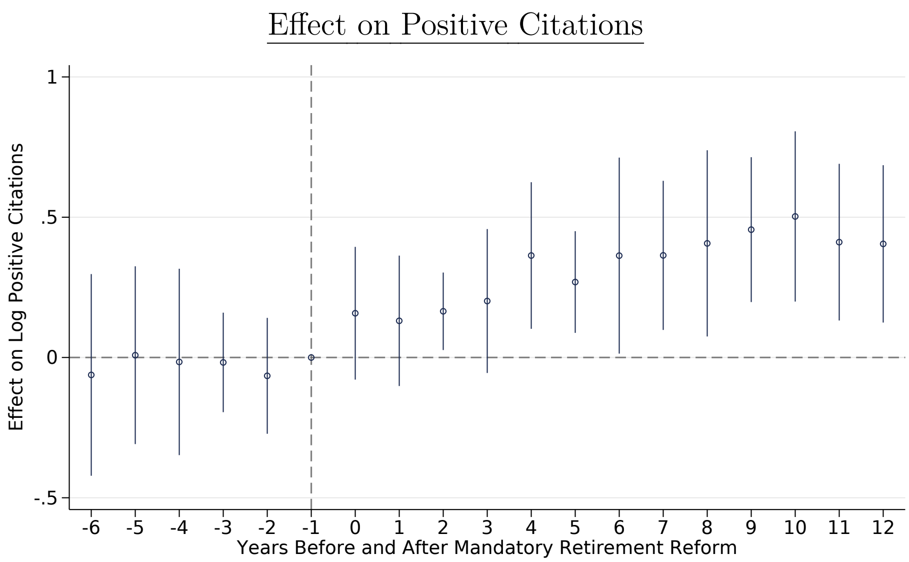
Judge performance before and after reforms implementing retirement ages of 70, 72 or 75. The outcome is the log positive citations of a judge in a year. Time series is a coefficient plot from the event study regression (2), with coefficents estimated relative to the year before the reform. Regression includes court and year fixed effects and court-specific event windows, plus initial rules, cases, and age variables, interacted with year. 95% confidence intervals constructed with standard errors clustered by state.

Figure A.6: Event-Study Effect of Retirement Reform on Judge Performance: Citations in Levels



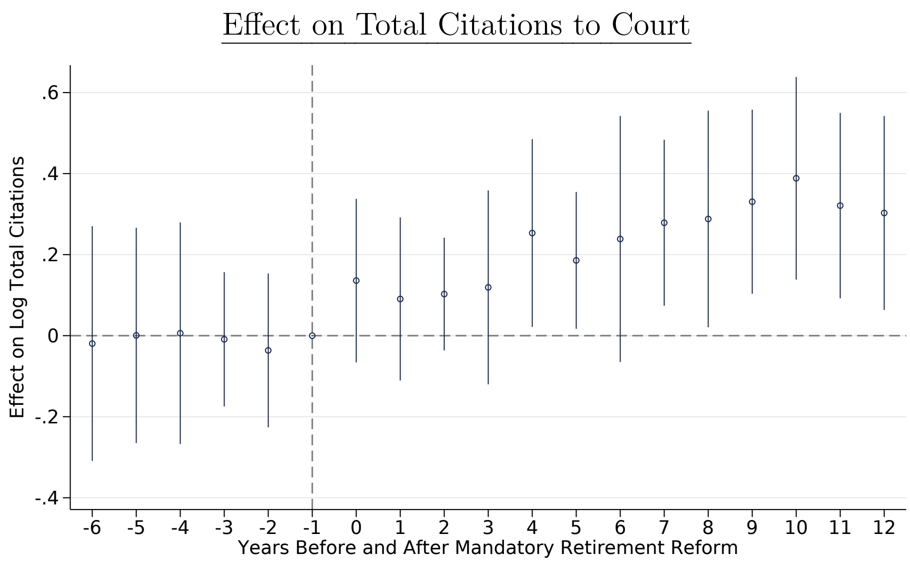
Judge performance before and after reforms implementing retirement ages of 70, 72 or 75. The outcome is the number of positive citations of a judge in a year. Time series is a coefficient plot from the event study regression (2), with coefficents estimated relative to the year before the reform. Regression includes court and year fixed effects and court-specific event windows. 95% confidence intervals constructed with standard errors clustered by state.

Figure A.7: Event-Study Effect of Retirement Reform on Judge Performance: Within 10 Years



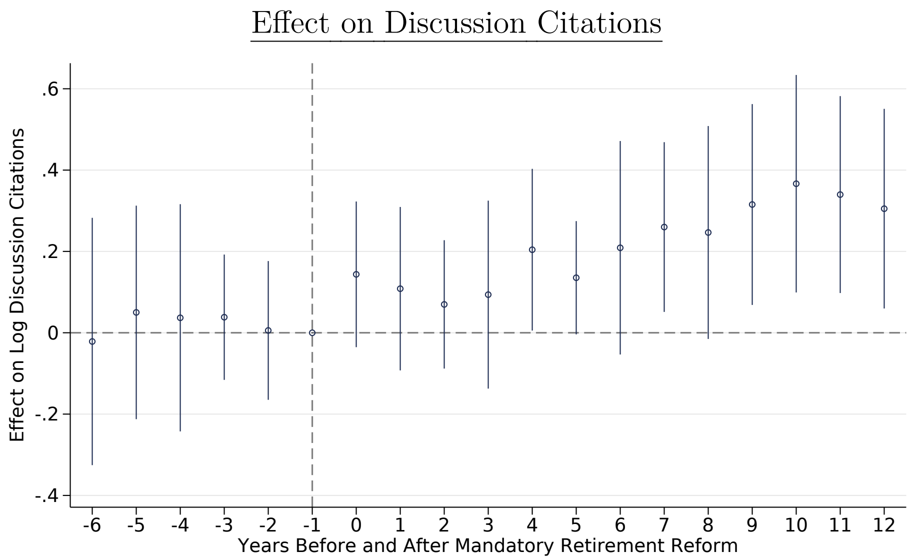
Judge performance before and after reforms implementing retirement ages of 70, 72 or 75. The outcome is the log positive citations of a judge in a year that were made within ten years of a case. Time series is a coefficient plot from the event study regression (2), with coefficents estimated relative to the year before the reform. Regression includes court and year fixed effects and court-specific event windows. 95% confidence intervals constructed with standard errors clustered by state.

