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DNA laws and the pursuit of racial justice: access to forensic DNA technology and the exoneration of the wrongfully convicted

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DNA Laws and the Pursuit of Racial Justice: Access to Forensic DNA Technology and the Exoneration of the Wrongfully Convicted

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Abstract

We provide evidence that the passage of "DNA laws" streamlining access to forensic DNA technology was a watershed in the exoneration of Black Americans. Exploiting staggered adoption across states, we find that DNA laws increased exonerations of wrongfully convicted Black individuals serving life sentences for sexual offenses by nearly 200%, freeing over 50 individuals — plausibly over 10% of the wrongfully convicted — and saving nearly 900 years of prison time. Our findings suggest that DNA laws redressed longstanding inequalities in access to other exoneration pathways. More generally, changes on multiple margins (technological and legal) may be necessary to reduce racial disparities.

Keywords: Racial inequality, criminal sentencing, legal institutions, technology and justice
JEL Classification: K40, J15, D63

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1 Introduction

Racial injustice has been a constant feature of the American legal system throughout US history and into the present. From fugitive slave laws, to chain gangs, to police forces that violate the equal protection clause of the US Constitution, Black Americans have consistently faced discrimination by the very institutions intended to promote justice. Indeed, even today, Black men are imprisoned at six times the rate of whites (Carson and Sabol, 2012); they face discrimination in bail hearings (Arnold et al., 2018); when convicted, they are sentenced to more severe sentences (e.g., Abrams et al., 2012; Alesina and Ferrara, 2014; Rehavi and Starr, 2014). Existing evidence also suggests that Black Americans are wrongfully convicted at a substantially higher rate than Whites (Bjerk and Helland, 2020). Such wrongful convictions are among the most egregious expressions of racial injustice, with notable instances such as the Central Park Five attracting public attention and the broader issue motivating non-profit organizations such as the Innocence Project.

Technological change, in particular forensic DNA technology, offers the promise of correcting past injustices. Legal scholars have described it as "the most significant forensic advancement of the past century. The reliability of its accuracy is unparalleled when biological materials are gathered and tested absent contamination. Thousands of defendants have been convicted using DNA technology. Hundreds have been exonerated by way of post-conviction testing" (Brooks and Simpson, 2010).

Yet, such technological change may be insufficient on its own: the existence of DNA technology does not imply access to it. In 1999, the US Department of Justice issued a report that documented obstacles to DNA technology and aimed "to identify ways to maximize the value of DNA in our criminal justice system" (US Department of Justice, 1999). Its conclusion was simple: "Where DNA can establish actual innocence, the recommendations encourage the pursuit of truth over the invocation of appellate time bars." This report shaped subsequent state legislation and significantly streamlined access to post-conviction DNA testing. Within five years, 40 states had adopted laws that "provide a mechanism ... to apply to a court for DNA testing that may prove their innocence ... outside of the person's regular course of appeals, or after their appeals have been exhausted."

In this paper, we argue that state DNA laws streamlining access to forensic DNA technology were an important, unrecognized complement to technological change, significantly increasing the number of wrongfully convicted Black Americans who were exonerated. These laws also sped up the rate at which wrongfully convicted Black individuals were exonerated. While wrongfully convicted Blacks were exonerated significantly more slowly than others prior to DNA laws, we find convergence in time to exoneration following DNA laws' passage.

We motivate our analysis using a simple conceptual framework in which DNA laws reduce the cost of a highly effective exoneration technology that was previously financially and procedurally costly to access (see, e.g., US Department of Justice, 1999). Importantly, the effects of this change may have been particularly pronounced for Black Americans: in the absence of DNA laws alternative exoneration technologies existed (e.g., uncovering false testimony or police misconduct), to which wrongfully convicted Black individuals may not have had equal access (e.g., due to poor legal representation or discrimination). DNA laws that streamlined access to post-conviction forensic DNA technology may have reduced the scope for discrimination in the discovery of police misconduct or the interpretation of new evidence. Thus, while DNA laws brought down the cost of DNA-based exoneration for Blacks and non-Blacks alike, for non-Blacks the result may have been the substitution of DNA-based exoneration for existing technologies of exoneration.[1] For Blacks, the result may have been a significant net increase in total exoneration due to the absence of good substitutes. Lower cost, less discriminatory access to more effective exoneration technology may also have sped up exoneration, particularly for Blacks who otherwise may not have been exonerated at all.

We empirically examine the impact of DNA laws that streamlined post-conviction access to forensic DNA technology on the exoneration of individuals convicted of sexual offenses and sentenced to life in prison — these cases are likely to be most impacted by forensic DNA technology, due to the presence and preservation of physical evidence. We consider the effects of DNA laws on exoneration counts, and on the speed of exoneration. Our empirical analysis uses comprehensive data on exonerated individuals from the National Registry of Exonerations. This dataset includes demographic information on the wrongfully convicted individual, details about the conviction

[1] We compare the exoneration of wrongfully convicted Blacks to that of "non-Blacks", reflecting the specific experience of discrimination experienced by Black individuals in the United States. In practice, our "non-Black" category comprises around 95% "White" individuals and 5% Hispanic individuals. Comparing "Blacks" with "Whites" or comparing "minorities" (i.e., Blacks and Hispanics) with "Whites" yields very similar patterns.

offense, dates of conviction and exoneration, as well as the contributing factors to the wrongful convictions, and the technology of exoneration. We combine this dataset with information on states' adoption of DNA laws, which were adopted in a staggered manner beginning in the late 1990s, with nearly all adoptions following the Department of Justice (1999) report.

We begin by presenting event study patterns of exoneration counts, examining the impact of DNA laws on individuals (regardless of race) convicted prior to the passage of DNA laws, and serving life sentences for sex offenses. We find no evidence of pre-law differential exoneration trends, and find a significant post-law increase in DNA-based exonerations as well as a significant (albeit slightly smaller) increase in total exonerations (i.e., regardless of exoneration technology). Difference in difference models that vary the sample examined, the crimes considered, controls included, and empirical specification (including recently developed models estimating treatment effects in contexts of staggered treatment timing) all estimate significant effects of DNA laws on DNA-based exonerations and smaller (still significant) effects on total exonerations.

We then examine the impact of DNA laws separately by race. We first present event study patterns of exonerations by race, again examining the impact of DNA laws on individuals convicted prior to the passage of DNA laws, and serving life sentences for sex offenses. Patterns observed differ strikingly by race. Black wrongfully convicted individuals experience a sharp increase in *both* DNA-based and total exonerations following the passage of DNA laws (again, with no evidence of differential exoneration trends prior to the laws' passage). The estimated effect of DNA laws on total Black exonerations is around 0.08 per state$\times$year; this is around a 200% increase over the pre-law mean, during which DNA testing technology was available, but less accessible. Non-Black individuals experience an increase in DNA-based exonerations but *not* total exonerations. Consistent with our conceptual framework, our empirical evidence suggests that DNA laws increased access to exoneration technology for wrongfully convicted Blacks, while allowing for substitution to an alternative exoneration technology for non-Blacks.

Triple difference models that allow for heterogeneous effects of DNA laws by race confirm the robustness of the event study patterns. Across specifications, we find significant increases in DNA-based exonerations regardless of race, and find increases in *total* exonerations of wrongfully convicted Black individuals, but not of non-Black individuals. Our estimates imply that over 15 years post-law, DNA laws were responsible for 50–60 additional exonerations of wrongfully convicted Black individuals; this is a major contribution to justice when compared with the total number of exonerations of Blacks in our sample of around 100. As we discuss in the Conclusion, a back-of-the-envelope calculation suggests that DNA laws were responsible for freeing a substantial share — over 10% — of the stock of Black individuals wrongfully convicted of sexual offenses and sentenced to life in prison at the time when the laws were passed.

Why do DNA laws differentially increase total exonerations of wrongfully convicted Black individuals? In our conceptual framework we proposed that Blacks may have faced a higher cost of accessing non-DNA exoneration technology, perhaps reflecting a discriminatory legal environment. In this case, streamlined access to a powerful, less discriminatory exoneration technology (i.e., DNA testing) would be particularly important in a context of greater racial discrimination. It would also be *differentially* impactful for Black individuals where the DNA laws were more expansive, i.e., allowing a broader range of convicted individuals greater access to DNA testing.[2] The intuition is that, facing higher-cost non-DNA alternative exoneration technologies, more Black individuals than non-Black require access to DNA technology to be exonerated at all; greater access to DNA technology is especially important for this group. To assess these possibilities, we: (i) test whether the effects of DNA laws vary *both* by race *and* by the level of historical racial animus in the state in which an individual was wrongfully convicted; and, (ii) test whether the effects of DNA laws vary *both* by race *and* by the expansiveness of the state's DNA law. We find differential effects by *both* historical racial animus and expansiveness of DNA laws — even considering both sources of heterogeneity in the same model. These findings support the proposition that wrongfully convicted Black Americans faced differentially high costs of non-DNA exoneration, with discrimination at the state level plausibly contributing to these costs.

We next consider the effects of DNA laws on the *rate* of exoneration — the time lapse from conviction to exoneration — overall and by race. Reflecting the more general racial disparities in the criminal justice system, wrongfully convicted Blacks in our dataset spend over five years longer in prison prior to exoneration than non-Blacks. To estimate the impact of DNA laws on the rate of exoneration, we conduct a survival analysis, controlling for state and year fixed effects. Examining all exonerated individuals regardless of race, we find that DNA laws indeed acceler-

[2]In practice, DNA laws varied in: (i) provision of counsel to convicted individuals in the initial stages of pursuing DNA testing; (ii) willingness to reconsider convictions arising from plea agreements; and, (iii) costs borne by convicted individuals in pursuing access to DNA testing (for discussion of this variation, see Brooks and Simpson, 2010).

ated exoneration. Yet, this obscures important differences by race. While Blacks were exonerated significantly more slowly than non-Blacks prior to the passage of DNA laws, we find a significant increase in the speed of exoneration for Blacks and essentially complete convergence of time to exoneration across races following the laws.[3] Our results remain very similar when we control for year of conviction fixed effects, or for demographic characteristics of the wrongfully convicted individual, crime characteristics, and characteristics of the wrongful conviction and exoneration (e.g., whether an innocence organization was involved).

To quantify the increased speed of exoneration of wrongfully convicted Blacks, we simulate their counterfactual exonerations had there been no DNA laws. To do so, we first estimate a survival function predicting time to exoneration only for the time period *prior* to the passage of DNA laws. We use demographic characteristics (race and age at conviction), state of wrongful conviction, conviction offense, and other case characteristics. Based on this "no law" survival function, we are able to predict hazard ratios that *would have* applied to wrongfully convicted Blacks who were not yet exonerated at the time of the DNA laws' passage. Among these 78 wrongfully convicted individuals, we simulate the time to exoneration 1,000 times based on the individual-specific predicted hazard ratio. We find that in the "typical" (i.e., median) simulation over 60% of these individuals would *not* have been exonerated without DNA laws, spending their lives behind bars.[4] That is, we estimate that in the absence of DNA laws, around 50 additional wrongfully convicted Black Americans would have spent the rest of their lives behind bars. We estimate that the average time spent in prison would have been nearly 11 years longer in the absence of the DNA laws; multiplied by the 78 wrongfully convicted individuals, this amounts to nearly 900 years of additional prison time.

Our analysis most directly contributes to a broad social science literature on wrongful convictions and exonerations. Overviews include Gross et al. (2004), Gross and O'Brien (2008), and Gould and Leo (2010). Among the few empirical studies of exoneration, the work of Bjerk and

[3]It is certain that some individuals, both Black and non-Black, remain wrongfully convicted, meaning that our analysis of exonerated individuals is necessarily on an incomplete sample of those individuals who were wrongfully convicted. If some Blacks continue to remain wrongfully convicted longer than non-Blacks, this would reduce the degree of convergence by race. However, we see no reason why the more rapid exoneration of some Blacks would increase the time to exoneration for others, meaning the qualitative finding of convergence is valid.

[4]To be precise, these individuals are not released prior to the 39 year total prison time that the US government considers a full term for a life sentence (US Sentencing Commission, 2015).

Helland (2020) is closest to ours, explicitly considering racial inequalities.[5] Bjerk and Helland (2020) leverage data on exonerations of individuals convicted of rape to shed light on differential *wrongful conviction* by race. They find substantially more exonerated Blacks, relative to the number of Black individuals convicted of rape, than Whites, suggesting a higher likelihood of wrongful conviction of Blacks than Whites, under plausible assumptions. The logic of this analysis is analogous to that in Alesina and Ferrara (2014), who examine legal reversals of murder convictions, by race of convict and of victim, to shed light on differential judicial errors (i.e., bias) by race. While Bjerk and Helland (2020) and Alesina and Ferrara (2014) use legal reversals to shed light on judicial racial bias, we study the determinants of exoneration itself, identifying the unrecognized, but substantial, effect of DNA laws for wrongfully convicted Blacks; we highlight differential access to exoneration technology as an important source of racial disparities in exoneration rates prior to the passage of DNA laws.

Our findings thus contribute to the more general empirical literature on racial inequality in the US criminal justice system (see Lang and Kahn-Lang Spitzer, 2020 for a review).[6] Existing work has examined police searches (e.g., Knowles et al., 2001; Anwar and Fang, 2006); and, Antonovics and Knight, 2009); police use of force (Fryer, 2019; Hoekstra and Sloan, 2022); bail hearings (Arnold et al., 2018); sentencing (Mustard, 2001; Abrams et al., 2012; Alesina and Ferrara, 2014; Rehavi and Starr, 2014; McConnell and Rasul, 2018; Feigenberg and Miller, 2021); and parole decisions (Anwar and Fang, 2015; Mechoulan and Sahuguet, 2015). While we cannot isolate discrimination *per se* (a primary aim of much of this literature), we document both first-order racial inequalities in exoneration rates, and a significant reduction in such inequality arising from the combination of a new technology (DNA testing) and a particular set of laws (providing streamlined access to DNA testing).

In so doing, we contribute to the literature on the role of technology in criminal justice, from the use of information technology (Mastrobuoni, 2020); to the use of risk assessment algorithms (e.g., Berk, 2017; Cowgill, 2018; Stevenson and Doleac, 2021). Closest to our work, Doleac (2017) and Anker et al. (2021) find that DNA databases can deter crime, reduce recidivism, and increase rates of criminal detection. We highlight an additional margin along which DNA technology enhances

[5] The importance of racial differences in exoneration rates is suggested by Smith and Hattery (2011).

[6] A broader literature also exists on judicial bias outside the United States. See, for example, Ash et al. (2025).

criminal justice: in addition to identifying actual culprits, it can also thereby exonerate the falsely convicted. Crucially, we also highlight the heterogeneity in the impact of technology depending on complementary policies and institutions. In the absence of DNA laws, we find large disparities in exoneration rates between falsely convicted Blacks and non-Blacks even when DNA analysis was technically feasible. Enhancing justice through technology required legal guarantees of *access* to that technology. We thus join other scholars in noting the ambiguous impact of technology on racial inequality (e.g., Barocas and Selbst, 2016; Kleinberg et al., 2018), pointing to the importance of responses on multiple margins, in this case, both technological and legal.

Most generally, our finding that forensic DNA technology had much larger effects on exonerations after DNA laws were passed — and that the effect of these laws varied, depending on the institutional context — provides a high-stakes illustration of the importance of policy and institutions in shaping the social welfare consequences of technological change (Acemoglu and Johnson, 2023).

In what follows, in Section 2, we describe the institutional setting of our study; in Section 3, we present our conceptual framework and its predictions; in Section 4, we describe our data; in Section 5, we present our empirical analyses of the laws' effects on exoneration counts and rates of exoneration; in Section 6, we offer concluding thoughts.

2 Institutional Background

2.1 The First Application of DNA Testing to Exoneration: the Case of Gary Dotson

In 1979, Gary Dotson was convicted of aggravated kidnapping and rape in Illinois, receiving a sentence of twenty-five to fifty years.[7] Six years into Dotson's sentence, the victim in the case recanted her testimony, confessing to the fabrication of the "crime". However, in light of various inconsistencies in the victim's modified testimony, the trial judge proclaimed her more believable in her original claim, and ordered Dotson to remain in prison. The development of DNA testing technology offered Dotson hope of definitive evidence of his innocence, but a 1987 effort to test a physical evidence sample against his DNA failed due to the age of the sample. DNA testing

[7] This summary of the Dotson case is largely based on the article, "First DNA Exoneration," published online by the Northwestern University Bluhm Legal Clinic Center on Wrongful Convictions. See `https://www.law.northwestern.edu/legalclinic/wrongfulconvictions/exonerations/il/gary-dotson.html`, last accessed October 14, 2022.

technology continued to improve, however, leading to the positive exclusion of Dotson as the source of the evidence sample in 1988. This was the first demonstration of the power of forensic DNA testing technology to exonerate someone who was wrongfully convicted.

2.2 Barriers to Accessing the New Technology

Prior to the implementation of state DNA laws, a petitioner (i.e., someone convicted of a crime) could pursue the application of forensic DNA testing to their case at the state or federal levels.[8] All states provided post-conviction remedies, but in the absence of specific legislation streamlining access to DNA testing, these remedies were limited in their applicability to the new DNA technology, for several reasons. First, state post-conviction regulations often imposed statutes of limitations that precluded the possibility of novel DNA testing for individuals whose original trials occurred in the past and thus lacked DNA testing. In addition, requirements to produce "newly discovered material facts" in state post-conviction petitions may not have been interpreted as covering the use of new testing technology applied to previously examined DNA evidence. Discretion at the state level also raises the possibility of racial discrimination given the legal histories of many US States. Federal recourse has been provided under Habeas Corpus and Section 1983 Petitions claiming a violation of one's federally protected (e.g., civil) rights by the state. Yet, as discussed by Steinback (2007), federal petitions have not generally provided a clear path to DNA testing. Indeed, DNA testing rights under Section 1983 remain contested (see, e.g., Reed v. Goertz, argued before the US Supreme Court in 2022).

Summarizing this state of affairs, the US Department of Justice (1999) noted that "post-conviction requests for testing do not fit well into existing procedural schemes or established constitutional doctrine. ... Currently, the law in many jurisdictions is not clear as to the legal theory that entitles the petitioner to have any of these requests granted, or what the appropriate procedural mechanisms are for making these demands. Because of this present state of legal uncertainty, litigating post-conviction DNA applications often will be unnecessarily complex, expensive, and time consuming."

[8] See Steinback (2007) for a discussion of post-conviction remedies available in the absence of DNA testing laws.

2.3 Widespread Adoption of DNA Testing Laws

Yet, a growing understanding of the potential for DNA testing to revolutionize forensic science and criminal justice generated momentum toward expanding access to the technology. In June 1995, the US Department of Justice commissioned an informal review of cases in which individuals were released from prison as a result of post-trial forensic DNA testing. The resulting National Institute of Justice report identified twenty-eight cases of wrongful convictions that were overturned as a result of post-conviction DNA testing.[9]

Following the release of this report, US Attorney General Janet Reno created a National Commission on the Future of DNA Evidence, including a Working Group with the mission of generating a set of recommendations for streamlining access to post-conviction DNA testing. After three years, in 1999, the Working Group published a report (US Department of Justice, 1999) that synthesized their discussion, making recommendations on the future use of DNA testing in post-conviction appeals. The report quickly impacted state legislatures: while only two states had passed post-conviction DNA testing statutes prior to its release (Illinois and New York), 40 states adopted a post-conviction DNA law within the next five years (see Figure 1).