Figure A.8: Event-Study Effect of Retirement Reform on Judge Performance: All Citations



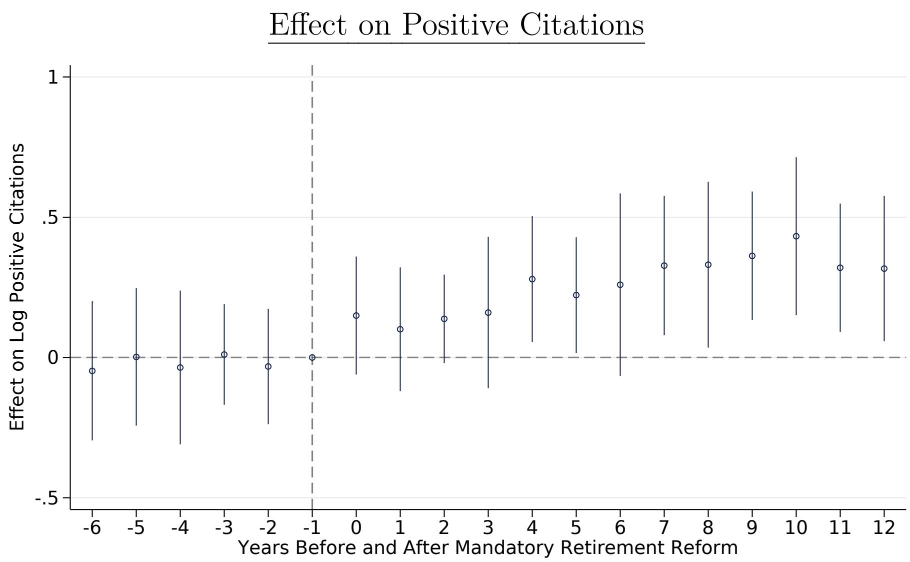
Judge performance before and after reforms implementing retirement ages of 70, 72 or 75. The outcome is the log total citations of a judge in a year (including non-positive negative cites). Time series is a coefficient plot from the event study regression (2), with coefficents estimated relative to the year before the reform. Regression includes court and year fixed effects and court-specific event windows. 95% confidence intervals constructed with standard errors clustered by state.

Figure A.9: Event-Study Effect of Retirement Reform on Judge Performance: Discussion Citations



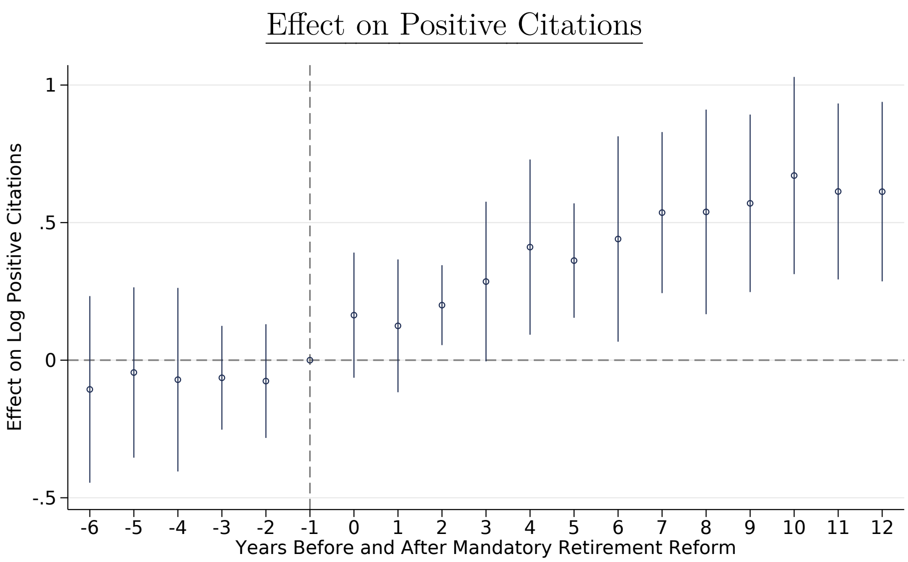
Judge performance before and after reforms implementing retirement ages of 70, 72 or 75. The outcome is the log discussion citations of a judge in a year. Time series is a coefficient plot from the event study regression (2), with coefficents estimated relative to the year before the reform. Regression includes court and year fixed effects and court-specific event windows. 95% confidence intervals constructed with standard errors clustered by state.

Figure A.10: Event-Study Effect of Retirement Reform on Judge Performance: Only Reform States



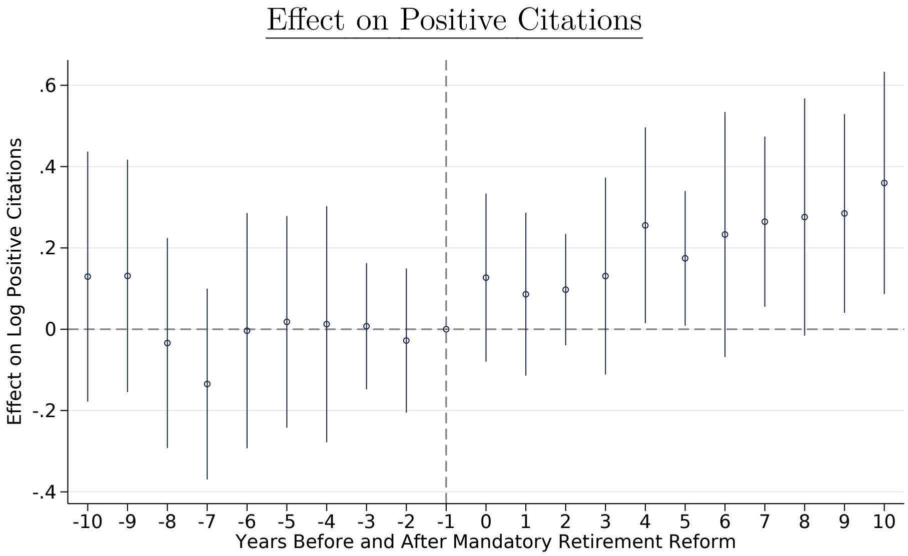
Judge performance before and after reforms implementing retirement ages of 70, 72 or 75. Sample limited to reform states. The outcome is the log positive citations of a judge in a year. Time series is a coefficient plot from the event study regression (2), with coefficents estimated relative to the year before the reform. Regression includes court and year fixed effects and court-specific event windows. 95% confidence intervals constructed with standard errors clustered by state.

Figure A.11: Event-Study Effect of Retirement Reform on Judge Performance: Only Event-Study Window



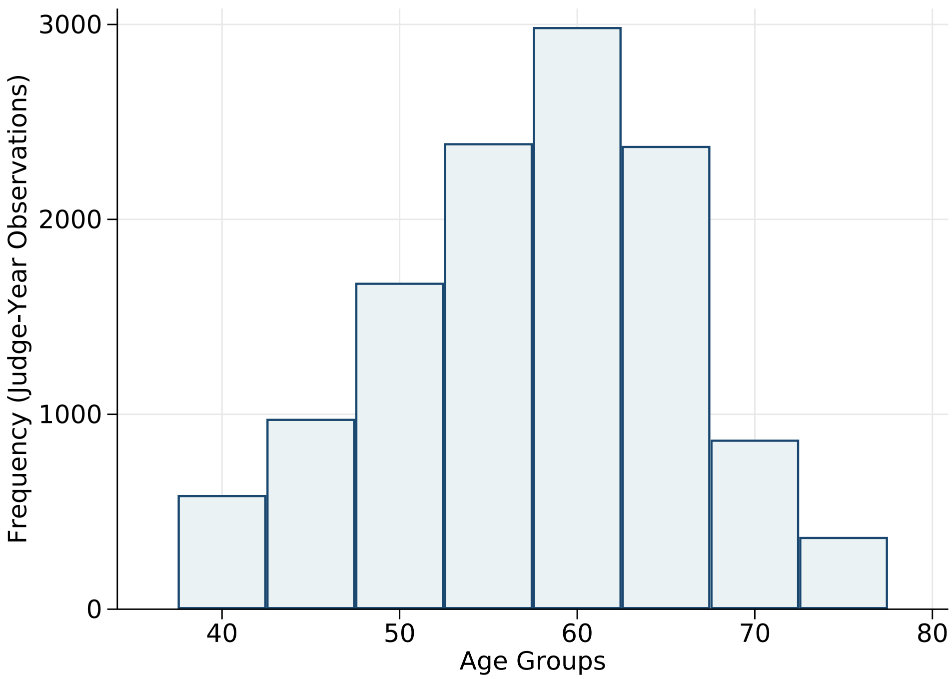
Judge performance before and after reforms implementing retirement ages of 70, 72 or 75. Sample limited to event windows (6 years before up until 12 years after reform, so year fixed effects drop out).The outcome is the log positive citations of a judge in a year. Time series is a coefficient plot from the event study regression (2), with coefficents estimated relative to the year before the reform. Regression includes court and year fixed effects and court-specific event windows. 95% confidence intervals constructed with standard errors clustered by state.

Figure A.12: Event-Study Effect of Retirement Reform on Judge Performance: 10 Pre-Periods



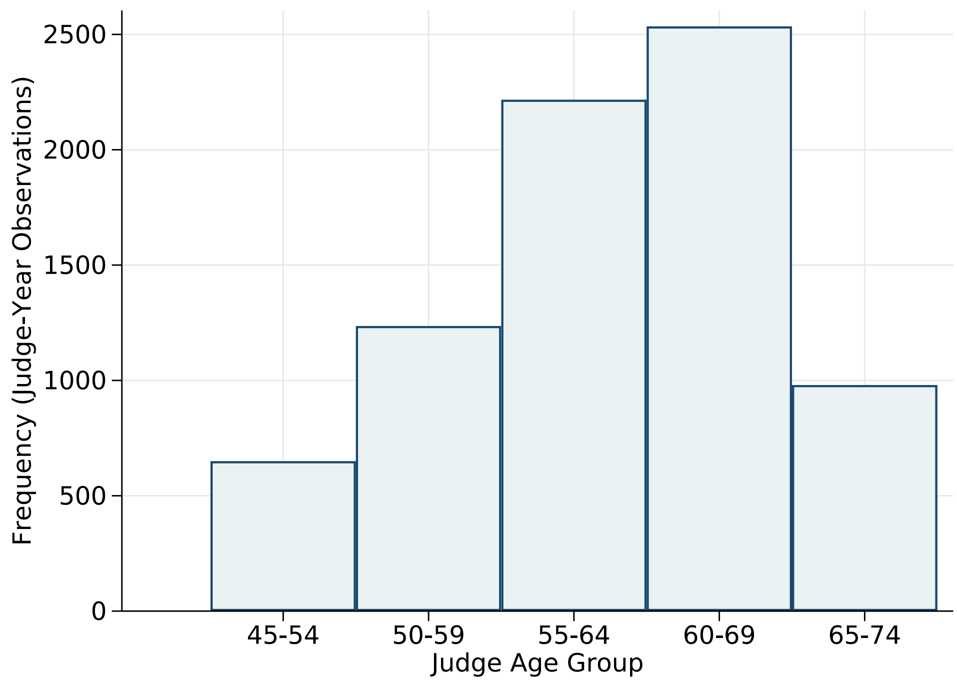
Judge performance before and after reforms implementing retirement ages of 70, 72 or 75. The outcome is the log positive citations of a judge in a year. Ten periods before and after included. Time series is a coefficient plot from the event study regression (2), with coefficents estimated relative to the year before the reform. Regression includes court and year fixed effects and court-specific event windows. 95% confidence intervals constructed with standard errors clustered by state.

Figure A.13: Distribution over Age Groups for Life Cycle Coefficient Plots



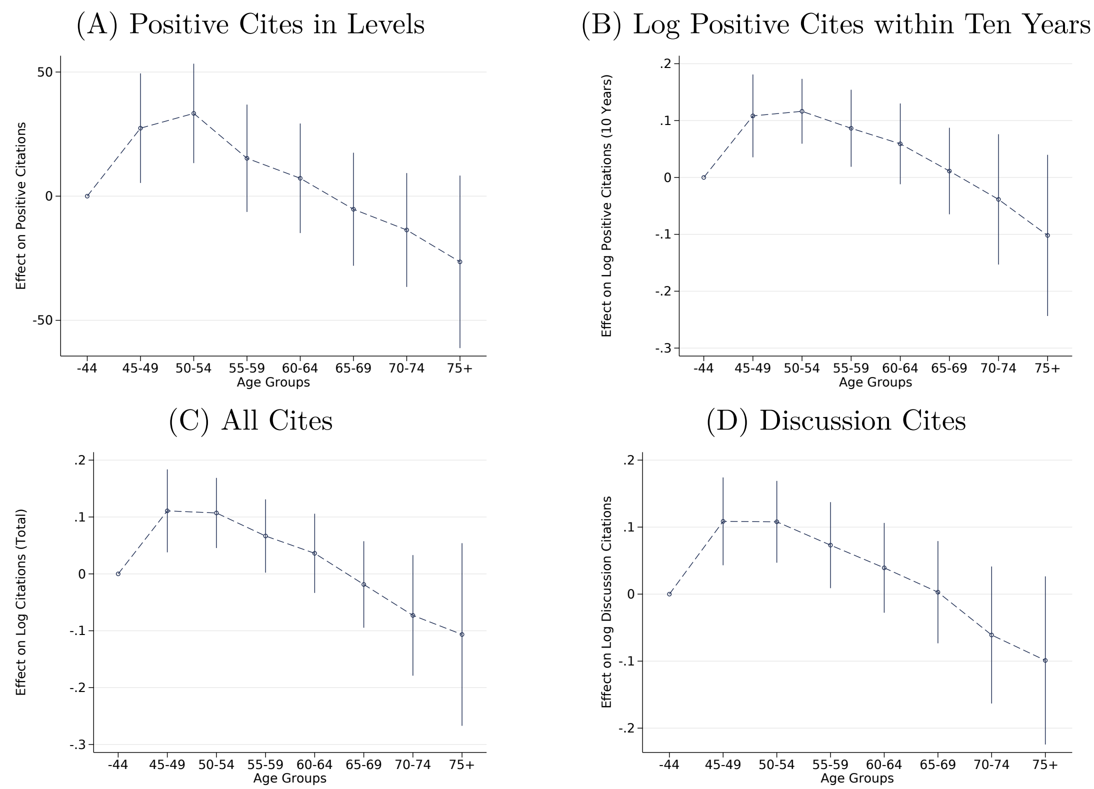
Notes. Number of judge-year observations in each five-year age group for the life cycle coefficient plots.

Figure A.14: Distribution over Age Groups for Balanced Sample Analysis



Notes. Histogram of age groups for balanced sample analysis. Number of judge-years in each overlapping ten-year balanced sample.