2.4 Heterogeneity across State DNA Laws

State DNA laws all provide a mechanism for convicted individuals to apply to a court for DNA testing that may prove their innocence, but these statutes are not identical in their content across US states. Important dimensions along which these laws vary include[10]:

- Scope of coverage: some laws restrict the right to DNA testing to individuals convicted of particular crimes, while others are less restrictive. Some laws restrict the right to DNA testing to individuals who did not enter a guilty plea.
- Provision of legal services: some laws require the judge to appoint counsel prior to the motion.
- Financial burden: some state laws impose costs on the appellant (either *ex ante* or upon unsuccessful appeal), while others do not.

[9]For a summary, see `https://bit.ly/3DEWnZ8`, last accessed November 4, 2022.

[10]See Brooks and Simpson (2010) for further discussion.

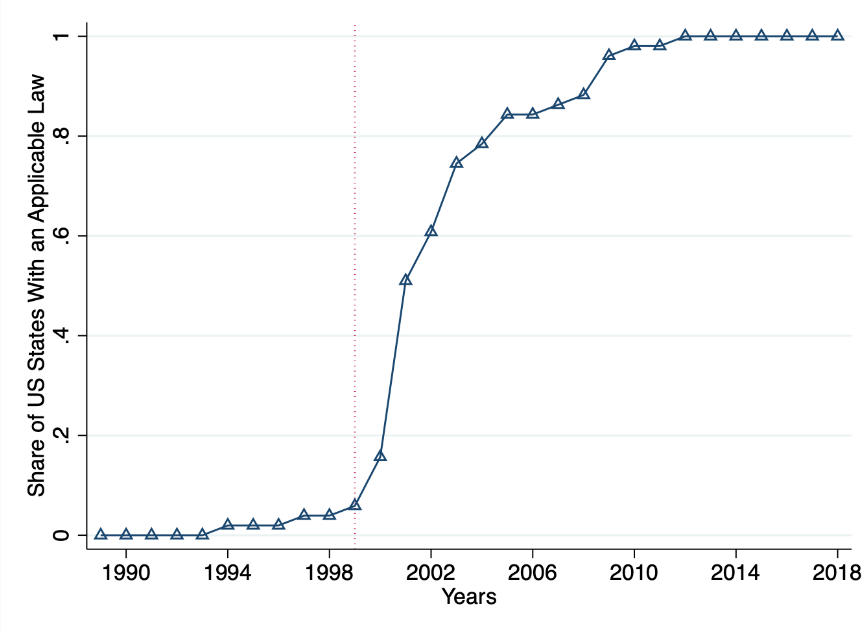


Figure 1: The Temporal Diffusion of Post-Conviction DNA Testing Laws

Notes: This figure illustrates the cumulative share of US states that enacted an applicable post-conviction DNA testing law between 1988 and 2018. The vertical red dotted line indicates the year 1999, following the US Department of Justice report on DNA evidence and wrongful convictions, which preceded the rapid adoption of these laws across most jurisdictions.

Importantly, our baseline analysis exploits the timing of the adoption of any post-conviction DNA law as the main source of identifying variation. However, to better understand the mechanisms underlying the impact of the laws — and, potentially, their greater impact for historically disadvantaged Black Americans — we explore heterogeneous effects emerging from the differences across statutes along these dimensions.[11]

3 Conceptual Framework

We motivate our empirical analyses with the predictions of a simple conceptual framework in which laws streamlining access to post-conviction DNA testing ("DNA laws") have differing effects by race stemming from unequal access to alternative exoneration technologies, and DNA laws provide access to DNA technology at a low "price" independent of race ("price" here is broadly construed, incorporating financial costs, time, and the existence of legal barriers). The framework illustrates how DNA laws may affect: (*i*) DNA-based and total exonerations, indepen-

[11] In Online Appendix Table C.1 we provide information on state DNA laws along the dimensions outlined above.

dent of race; (*ii*) exonerations differentially by race; and, (*iii*) exonerations differentially by race and depending on the state's level of racial discrimination and on the state DNA law's expansiveness of coverage.

We present our framework in more detail, and depict it graphically in the Online Appendix. We consider a distribution of wrongfully convicted individuals, with differing ability to pay for exoneration technology. Ability to pay should be broadly construed to reflect individual characteristics, as well as case characteristics, such as the available evidence that might serve as the basis for exoneration — for example, better legal representation or more abundant physical evidence may enhance an individual's "ability to pay" for exoneration technology. Individuals face "prices" of exoneration technologies (DNA or non-DNA), with the price of DNA exoneration falling after DNA laws. We assume that the price of non-DNA technology differs by race, reflecting plausibly differential access to non-DNA exoneration technology (e.g., due to differences in quality of legal representation or to discrimination within the legal system). We also assume that the post-DNA law price of DNA technology does not differ by race, reflecting the laws' intent to generally streamline access to a race-neutral technology of exoneration (relaxing this assumption does not meaningfully affect our analysis).

This framework generates the following predictions, both pooling across race, as well as considering wrongfully convicted Black individuals and non-Blacks separately:

Hypothesis 1: Impact of DNA laws, pooling across races. The passage of DNA laws will strictly increase *DNA-based* exonerations, and strictly increase total exonerations.

This reflects the reduced cost of an effective exoneration technology (DNA testing), which allows some individuals with low "ability to pay" to access exoneration technology. However, there may exist some substitution of DNA-based exonerations for non-DNA exonerations as some individuals who could access non-DNA technology in the absence of DNA laws substitute toward DNA-based exoneration.

Hypothesis 2: Impact of DNA laws by race. The passage of DNA laws will increase *both* DNA-based and total exoneration among wrongfully convicted Blacks.

This is a result of Blacks facing a differentially high price of non-DNA exoneration technology — hence, DNA laws provide new access to exoneration technology for many Black individuals. The passage of DNA laws will strictly increase DNA-based exoneration for non-Blacks (as the cost of this technology falls), but will only weakly increase total exonerations for non-Blacks: effects on total exoneration will reflect both greater DNA-based exoneration and substitution to DNA-based exoneration from non-DNA exoneration. Substitution is more prevalent for non-Blacks due to their lower initial cost of non-DNA exoneration.

Hypothesis 3: The passage of DNA laws will have a larger differential effect on total exonerations for Blacks in states with: (*i*) greater racial discrimination; (*ii*) more expansive DNA laws.

Heterogeneity by level of discrimination arises because the impact of DNA laws on *total* exonerations was predicted to be differentially large for Black individuals due to their larger gap between the price of non-DNA technology and the post-law price of DNA technology. The greater is racial discrimination, the higher the price of non-DNA technology, and hence the greater the impact of DNA laws. Heterogeneity by expansiveness of DNA laws (e.g., allowing access to post-conviction DNA testing even among individuals who pleaded guilty) results from Black individuals' greater reliance on DNA exoneration. Restrictions on access to DNA testing will limit the benefits of laws that differentially benefit wrongfully convicted Blacks.

Hypothesis 4: Reflecting the increase in access to exoneration technology for Blacks, the passage of DNA laws will increase the *rate* of exoneration for Blacks, while (due to substitution across exoneration technologies) the passage of DNA laws will only weakly increase the exoneration rate of non-Blacks.

4 Data and Descriptive Statistics

We test these predictions using a unique dataset we have constructed that combines individual-level exoneration data with state-level information on the timing and content of DNA laws, as well as state-level measures of racial discrimination. We describe these datasets in turn, then discuss our sample restrictions, and present descriptive statistics.

4.1 Exonerations and Incarceration Data

Data on exonerations are retrieved from the National Registry of Exonerations (NRE).[12] The Registry, founded in 2012, provides detailed information about every known exoneration in the United States since 1989. Exonerations are defined as cases in which a person was wrongly convicted of a crime and later cleared of all the charges based on new evidence of innocence. Data available include race (reported by the exonerated individual), gender (also self-reported), age, state, and year of conviction of the individual later exonerated for the crime. The database also reports information on the primary conviction offense, as well as secondary conviction offenses (if applicable), whether the defendant pleaded guilty, the sentence received, as well as extensive information on the factors contributing to the wrongful conviction. These are: mistaken witness identification, false or misleading forensic evidence, perjury or false accusation, official misconduct, inadequate legal defense, and co-defendant confession. Finally, the database reports information on the year of exoneration, whether DNA technology was used to achieve the exoneration, and whether an innocence organization or a conviction integrity unit led the exoneration process.[13] These data come from different underlying sources: administrative data from the original case leading to conviction; information that arises as a result of a successful exoneration process (e.g., discovery that original forensic evidence was misleading); and, information that is uncovered by other legal processes (e.g., a co-defendant's confession).

Using the exonerations database, we can directly construct counts of exonerations by state$\times$year and we can calculate the time from conviction to exoneration for use in a duration analysis (i.e., in estimating a proportional hazard model). We also construct exoneration *shares* relative to the incarcerated population — pooling all races, and separately by race. To do so, we use incarceration data at the state$\times$year$\times$race level from the National Prisoner Statistics (NPS) Series collected by the United States Bureau of Justice Statistics.[14]

[12] The data are available at `https://bit.ly/3DtvtU4`. We downloaded data from the website in February, 2019.

[13] Innocence organizations are *pro bono* efforts by attorneys and law students aimed at exonerating the wrongfully convicted. For example, the Innocence Project was "Founded in 1992 by Barry C. Scheck and Peter J. Neufeld at the Benjamin N. Cardozo School of Law at Yeshiva University ... to free the innocent, prevent wrongful convictions, and create fair, compassionate, and equitable systems of justice for everyone. See `https://innocenceproject.org/`. A conviction integrity unit is a "division of a prosecutorial office that works to prevent, identify, and remedy false convictions." See `https://bit.ly/3EOOjmT`, last accessed November, 4, 2022.

[14] These data are available in the ICPSR archive: `https://www.icpsr.umich.edu/web/NACJD/series/886`, last accessed June 11, 2025.

4.2 State Laws and Institutions

We gather information about states' post-conviction DNA laws by using the search engine provided by the Innocence Project,[15] crosschecking this information with the legal literature (e.g., Kobilinsky et al., 2005, Steinback, 2007, Brooks and Simpson, 2010) and information collected by the National Conference of State Legislatures.[16] Using this information, we code the year of enactment of post-conviction DNA laws across the 50 US states and the District of Columbia (see Figure 1 and Online Appendix Table C.1) as well as specific statute characteristics, discussed above: restrictions on the scope of coverage; requirements for pre-motion legal counsel; and, financial costs to the petitioner.[17]

In addition to collecting comprehensive information on the timing of state DNA laws' passage, we also collect information on two additional institutional changes that may also contribute to exoneration. First, we identify the establishment of a state's first conviction integrity unit (CIU) from documentation made available by the National Registry of Exonerations.[18] Second, we identify the establishment of a state's first innocence organization (IO), building on information made available by the Innocence Network.[19]

4.3 Measures of Racial Animus

We proxy for potential discrimination against Black Americans by state using three measures of state-level historical racial animus. First, we use historical lynching data housed at the Tuskegee University archives.[20] Next, we consider whether a state was part of the of the Confederate States of America.[21] Finally, we consider the states subject in their entirety to Section 5 of the Voting Rights Act (VRA).[22]

[15] The search engine can be found at `https://innocenceproject.org/`. One can search, for example, for "Alabama," which yields a link the state's post-conviction DNA testing statute: `http://bit.ly/3WSz5aW`. All links last accessed November 4, 2022.

[16] See National Conference of State Legislatures, "Post Conviction DNA Testing", 2013. Available online at `https://bit.ly/3heDUeF`, last accessed November 10, 2022.

[17] All states had DNA laws by 2013. See National Conference of State Legislatures, "Post Conviction DNA Testing", 2013.

[18] See `https://bit.ly/3EOOjmT`, last accessed January 31, 2023.

[19] See `http://bit.ly/3HKsKcj`, last accessed January 31, 2023.

[20] The lynching data are available at `https://bit.ly/3DJ0T9g`, last accessed November 4, 2022.

[21] A list of the Confederate states is at `https://bit.ly/3T7LzIN`, last accessed November 10, 2022.

[22] The states subject to Section 5 of the VRA are listed at `https://bit.ly/3WwWdMg`, last accessed November 10, 2022. See, for example, Cascio and Washington (2014), Bernini et al. (2022), and Aneja and Avenancio-Leon (2019) for discus-

4.4 Sample Restrictions and Descriptive Statistics

In constructing our baseline sample of exonerations, we impose three sets of restrictions: based on the conviction offense; based on sentence imposed; and, based on the timing of conviction relative to the passage of state DNA laws. It is important to note that our results are qualitatively identical if we relax any of these sample restrictions (discussed below).

Sample restrictions based on conviction offense We focus on wrongful conviction for sexual offenses (i.e., sexual assault, rape, and sexual offenses against minors), whether those crimes are the primary conviction offense or a secondary offense (e.g., in the case of a conviction for murder that also included a rape conviction). Our focus on sexual offenses reflects the fact that these are offenses in which biological evidence is often present, making forensic DNA analysis particularly relevant. Of course, DNA testing and DNA laws have impacts beyond this set of cases, so we do not claim to identify the full social benefit of DNA testing or DNA laws.

Sample restrictions based on sentence imposed We focus on those sex offenses for which individuals received "life" sentences[23] for two reasons: first, the magnitude of injustice in these cases is arguably of the "highest stakes", making them of particular interest.[24] Second, in these cases, wrongfully convicted individuals have greater opportunity to pursue exoneration — in many states, evidence is only preserved as long as an individual is incarcerated, so upon release, DNA testing of physical evidence may be impossible (see (Stephens, 2018) for a review of evidence preservation laws across states). A life sentence provides the wrongfully convicted individual with more time to pursue DNA analysis prior to the destruction of physical evidence.

Sample restrictions based on timing of conviction One could imagine that the passage of a DNA law endogenously changes the composition of post-law wrongful convictions (e.g., by affecting how aggressively cases are prosecuted), thus complicating comparisons of exonerations before and after a law's passage. Our baseline analysis thus only includes convictions *prior* to the

sions of historical discrimination in the VRA states.

[23]To be precise, the sentences are typically sentences up to life, with a possibility of earlier parole.

[24]One exception to our focus on the "highest stakes" cases is that we exclude wrongful convictions resulting in death sentences from our baseline sample. We do so because appellate procedure in death penalty cases differs from that in other cases, complicating comparisons of post-conviction outcomes between death penalty cases and others. As noted above, including death penalty cases or less severe sentences does not affect our findings.

passage of a DNA law in the state of conviction. In robustness exercises we consider: (i) convictions that occurred prior to *any* DNA law passed in the United States; and, (ii) convictions that occur both before and after the passage of DNA laws in the state of conviction. Our results are very similar considering these alternative sets of convictions.

Summary statistics for the baseline sample We present summary statistics describing the 190 exonerations in our baseline sample in Table 1, as well as summary statistics splitting the sample by the race of the exonerated individual (104 Black and 86 non-Black). One can see that the exonerated individuals were, on average, convicted in their late 20s and were typically men. Their wrongful conviction often involved official misconduct and rarely (but not never) involved a guilty plea. One can see that wrongfully convicted Blacks were nearly twice as likely to have suffered from inadequate legal defense.

A substantial share of exonerations (around 60%) relied on DNA technology, with a larger share of DNA-based exonerations for wrongfully convicted Blacks (nearly 75%). Around 17 years elapsed, on average, between conviction and exoneration, but this obscures heterogeneity by race. Wrongfully convicted Black individuals are exonerated nearly 20 years after wrongful conviction, while non-Black individuals are exonerated around 14 years after wrongful conviction.

In Figure B.1, we map the number of total exonerations and the number of DNA-based exonerations in our baseline sample by state. We pool across races in Panels A and B, then show patterns for Blacks and non-Blacks separately in Panels C–F. One can see that exonerations and DNA-based exonerations are not regionally concentrated, but rather occur across the country.

5 Empirical Analysis

Our empirical analysis begins with a state×year-level study of DNA laws' impact, regardless of race (testing Hypothesis 1). We then examine (at the state×year×race-level) the differential effects of DNA laws by race (Hypothesis 2), before considering the specific characteristics of states and their DNA laws, which our framework suggests may shape the impact of DNA laws on wrongfully convicted Black individuals (Hypothesis 3). Finally, we analyze an individual-level panel dataset to study the impact of DNA laws on the rate of exoneration (Hypothesis 4) and to estimate

Table 1: Descriptive Statistics

	All Races	Black	Non-Black
Information on Exonerees			
Age at wrongful conviction	26.832	26.000	27.837
Male	0.942	1.000	0.872
Wrongful Conviction Factors			
False confession	0.184	0.192	0.174
Mistaken witness identification	0.447	0.615	0.244
False/misleading forensic evidence	0.347	0.327	0.372
Official misconduct	0.537	0.481	0.605
Inadequate legal defense	0.132	0.163	0.093
Co-defendant confessed	0.105	0.125	0.081
Guilty plea	0.053	0.048	0.058
Exoneration Details			
Innocence Organization involved	0.411	0.490	0.314
Conviction Integrity Unit involved	0.063	0.106	0.012
DNA evidence used	0.611	0.731	0.465
Days to exoneration	6303.6	7278.9	5124.2
Charge Details			
Main charge: Murder	0.295	0.298	0.291
Main charge: Sex offense	0.400	0.500	0.279
Main charge: Child sex offense	0.305	0.202	0.430
Secondary charge: Sexual assault	0.084	0.067	0.105
Secondary charge: Child abuse	0.021	0.029	0.012
Secondary charge: Rape	0.247	0.250	0.244
Number of cases	190	104	86

Notes: Descriptive statistics for the baseline sample of exonerees wrongfully convicted for life in sexual offense cases.

counterfactual rates of exoneration in the absence of DNA laws.

5.1 The Effect of DNA Laws on Exoneration

Event study estimates We begin our analysis of DNA laws' effects by presenting estimates from the following event study model:

$$Exoneration_{st} = \gamma_s + \delta_t + \sum_T \beta_{1T} Law_{it} + \epsilon_{st},$$

where the outcome, $Exoneration_{st}$, is a count of exonerations in state s in year t.[25] We estimate

[25] We include all exonerations from 10 years prior to the passage of a DNA law in state s until 10 years after the law's passage. Note that we use the term "state" throughout despite the fact that one jurisdiction in our analysis, Washington, DC, is not a US state.

time-varying effects depending on the number of years to/from the passage of a DNA law (the coefficients on the Law_{it} variable, β_{1T}), controlling for state fixed effects (γ_s) and year fixed effects (δ_t).

In Figure 2, Panel A, we consider only DNA-based exonerations, and plot the coefficients β_{1T}, estimated relative to the omitted year of a DNA law's passage, along with their 90% confidence intervals (based on standard errors clustered at the state level).[26] One can see in the figure that prior to DNA laws' passage, there is no significant pre-trend in exonerations, but in the year immediately following a DNA law's passage, DNA-based exonerations increase by a statistically significant 0.15 per state×year, persisting for the decade following a DNA law's passage. This amounts to around 75 estimated additional DNA-based exonerations in the decade following DNA laws.