Figure A.15: Dynamic Analysis: Additional Performance Measures

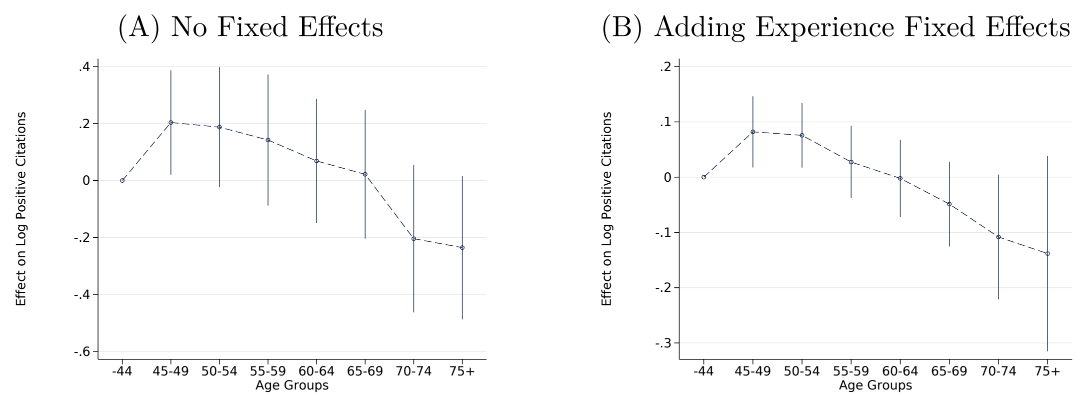


Dynamic coefficient plots for estimates of five-year age group differences, relative to the age < 45 group. Observation is a judge working in a year. All graphs contain court-year interacted fixed effects, first year baselines, and cohort fixed effects. Outcomes are as indicated. 95% confidence intervals constructed using standard errors clustered by state.

Figure A.16: Dynamic Analysis: Case Types

Dynamic coefficient plots for estimates of five-year age group differences, relative to the age < 45 group. Observation is a judge working in a year. All graphs contain court-year interacted fixed effects, first year baselines, and cohort fixed effects. 95% confidence intervals constructed using standard errors clustered by state.

Figure A.17: Judge Age and Judge Performance, Additional FE Specifications



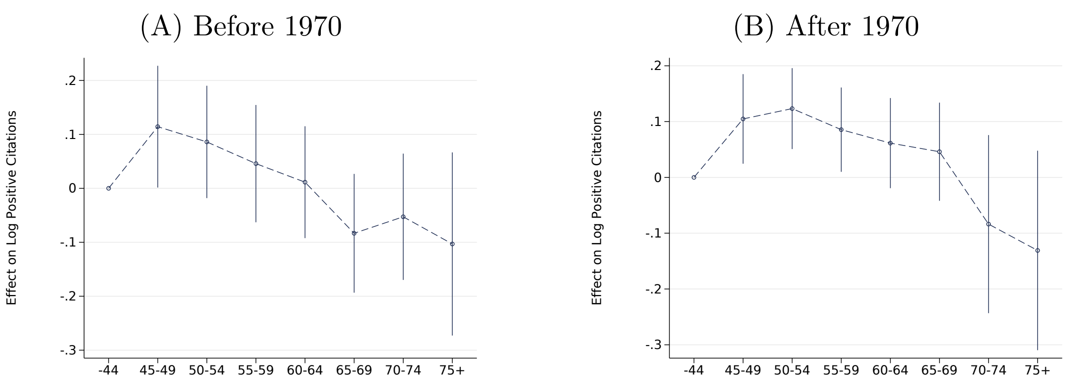
Dynamic coefficient plots for estimates of five-year age group differences, relative to the age < 45 group. Outcom is log positive cites. Observation is a judge working in a year. Panel A has no fixed effects; Panel B contains court-year interacted fixed effects, first year baselines, cohort fixed effects, and fixed effects for number of years on court. 95% confidence intervals constructed using standard errors clustered by state.

Table A.6: Effect of Reform on Log Cites, Only Reform States

	(1)	(2)	(3)	(4)	(5)
	Effect on Log Cites per Judge				
Retirement Reform	0.295**	0.262**	0.273*	0.349*	0.301*
	(0.0818)	(0.0869)	(0.113)	(0.158)	(0.115)
Court FE, Year FE	X	X	X	X	X
Court Trends/Windows		X	X	X	X
Init Court Rules × Year FE			X	X	X
Init Case Types × Year FE				X	X
Init Age × Year FE					X
N	5562	5562	5562	5562	5562
R-sq	0.288	0.346	0.382	0.435	0.468

Observation is a judge working in a year. "Retirement Reform" is an indicator for the ten years after the introduction of mandatory retirement. Court Treat Windows means court-specific treatment windows (ten years before and after reform). "Init X" × year FE means initial values are interacted with year. "Init Court Rules" includes a state's 1947 rules for judge selection/retention system, admin office, intermediate appellate court, number of judges, and term length. "Init Case Types" includes a court's 1947 average values for case characteristics (legal area and related industries). "Init Age" includes the initial mean and standard deviation for judge age on the court. Standard errors clustered by state in parentheses. + p<.0.1, * p<0.05, ** p<0.01.

Figure A.18: Judge Age and Judge Performance, Before/After 1970



Dynamic coefficient plots for estimates of five-year age group differences, relative to the age < 45 group. Observation is a judge working in a year. All graphs contain court-year interacted fixed effects, first year baselines, and cohort fixed effects. Outcomes are log positive cites to a judge in a year. 95% confidence intervals constructed using standard errors clustered by state.

Table A.7: Effect of Reform on Log Cites, Judge Fixed Effects

	(1)	(2)	(3)	(4)	(5)
	Effect on Log Cites per Judge				
Retirement Reform	0.175*	0.173*	0.170*	0.221*	0.210*
	(0.0768)	(0.0726)	(0.0728)	(0.0872)	(0.0801)
Court FE, Year FE	X	X	X	X	X
Judge FE	X	X	X	X	X
Court Trends/Windows		X	X	X	X
Init Court Rules × Year FE			X	X	X
Init Case Types × Year FE				X	X
Init Age × Year FE					X
N	14905	14905	14905	14905	14905
R-sq	0.675	0.683	0.691	0.700	0.710

Observation is a judge working in a year. “Retirement Reform” is an indicator for the ten years after the introduction of mandatory retirement. Court Treat Windows means court-specific treatment windows (ten years before and after reform). “Init X” × year FE means initial values are interacted with year. “Init Court Rules” includes a state’s 1947 rules for judge selection/retention system, admin office, intermediate appellate court, number of judges, and term length. “Init Case Types” includes a court’s 1947 average values for case characteristics (legal area and related industries). “Init Age” includes the initial mean and standard deviation for judge age on the court. Standard errors clustered by state in parentheses. + p<.0.1, * p<0.05, ** p<0.01.

Table A.8: Comparing Judges Selected Before/After the Reform

	(1)	(2)	(3)
	Starting Age	Log Cites / Case	Rank Cites / Case
Selected Post Reform	0.0478	0.115**	0.159**
	(1.254)	(0.0209)	(0.0270)
Court × Year FE	X	X	X
N	13655	15002	15002
R-sq	0.299	0.005	0.001

Observation is a judge working in a year. “Selected Post Reform” is an indicator for judges selected after the introduction of mandatory retirement. Standard errors clustered by state in parentheses. + p<.0.1, * p<0.05, ** p<0.01.