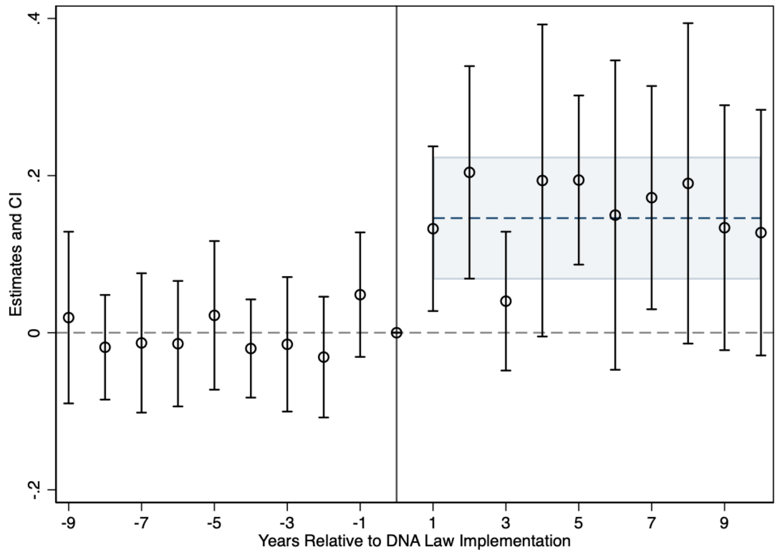
In Figure 2, Panel B, we consider total exonerations, and plot the coefficients β_{1T}, estimated relative to the omitted year of a DNA law's passage, along with their 90% confidence intervals. Again, one can see in the figure that prior to DNA laws' passage, there is no significant pre-trend, but in the year immediately following a DNA law's passage, total exonerations increase by a statistically significant 0.15 per state×year. The higher number of exonerations again largely persists for the entire decade following a DNA law's passage, though point estimates begin to decline and statistical significance fades slightly.

In addition to plotting the year-specific estimated effects of DNA laws, in Figure 2, Panels A and B, we show in hatched boxes the estimated effects of DNA laws over the entire post-law period, relative to the entire pre-law period. To be precise, we estimate a simple difference-in-differences model and plot the post-law coefficient and 90% confidence interval relative to the entire pre-law period, controlling for state and year fixed effects. The boxes capture the general patterns seen in the event study estimates: significant effects of DNA laws on both DNA-based and total exonerations.

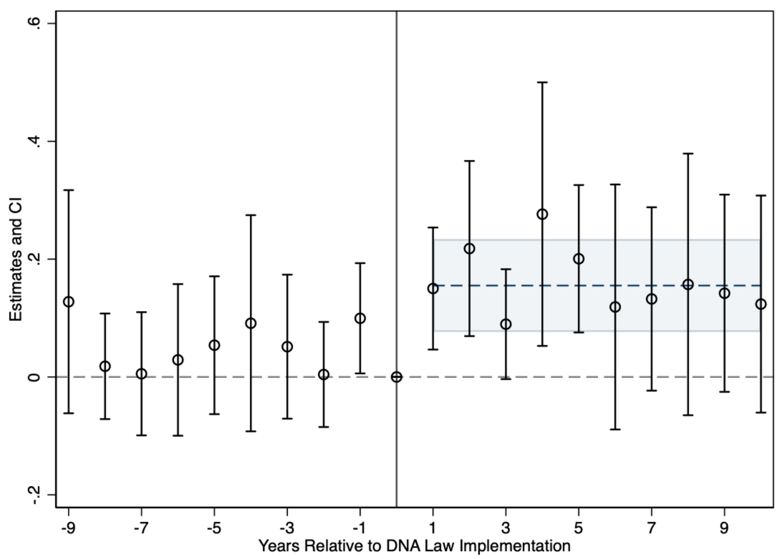
Dynamic effects of DNA laws The dynamic effects of DNA laws estimated in Figure 2 are worth some discussion. One might have expected DNA laws to have an effect only in the short-run: the stock of individuals wrongfully convicted prior to the laws' passage (to which we restrict our analysis) is fixed, and effects of the laws should dissipate once these individuals are exonerated.

[26]Estimated coefficients are reported in Appendix Table C.2.

Figure 2: Event Study: Impact of DNA Laws on Exonerations over Time



Panel (a): DNA-based Exonerations: Pooling Across Races



Panel (b): Total Exonerations: Pooling Across Races

Notes: These figures present event study estimates and 90% confidence intervals for the impact of DNA laws on exonerations. The x-axis represents years relative to the year of the law's passage (Year 0), which is omitted as the reference category. Panel (a) shows DNA-based exonerations, while panel (b) includes all exonerations. Dashed horizontal lines represent the post-treatment average effect (relative to the pre-treatment period) estimated using a difference-in-differences model. All specifications include state and year fixed effects with standard errors clustered at the state level.

However, this process might take time for several reasons. First, the process of exoneration may be lengthy due to the legal requirements and processing time. Second, DNA technology has improved over time, allowing some individuals to be exonerated only after a lag. Finally, some exonerations may occur after DNA matches are found in a database (e.g., of convicted felons), and this, too, may take time. Thus, the observed persistent effect of DNA laws on exoneration over a decade is not entirely surprising.

Difference-in-differences estimates and robustness We next estimate DNA laws' effects over the entire post-law period, compared to the pre-law period, in order to increase the power of our test of DNA laws' impact, to concisely capture this impact, and to present a wide range of robustness specifications in a compact manner.[27] To do so, we estimate the following difference-in-differences model:

$$Exoneration_{st} = \gamma_s + \delta_t + \beta_1 * Post_{st} + X_{st} + \epsilon_{st},$$

where the outcome, $Exoneration_{st}$, is a count of exonerations in state s in year t and the explanatory variable of interest is the dummy variable $Post_{st}$, which equals 1 if a state had passed a DNA law prior to year t. We control for state fixed effects (γ_s) and year fixed effects (δ_t), and we include different sets of state×year-varying controls (X_{st}) in different specifications; ϵ_{st} is the error term, which we allow to exhibit correlation across observations for the same state.

In Table 2, Panel A we present estimates from the model considering only DNA-based exonerations as the outcome, and in Panel B we present estimates using total exonerations as the outcome. As discussed above, we hypothesize that DNA laws should significantly increase DNA-based exonerations as well as total exonerations, though changes in the latter may also reflect substitution across technologies of exoneration. In column 1, we show the estimated effects of DNA laws from a parsimonious model controlling only for state and year fixed effects. One can see in Panel A that DNA laws increase DNA-based exonerations by 0.14 per state×year, a large effect relative to the pre-law mean of 0.039, amounting to over 100 additional DNA-based exonerations in the years after the passage of DNA laws.[28] In Panel B one can see that the impact on total exonerations

[27]We include all exonerations between 1989 (the year of the first exoneration in the NRE data) through 2018. The 30-year period allows allows us to study long-term effects of DNA laws, extending 17 years (the average time to exoneration) beyond the adoption year in the median state (2001).

[28]The estimate of additional exonerations comes from multiplying the estimated effect of 0.14 by the number of post-law state×year observations in our data (783).

is slightly smaller (reflecting substitution across exoneration technologies): around 0.10 exonerations per state×year. This implies an additional 75 individuals were exonerated as a result of DNA laws' passage. The results in Table 2, column 1, align very closely with the event-study estimates in Figure 7.

We next evaluate the robustness of these estimates to a variety of different modeling choices. In Table 2, column 2, we estimate our baseline model from column 1, but now consider standardized exonerations (rather than counts) as the outcome. One can see that DNA-based exonerations are estimated to increase by 0.6 standard deviations post-law, while total exonerations increase by 0.23 standard deviations. Next, because exonerations are count data with a substantial number of state×year cells with 0 exonerations, we estimate a Poisson model. One can see in Table 2, column 3, that DNA laws significantly increased both DNA-based and total exonerations in this specification as well.[29] Another consideration is benchmarking exoneration counts against the population of incarcerated individuals at the state×year level. To do so, we construct exoneration *shares* in each state×year and consider these shares as the outcome variable. We show estimates weighting observations by the incarcerated population in each state×year in able 2, column 4; unweighted estimates are shown in column 5.[30] One can see in Table 2, that DNA laws increased both DNA-based and total exonerations when examining shares as well as counts — estimates are statistically significant for DNA-based exonerations and are on the margin of significance for total exonerations.

We next consider several specifications that help address questions about the possibly endogenous timing of DNA laws. One natural concern is that more punitive states, with larger stocks of (wrongfully) convicted individuals would exhibit larger increases in the post-law period due to broader trends favoring the exoneration of the wrongfully convicted, rather than causal effects of the DNA laws themselves. To evaluate this possibility, we control for the state's incarcerated population in the year prior to the implementation of its DNA law interacted with a full set of year

[29]The magnitude of the estimated effect in the Poisson specification implies around a 235% increase in the count of DNA-based exonerations and around an 80% increase in the count of total exonerations — both magnitudes are similar to the estimates in the baseline specification.

[30]Note that we do not consider exoneration shares in our baseline analysis for two reasons: first, the relevant "denominator" is the stock of wrongfully convicted individuals *prior* to the passage of DNA laws (reflecting our sample of exonerations of individuals convicted prior to the laws' passage). This denominator is fixed for a given state and thus is absorbed by the state fixed effects that we include in our baseline model. Second, a precise measure of the number of wrongfully convicted individuals who satisfy our various sample restrictions (e.g., conviction offense and sentence) is not available, forcing us to use a coarser measure of the incarcerated population by state.

fixed effects. In Table 2, column 6, one can see that controlling for the time-varying effect of the stock of incarcerated individuals does not affect meaningfully our estimates. Another consideration is whether DNA laws coincided with other institutional changes that may have contributed to DNA-based exonerations. We specifically consider the roles of innocence organizations and conviction integrity units, controlling for their (time-varying) presence in a state in Table 2, column 7. One can see that controlling for these institutional changes across states has almost no impact on the estimated effects of DNA laws. Next, we address the more general concern that different states followed different trends of exoneration (e.g., due to changing political, economic, or social environments), creating the spurious appearance of an effect of DNA laws. We thus, in Table 2, column 8, add state-specific quadratic time trends to the baseline model, and this, too, has almost no effect on our estimates. We next consider the different case composition depending on whether states adopted DNA laws early or late — late adopters will naturally have a different stock of wrongful convictions potentially uncovered by DNA laws. To address this concern, we consider only those exonerations that arise from convictions prior to *any* DNA law (in practice, wrongful convictions dating from 1993 or earlier). We estimate our baseline model considering only these exonerations and find very similar results (Table 2, column 9). We next consider the possibility that our results are driven by states that adopted DNA laws prior to the 1999 US Department of Justice report. These states (Illinois and New York) may have adopted DNA laws in anticipation of state-level changes in exonerations, while other states adopted DNA laws at least in part in response to the nation-level external event of the Report. We thus estimate our baseline model, but dropping Illinois and New York; our results are largely unchanged (Table 2, column 10).[31]

[31] We also consider the possibility that our results are driven by changed exonerations in specific US Federal Appeals Court Circuits. We drop one circuit at a time and find that our results estimated from the remaining circuits are very similar to the baseline estimates. See Online Appendix Table C.3.

Table 2: The Impact of DNA Laws on Exonerations

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Baseline	Standardized	Poisson	Shares Weighted	Shares Unweighted	Incarcerated Pop. × Year FE	IO-CIU	State Trends	Pre-1994 Convictions	Excl. IL and NY
Panel A: DNA-Based Exonerations										
Post	0.137***	0.607***	1.217***	0.430**	0.599***	0.105***	0.138***	0.138***	0.129***	0.114***
	(0.040)	(0.175)	(0.346)	(0.182)	(0.199)	(0.039)	(0.040)	(0.043)	(0.041)	(0.029))
Pre-Law $\bar{Y}$	0.039	0	0.039	0.299	0.299	0.039	0.039	0.039	0.04	0.04
Panel B: Total Exonerations										
Post	0.099**	0.230**	0.593**	0.269	0.423*	0.077*	0.097**	0.114**	0.082*	0.079**
	(0.040)	(0.092)	(0.299)	(0.190)	(0.248)	(0.040)	(0.041)	(0.043)	(0.043)	(0.032)
Pre-Law $\bar{Y}$	0.089	0	0.089	0.601	0.089	0.089	0.089	0.089	0.09	0.09
State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,530	1,530	1,530	1,511	1,511	1,530	1,530	1,530	1,530	1,470

Notes: Panel A reports results for DNA-based exonerations, while Panel B reports results for total exonerations. Column (1) estimates the baseline model controlling for state and year fixed effects. Column (2) uses a standardized dependent variable (mean 0, standard deviation 1). Column (3) estimates a Poisson model to account for the count nature of the data. Column (4) uses exoneration shares (i.e., exonerations/people incarcerated) as the outcome, weighting observations by the incarcerated population in each state×year. Missing incarceration data for a small number of state×year observations accounts for the reduced sample size. Column (5) uses exoneration shares as the outcome without weighting observations. Column (6) controls for the state's incarcerated population in the year before the implementation of its DNA law, interacted with a full set of year fixed effects. Column (7) controls for the time-varying presence of Innocence Organizations (IO) and Conviction Integrity Units (CIU). Column (8) adds state-specific quadratic time trends to the baseline model. Column (9) restricts the sample to exonerations arising from convictions before any DNA law (convictions dating from 1993 or earlier). Column (10) excludes Illinois and New York (states that adopted DNA laws before the 1999 US DOJ report) to address endogenous timing concerns. All regressions include state and year fixed effects. Standard errors clustered at the state level are reported in parentheses. Significance levels are indicated by *** p<0.01, ** p<0.05, * p<0.1.

Another broad class of questions about our baseline estimates is whether they are robust to relaxing the sample restrictions we imposed. In Online Appendix Table C.4, we consider a range of specifications that vary the crimes, cases, and years included. We first maintain our focus on sexual offenses, but now consider wrongful convictions regardless of the sentence imposed. This has no impact on the estimated effects of DNA laws, suggesting that the effects of the laws are primarily observed among individuals receiving life sentence cases (which is sensible, as discussed above). We then relax sample restrictions relating to both crime and sentence, considering all crimes and all sentences. We find that the estimated effect of DNA laws on DNA-based exonerations are nearly unchanged, while the effects on total exonerations are somewhat larger, albeit imprecisely estimated. Next, we include exonerations in the year of a DNA law's passage and in following years. We also estimate a model dropping the year when a state's DNA law was passed. In both cases, our results remain very similar to the baseline model. Finally, we consider the longest balanced panel that includes all 50 states plus Washington, DC (from 5 years before through 6 years after passage of a DNA law). Again, our baseline results are unaffected.

The staggered timing of DNA laws' passage raises the additional concern that early- and late-adopting states may exhibit heterogeneous treatment effects. Such heterogeneity may distort treatment effect estimates (see Goodman-Bacon, 2021, De Chaisemartin and d'Haultfoeuille, 2020, Borusyak et al., 2024). To assess the impact of the staggered timing of DNA laws' passage, we first follow Goodman-Bacon (2021), and estimate treatment effects (from our parsimonious specification presented in Table 2, column 1) separately for early adopters (relative to later adopters) and late adopters (relative to early adopters). We also separately estimate all of the possible 2×2 diff-in-diff estimates (comparing states treated in a given year to comparison states treated in every other year). One can see in Online Appendix Figure B.2, Panels A and D, that early- and late-adopters' treatment effects are very similar to each other, and to our baseline model. One can also see that our estimates are not driven by a small number of highly-weighted estimates. We next implement three estimators allowing for heterogeneous and dynamic treatment effects (Sun and Abraham, 2021, Callaway and Sant'Anna, 2021, Borusyak et al., 2024). One can see in Online Appendix Figure B.3, Panels A and D, that we find statistically significant effects of DNA laws on both DNA-based and total exonerations across specifications.

5.2 Heterogeneous Effects of DNA Laws by Race

We next consider the effects of DNA laws by race. To do so, we construct a state×year×race panel (where race is Black or non-Black), and estimating both event-study and triple-difference models.

Event study estimates We begin our analysis of DNA laws' heterogeneous effects by race by estimating the following event study model:

$$Exoneration_{str} = \gamma_s + \delta_t + \sum_T \beta_{1T} Law_{it} + \sum_T \beta_{2T} Law_{it} * \mathbf{1}_{r=\text{Black}} + \beta_3 * \mathbf{1}_{r=\text{Black}} + \epsilon_{st},$$

where the outcome, $Exoneration_{str}$, is now a count of exonerations in state s in year t for individuals of race r.[32] The model is identical to the event study model estimated above, but adds an indicator variable for the Black exoneration category ($\mathbf{1}_{r=\text{Black}}$), as well as the interaction between the Black exoneration category and the series of time-varying effects of DNA laws. The interactions' effects, $\sum_T \beta_{2T} Law_{it} * \mathbf{1}_{r=\text{Black}}$, capture the *differential* time-varying effects, depending on the number of years to/from the passage of a DNA law, by race. As in the event study above, we control for state fixed effects (γ_s) and year fixed effects (δ_t) and cluster standard errors by state.

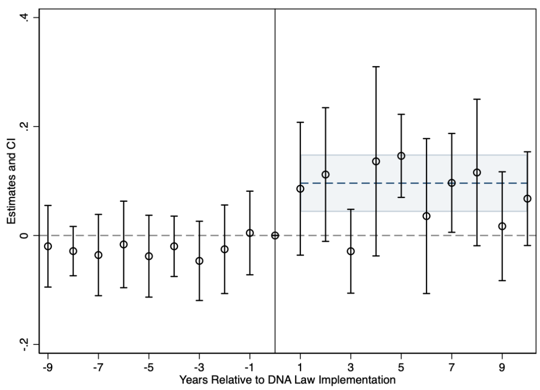
In Figure 3, Panel A, we consider only DNA-based exonerations as the outcome, and plot the sums of the coefficients β_{1T} and β_{2T}, showing the evolution of DNA-based exonerations for wrongfully convicted Black individuals around the passage of DNA laws.[33] In Panel B, we plot the same sums of coefficients in a model considering all exonerations as the outcome, showing the evolution of total exonerations for wrongfully convicted Blacks.

Recall that our Hypothesis 2 proposed that DNA laws should increase both DNA-based and total exonerations among wrongfully convicted Blacks. Examining the patterns in Figure 3, Panels A and B, one can see that these predictions receive strong support. Exonerations of Black individuals appear to follow parallel trends across states prior to the passage of DNA laws; however, immediately following DNA laws' passage we see that Black exonerations — both DNA-based and total — significantly increase, remaining above their pre-law level for an entire decade. We

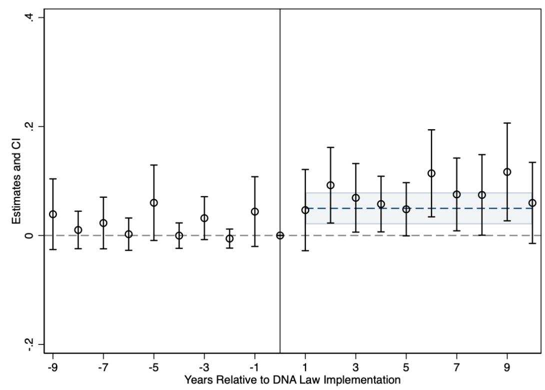
[32] Race is coded as either the exoneration of Black individuals or non-Black individuals. As in the event study pooling races, we include all exonerations from 10 years prior to the passage of a DNA law in state s until 10 years after the law's passage. Again, "states" include Washington, DC.

[33] To be clear, this is not the *differential* exoneration of Black individuals, compared to non-Blacks, which we discuss further below. We report the plotted sums of coefficients in Online Appendix Table C.5.

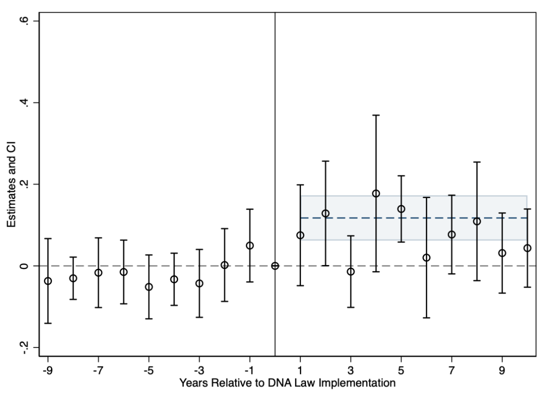
Figure 3: Event Study: Impact of DNA Laws on Exonerations over Time, By Race



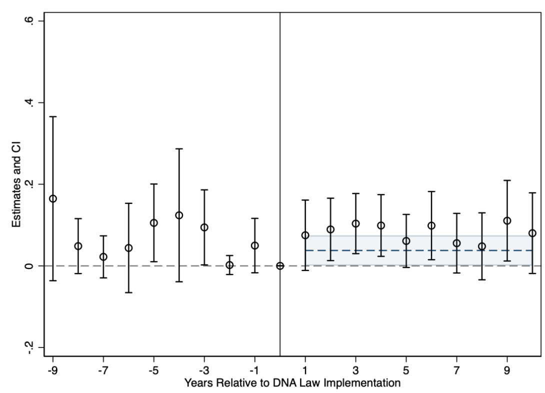
(a) DNA-based Exonerations: Black



(b) DNA-based Exonerations: Non-Black



(c) Total Exonerations: Black



(d) Total Exonerations: Non-Black

Notes: These figures present event study estimates and 90% confidence intervals for the impact of DNA laws implementation on exonerations. The x-axis represents years relative to the year of the law's passage (Year 0), which is omitted as the reference category. The top panel focuses on DNA-based exonerations, while the bottom panel includes all exonerations. Dashed horizontal lines represent the post-treatment average effect. All specifications include state and year fixed effects with standard errors clustered at the state level.

estimate an effect of DNA laws of around 0.10 additional DNA-based, and 0.12 total, exonerations of Black individuals per state×year following the passage of a DNA law. This amounts to around 50 DNA-based exonerations and 60 total exonerations in the decade following DNA laws' passage.

In addition to showing year-by-year exonerations, we also we show in hatched boxes the estimated effects of DNA laws for Blacks over the entire post-law period, relative to the entire pre-law period. To be precise, we estimate a simple difference in difference model as we did above, but now including a dummy variable for Black exonerations, as well as the interaction of $Post_{st} \times Black_r$, and plot the sum of the post-law coefficient and the interaction, along with the 90% confidence interval relative to the entire pre-law period, controlling for state and year fixed effects. The boxes capture the general patterns seen in the event study estimates: significant effects of DNA laws on Blacks' DNA-based and total exonerations.

In Figure 3, Panels C and D, we repeat the analyses from Panels A and B, but now examining exonerations among non-Blacks; that is, we plot the coefficients β_{1T} from the event study model, considering only DNA-based exonerations (Panel C) and total exonerations (Panel D), respectively. As in Panels A and B, we also we show in hatched boxes the estimated effects of DNA laws for non-Blacks over the entire post-law period, relative to the entire pre-law period.

Recall that our Hypothesis 2 proposed that DNA laws should strictly increase DNA-based exonerations for non-Blacks, but only weakly increase total exonerations due to greater substitution across exoneration technologies for non-Blacks. One can see evidence consistent with our predictions in Figure 3. Examining the estimates in Figure 3, Panel C, one can first see that DNA-based exonerations for non-Blacks follow parallel trends prior to DNA laws' passage, then significantly increase by around 0.05 per state×year following the passage of a DNA law. This amounts to around 25 additional DNA-based exonerations for non-Blacks in the decade following DNA laws. In Figure 3, Panel D, one can see that some individual years prior to the passage of a DNA law exhibited more exonerations of non-Blacks than in the year of the law's passage; yet, there is no systematic pre-law trend in total exonerations for non-Blacks. Following the passage of a DNA law, one can see a marginally significant increase in total exonerations of non-Blacks of around 0.04 per state×year. Especially given the noisy pre-law estimates, we do not draw strong conclusions regarding the effect of DNA laws on the total exonerations of non-Blacks. We explore this effect across a range of specifications in a range of difference in difference specifications, next.

Triple-difference estimates and robustness We next estimate DNA laws' effects over the entire post-law period, compared to the pre-law period, allowing for differential exonerations by race in the pre-period, as well as heterogeneous effects of DNA laws by race. To do so, we use our state×year×race panel (where race is Black or non-Black), and estimate the following triple-difference model:

$$Exoneration_{str} = \gamma_s + \delta_t + \beta_1 * Post_{st} + \beta_2 * \mathbf{1}_{r=\text{Black}} + \beta_3 * Post_{st} * \mathbf{1}_{r=\text{Black}} + X_{st} + \epsilon_{str},$$

where the outcome, $Exoneration_{str}$, is a count of exonerations in state s in year t for individuals of race r. The model is identical to the difference-in-differences model estimated above, but adds an indicator variable for the Black exoneration category ($\mathbf{1}_{r=\text{Black}}$), as well as the interaction of $Post_{st}$ and $\mathbf{1}_{r=\text{Black}}$. The coefficient on $\mathbf{1}_{r=\text{Black}}$ (β_2) estimates the difference in exoneration counts for Blacks and non-Blacks in the era prior to DNA laws. The coefficient on $Post_{st} * \mathbf{1}_{r=\text{Black}}$ (β_3) allows the impact of DNA laws to differ between Blacks and non-Blacks. As above, we control for state fixed effects (γ_s) and year fixed effects (δ_t), and include different sets of state×year-varying controls (X_{st}) in different specifications; again, ϵ_{st} is the error term, and we allow it to be correlated across observations for the same state.

In Table 3, Panel A we present estimates from the model considering only DNA-based exonerations as the outcome, and in Panel B we present estimates using total exonerations as the outcome; we report the coefficients β_2 (showing pre-law differences in exoneration by race); β_1 (showing the impact of DNA laws for non-Blacks); and β_3 (showing the differential impact of DNA laws for Blacks. We also report p-values from a test that the sum of β_1 and β_3 equals zero (which tests the null hypothesis that DNA laws have no effect on Black individuals' exonerations).

In column 1, we show the estimated effects of DNA laws from a parsimonious model controlling only for state and year fixed effects. One can see in Panel A that prior to DNA laws, there was no significant difference in DNA-based exonerations between Blacks and non-Blacks; following DNA laws' passage, DNA-based exonerations significantly increase for both Blacks ($p < 0.01$) and non-Blacks ($p < 0.01$). DNA laws are estimated to have a larger effect on Blacks' exonerations, but this differential effect is marginally statistically insignificant ($p = 0.13$). When examining total exonerations, one can see that Black exonerations were modestly (statistically insignificantly) below those of non-Blacks prior to DNA laws' passage. Following DNA laws, one can see that total exonerations modestly (statistically insignificantly) increase for non-Blacks ($p = 0.37$), while total exonerations significantly increase for Blacks, by 0.08 per state×year ($p < 0.01$), qualitatively similar to what we observed in the event study analysis presented in Figure 3. We also find that the effect of DNA laws on Blacks is statistically significantly greater than that for non-Blacks ($p < 0.05$).[34] The magnitude of the effect on Black exonerations is substantial: it represents nearly a 100% increase in exonerations relative to the pre-law mean of 0.089 across races, and is even more striking relative to the 0.03 per state×year for Blacks.

We next evaluate the robustness of these estimates to a variety of different modeling choices, as was done in our baseline difference in difference analysis presented in Table 2. Now, in Table 3, column 2, we estimate our baseline model from column 1, but now consider standardized exonerations (rather than counts) as the outcome, and in column 3, we estimate a Poisson model. One can see that our conclusions are unchanged: consistent with our Hypothesis 2, DNA laws increase DNA-based exonerations for Blacks and non-Blacks, while increasing total exonerations significantly for Blacks, but not for non-Blacks (with the difference between groups also being statistically significant). In columns 4 and 5, we construct exoneration *shares* in each state×year×race cell, with exonerations in the numerator and the incarcerated population of race r in each state×year cell in the denominator (we weight observations by the incarcerated population in each state×year×race cell in column 4; unweighted estimates are shown in column 5). One can see that our results are qualitatively the same when considering exoneration shares.

[34] In Online Appendix Table C.6, columns 7 and 8, we present estimates of the same specifications as in Table 3, column 1, but considering (i) a comparison of Black individuals' exoneration against White individuals' (i.e., dropping Hispanics from the non-Black category); (ii) a comparison of Whites' exonerations against the exoneration of minorities (i.e., pooling Hispanics with Black individuals). We find that a comparison between Black individuals and Whites does not affect our findings of substantial and significant effects of DNA laws for Black individuals' exonerations. We also find that a consideration of "minorities" as a group yields patterns very similar to those considering Black individuals. These findings are, perhaps, unsurprising given that over 95% of minority individuals in our sample are Black and over 90% of the non-Black individuals in our sample are White.

Table 3: The Impact of DNA Laws on Exonerations by Race

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Baseline	Stand.	Poisson	Shares Weighted	Shares Un-weighted	Incarc. × Year FE	IO-CIU	State Trends	Pre-94 Convict.	Excl. NY & IL
Panel A: DNA-Based Exonerations										
Post	0.0545***	0.359***	1.088**	0.328**	0.915	0.0357**	0.0557***	0.0495***	0.0494***	0.0478***
	(0.0152)	(0.0980)	(0.441)	(0.158)	(0.579)	(0.0151)	(0.0165)	(0.0160)	(0.0170)	(0.0120)
Black	0.00937	1.27e-07	0.492	0.0840	-0.133	0.00970		-0.00780	0.00937	0.00820
	(0.00869)	(0.0558)	(0.435)	(0.0941)	(0.178)	(0.00866)		(0.0150)	(0.00869)	(0.00877)
Post × Black	0.0277	0.150	0.201	0.223	1.199	0.0304*	0.0263	0.0387*	0.0302*	0.0189
	(0.0178)	(0.114)	(0.505)	(0.138)	(1.113)	(0.0180)	(0.0261)	(0.0194)	(0.0153)	(0.0158)
Total Effect on Blacks	0.0822***	0.5089***	1.2887***	0.5507**	2.113	0.0660***	0.0820***	0.0881***	0.0797***	0.0666***
	(0.0264)	(0.1637)	(0.4114)	(0.2243)	(1.6113)	(0.0245)	(0.0294)	(0.0281)	(0.0255)	(0.0199)
Pre-Law $\bar{Y}$	0.039	0	0.039	0.299	0.299	0.039	0.039	0.039	0.04	0.04
Panel B: Total Exonerations										
Post	0.0185	0.0769	0.0784	-0.0180	0.492	0.00909	0.0246	0.0282	0.00689	0.0145
	(0.0205)	(0.0778)	(0.353)	(0.200)	(0.618)	(0.0176)	(0.0221)	(0.0197)	(0.0230)	(0.0198)
Black	-0.0201	-8.48e-08	-0.455	-0.227	-0.371	-0.00986		-0.0256	-0.0174	-0.0219
	(0.0180)	(0.0572)	(0.357)	(0.161)	(0.294)	(0.0120)		(0.0175)	(0.0176)	(0.0183)
Post × Black	0.0622**	0.333***	1.006**	0.623***	1.628	0.0612**	0.0476	0.0501**	0.0685***	0.0503**
	(0.0258)	(0.108)	(0.391)	(0.193)	(1.166)	(0.0249)	(0.0318)	(0.0228)	(0.0228)	(0.0240)
Total Effect on Blacks	0.0807***	0.4102***	1.0840***	0.6054***	2.1204	0.0703***	0.0721**	0.0783***	0.0754***	0.0648***
	(0.0264)	(0.1351)	(0.3308)	(0.2118)	(1.6357)	(0.0264)	(0.0293)	(0.0265)	(0.0252)	(0.0198)
Pre-Law $\bar{Y}$	0.089	0	0.089	0.601	0.089	0.089	0.089	0.089	0.09	0.09
Observations	3,060	3,060	3,060	3,016	3,016	3,060	3,060	3,060	3,060	2,940

Notes: 'Post' is the effect of the policy on Non-Blacks. 'Black' estimates the pre-law difference. 'Post × Black' estimates the differential impact on Blacks. 'Total Effect on Blacks' reports the linear combination of the Post coefficient and the Interaction term. Columns correspond to: (1) Baseline model; (2) Standardized outcome; (3) Poisson model; (4) Exoneration shares weighted by incarcerated population by race; (5) Exoneration shares unweighted; (6) Controls for state incarcerated population (by race) in the year before the law's adoption × Year FE; (7) Controls for the opening of the first IO & CIU × Race FE; (8) State × Race specific quadratic time trends; (9) Sample restricted to convictions finalized before 1994 (pre-DNA laws); (10) Sample excludes IL and NY (early adopters). All regressions include state and year fixed effects. Standard errors clustered at the state level are reported in parentheses. Significance levels are indicated by *** p<0.01, ** p<0.05, * p<0.1.

We next consider specifications that help address questions about the possibly endogenous timing of DNA laws. First, to address concerns about differential DNA law adoption timing in more punitive states, we control for the state's incarcerated population (now *by race*) in the year prior to the implementation of its DNA law interacted with a full set of year fixed effects. One can see in Table 3, column 6, that this set of controls does not meaningfully affect our estimates. Another consideration is whether DNA laws coincided with other institutional changes that may have contributed to DNA-based exonerations, and which might have had differential effects by race. We specifically consider the race-specific effects of innocence organizations and conviction integrity units, controlling for their (time-varying) presence in a state, interacted with the race dummy variable. In Table 3, column 7, one can see that controlling for these race-specific effects of institutional changes has almost no impact on the estimated effects of DNA laws. Next, we address the more general concern that different states followed different race-specific trends of exoneration (e.g., due to changing political, economic, or social environments), creating the spurious appearance of an effect of DNA laws that differs by race. We thus, in Table 3, column 8, add state×race-specific quadratic time trends to the baseline model, and this, too, has almost no effect on our estimates. We next consider the different case composition depending on whether states adopted DNA laws early or late — late adopters will naturally have a different stock of wrongful convictions potentially uncovered by DNA laws. To address this concern, we consider only those exonerations that arise from convictions prior to *any* DNA law (in practice, wrongful convictions dating from 1993 or earlier). We estimate our baseline model considering only these exonerations and find very similar results (Table 3, column 9). We finally consider the possibility that our results are driven by states that adopted DNA laws prior to the 1999 US Department of Justice report (Illinois and New York). We thus estimate our baseline model, but dropping Illinois and New York; our results are largely unchanged (Table 3, column 10).[35]

We next examine whether the estimated differential effects of DNA law by race are robust to relaxing the sample restrictions we imposed. We consider the same range of specifications that vary the crimes, cases, and years included as we presented in Online Appendix Table C.4. We first consider all sexual offenses regardless of sentence length; we then consider all crimes and all sen-

[35]We also consider the possibility that our results are driven by changed exonerations in specific US Federal Appeals Court Circuits. We drop one circuit at a time and find that our results estimated from the remaining circuits are very similar to the baseline estimates. See Online Appendix Table C.7.

tence lengths; and, we include convictions from years after DNA laws are adopted. We then drop exonerations the year in which a DNA law was passed; finally, we estimate our baseline model on the longest possible balanced panel. One can see in Online Appendix Table C.6, columns 2–6, that in comparison with the baseline (column 1), our results are very robust to these changes in sample. In particular, we generally see DNA laws increasing DNA-based exonerations for Blacks and non-Blacks, while total exonerations only significantly increase for Blacks. We finally consider once more the impact of the staggered timing of DNA laws' passage on our estimated heterogeneous effects by race. One can see in Online Appendix Figures B.2 and Figure B.3, Panels B, C, E, and F, that our results are not likely to be driven by these concerns.

5.3 Heterogeneous Effects of DNA Laws

Why do DNA laws differentially increase total exonerations of wrongfully convicted Black individuals? In our conceptual framework we proposed that Blacks may have faced a higher cost of accessing non-DNA exoneration technology, perhaps reflecting a discriminatory legal environment facing wrongfully convicted Blacks. In this case, DNA laws providing streamlined access to a powerful, less discriminatory exoneration technology (i.e., DNA testing) would be particularly important in a context of greater racial discrimination. DNA laws would also be particularly impactful for Black individuals where the DNA laws were more expansive, i.e., allowing a broader range of convicted individuals greater access to DNA testing. We next test these predictions of our framework.

We estimate the following model allowing heterogeneous effects by both race, r, and by a state characteristic index, $index_s$, where the characteristic index is either racial animus or the expansiveness of DNA laws in state s:

$$\begin{aligned} Exoneration_{str} &= \gamma_s + \delta_t + \beta_1 * Post_{st} + \beta_2 * \mathbf{1}_{r=\text{Black}} + \beta_3 * Post_{st} * \mathbf{1}_{r=\text{Black}} \\ &+ \beta_4 * Post_{st} * \mathbf{1}_{r=\text{Black}} * index_s \\ &+ \beta_5 * \mathbf{1}_{r=\text{Black}} * index_s + \beta_6 * Post_{st} * index_s + X_{st} + \epsilon_{str}. \end{aligned}$$

The outcome, $Exoneration_{str}$, is a count of total exonerations in state s in year t for individuals of race r. In addition to the variables included in the model testing for heterogeneous effects of DNA laws by race, this model includes the interaction of the post-law indicator, the Black race indicator, *and* an index of a state characteristic, $index_s$, which is either racial animus in a state, $animus_s$, or the expansiveness of DNA laws in a state, $expansiveness_s$. The model also includes the lower order terms in this interaction.