Table A.9: Effect of Reform on Citations: Alternative Clustering

	(1)	(2)	(3)	(4)	(5)	(6)
Clustering Group	State and Year		Judge		None (Robust)	
Retirement Reform	0.228**	0.253**	0.228**	0.253**	0.228**	0.253**
	(0.0458)	(0.0436)	(0.0438)	(0.0412)	(0.0291)	(0.0300)
Court FE, Year FE	X	X	X	X	X	X
Court Trends/Windows		X		X		X
N	15010	15010	15010	15010	15010	15010
R-sq	0.460	0.526	0.460	0.526	0.460	0.526

Notes. Observation is a judge working in a year. "Retirement Reform" is an indicator for the ten years after the introduction of mandatory retirement. Court Treat Windows means court-specific treatment windows (ten years before and after reform). Standard errors clustered by state in parentheses. + p<.0.1, * p<0.05, ** p<0.01.

Table A.10: Effect of Reform on Log Cites, Alternative Weighting

	(1)	(2)	(3)	(4)
	Effect on Log Cites per Judge			
Retirement Reform	0.211**	0.253**	0.133+	0.181*
	(0.0750)	(0.0858)	(0.0736)	(0.0802)
Weighting	# of Opinions		Judges Equal	
Court FE, Year FE	X	X	X	X
Court Trends/Windows		X		X
N	15010	15010	14997	14997
R-sq	0.496	0.569	0.421	0.499

Observation is a judge working in a year. "Retirement Reform" is an indicator for the ten years after the introduction of mandatory retirement. Court Treat Windows means court-specific treatment windows (ten years before and after reform). Standard errors clustered by state in parentheses. + p<.0.1, * p<0.05, ** p<0.01.

Table A.11: Effect of Reform on Log Cites, with Time-Varying Controls

	(1)	(2)	(3)	(4)	(5)	(6)
	Effect on Log Positive Cites per Judge					
Retirement Reform	0.106+	0.148*	0.251**	0.271**	0.202**	0.225**
	(0.0572)	(0.0703)	(0.0886)	(0.0804)	(0.0725)	(0.0804)
Court FE, Year FE	X	X	X	X	X	X
Court Trends/Windows		X		X		X
Case Controls	X	X				
Rule Controls			X	X		
Judge Experience FE					X	X
N	13304	13304	13304		13304	13304
R-sq	0.585	0.609	0.618		0.630	0.638

Observation is a judge working in a year. “Retirement Reform” is an indicator for the ten years after the introduction of mandatory retirement. Court Treat Windows means court-specific treatment windows (ten years before and after reform).Case controls means the first five principal components of the matrix of controls for legal topic and related industries. Rule controls means rules for selection and retention of juges and other institutional items. Judge Experience FE means fixed effects for yeras on the court. Standard errors clustered by state in parentheses. + p<.0.1, * p<0.05, ** p<0.01.

Table A.12: Effect of Reform on Log Cites, with Lagged Outcome

	(1)	(2)	(3)	(4)	(5)
	Effect on Log Positive Cites per Judge				
Retirement Reform	0.143**	0.172*	0.165*	0.209**	0.206**
	(0.0504)	(0.0644)	(0.0661)	(0.0711)	(0.0635)
Court FE, Year FE	X	X	X	X	X
Lagged y_{ist}	X	X	X	X	X
Court Trends/Windows		X	X	X	X
Init Court Rules × Year FE			X	X	X
Init Case Types × Year FE				X	X
Init Age × Year FE					X
N	13304	13304	13304	13304	13304
R-sq	0.585	0.609	0.618	0.630	0.638

Observation is a judge working in a year. “Retirement Reform” is an indicator for the ten years after the introduction of mandatory retirement. Includes lagged outcome variable by judge in the regression. Court Treat Windows means court-specific treatment windows (ten years before and after reform). “Init X” × year FE means initial values are interacted with year. “Init Court Rules” includes a state’s 1947 rules for judge selection/retention system, admin office, intermediate appellate court, number of judges, and term length. “Init Case Types” includes a court’s 1947 average values for case characteristics (legal area and related industries). “Init Age” includes the initial mean and standard deviation for judge age on the court. Standard errors clustered by state in parentheses. + p<.0.1, * p<0.05, ** p<0.01.

Table A.13: Effect of Reform on Citations: Separately by Maximum Age Imposed

	(1)	(2)	(3)	(4)	(5)	(6)
Maximum Age	70		72		75	
Retirement Reform	0.212+	0.291*	0.396**	0.310**	0.155+	0.165**
	(0.117)	(0.133)	(0.113)	(0.0773)	(0.0899)	(0.0384)
Court FE, Year FE	X	X	X	X	X	X
Court Trends/Windows		X		X		X
N	15010	15010	15010	15010	15010	15010
R-sq	0.459	0.524	0.459	0.518	0.458	0.517

Notes. Observation is a judge working in a year. "Retirement Reform" is an indicator for the ten years after the introduction of mandatory retirement. Court Treat Windows means court-specific treatment windows (ten years before and after reform). Standard errors clustered by state in parentheses. + p<.0.1, * p<0.05, ** p<0.01.

Table A.14: Effect of Mandatory Retirement Reform, Other Institutional Features

	(1)	(2)	(3)	(4)	(5)	(6)
			Effect on How Judgeship Ended			
	Experience		Retirement	Death	Other Job	Lost Election
Retirement Reform	-1.301*	-1.464*	-0.0123	0.00633	0.00687	-0.0134
	(0.593)	(0.695)	(0.0463)	(0.0281)	(0.0505)	(0.0163)
Year FE, Court FE	X	X	X	X	X	X
Court Trends/Windows		X	X	X	X	X
N	15010	15010	15010	15010	15010	15010
R-sq	0.162	0.189	0.155	0.114	0.125	0.074

Notes. Observation is a judge working in a year. "Retirement Reform" is an indicator for the ten years after the introduction of mandatory retirement. "Experience" is the years of experience of each judge. Each of the outcome about the end of judgeship are dummy equal to 1 indicating how the judgeship ended. Court Treat Windows means court-specific treatment windows (ten years before and after reform). Standard errors clustered by state in parentheses. + p<.0.1, * p<0.05, ** p<0.01.

Table A.15: Effect of Mandatory Retirement Reform, Other Behavioral Dimensions

	(1)	(2)	(3)	(4)	(3)	(4)	(5)	(6)
	Work Output		Caselaw Research		Overruled Rate		Addendum Ops	
Retirement Reform	0.0310	0.0455	-0.0475	-0.00141	0.0305	0.100	-0.349	0.422
	(0.0643)	(0.0592)	(0.0397)	(0.0359)	(0.0857)	(0.0789)	(0.911)	(0.912)
Year FE, Court FE	X	X	X	X	X	X	X	X
Court Trends/Windows		X		X		X		X
N	15010	15010	15010	15010	15010	15010	15010	15010
R-sq	0.326	0.510	0.154	0.174	0.353	0.448	0.489	0.548

Observation is a judge working in a year. "Retirement Reform" is an indicator for the ten years after the introduction of mandatory retirement. "Work Output" is log number of words written in a year. "Caselaw Research" is number of previouc cases cites. "Overruled rate" is being overruled by a higher court. "Addendum Ops" is number of discretionary and concurring opinions (in logs). Court Treat Windows means court-specific treatment windows (ten years before and after reform). Standard errors clustered by state in parentheses. + p<.0.1, * p<0.05, ** p<0.01.