For our measure of racial animus, we consider an index that is the standardized first principal component of the state's: (i) membership in the Confederacy; (ii) exposure to Section 5 of the Voting Rights Act; and (iii) historical lynchings of Black Americans. Our measure of DNA law expansiveness is the standardized first principal component of indicator variables for: (i) restrictions on the scope of coverage; (ii) requirements for pre-motion legal counsel; and, (iii) financial costs to the petitioner (all coded so that the principal component is larger for states with more expansive laws).[36]

In Table 4, we present our findings. For reference, we present estimates from our baseline specification (without considering state-level heterogeneity) in column 1, estimated from the same sample of 48 states for which we are able to measure all components of our indices. Results are very similar to those in Table 3, column 1. In column 2, we estimate a model allowing for heterogeneous effects depending on the expansiveness of a state's DNA law. One can see that at the mean expansiveness index value of 0, DNA laws are estimated to have a significant and positive differential impact on the exoneration of Black individuals (this is captured by the coefficient on $Post_{st} * \mathbf{1}_{r=\text{Black}}$). Consistent with the prediction of our conceptual framework, one can see that more expansive DNA laws further enhance the impact of DNA laws on Blacks' exonerations — the coefficient on $Post_{st} * \mathbf{1}_{r=\text{Black}} * index_s$ is positive and statistically significant. A one standard deviation increase in the expansiveness index nearly doubles the differential effect of DNA laws on Blacks' exonerations. In column 3, we estimate an analogous model, but now allowing for heterogeneous effects depending on a state's historical racial animus. One can see that at the mean level of racial animus, DNA laws are again estimated to have a significant and positive differential impact on the exoneration of Black individuals. Again, consistent with the prediction of our conceptual framework, DNA laws have a significantly greater effect on Blacks in states with greater racial animus, with DNA laws' differential effects on Blacks nearly doubling in states with one standard deviation greater racial animus.

[36]Consideration of any one of the index components alone yields nearly identical results. See Online Appendix Table C.8.

A natural question is whether these two dimensions of heterogeneity are distinct: perhaps those states with greater historical racial animus are those implementing less expansive DNA laws. In fact, the correlation between the racial animus index and the expansiveness index is a statistically insignificant 0.04, suggesting that there exists meaningful independent variation in the two indices to allow for identification of each of their effects, controlling for the other. To more systematically evaluate the impact of these two dimensions of state heterogeneity, we estimate our model testing for heterogeneous effects of DNA laws by race, now including interactions between the post-law indicator, the Black race indicator, and *both* state characteristic indices (as well as all lower-order terms). In Table 4, column 4, one can see that in states at the mean level of racial animus and DNA law expansiveness, DNA laws are estimated to have significant, positive differential effects on the exoneration of Black individuals. Moreover, *both* greater DNA law expansiveness and greater historical racial animus are estimated to significantly increase DNA laws' effects, holding the other dimension of heterogeneity fixed.

5.4 The Effect of DNA Laws on the Speed of Exoneration

We next turn to the question of how these DNA laws affected a second margin along which the injustice of wrongful conviction can be addressed: the *rate* at which the wrongfully convicted were exonerated. We begin by presenting descriptive evidence suggesting the effects of DNA laws on the rate of exoneration. In Figure 4, Panel A, plot Kaplan-Meier estimated "survival curves" (i.e., curves indicating estimated time in prison prior to exoneration) showing the time to exoneration for all wrongfully convicted individuals (pooling across races), before versus after the passage of DNA laws. One can see in the figure that individuals were exonerated far more quickly following DNA laws' passage.

In Figure 4, Panel B, we consider the differential effects of DNA laws by race, plotting Kaplan-Meier estimated survival curves showing the time to exoneration for: (i) Black individuals, prior to DNA laws; (ii) non-Black individuals, prior to DNA laws; (iii) Black individuals, after DNA laws; and, (iv) non-Black individuals, after DNA laws. One can see in the figure that the acceleration in the rate of exoneration following the passage of DNA laws was largely due to the effects of the laws on wrongfully convicted Blacks. One can see that prior to DNA laws' passage, wrongfully convicted Black individuals were estimated to remain in prison for a far longer time than non-

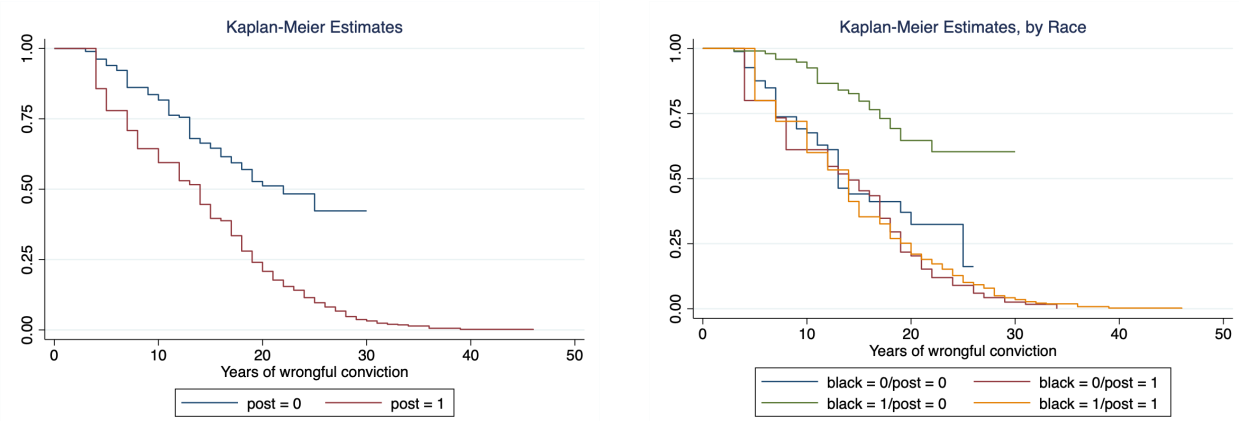
Table 4: Heterogeneous Effects of DNA Laws on Exonerations

	(1) Baseline	(2) Expansiveness Index	(3) Racism Index	(4) Horse Race
Post	0.0193	0.0190	0.0161	0.0160
	(0.0222)	(0.0219)	(0.0229)	(0.0228)
Black	-0.0216	-0.0223	-0.0227	-0.0234
	(0.0193)	(0.0192)	(0.0194)	(0.0193)
Post × Black	0.0632**	0.0644**	0.0676**	0.0687**
	(0.0273)	(0.0261)	(0.0273)	(0.0264)
Post × Expansion Index		-0.0434		-0.0434
		(0.0352)		(0.0358)
Black × Expansion Index		-0.0365		-0.0372
		(0.0307)		(0.0306)
Post × Black × Expansion Index		0.0594*		0.0557*
		(0.0324)		(0.0330)
Post × Racism Index			0.00884	0.0108
			(0.0162)	(0.0171)
Black × Racism Index			0.0227*	0.0237
			(0.0134)	(0.0143)
Post × Black × Racism Index			0.0532**	0.0510**
			(0.0254)	(0.0247)
Observations	2,880	2,880	2,880	2,880
State FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES

Notes: The table reports estimates including interactions with state-level indices. The outcome variable is total exonerations. 'Expansiveness Index' proxies for greater access to forensic DNA testing in a state. 'Racism Index' proxies for a state's historical racial animosity. Our measure of DNA law expansiveness is the standardized first principal component of indicator variables for: (i) restrictions on the scope of coverage; (ii) requirements for pre-motion legal counsel; and (iii) financial costs to the petitioner (all coded so that the principal component is larger for states with laws supporting petitioner access to DNA technology). Our measure of racial animus is an index that is the standardized first principal component of the state's: (i) membership in the Confederacy; (ii) exposure to Section 5 of the Voting Rights Act; and (iii) historical lynchings of Black Americans. All analyses (including the baseline specification, for comparison) are conducted on 48 states because for three states lynchings data are not available. All regressions include state and year fixed effects. Standard errors clustered at the state level are reported in parentheses. Significance levels are indicated by *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Black individuals. Moreover, Black individuals were estimated to remain in prison far longer prior to DNA laws than following DNA laws' passage. Indeed, we find that following DNA laws, Black and non-Black individuals' survival curves are nearly overlapping. Non-Black individuals appear to benefit slightly from DNA laws, experiencing slightly early exoneration following the laws' passage.

Figure 4: Time to Exoneration by Race and Policy Period



(a) Pre- vs. Post-Law Adoption

(b) By Race and Policy Period

Notes: Kaplan-Meier survival curves show the probability of remaining incarcerated for a wrongful conviction over time. Panel (a) shows the overall acceleration of exonerations post-law ($post = 1$). Panel (b) illustrates that while Black defendants ($black = 1$) faced significantly lower exoneration rates pre-law, the gap narrows substantially in the post-law period. Non-Black defendants show a significantly higher baseline probability of exoneration prior to law adoption, and they experience a comparatively smaller increase in the speed of exoneration following the policy change.

To more systematically examine the effects of DNA laws on the time to exoneration, we estimate Cox proportional hazard models using individual, exoneree-level data. We first pool together wrongfully convicted individuals of all races, estimating the following model:

$$E_{ist} = E_0(t)\exp(\gamma_s + \delta_t + \beta_1 * Post_{ist}) + \epsilon_{ist},$$

where the outcome of interest is an exoneration dummy variable, E_{ist}, indicating whether an individual i, who was convicted in state s is exonerated in year t. $E_0(t)$ is the baseline hazard function evaluated in year t; γ_s and δ_t are sets of state and year fixed effects, respectively. The coefficient of interest is on the $Post_{ist}$ dummy variable, β_1, which captures the change in the likelihood of exoneration after the passage of a DNA law in state s.

One can see the results in Table 5, column 1. We find a coefficient on $Post_{ist}$ equal to 0.626, which implies an increased rate of exoneration of around 87% relative to the pre-law period.[37] It appears that, consistent with the pattern seen in Figure 4, Panel A, DNA laws significantly accelerated the rate of exoneration when considering all wrongfully convicted individuals.

We next test for heterogeneous effects of DNA laws on exoneration rates by the race of the wrongfully convicted individual. To examine this possibility, we estimate the following model:

$$E_{ist} = E_0(t)\exp(\gamma_s + \delta_t + \beta_1 * Post_{ist} + \beta_2 * Black_{ist} + \beta_3 * Post_{ist} * Black_{ist}) + \epsilon_{ist},$$

which is the same as the specification estimated in Table 5, column 1, but now adding a dummy variable indicating that an individual is Black, as well as the interaction of the Black indicator with the post-law dummy variable. We present our estimates in Table 5, column 2. The estimated coefficient on $Black_{ist}$ is -0.912, indicating a 60% lower likelihood of exoneration for wrongfully convicted Blacks prior to the passage of DNA laws (again matching what was seen in Figure 4, Panel B). The estimated coefficient on $Post_{ist}$ — indicating the effect of DNA laws on non-Blacks — is 0.151, suggesting a slight increase in the rate of exoneration, but this effect is not statistically significantly different from 0. The difference between the effect of DNA laws on Blacks and on non-Blacks can be observed in the coefficient on $Post_{ist} * Black_{ist}$: this is 0.894, or around a 150% greater effect of DNA laws on Blacks. The effect of DNA laws on wrongfully convicted Blacks can be calculated as the sum of the coefficient on coefficient on $Post_{ist}$ and that on $Post_{isct} * Black_{ist}$: this is 1.045, indicating a nearly 200% increase in the rate of exoneration for Blacks following the passage of DNA laws. In Table 5, we also present the sum of the coefficients on $Black_{ist}$ and on $Post_{ist} * Black_{ist}$, which captures the post-law difference in exoneration rates for Black and non-Black individuals. One can see that this sum of coefficients is very close to 0 (to be precise, it is -0.019) and is statistically indistinguishable from 0, indicating a substantial degree of convergence (and again matching Figure 4, Panel B).[38]

We next consider a range of possible questions about the estimates from the parsimonious specification presented in Table 5, column 2. First, we consider the possibility that changes in exoneration rates post-law may not reflect racial differences, but rather differences in other character-

[37]This can be seen by exponentiating the coefficient: $\exp(0.626) = 1.870$, indicating an 87% increase in the hazard ratio.

[38]Even the lower bound of our 90% confidence interval indicates that half of Black individuals' pre-law disadvantage in exoneration rates was closed by DNA laws. At the upper end of the 90% confidence interval, Black individuals are actually estimated to be exonerated nearly 50% more rapidly than non-Blacks in the post-law period.

istics of the wrongfully convicted correlated with race. We thus, in Table 5, column 3, estimate the model from column 2, but adding a set of "baseline controls": fixed effects for the crime allegedly committed; demographic characteristics of the wrongfully convicted; and a set of case characteristics. One can see that our findings in column 3 essentially match what was found before. Next, we add to the model with baseline controls fixed effects for the year of conviction (holding fixed both the year of conviction and the year of exoneration). This analysis compares individuals in prison for the same length of time. In Table 5, column 4, one can see that our results are very similar, although they are a bit less precise due to loss of power. In column 5, we add to the model with baseline controls additional features of the individual's exoneration: the involvement of a conviction integrity unit or an innocence organization, and the use of DNA technology. While these controls may be endogenous, one may wonder whether they account for the differential changed rates of exoneration by race following DNA laws' passage (e.g., if Innocence Organizations are established post-law and differentially assist wrongfully convicted Blacks). In fact, we find that these controls do not greatly affect our estimates. Finally, one may wonder whether the baseline controls have time-varying effects on exoneration rates associated with the timing of DNA laws' passage. While we do not have statistical power to allow each of the baseline controls to have time varying effects, we can collapse the controls into their first principal component and add this plus its interaction with $Post_{ist}$ to our model with baseline controls. One can see in Table 5, column 6, that these controls due not affect our findings.[39]

[39]In Online Appendix Table C.9, we explore the robustness of the survival analysis findings with respect to our sample choices. We find that our results are essentially unchanged if we consider: only convictions prior to the passage of any DNA law; convictions that occurred following a state's DNA law passage; a broader set of conviction offenses and sentence severity; convictions after DNA laws were passed; a strict comparison of Blacks and non-Hispanic Whites; or, a comparison of Blacks and Hispanics (i.e., "minorities") versus Whites.

Table 5: The Impact of DNA Laws on the Rate of Exoneration

	(1)	(2)	(3)	(4)	(5)	(6)
	Pooling Races	Parsimonious	Baseline Controls	Baseline Controls + Year of Conviction FE	Baseline Controls + Endogenous Controls	Baseline Controls + PCA × Post
Post	0.626**	0.151	0.212	0.190	-0.010	0.130
	(0.308)	(0.368)	(0.380)	(0.428)	(0.412)	(0.385)
Black		-0.912***	-0.676*	-0.486	-0.615	-0.709*
		(0.301)	(0.370)	(0.434)	(0.393)	(0.369)
Post × Black		0.894**	0.792**	0.778	0.858**	0.894**
		(0.404)	(0.403)	(0.485)	(0.428)	(0.436)
Total Effect on Blacks		1.045***	1.004***	0.968***	0.849***	1.024***
		(0.328)	(0.320)	(0.341)	(0.312)	(0.319)
Test of Convergence		-0.019	0.115	0.292	0.243	0.185
		(0.245)	(0.316)	(0.320)	(0.337)	(0.340)
State FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,448	3,448	3,448	3,448	3,448	3,448

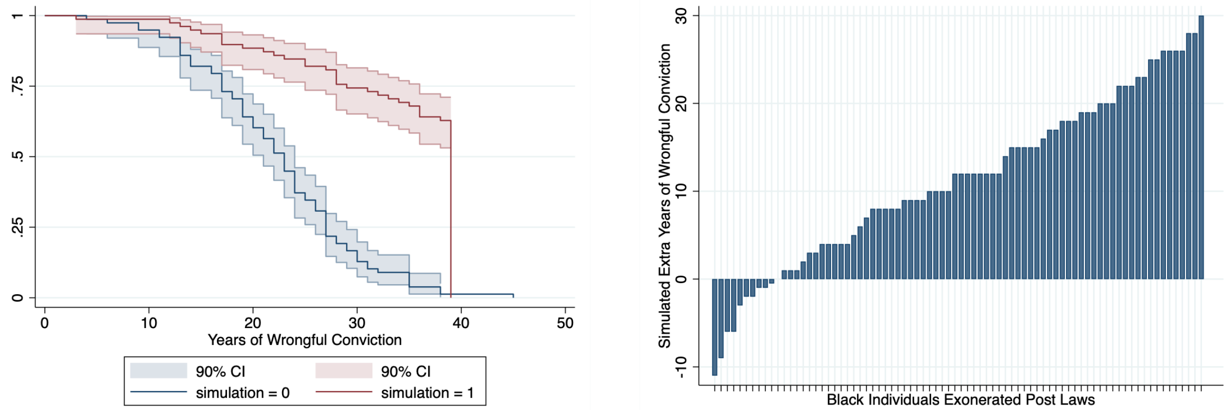
Notes: Table presents estimates Cox proportional hazard models using individual, exoneree-level data, as described in the text. Column (1) estimates the model pooling across races. Column (2) introduces the race interaction into the baseline model. Column (3) adds baseline controls: demographics, wrongful conviction, and crime fixed effects. Column (4) adds year of conviction fixed effects to column 3. Column (5) adds to column 3 other potentially endogenous controls: whether the exoneration was achieved using DNA technology, conducted by an Innocence Organization, or a Conviction Integrity Unit. Column (6) adds to column 3 the Principal Component (obtained using all the controls employed in column 3) and its interaction with the variable Post. The "Total Effect on Blacks" row reports the linear combination of the post-policy coefficient and the interaction term. The "Test of Convergence" reports the sum of the race indicator and the interaction term. All regressions include state and year fixed effects. Standard errors clustered at the state level are reported in parentheses. Significance levels are indicated by *** p<0.01, ** p<0.05, * p<0.1.

Simulation Exercise: Exoneration Rates in the Absence of DNA Laws To quantify the increase in Blacks' rate of exoneration, we conduct a counterfactual simulation of exoneration rates had the DNA laws not passed. To do so, we first estimate a survival rate in the pre-DNA law period for wrongfully convicted Blacks using the cross-sectional characteristics included in Table 5, column 3: state fixed effects, age at conviction, gender, case characteristics, and offense (i.e., crime) fixed effects. This model tells us how individual and case characteristics predicted individual exoneration rates *prior* to the DNA laws' passage. We then use the coefficients on individual and case characteristics estimated from the *pre*-law data to predict the hazard rates wrongfully convicted Blacks would have faced in the post-law era had the DNA laws not passed.

For the 78 Black individuals wrongfully convicted of sexual offenses and sentenced to life in prison prior to the DNA laws' passage, and who were not yet exonerated at the time of DNA laws, we simulate each individual's time to exoneration using their counterfactual pre-law predicted hazard rate 1,000 times. For each individual, we calculate the median time in prison prior to exoneration across the 1,000 iterations, up to a maximum of 39 years in prison, which the US government considers a full term for a life sentence. In Figure 5, Panel A, we plot the simulated Kaplan-Meier survival curve and also plot for comparison these individuals' *actual* survival curve. Among the 78 Black individuals wrongfully convicted of sexual offenses (and sentenced to life in prison) prior to the DNA laws' passage, and not yet exonerated, we find that in the "typical" (i.e., median) simulation over 60% of these individuals would *not* have been exonerated without DNA laws, spending their lives behind bars.[40] This corresponds quite closely to the our estimate of 50–60 additional Black individuals exonerated as a result of DNA laws in our state×year×race-level panel. It also suggests that DNA laws significantly amplified the impact of DNA technology *per se*. Among those Black individuals in our sample, we find a *total* of 76 DNA-based exonerations; our simulation suggests that *two-thirds* of the DNA-based exonerations we observe were attributable to DNA laws.

[40] We count as "exonerated" individuals predicted to have been released prior to the passage of the 39 year "life sentence" total prison time. Alternative definitions (e.g., based on release prior to an "old age" cut off) yield very similar results.