Table A.16: Judge Age and Additional Performance Measures, Rank Percentiles

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Cites in 10 Years		All Cites		Discuss Cites		Out-of-State Cites	
Judge Age (Years)	-0.00445**	0.0190+	-0.00460**	0.0172+	-0.00498**	0.0182*	-0.00366**	0.00134
	(0.000878)	(0.00981)	(0.000815)	(0.00880)	(0.000812)	(0.00691)	(0.000685)	(0.00749)
Age Squared		-0.000198*		-0.000184*		-0.000196**		-0.0000422
		(0.0000856)		(0.0000771)		(0.0000600)		(0.0000661)
Court-Year FE	X	X	X	X	X	X	X	X
First-Year Baseline	X	X	X	X	X	X	X	X
Cohort FE / Trends	X	X	X	X	X	X	X	X
N	13655	13655	8181	13655	13655	13655	13655	13655
R-sq	0.768	0.769	0.195	0.697	0.698	0.690	0.691	0.674

Observation is a judge working in a year. Outcomes are in rank percentiles. "Cites in 10 years" is log of positive cites to a judge in a year, within ten years of a case. "All Cites" includes negative and distinguishing (not just positive) cites. "Discuss cites" means the case was positively discussed and applied. "Out-of-state cites" means citations from courts in other states. Court-Year FE is interacted court-year fixed effects. 1st-Year Base means a judge's value for the outcome in their first year on the court is included as a control. Cohort FE means fixed effect for decade that the judge started on the court. Cohort Trends means judge starting-year interacted with court fixed effect. Standard errors clustered by state in parentheses. + p<.0.1, * p<0.05, ** p<0.01.

Table A.17: Judge Age and Quantity vs. Quality, Log Outcomes

	(1)	(2)	(3)	(4)	(5)	(6)
	Quantity (Log Number of Opinions)			Quality (Log Positive Cites per Case)		
Judge Age	-0.000991	-0.00310**	0.0296**	-0.00601**	-0.00328**	0.00319
	(0.000768)	(0.000798)	(0.00581)	(0.000781)	(0.000711)	(0.00707)
Age Squared			-0.000276**			-0.0000547
			(0.0000492)			(0.0000627)
Court-Year FE	X	X	X	X	X	X
1st-Year Base		X	X		X	X
Cohort FE/Trend		X	X		X	X
N	13655	13655	13655	13655	13655	13655
R-sq	0.684	0.711	0.713	0.804	0.827	0.827

Observation is a judge working in a year. Outcomes are in logs: number of opinions, or citations per opinion. Court-Year FE is interacted court-year fixed effects. 1st-Year Base means a judge's value for the outcome in their first year on the court is included as a control. Cohort FE means fixed effect for decade that the judge started on the court. Cohort Trends means judge starting-year interacted with court fixed effect. Standard errors clustered by state in parentheses. + p<.0.1, * p<0.05, ** p<0.01.

Table A.18: Judge Age and Quantity vs. Quality, Rank Percentile Specification

	(1)	(2)	(3)	(4)	(5)	(6)
	Quantity (Rank Percentile)			Quality (Rank Percentile)		
Judge Age	-0.00132+	-0.00304**	0.0281**	-0.00665**	-0.00361**	0.00259
	(0.000684)	(0.000895)	(0.00668)	(0.000856)	(0.000786)	(0.00661)
Age Squared			-0.000263**			-0.0000523
			(0.0000572)			(0.0000587)
Court-Year FE	X	X	X	X	X	X
1st-Year Base		X	X		X	X
Cohort FE/Trend		X	X		X	X
N	13655	13646	13646	13655	13646	13646
R-sq	0.021	0.089	0.094	0.036	0.159	0.159

Observation is a judge working in a year. Outcomes are within-court-year rank percentiles: number of opinions, or citations per opinion. Court-Year FE is interacted court-year fixed effects. 1st-Year Base means a judge's value for the outcome in their first year on the court is included as a control. Cohort FE means fixed effect for decade that the judge started on the court. Cohort Trends means judge starting-year interacted with court fixed effect. Standard errors clustered by state in parentheses. + p<.0.1, * p<0.05, ** p<0.01.

Table A.19: Case Type and Importance by Judge Age and Case Allocation Rule

	(1) Crim Cases	(2) Civil Cases	(3) Admin Cases	(4) Con Law Cases	(5) Pred. Cites
Age × Random	0.00427	-0.00435	-0.0164	-0.0196	-0.00127
	(0.00845)	(0.00700)	(0.0115)	(0.0129)	(0.00188)
Age × Not Rand	0.0265	-0.0198	-0.00161	-0.0131	-0.0000133
	(0.0209)	(0.0230)	(0.0176)	(0.0194)	(0.00229)
Court-Year FE	X	X	X	X	X
N	13643	13643	13607	13632	13599
adj. R-sq	0.140	0.209	-0.062	-0.042	0.397

Observation is a judge working in a year. "Random" is an indicator for random-assignment states, while "Not Rand" means discretionary assignment. "Crim Cases" means proportion of cases on criminal law in a year (and respectively for civil cases, administrative cases, and constitutional law cases). "Pred. Cites" means the predicted case quality computed from an OLS regression with case characteristics (legal area and related industries). Standard errors clustered by state in parentheses. + p<.0.1, * p<0.05, ** p<0.01.

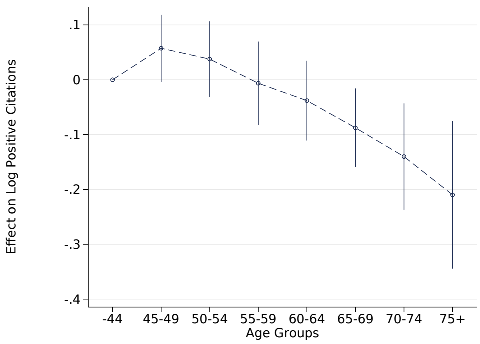
Table A.20: Judge Age and Judge Performance, by Retirement Rule

	(1)	(2)	(3)	(4)	(5)	(6)
	Voluntary Retirement			Mandatory Retirement		
	Log Cites		Rank	Log Cites		Rank
Judge Age (Years)	-0.00962**	0.0181	-0.00576**	-0.00615**	0.0519**	-0.00390**
	(0.00320)	(0.0249)	(0.00147)	(0.00160)	(0.0137)	(0.00122)
Age Squared		-0.000231			-0.000494**	
		(0.000227)			(0.000119)	
Court-Year FE	X	X	X	X	X	X
First-Year Baseline	X	X	X	X	X	X
Cohort FE / Trends	X	X	X	X	X	X
N	4688	4688	4688	8967	8967	8967
R-sq	0.692	0.692	0.059	0.613	0.616	0.043

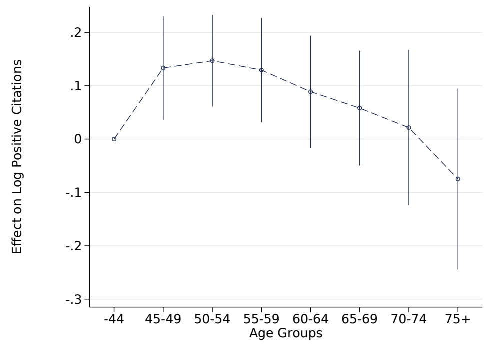
Observation is a judge working in a year. "Log Positive Cites" is log of positive cites to a judge in a year. "Rank Percentile Cites" means judges are uniformly distributed between zero and one based on number of positive citations within court-year (0 is lowest, 1 is highest). Court-Year FE is interacted court-year fixed effects. First-Year Baseline means a judge's value for the outcome in their first year on the court is included as a control. Cohort FE means fixed effect for decade that the judge started on the court. Cohort Trends means judge starting-year interacted with court fixed effect. Standard errors clustered by state in parentheses. + p<.0.1, * p<0.05, ** p<0.01.