Figure 5: Simulated Impact of DNA Laws on Wrongful Conviction Duration



(a) Survival Curves: Observed vs. Simulated

(b) Individual Simulated Extra Years Served

Notes: Panel (a) presents Kaplan-Meier survival curves with 90% confidence intervals comparing observed exoneration rates ($simulation = 0$) with median simulated rates (from 1,000 simulations) in the absence of DNA laws ($simulation = 1$). Panel (b) illustrates the median simulated "extra" years of wrongful conviction served for 78 Black individuals in the absence of DNA laws (simulated years in prison minus actual years), showing that the majority would have served significantly longer terms (negative numbers indicate that individuals' actual time to exoneration was longer than simulated, despite the passage of DNA laws).

In Figure 5, Panel B, we plot the difference between actual years in prison and (median) simulated years in prison for each individual. For ten individuals, simulated time in prison is less than actual time in prison; however, for the vast majority of individuals, simulated time in prison in the absence of DNA laws is substantially larger than actual time. We estimate that across individuals, the average time spent in prison — prior to exoneration or up to the 39 year "life term" for those not exonerated in the simulation — would have been over 11 years longer in the absence of the DNA laws. Multiplied by the 78 wrongfully convicted individuals, this amounts to nearly 900 person$\times$years of additional prison time that would have been suffered in the absence of DNA laws.

6 Conclusion

We have provided evidence that the passage of laws streamlining access to forensic DNA technology was a watershed in the exoneration of the wrongfully convicted, especially the exoneration of wrongfully convicted Black Americans. We find that the passage of DNA laws differentially increased exonerations of Black individuals convicted of sexual offenses and sentenced to life in prison, particularly in states with greater historical racial animus and in states with more expansive DNA laws, consistent with DNA laws addressing prior unequal access to alternative exoneration technologies. The effects we estimate are economically substantial: DNA laws increased exonerations of wrongfully convicted Blacks by nearly 200%, relative to a pre-law period during which DNA testing technology existed, but was less accessible. On the extensive margin, we estimate that DNA laws were responsible for freeing more than 50 wrongfully convicted Black Americans who would otherwise have died in prison; on the intensive margin, DNA laws freed innocent individuals from nearly 900 years of prison time due to more rapid exoneration.

While it is impossible to quantify the injustice of wrongful conviction, one lens on the significance of DNA laws, at the individual level, is provided by the compensation ordered by fellow citizens, serving on juries, to be paid to those exonerated. The National Registry of Exonerations calculates an average civil award per plaintiff of $349,000 per year of prison time wrongfully served.[41] If we take this compensation as an indicator of the welfare loss per year of wrongful imprisonment, the nearly 900 years of prison time avoided by DNA laws suggests welfare benefits of over $300 million to individuals exonerated in our sample. Another perspective on the importance of DNA laws, at an aggregate level, is provided by a comparison of the number of individuals exonerated as a result of DNA laws to estimates of the stock of wrongfully convicted individuals. A back-of-the-envelope calculation suggests that DNA laws were responsible for freeing a substantial share — over 10% — of the stock of Black individuals wrongfully convicted of sexual offenses and sentenced to life in prison at the time when the laws were passed.[42]

Even in an era with DNA testing available — arguably the most significant forensic technological advance of the twentieth century — we estimate that around two-thirds of the DNA-based exoneration of wrongfully convicted Black individuals in our sample would *not* have occurred in the absence of DNA laws.[43] Our findings reveal that the mere existence of a technology that

[41] See `https://shorturl.at/l5WcM`, last accessed March 11, 2026.

[42] The calculation was made as follows: we first estimate the number of Black individuals convicted of sexual offenses and serving a life sentence to be approximately 15,000 individuals. These data come from `https://shorturl.at/6gzau`, last accessed March 11, 2026. We then apply the estimated share of wrongful conviction, which ranges from 1–5%. The Innocence Project estimates 1% (see `https://innocenceproject.org/news/how-many-innocent-people-are-in-prison/`, last accessed January 19, 2026); Gross et al. (2014) estimate 4.4%; Risinger (2007) suggests a range of 3.3-5%. Using the middle of this range (3%) yields 450 wrongfully convicted individuals. DNA laws are thus estimated to have exonerated 50 individuals in our sample out of an estimated stock of 450 wrongfully convicted individuals meeting our sample restrictions, or 11.1%.

[43] Further streamlining of access to DNA testing might further mitigate (racial) injustice: for example, by ensuring the preservation of physical evidence; supporting petitioners post-conviction; and linking test results to large-scale DNA

can reduce racial disparities, whether in the legal, medical, or corporate domains, may be insufficient to ensure that its full social benefits are attained. Complementary public policy changes are also necessary to provide widespread access to novel, potentially equalizing technology and thus greater equality.

Our findings also point to open questions for future research. Most basically, what are the underlying causes of wrongful convictions? Do they arise from political pressure on prosecutors or judges (as in, e.g., Berdejó and Yuchtman, 2013; Dippel and Poyker, 2021)? What are other causal drivers of exonerations? Have expansions of DNA databases (as in, e.g., Doleac, 2017; Anker et al., 2021) played a role? What are the consequences of an exoneration for the performance of the criminal justice system? Do police, attorneys, or judges change their behavior in response to the announcement of an exoneration? Finally, does the announcement of an exoneration change citizens' views regarding the criminal justice system — and if so, in which direction? Exoneration of the wrongfully convicted is a dramatic expression of injustice corrected, and thus may have important social, political, and legal consequences worthy of further study.

databases (such as the Federal CODIS database).

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ONLINE APPENDIX

Appendix A Conceptual Framework

We present our model graphically in Figure A.1. In the figure, we depict a distribution of wrongfully convicted individuals' ability to pay for exoneration technology, $f()$. Ability to pay should be broadly construed to reflect individual characteristics, as well as case characteristics, such as the available evidence that might serve as the basis for exoneration — for example, better legal representation or more abundant physical evidence may enhance an individual's "ability to pay" for exoneration technology.[1] The model also depicts the (broadly construed) "prices" of exoneration technologies (DNA or non-DNA) before and after DNA laws, which may depend on an individual's race.

Exoneration Prior to the Passage of DNA Laws

DNA testing is a highly effective technology of exoneration, and it was available to the wrongfully convicted prior to the passage of DNA laws. However, as described above, prior to the passage of DNA laws there existed substantial barriers to the use of forensic DNA technology for exoneration. The use of DNA technology was extremely costly, with a reduced form price, $p_{DNA,pre}$ including legal constraints on the ability of the wrongfully convicted to appeal their convictions, logistical challenges in having evidence tested, and the financial costs of legal representation needed to overcome the legal and logistical challenges. Thus, although DNA testing was available as a technology of exoneration, prior to the passage of laws streamlining access to this technology, its cost would have been prohibitive for many wrongfully convicted individuals.

Prior to the passage of DNA laws, wrongfully convicted individuals thus would largely have relied on other exoneration technologies (uncovering false testimony or police misconduct, among others). These technologies, too, were costly, available at a price $p_{non-DNA}$. We assume that prior to the passage of DNA laws, non-DNA exoneration technology was less costly than DNA technology; that is, prior to DNA laws' passage, $p_{non-DNA} < p_{DNA,pre}$. Non-DNA exoneration technologies also may not have been equally available to all wrongfully convicted individuals (e.g., due to discrimination or inadequate legal representation; we consider variation in the price of non-DNA and DNA technologies below).

In our model, individuals in the distribution $f()$ with an ability to pay greater than $p_{DNA,pre}$ are able to be exonerated using either DNA or non-DNA technology even prior to the DNA laws (region A in Figure A.1, Panel (a)). Individuals with an ability to pay greater than $p_{non-DNA}$ but less than $p_{DNA,pre}$ can *only* be exonerated with non-DNA technology prior to DNA laws (region B in Figure A.1, Panel (a)). Finally, individuals in the distribution $f()$ with an ability to pay less than $p_{non-DNA}$ are unable to access any exoneration technology (regions C and D in Figure A.1, Panel (a)).

The Impact of DNA Laws on Exoneration

DNA laws can be thought of as significantly reducing the cost of DNA testing as a technology of exoneration: $p_{DNA,post} < p_{DNA,pre}$. Indeed, the streamlined, state-supported nature of DNA testing after the passage of DNA laws would often have made it the *least cost* exoneration technology for many wrongfully convicted individuals, that is, $p_{DNA,post} < p_{non-DNA}$.[2]

The next question is whether DNA-based exonerations will merely act as substitutes for non-DNA exonerations, or whether *total* exonerations will increase. Intuitively, this depends on whether alternative exoneration technologies were already available to wrongfully convicted individuals at a low enough cost to ensure their exoneration. In our model, individuals in the distribution $f()$ with an ability to pay greater than $p_{DNA,pre}$ are unaffected by the DNA law: they continue to be able to be exonerated using either DNA or non-DNA technology (region A in Figure A.1, Panel

[1] These characteristics could have been modeled as sources of individual-specific "price" variation, but for expositional purposes, we fix the price of an exoneration technology across individuals, and allow ability to pay to vary across individuals.

[2] Of course, DNA technology will not be available to all wrongfully convicted individuals: some crimes do not leave any DNA that is useable as evidence. More generally, in some cases, non-DNA exoneration technology may be "lower cost" than DNA technology (for example, if a witness recants their testimony). We abstract from this heterogeneity in our model, focusing on those cases in which DNA laws make DNA technology more accessible (i.e., lower "price") than non-DNA technology. This is particularly appropriate for the severe sexual crimes on which we focus our empirical analysis.

(a)). Individuals with an ability to pay greater than $p_{non-DNA}$ but less than $p_{DNA,pre}$ can, following the DNA law's passage, be exonerated using *either* non-DNA technology or DNA technology (region B in Figure A.1, Panel (a)). These individuals may *substitute* DNA for non-DNA technology post-law. Next, individuals in the distribution $f()$ with an ability to pay less than $p_{non-DNA}$, but greater than $p_{DNA,post}$ can be exonerated *only* using DNA technology, and only post-law (region C and in Figure A.1, Panel (a)). This region represents the *net* increase in exonerations due to the passage of DNA laws.

The model suggests that the net effect of DNA laws on total exonerations will be smaller than the effect on DNA-based exonerations. How much smaller depends on the degree of substitution from non-DNA to DNA-based exoneration post-DNA laws, and the number of individuals who are now able to gain access to some exoneration technology — typically DNA technology — after the passage of the laws.

The Differential Impact of DNA Laws for Black Americans

The effects of DNA laws may have been particularly large for Black Americans due to the higher costs of exoneration using non-DNA technologies for wrongfully convicted Blacks. These higher costs may arise from discrimination in the criminal justice system: for example, a judge's evaluation of prosecutorial misconduct, the veracity of witness testimony, police adherence to legal standards of collecting or handling evidence, may be biased by explicit or implicit racism. Costs of non-DNA exoneration for Black individuals may also have been higher due to lower-quality legal representation (e.g., due to differences in financial resources by race). Wrongfully convicted Blacks thus likely had less access to non-DNA exoneration, which was particularly important prior to the DNA laws, when DNA technology was costly to access. More formally, we assume that $p_{non-DNA,Black} > p_{non-DNA,non-Black}$, reflecting Black individuals' higher cost of accessing non-DNA technology.

Importantly, because racism does not so easily distort scientific interpretation of forensic DNA, and because DNA laws establish streamlined access to DNA technology, we treat the costs of accessing DNA technology as being independent of race. In particular, we assume that $p_{DNA,pre}$ and $p_{DNA,post}$ do not vary by race.[3]

Under these assumptions, our conceptual framework predicts a greater impact of DNA laws on *net* exonerations for Black individuals than for non-Blacks. One can see this in Figure A.1, Panel (b), which depicts how the fall in the price of DNA technology allows both Black individuals and non-Blacks to access this new technology. In some cases, access to DNA technology is made available to individuals who could afford non-DNA technology, indicating the possibility of substitution across exoneration technologies. This is region B in Figure A.1, Panel (b), for Black individuals and region $B' + B$ for non-Blacks. The greater region of substitution for non-Blacks reflects their lower price of non-DNA exoneration technology (for example, due to the effects of discrimination reducing access for Black individuals). Finally, some individuals *only* gain access to exoneration technology following DNA laws — these individuals represent net increases in exoneration as a result of the laws. In Figure A.1, Panel (b), these individuals are in region C for non-Blacks, and region $B' + C$ for Blacks. The difference again reflects the differential access to non-DNA technology for Black individuals, making post-law access to DNA technology differentially important.

Variation in Legal and Institutional Context

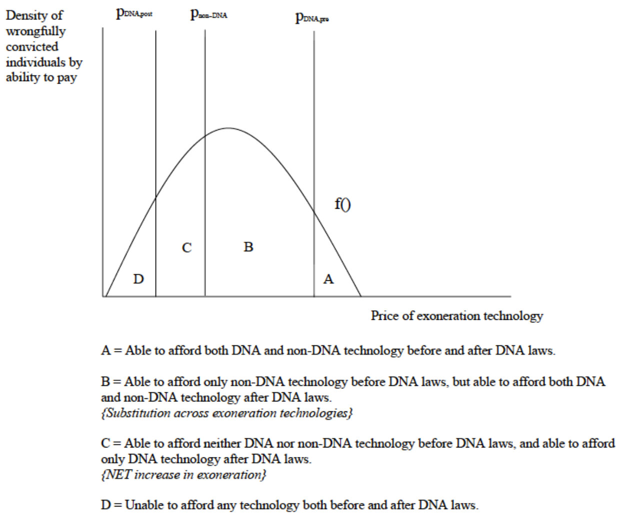
We next consider sources of heterogeneity in the impact of DNA laws for Black individuals across states. We consider first the impact of racial discrimination, and second, the expansiveness of DNA laws' coverage.

Racial discrimination As was seen in Figure A.1, Panel (b), the impact of DNA laws on *total* exonerations was predicted to be differentially large for Black individuals due to their larger gap between the price of non-DNA technology and the post-law price of DNA technology. This same logic can be applied within the set of wrongfully convicted Black individuals: the higher is their price of non-DNA technology, the greater the potential impact of DNA laws that provide streamlined access to DNA technology.

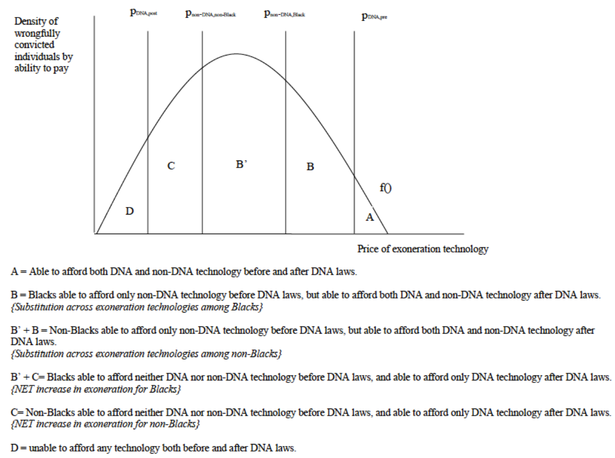
We illustrate this logic in Figure A.1, Panel (c), considering racial discrimination at the state level as a key determinant of the price of non-DNA technology for Black individuals. In contexts with higher levels of racial animus, we expect it to be more difficult for Black individuals to access non-DNA technology, due to discriminatory applications of legal standards, unequal access to legal representation, or differences in financial resources. That is, we

[3] While we believe it is likely that there exists less scope for discrimination to shape DNA-based exoneration than non-DNA-based exoneration, it is possible that discrimination also distorts the application of DNA laws across races. In this case, $p_{DNA,post}$ is greater for Blacks than for non-Blacks, and we would expect a more muted effect of DNA laws on Black exonerations.

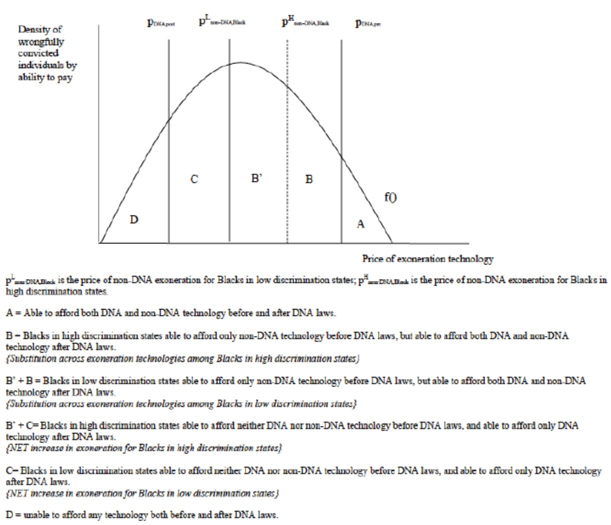
Figure A.1: Theoretical Models of Exoneration Access by Ability to Pay



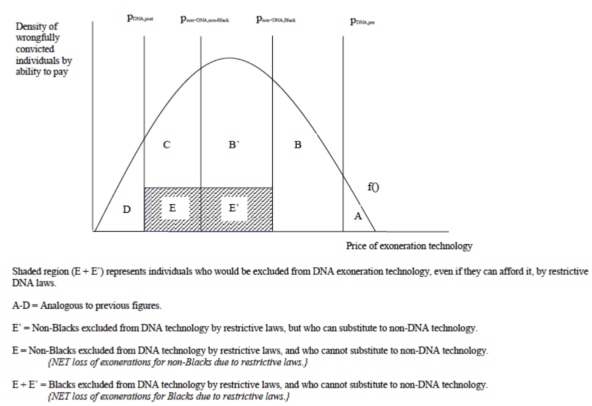
(a) General Access



(b) Access by Race



(c) High Discrimination States



(d) Restrictive DNA Laws

expect the price of non-DNA exoneration technology to be higher for Blacks in high discrimination states than in low discrimination states: $p^H_{non-DNA,Black} > p^L_{non-DNA,Black}$. We assume (for simplicity) that DNA laws reduce the price of DNA technology to the same level regardless of racial discrimination.

In this case, it is straightforward to see that DNA laws' impact on net exonerations (beyond substitutions across exoneration technologies) will be greater for Blacks specifically in those states with greater racial animus. A larger set of Black individuals in high discrimination states are *only* able to access exoneration technology after DNA technology is made available by the passage of DNA laws (in Figure A.1, Panel (c), compare region C for Black individuals in low discrimination states, to region $B' + C$ for those in high discrimination states).

DNA laws' expansiveness A second determinant of the impact of DNA laws on the exoneration of black individuals is whether there exist any restrictions that prevent those who could otherwise "afford" DNA technology from accessing that technology. Examples of such restrictions in practice are DNA laws that exclude individuals from pursuing DNA technology if they pled guilty, laws that impose financial burdens on petitioners, and laws that do not provide legal assistance to individuals in advance of their motion to re-examine evidence. We illustrate the impact of such restrictions in Figure A.1, Panel (d), graphically "indicating" a set of individuals who could otherwise afford DNA technology, but who are excluded by restrictive DNA laws (regions E and E' in Figure A.1, Panel (d)). Importantly, *some* of these individuals can substitute DNA technology (from which they have been excluded) with non-DNA technology; however, for individuals who could *only* afford DNA technology post-law, this exclusion implies that no exoneration is possible. One can see that exclusion due to restrictive DNA laws is particularly costly for Black individuals, as the region of those who cannot be exonerated ($E + E'$) is larger than for non-Blacks (E). It is evident in Figure A.1, Panel (d), that the more expansive the DNA law, the larger the impact on total exoneration will be for Black individuals.

The effects of DNA laws on the rate of exoneration Importantly, increased access to DNA exoneration technology can affect the *extensive* margin of exoneration — that is, the number of individuals exonerated — as well as the *intensive* margin: the rate (or speed) of exoneration for a wrongfully convicted individual. Effects on the intensive margin for those who newly are able to access exoneration technology following DNA laws' passage are unambiguous: from no chance at exoneration, their rate of exoneration can only increase following the laws. For individuals who could access non-DNA technology, post-DNA law access to DNA technology should (weakly) increase the rate of exoneration due to the availability of a second technology of exoneration. Finally, individuals who do not have access to exoneration technology of any kind should also be unaffected. One important caveat is that this assumes that the increased exoneration due to the passage of DNA laws does not generate negative spillovers across individuals (e.g., due to congestion).[4]

Predictions

This framework thus generates the following predictions pooling across races, as well as considering wrongfully convicted Black individuals and non-Blacks separately:

Hypothesis 1: Impact of DNA laws, pooling across races. The passage of DNA laws will strictly increase *DNA-based* exonerations, and strictly increase total exonerations, though there may exist some substitution of DNA-based exonerations for non-DNA exonerations.

Hypothesis 2: Impact of DNA laws by race. The passage of DNA laws will increase *both* DNA-based and total exoneration among wrongfully convicted Blacks. The passage of DNA laws will strictly increase DNA-based exoneration for non-Blacks, but will only weakly increase total exonerations for non-Blacks (effects on total exoneration will reflect both greater DNA-based exoneration and substitution to DNA-based exoneration from non-DNA exoneration).

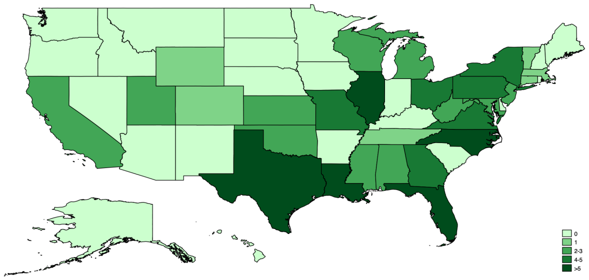
Hypothesis 3: The passage of DNA laws will have a larger differential effect on total exonerations for Blacks in states with: (*i*) greater racial discrimination; (*ii*) more expansive DNA laws.

[4]Importantly, selection into exoneration post-law might create the *appearance* of a reduction in exoneration rates: if individuals who newly acquire access to exoneration technology have been wrongfully imprisoned longer, observed exonerations will occur at a slower rate (but this is a spurious relationship due to the differential selection).

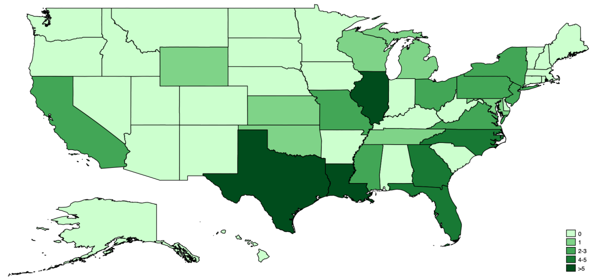
Hypothesis 4: Reflecting the increase in access to exoneration technology for Blacks, the passage of DNA laws will increase the *rate* of exoneration for Blacks, while (due to substitution across exoneration technologies) the passage of DNA laws will only weakly increase the exoneration rate of non-Blacks.

Appendix B Appendix Figures

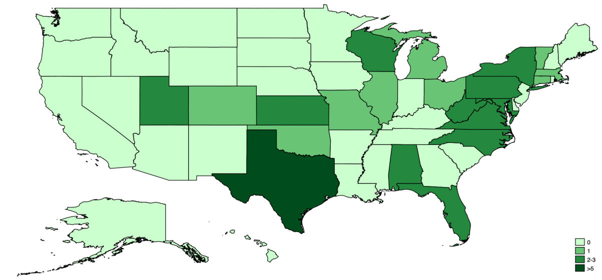
Figure B.1: Geographic Distribution of Exonerations by Type and Race



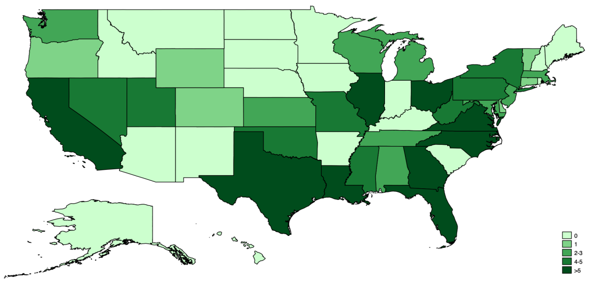
(a) DNA-based Exonerations: All Races



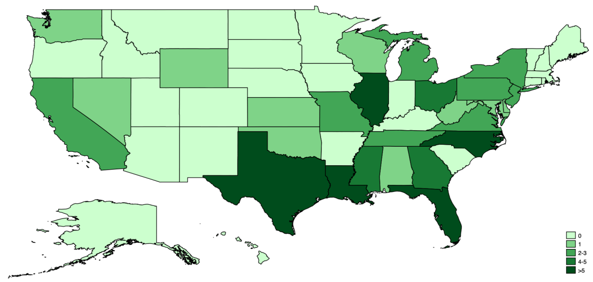
(b) DNA-based Exonerations: Black



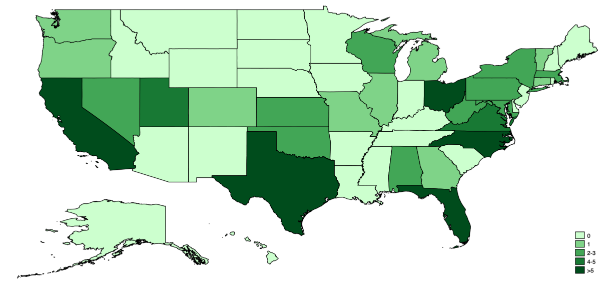
(c) DNA-based Exonerations: Non-Black



(d) Total Exonerations: All Races



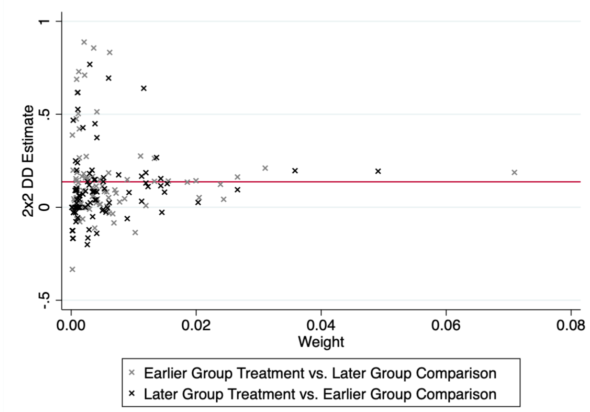
(e) Total Exonerations: Black



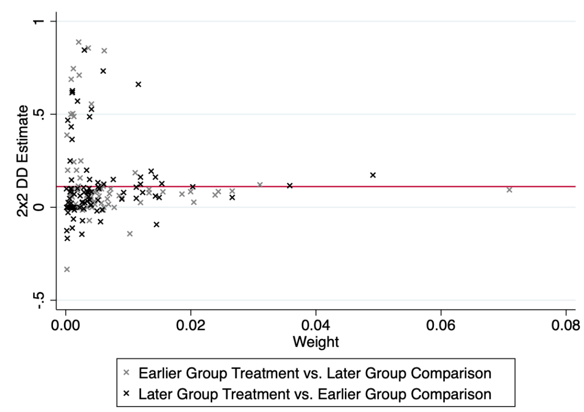
(f) Total Exonerations: Non-Black

Notes: This figure displays the geographic distribution of exonerations per state for the period 1988–2018. The top panel reports DNA-based exonerations, while the bottom panel reports all exonerations. Columns distinguish between the full sample, Black defendants, and Non-Black defendants. Shading intensity represents the volume of cases as indicated by the legend in each map.

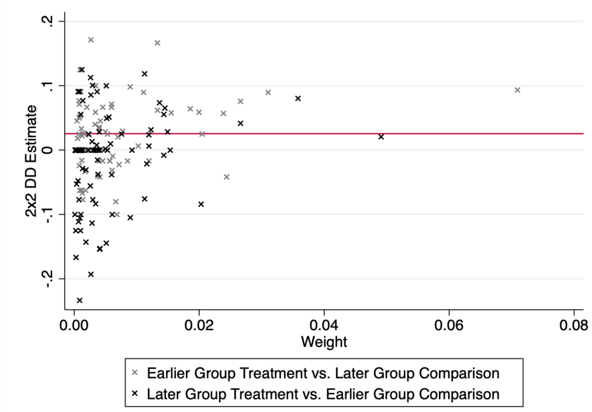
Figure B.2: Goodman-Bacon Decomposition: 2×2 DD Estimates and Weights



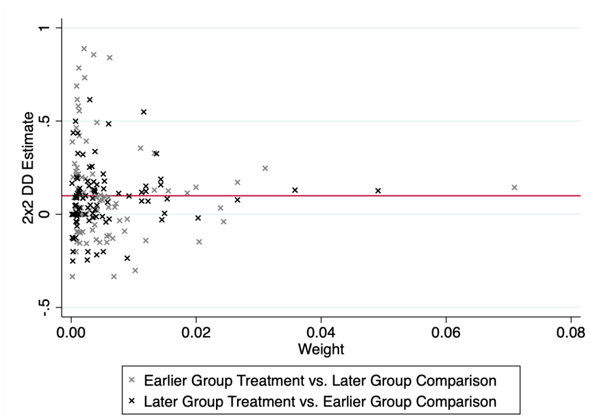
(a) DNA-based Exonerations: All Races



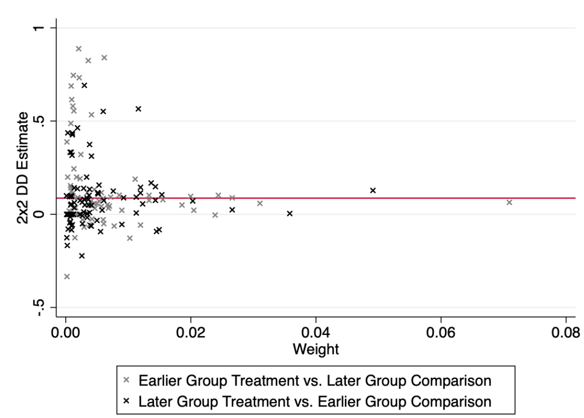
(b) DNA-based Exonerations: Black



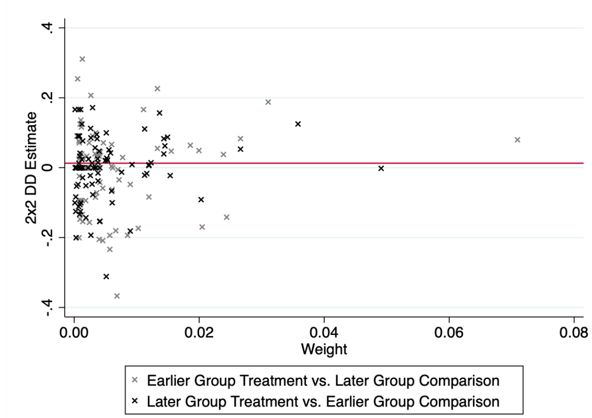
(c) DNA-based Exonerations: Non-Black



(d) Total Exonerations: All Races



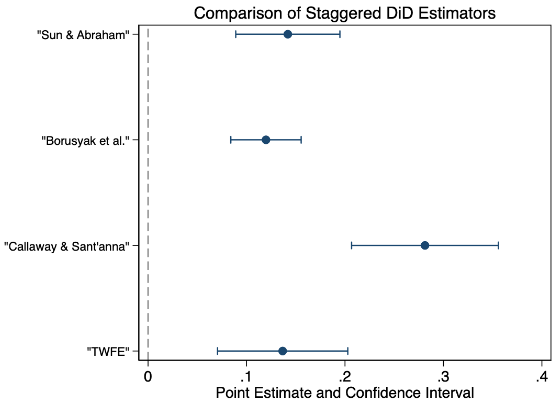
(e) Total Exonerations: Black



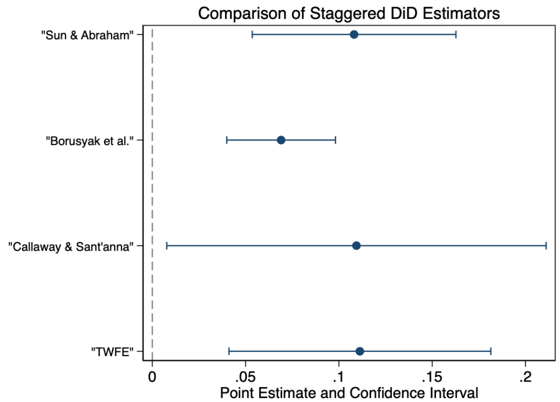
(f) Total Exonerations: Non-Black

Notes: This figure presents the Goodman-Bacon decomposition for the staggered adoption of DNA laws. Each point represents a 2×2 difference-in-differences estimate compared against its weight in the overall ATT. The red horizontal line indicates the weighted average estimate. Gray crosses represent "Earlier Group Treatment vs. Later Group Comparison," while black crosses indicate "Later Group Treatment vs. Earlier Group Comparison".

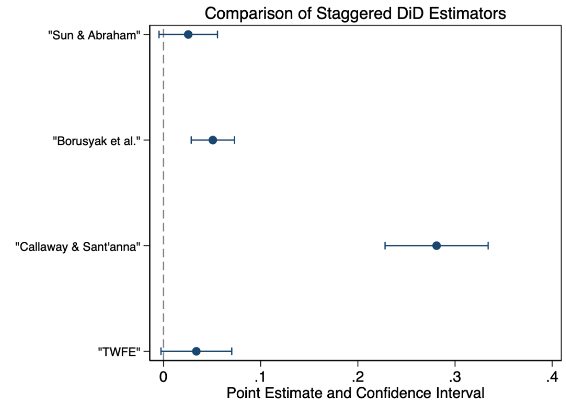
Figure B.3: Robustness: Comparison of Staggered Difference-in-Differences Estimators



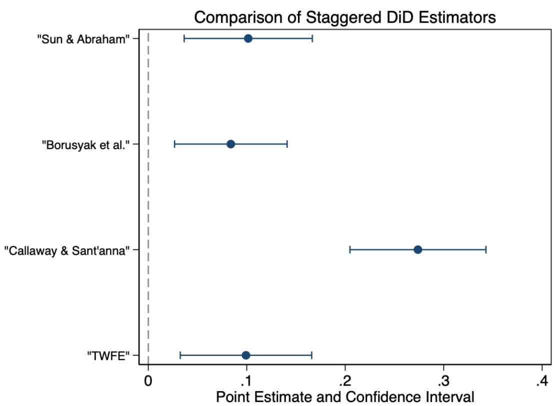
(a) DNA-based Exonerations: All Races



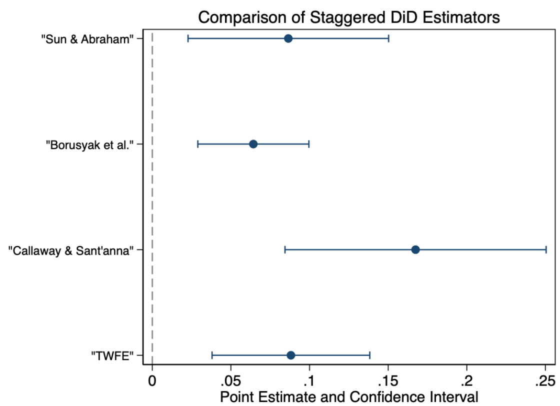
(b) DNA-based Exonerations: Black



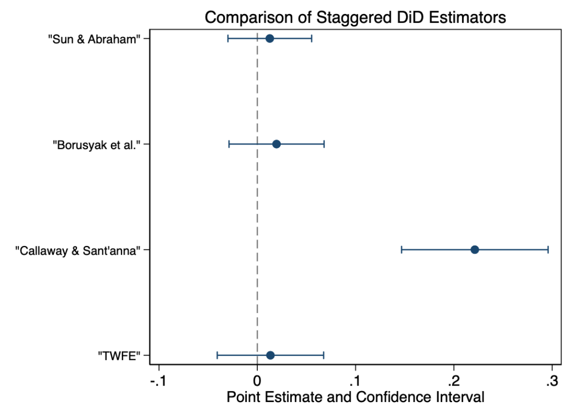
(c) DNA-based Exonerations: Non-Black



(d) Total Exonerations: All Races



(e) Total Exonerations: Black



(f) Total Exonerations: Non-Black

Notes: This figure compares the baseline Two-Way Fixed Effects (TWFE) estimates with alternative estimators designed to be robust to staggered treatment timing and heterogeneous treatment effects. The top panel reports results for DNA-based exonerations, and the bottom panel reports results for all exonerations. Each plot displays point estimates and 95% confidence intervals for the average treatment effect on the treated (ATT) using estimators from Callaway and Sant'Anna, Sun and Abraham, and Borusyak et al.

Appendix C Appendix Tables

Table C.1: DNA Law Characteristics

	(1) Impl. Year	(2) Counsel Required	(3) Crime Restr.	(4) Plea Restr.	(5) Onus of Payment
New York	1994			Yes	
Illinois	1997				
Minnesota	1999				
California	2000	Yes			
Washington	2000				
Arizona	2000				
Delaware	2000				
Oklahoma	2000		Yes		
Idaho	2001				
Wisconsin	2001				
Utah	2001				Yes
Virginia	2001				
Louisiana	2001				
North Carolina	2001				Yes
Nebraska	2001				
Michigan	2001				
Indiana	2001		Yes		
Arkansas	2001				Yes
Florida	2001			Yes	
Kansas	2001		Yes		Yes
Oregon	2001	Yes	Yes		
Maryland	2001		Yes		Yes
Maine	2001				
Missouri	2001				Yes
Texas	2001	Yes			
Tennessee	2001		Yes		

Table C.1: (Continued) DNA Law Characteristics

	(1) Impl. Year	(2) Counsel Required	(3) Crime Restr.	(4) Plea Restr.	(5) Onus of Payment
Kentucky	2002		Yes		
New Jersey	2002				Yes
Rhode Island	2002				
Pennsylvania	2002				
District of Columbia	2002		Yes		
Nevada	2003				
Montana	2003				
New Mexico	2003				
Ohio	2003			Yes	
Georgia	2003				
Colorado	2003				Yes
Connecticut	2003				
West Virginia	2004	Yes			
New Hampshire	2004				
Hawaii	2005				
North Dakota	2005				
Iowa	2005				Yes
Vermont	2007		Yes	Yes	
Wyoming	2008	Yes		Yes	
South Dakota	2009				Yes
Alabama	2009		Yes		
Mississippi	2009				
South Carolina	2009		Yes	Yes	Yes
Alaska	2010		Yes	Yes	
Massachusetts	2012				

Notes: This table shows the year of DNA laws' enactment; whether the law requires the provision of counsel to petitioners prior to their motion; whether the laws were limited in scope depending on the conviction offense or the defendant's plea; and whether the law imposed financial costs on petitioners.