Figure A.19: Judge Age and Judge Performance, Alternative Weighting

(A) Weighting by Number of Opinions



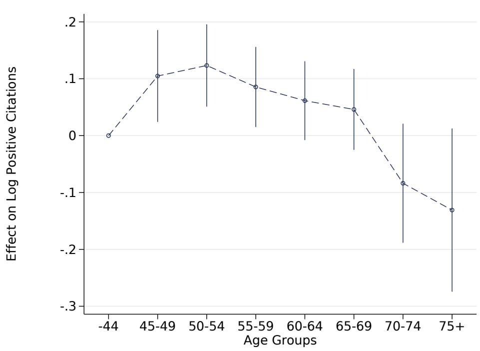
(B) Weighting by Inverse Career Length



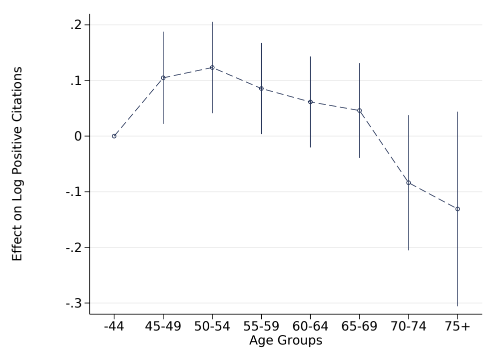
Observation is a judge working in a year. All graphs contain court-year fixed effects. “With Controls” means a baseline for a judge’s first year on the court, fixed effects for decade that the judge started on the court, and judge starting-year interacted with court fixed effect.

Figure A.20: Judge Age and Judge Performance, Alternative Clustering

(A) Clustering at State-Year Level

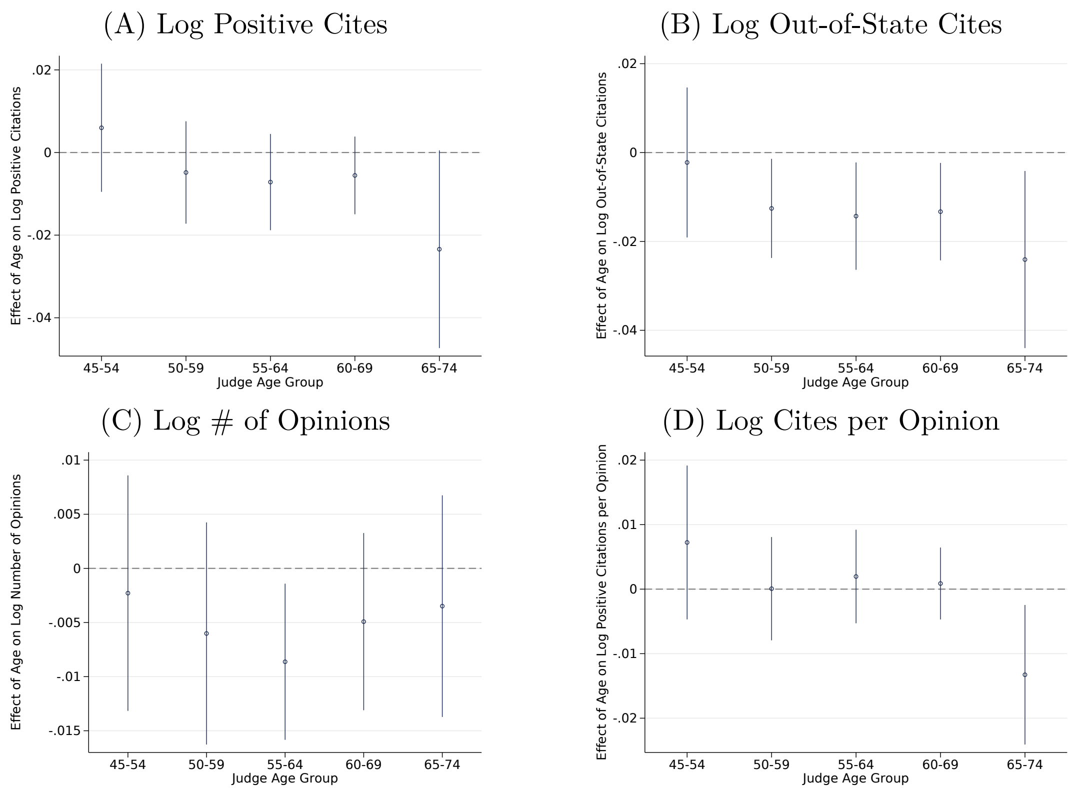


(B) Clustering at Judge Level



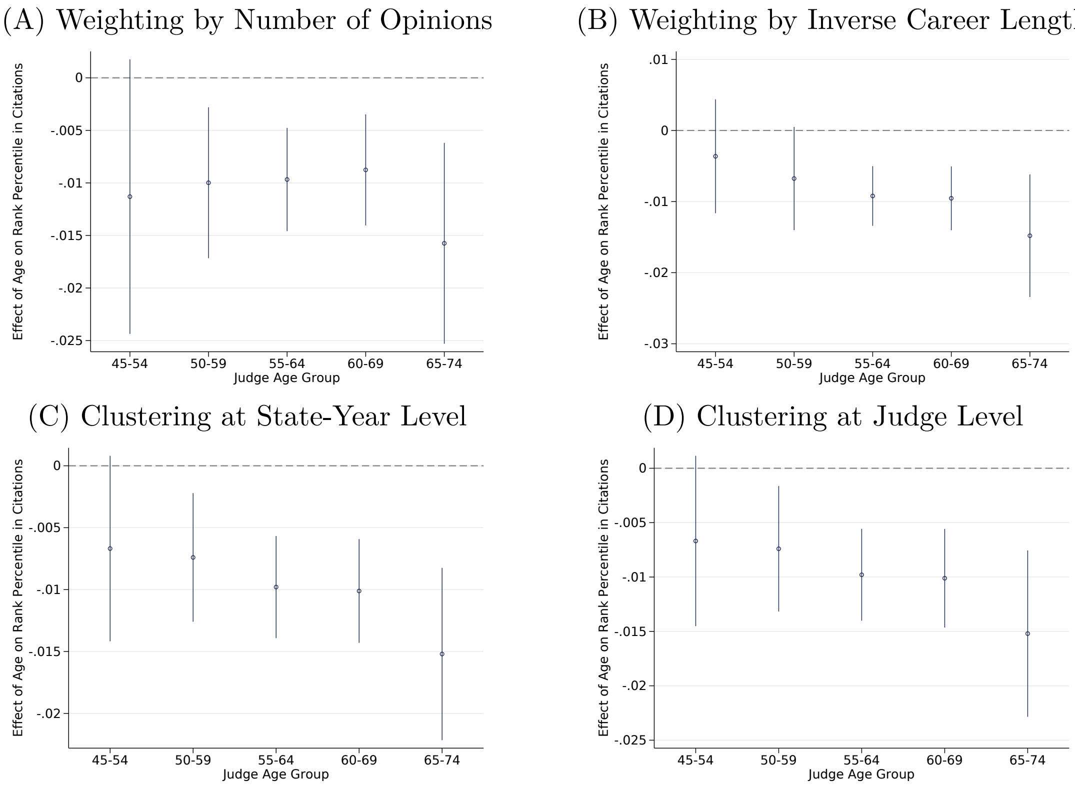
Observation is a judge working in a year. All graphs contain court-year fixed effects. “With Controls” means a baseline for a judge’s first year on the court, fixed effects for decade that the judge started on the court, and judge starting-year interacted with court fixed effect.