Table C.2: Event Study Estimates of DNA Laws on Exonerations

Relative Year	DNA-Based Exonerations	Total Exonerations
-9	0.019	0.128
	(0.065)	(0.113)
-8	-0.019	0.018
	(0.040)	(0.053)
-7	-0.013	0.005
	(0.053)	(0.062)
-6	-0.014	0.029
	(0.048)	(0.077)
-5	0.022	0.054
	(0.056)	(0.070)
-4	-0.020	0.091
	(0.037)	(0.109)
-3	-0.015	0.051
	(0.051)	(0.073)
-2	-0.031	0.004
	(0.046)	(0.053)
-1	0.048	0.100*
	(0.047)	(0.056)
+1	0.132**	0.150**
	(0.063)	(0.062)
+2	0.204**	0.218**
	(0.081)	(0.089)
+3	0.040	0.090
	(0.053)	(0.056)
+4	0.194	0.276**
	(0.118)	(0.133)
+5	0.194***	0.201***
	(0.064)	(0.075)
+6	0.150	0.119
	(0.117)	(0.124)
+7	0.172**	0.132
	(0.085)	(0.093)
+8	0.190	0.157
	(0.122)	(0.132)
+9	0.134	0.142
	(0.093)	(0.100)
+10	0.127	0.124
	(0.093)	(0.110)
State FE	Yes	Yes
Year FE	Yes	Yes

Notes: The table reports event study estimates of the effects of DNA laws on exonerations. The dependent variables are the count of DNA-based exonerations and total exonerations, respectively. The coefficients are relative to the omitted year of the law's passage (Year 0). All specifications include state and year fixed effects. Standard errors clustered at the state level are reported in parentheses. Significance levels are indicated by *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table C.3: The Impact of DNA Laws on Exonerations, Robustness to Excluding Specific Federal Circuits

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Excl. 1st Circ.	Excl. 2nd Circ.	Excl. 3rd Circ.	Excl. 4th Circ.	Excl. 5th Circ.	Excl. 6th Circ.	Excl. 7th Circ.	Excl. 8th Circ.	Excl. 9th Circ.	Excl. 10th Circ.	Excl. 11th Circ.	Excl. DC Circ.
Panel A: DNA-Based Exonerations												
Post	0.152***	0.148***	0.138***	0.135***	0.111***	0.126***	0.114***	0.147***	0.165***	0.140***	0.134***	0.137***
	(0.042)	(0.043)	(0.042)	(0.042)	(0.040)	(0.040)	(0.029)	(0.044)	(0.047)	(0.043)	(0.043)	(0.040)
Panel B: Total Exonerations												
Post	0.115***	0.109**	0.097**	0.099**	0.087**	0.088**	0.077**	0.103**	0.132***	0.104**	0.086**	0.099**
	(0.042)	(0.044)	(0.041)	(0.043)	(0.042)	(0.040)	(0.031)	(0.045)	(0.045)	(0.044)	(0.042)	(0.040)
State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,410	1,440	1,440	1,380	1,440	1,410	1,440	1,320	1,260	1,350	1,440	1,500

Notes: Panel A reports results for DNA-based exonerations, while Panel B reports results for total exonerations. The table reports estimates from the baseline model, dropping one US Federal Appeals Court Circuit at a time to evaluate the sensitivity of the results to specific geographic regions. All regressions include state and year fixed effects. Standard errors clustered at the state level are reported in parentheses. Significance levels are indicated by *** p<0.01, ** p<0.05, * p<0.1.

Table C.4: The Impact of DNA Laws on Exonerations, Robustness to Sample Changes

	(1)	(2)	(3)	(4)	(5)	(6)
	Baseline	All Sex Crimes	All Crimes & Sentences	Incl. Post-Law Convictions (Sex/Life)	Drop Year of Passage	Balanced Panel
Panel A: DNA-Based Exonerations						
Post	0.137***	0.152***	0.134**	0.130***	0.133***	0.121**
	(0.040)	(0.054)	(0.064)	(0.036)	(0.040)	(0.055)
Panel B: Total Exonerations						
Post	0.099**	0.102	0.146	0.103***	0.078*	0.142***
	(0.040)	(0.079)	(0.141)	(0.037)	(0.041)	(0.051)
State FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,530	1,530	1,530	1,530	1,479	612

Notes: Panel A reports results for DNA-based exonerations, while Panel B reports results for total exonerations. Column (1) reports the baseline specification (sexual offenses, life sentences, pre-law convictions). Column (2) considers all sexual offenses regardless of sentence length. Column (3) considers all crimes and all sentence types. Column (4) adds to the baseline sample convictions that occurred in the year of a DNA law's passage or in the years following. Column (5) estimates the baseline model but drops observations from the year of the DNA law's passage. Column (6) estimates the baseline model using the longest possible balanced panel (including 50 states plus Washington, DC, from 5 years before to 6 years after the law's passage). All regressions include state and year fixed effects. Standard errors clustered at the state level are reported in parentheses. Significance levels are indicated by *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table C.5: Event Study Estimates of DNA Laws on Exonerations by Race

	Black Defendants		Non-Black Defendants	
Relative Year	DNA-Based Exonerations	Total Exonerations	DNA-Based Exonerations	Total Exonerations
-9	-0.020	-0.037	0.039	0.165
	(0.045)	(0.062)	(0.039)	(0.120)
-8	-0.029	-0.030	0.010	0.049
	(0.027)	(0.031)	(0.021)	(0.040)
-7	-0.036	-0.017	0.023	0.022
	(0.045)	(0.051)	(0.028)	(0.031)
-6	-0.016	-0.015	0.002	0.044
	(0.047)	(0.047)	(0.018)	(0.065)
-5	-0.038	-0.051	0.060	0.105*
	(0.045)	(0.047)	(0.041)	(0.057)
-4	-0.020	-0.033	-0.000	0.124
	(0.033)	(0.038)	(0.014)	(0.097)
-3	-0.047	-0.043	0.032	0.094*
	(0.043)	(0.050)	(0.023)	(0.055)
-2	-0.025	0.002	-0.006	0.002
	(0.049)	(0.053)	(0.010)	(0.014)
-1	0.005	0.050	0.044	0.050
	(0.046)	(0.053)	(0.038)	(0.040)
+1	0.086	0.075	0.047	0.075
	(0.073)	(0.074)	(0.044)	(0.051)
+2	0.112	0.129*	0.092**	0.089*
	(0.073)	(0.076)	(0.041)	(0.046)
+3	-0.029	-0.014	0.069*	0.104**
	(0.046)	(0.052)	(0.038)	(0.044)
+4	0.136	0.177	0.058*	0.099**
	(0.104)	(0.114)	(0.030)	(0.045)
+5	0.146***	0.140***	0.048	0.061
	(0.045)	(0.048)	(0.029)	(0.039)
+6	0.036	0.020	0.114**	0.099*
	(0.085)	(0.088)	(0.048)	(0.050)
+7	0.097*	0.077	0.075*	0.056
	(0.054)	(0.058)	(0.040)	(0.044)
+8	0.116	0.109	0.074*	0.048
	(0.080)	(0.087)	(0.044)	(0.049)
+9	0.017	0.031	0.117**	0.111*
	(0.060)	(0.059)	(0.054)	(0.059)
+10	0.068	0.044	0.060	0.080
	(0.051)	(0.057)	(0.044)	(0.059)
State FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

Notes: The table reports event study estimates of the effects of DNA laws on exonerations by race. The dependent variables are the count of DNA-based exonerations and total exonerations for Black and Non-Black defendants, respectively. The coefficients are relative to the omitted year of the law's passage (Year 0). All specifications include state and year fixed effects. Standard errors clustered at the state level are reported in parentheses. Significance levels are indicated by *** p<0.01, ** p<0.05, * p<0.1.

Table C.6: The Impact of DNA Laws on Exonerations by Race, Robustness to Sample Changes

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Baseline	All Sex Crimes	All Crimes & Sentences	Incl. Post-Law Convictions (Sex/Life)	Drop Year of Passage	Balanced Panel	Black vs White	Majority versus Minority
Panel A: DNA-Based Exonerations								
Post	0.0545***	0.0535**	0.0340	0.0510***	0.0509***	0.0344	0.0504***	0.0533***
	(0.0152)	(0.0237)	(0.0329)	(0.0130)	(0.0153)	(0.0228)	(0.0151)	(0.0152)
Black	0.00937	0.0295*	0.0187	0.00937	0.00575	0.0163	0.0107	0.0120
	(0.00869)	(0.0152)	(0.0154)	(0.00869)	(0.00827)	(0.0144)	(0.00939)	(0.0102)
Post × Black	0.0277	0.0446	0.0655	0.0277	0.0313*	0.0523*	0.0289	0.0301*
	(0.0178)	(0.0315)	(0.0404)	(0.0193)	(0.0182)	(0.0312)	(0.0177)	(0.0177)
Total Effect on Blacks	0.0822***	0.0982***	0.0996**	0.0787***	0.0822***	0.0867**	0.0793***	0.0834***
	(0.0264)	(0.0373)	(0.0419)	(0.0256)	(0.0268)	(0.0377)	(0.0264)	(0.0264)
Panel B: Total Exonerations								
Post	0.0185	0.00681	-0.0500	0.0231	0.00511	0.0332	0.0163	0.0200
	(0.0205)	(0.0467)	(0.0924)	(0.0184)	(0.0220)	(0.0284)	(0.0204)	(0.0206)
Black	-0.0201	-0.0669*	-0.157***	-0.0201	-0.0259	-0.0163	-0.0161	-0.0120
	(0.0180)	(0.0373)	(0.0421)	(0.0180)	(0.0194)	(0.0242)	(0.0184)	(0.0193)
Post × Black	0.0622**	0.0886**	0.246***	0.0558**	0.0680**	0.0752*	0.0608**	0.0593**
	(0.0258)	(0.0406)	(0.0815)	(0.0250)	(0.0272)	(0.0376)	(0.0255)	(0.0254)
Total Effect on Blacks	0.0807***	0.0955**	0.1960***	0.0790***	0.0731***	0.1083***	0.0771***	0.0793***
	(0.0264)	(0.0415)	(0.0685)	(0.0257)	(0.0270)	(0.0341)	(0.0260)	(0.0262)
Observations	3,060	3,060	3,060	3,060	2,958	1,224	3,060	3,060
State FE	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES

Panel A reports results for DNA-based exonerations, while Panel B reports results for total exonerations. The Black indicator variable refers to Blacks and Hispanics pooled together in column (8). Column (1) reports the baseline specification (sexual offenses, life sentences, pre-law convictions). Column (2) considers all sexual offenses regardless of sentence length. Column (3) considers all crimes and all sentence types. Column (4) adds to the baseline sample convictions that occurred in the year of a DNA law's passage or in the years following. Column (5) estimates the baseline model but drops observations from the year of the DNA law's passage. Column (6) estimates the baseline model using the longest possible balanced panel (including 50 states plus Washington, DC, from 5 years before to 6 years after the law's passage). Column (7) reports the results of Blacks vs Whites (therefore excluding Hispanics from the analysis). Column (8) estimates minority (Blacks and Hispanics) vs majority (Whites). All regressions include state and year fixed effects. Standard errors clustered at the state level are reported in parentheses. Significance levels are indicated by *** p<0.01, ** p<0.05, * p<0.1.

Table C.7: The Impact of DNA Laws on Exonerations by Race, Robustness to Excluding Specific Federal Circuits

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Excl. 1st Circ.	Excl. 2nd Circ.	Excl. 3rd Circ.	Excl. 4th Circ.	Excl. 5th Circ.	Excl. 6th Circ.	Excl. 7th Circ.	Excl. 8th Circ.	Excl. 9th Circ.	Excl. 10th Circ.	Excl. 11th Circ.	Excl. DC Circ.
Panel A: DNA-Based Exonerations												
Post	0.062***	0.058***	0.054***	0.052***	0.049***	0.049***	0.047***	0.057***	0.066***	0.054***	0.054***	0.056***
	(0.016)	(0.017)	(0.016)	(0.016)	(0.016)	(0.015)	(0.012)	(0.017)	(0.018)	(0.016)	(0.017)	(0.015)
Black	0.012	0.010	0.008	0.010	0.004	0.009	0.008	0.009	0.010	0.014	0.009	0.010
	(0.009)	(0.009)	(0.009)	(0.008)	(0.008)	(0.009)	(0.009)	(0.010)	(0.010)	(0.009)	(0.008)	(0.009)
Post × Black	0.028	0.032*	0.030	0.032*	0.013	0.029	0.020	0.032	0.034	0.031	0.026	0.026
	(0.019)	(0.019)	(0.019)	(0.018)	(0.016)	(0.019)	(0.016)	(0.021)	(0.022)	(0.019)	(0.018)	(0.018)
Total Effect on Blacks	0.0902***	0.0900***	0.0840***	0.0837***	0.0622**	0.0777***	0.0671***	0.0894***	0.0993***	0.0856***	0.0801***	0.0815***
	(0.0283)	(0.0285)	(0.0279)	(0.0281)	(0.0255)	(0.0277)	(0.0197)	(0.0297)	(0.0315)	(0.0291)	(0.0281)	(0.0268)
Panel B: Total Exonerations												
Post	0.025	0.021	0.016	0.016	0.020	0.012	0.012	0.016	0.037**	0.019	0.013	0.019
	(0.022)	(0.022)	(0.021)	(0.023)	(0.022)	(0.021)	(0.020)	(0.024)	(0.018)	(0.022)	(0.022)	(0.021)
Black	-0.019	-0.021	-0.024	-0.019	-0.027	-0.022	-0.022	-0.025	-0.005	-0.015	-0.019	-0.020
	(0.020)	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)	(0.021)	(0.012)	(0.019)	(0.019)	(0.018)
Post × Black	0.066**	0.068**	0.065**	0.067**	0.046*	0.065**	0.054**	0.072**	0.058**	0.067**	0.059**	0.061**
	(0.028)	(0.027)	(0.027)	(0.027)	(0.025)	(0.028)	(0.024)	(0.030)	(0.025)	(0.028)	(0.027)	(0.026)
Total Effect on Blacks	0.0903***	0.0884***	0.0812***	0.0834***	0.066**	0.0766***	0.0657***	0.0878***	0.0950***	0.0857***	0.0724***	0.0800***
	(0.0280)	(0.0286)	(0.0276)	(0.0282)	(0.0264)	(0.0275)	(0.0193)	(0.0298)	(0.0312)	(0.0291)	(0.0278)	(0.0268)
Observations	2,820	2,880	2,880	2,760	2,880	2,820	2,880	2,640	2,520	2,700	2,880	3,000
State FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Notes: The table reports estimates from the baseline model, dropping one US Federal Appeals Court Circuit at a time to evaluate the sensitivity of the results to specific geographic regions. 'Total Effect on Blacks' reports the linear combination of the Post coefficient and the Interaction term. All regressions include state and year fixed effects. Standard errors clustered at the state level are reported in parentheses. Significance levels are indicated by *** p<0.01, ** p<0.05, * p<0.1.

Table C.8: Estimates of DNA Laws on Total Exonerations: Components of Indices

	(1) Confederate State	(2) VRA Coverage	(3) Lynchings	(4) Pre-Motion Counsel	(5) No Plea Restriction	(6) No Payment Required
Post	0.0076	0.0139	0.0144	0.0401**	0.0605	0.0502
	(0.0247)	(0.0245)	(0.0272)	(0.0161)	(0.0385)	(0.0319)
Post × Black	0.0472	0.0451	0.0370	0.0383*	0.0172	-0.0061
	(0.0297)	(0.0284)	(0.0314)	(0.0216)	(0.0206)	(0.0374)
Post × Black × Component	0.0779	0.127*	0.0004**	0.243*	0.0513	0.0868*
	(0.0616)	(0.0722)	(0.0002)	(0.1410)	(0.0360)	(0.0482)
Observations	3,060	3,060	2,880	3,060	3,060	3,060
State FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES

Notes: The table reports triple-difference estimates interacting the Post × Black term with specific state characteristics (the "Component" listed in the column header). The outcome variable is total exonerations. 'Confederate State', 'VRA Coverage' and 'Lynchings' are components of the Racism Index. 'Pre-Motion Counsel', 'No Plea Restriction', and 'No Payment Required' are components of the Expansiveness Index. The analysis on lynchings is conducted on 48 states because for three states lynchings data are not available. All regressions include state and year fixed effects. Standard errors clustered at the state level are reported in parentheses. Significance levels are indicated by *** p<0.01, ** p<0.05, * p<0.1.

Table C.9: The Impact of DNA Laws on the Rate of Exoneration, Robustness to Changes in the Sample

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Baseline	All Sex Crimes	All Sentences and Crimes	Including Post-Law Convictions	Pre-1994 Convictions	Black versus White	Majority versus Minority
Post	0.151	-0.252	-0.0673	0.285	0.272	0.109	0.136
	(0.368)	(0.208)	(0.152)	(0.339)	(0.403)	(0.376)	(0.385)
Black	-0.912***	-0.543***	-0.459***	-0.986***	-1.011***	-0.861***	-0.778**
	(0.301)	(0.196)	(0.104)	(0.321)	(0.366)	(0.327)	(0.325)
Post $\times$ Black	0.894**	0.464**	0.304**	0.882**	0.811*	0.913**	0.855**
	(0.404)	(0.215)	(0.125)	(0.363)	(0.454)	(0.413)	(0.404)
Total Effect on Blacks	1.045***	0.212	0.237*	1.167***	1.083***	1.022***	0.991***
	(0.328)	(0.198)	(0.141)	(0.314)	(0.359)	(0.335)	(0.318)
Test of Convergence	-0.019	-0.079	-0.154*	-0.105	-0.200	0.052	0.077
	(0.245)	(0.138)	(0.088)	(0.203)	(0.262)	(0.238)	(0.229)
State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,448	9,015	21,280	3,617	3,043	3,373	3,448

Notes: Table presents estimates Cox proportional hazard models using individual, exoneree-level data, as described in the text. The Black indicator variable refers to Blacks and Hispanics pooled together in column (7). Column (1) reports the parsimonious specification from Table 5. Column (2) considers all sexual offenses regardless of sentence length. Column (3) considers all crimes and all sentence types. Column (4) adds to the baseline sample convictions that occurred in the year of a DNA law's passage or in the years following. Column (5) restricts the sample to convictions finalized prior to 1994. Column (6) limits the analysis to Black and White exonerees. Column (7) compares minorities (Blacks and Hispanics) to the majority (Whites). The "Total Effect on Blacks" row reports the linear combination of the post-policy coefficient and the interaction term. The "Test of Convergence" reports the sum of the Black indicator and the interaction term. All regressions include state and year fixed effects. Standard errors clustered at the state level are reported in parentheses. Significance levels are indicated by *** $p<0.01$, ** $p<0.05$, * $p<0.1$.