Figure A.21: Balanced Judge Samples: Log Outcomes



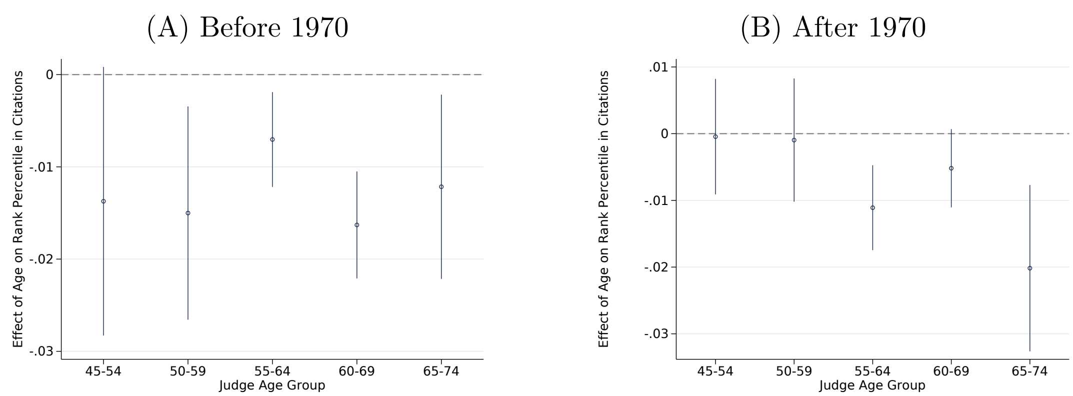
Performance-Age estimates for separate balanced samples of judges based on age group. Observation is a judge working in a year. Outcomes are in logs, regressed on age (in years) for the specified group. 95% confidence intervals constructed using standard errors clustered by state.

Figure A.22: Balanced Judge Samples: Alternative Weighting and Clustering



Performance-Age estimates for separate balanced samples of judges based on age group. Observation is a judge working in a year. Outcomes are in rank percentiles, regressed on age (in years) for the specified group. 95% confidence intervals constructed using standard errors clustered by state.

Figure A.23: Balanced Judge Samples: Before/After 1970



Performance-Age estimates for separate balanced samples of judges based on age group. Observation is a judge working in a year. Outcomes are in rank percentiles, regressed on age (in years) for the specified group. 95% confidence intervals constructed using standard errors clustered by state.

Table A.21: Additional Outcomes for Life Cycle Analysis

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Words Written	Affirm rate	Case Length	Research	Dissent	Overruled	Superseded
Judge Age	-0.00134	-0.00594	0.00154	-1.608	-0.00458*	0.00133	-0.00306**
	(0.00132)	(0.0217)	(0.00109)	(1.043)	(0.00182)	(0.000975)	(0.000883)
Court-Year FE	X	X	X	X	X	X	X
Cohort FE/Trends	X	X	X	X	X	X	X
N	13655	13655	13655	13655	13655	13655	13655
R-sq	0.563	0.747	0.719	0.607	0.504	0.328	0.464

Notes. Observation is a judge working in a year. "Words Written" is log of number of words written in opinions by a judge in a year. "Affirm Rate" is the rate that a judge affirms (rather than reverses) a lower court. "Case length" is words per opinion written. "Research" is previous cases cited in references. "Dissent" is rate of dissenting against other judges. "Overruled" is rate of being overruled by a higher court. "Superseded" is rate of being reversed by legislation. Court-Year FE is interacted court-year fixed effects. First-Year Baseline means a judge's value for the outcome in their first year on the court is included as a control. Cohort FE means fixed effect for decade that the judge started on the court. Cohort Trends means judge starting-year interacted with court fixed effect. Standard errors clustered by state in parentheses. + p<.0.1, * p<0.05, ** p<0.01.

Table A.22: Instrumenting Age with Reforms

	(1)	(2)	(3)	(4)	(5)
	Effect on Log Positive Cites per Judge				
Judge Age	-0.0916**	-0.139**	-0.0766**	-0.0893**	-0.0888**
	(0.0278)	(0.0395)	(0.0232)	(0.0249)	(0.0244)
Court FE, Year FE	X	X	X	X	X
Court Trends/Windows		X	X	X	X
Init Court Rules × Year FE			X	X	X
Init Case Types × Year FE				X	X
Init Age × Year FE					X
Cragg-Donald F-stat	44.526	39.694	43.803	46.821	45.943
Kleibergen-Paap F-stat	10.372	7.416	17.520	16.991	21.625
N	15010	15010	15010	15010	15010
R-sq	0.460	0.526	0.538	0.555	0.565

Notes. 2SLS estimates for effect of age on performance, instrumenting with the retirement reforms. Observation is a judge working in a year. "Retirement Reform" is an indicator for the ten years after the introduction of mandatory retirement. Court Treat Windows means court-specific treatment windows (ten years before and after reform). "Init X" × year FE means initial values are interacted with year. "Init Court Rules" includes a state's 1947 rules for judge selection/retention system, admin office, intermediate appellate court, number of judges, and term length. "Init Case Types" includes a court's 1947 average values for case characteristics (legal area and related industries). "Init Age" includes the initial mean and standard deviation for judge age on the court. Standard errors clustered by state in parentheses. + $p<.0.1$, * $p<0.05$, ** $p<0.01$.

D The Age Discrimination in Employment Act of 1967 Sec. 621

The Congress hereby finds and declares that

1. in the face of rising productivity and affluence, older workers find themselves disadvantaged in their efforts to retain employment, and especially to regain employment when displaced from jobs;

    (a) the setting of arbitrary age limits regardless of potential for job performance has become a common practice, and certain otherwise desirable practices may work to the disadvantage of older persons;

    (b) the incidence of unemployment, especially long-term unemployment with resultant deterioration of skill, morale, and employer acceptability is, relative to the younger ages, high among older workers; their numbers are great and growing; and their employment problems grave;

    (c) the existence in industries affecting commerce, of arbitrary discrimination in employment because of age, burdens commerce and the free flow of goods in commerce.

    (d) It is therefore the purpose of this chapter to promote employment of older persons based on their ability rather than age; to prohibit arbitrary age discrimination in employment; to help employers and workers find ways of meeting problems arising from the impact of age on employment.