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ABSTRACT

Correcting Racial Injustice: Forensic DNA Technology and the Exoneration of the Wrongfully Convicted*

We study the effects of laws streamlining access to post-conviction forensic DNA technology ("DNA laws"). We present a conceptual framework in which DNA laws' effects differ by race due to unequal access to non-DNA exoneration technologies. Consistent with the framework's predictions, we find that DNA laws: (i) increased DNA-based exonerations for Blacks and non-Blacks; (ii) increased total exonerations for Blacks, while non-Blacks exhibit substitution across exoneration technologies and smaller effects on total exonerations. We estimate that without DNA laws, around 100 wrongfully convicted Black Americans would have died in prison, with wrongfully convicted Blacks spending over 1,800 additional years imprisoned.

JEL Classification: K40, J15, D63

Keywords: racial inequality, criminal sentencing, legal institutions, technology and justice

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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). Wrongful convictions are among the most egregious expressions of racial injustice, with notable instances such as the Central Park Five or “Hurricane" Rubin Carter 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 significantly increased the number of wrongfully convicted Black Americans who were exonerated. These laws also sped up the rate at which wrongfully convicted Blacks were exonerated. While wrongfully convicted Blacks were exonerated significantly more slowly than others prior to DNA laws, we find convergence in exoneration rates following DNA laws' passage.

We begin by presenting a 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, to which Black defendants may not have had equal access (e.g., due to 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. For Blacks, the result may have been a significant net increase in total exoneration due to the absence of good substitutes. Low-cost access to the most 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 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, 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. These laws were adopted in a staggered manner in the years following the Department of Justice (1999) report.

We begin with a difference in differences model (controlling for state and year fixed effects) examining the impact of DNA laws on exoneration counts among all individuals (regardless of race) convicted prior to the passage of DNA laws and serving life sentences. We find that DNA laws significantly increase the number of DNA-based exonerations — by 0.13 per state$\times$year, over double the pre-law mean of 0.058. We estimate an event-study specification allowing us to test for pre-law differences in trends across states, and find none. This supports a causal interpretation of the DNA laws' effects on exonerations. Considering exonerations through any means (DNA or non-DNA), we find smaller overall effects: laws increase total exonerations of individuals serving life sentences by around 0.09 per state$\times$year, relative to a pre-law mean of 0.26. There thus seems to have been some substitution from non-DNA to DNA-based exoneration. These results are robust to a range of alternative specifications: for example, estimating different functional forms; including state-specific trends in exoneration; or, excluding any individual US judicial circuit. Our findings are also robust to applying difference-in-differences methods that are robust to dynamic and heterogeneous treatment effects (Goodman-Bacon, 2021; De Chaisemartin and d'Haultfoeuille, 2020).

We then examine the effects of the DNA laws by race. In a triple differences design, we find that *DNA-based* exonerations of Blacks and non-Blacks serving life sentences respond very similarly to the DNA laws.[1] However, we find significant differences in the *total* exoneration effects of the DNA laws by race. Among non-Blacks, there is nearly complete substitution of DNA-based exoneration for non-DNA exoneration. Total exonerations for non-Blacks increase by a statistically insignificant 0.006 per state$\times$year. For Blacks, the patterns are starkly different: DNA laws significantly increase the total number of exonerations — by over 0.08 per state$\times$year, a large effect relative to the pre-law mean of 0.11. We estimate an event-study specification allowing us to test for pre-law differences in trend rates of exoneration across states, and find none, suggesting a causal effect of DNA laws on exonerations for Blacks. Again, our findings are robust to a range of different empirical specifications.

These patterns are consistent with the conceptual framework: DNA laws providing streamlined access to exoneration technology appear to have been more valuable for wrongfully convicted Blacks, who plausibly faced a higher cost of accessing alternative technologies of exoneration. We next consider the mechanisms through which DNA laws improved access to exoneration technology. One possible interpretation of Blacks' pre-law higher cost of accessing exoneration technology is that it reflects a discriminatory legal environment facing wrongfully convicted Blacks. Streamlined access to a powerful exoneration technology (i.e., DNA testing) may be particularly important in a context of greater racial discrimination. To assess this possibility, we test whether the effects of DNA laws vary *both* by race *and* by the level of historical racial animus in the

[1]Our focus on historical injustice faced by Black Americans leads us to distinguish simply between Blacks and all others. Comparisons between Blacks and the majority white population yield qualitatively identical results.

state in which an individual was wrongfully convicted. We measure state racial animus in three ways: first, using historical lynching data housed at the Tuskegee University archives; second, using the states of the Confederacy; and, third, using the states subject in their entirety to Section 5 of the Voting Rights Act (VRA). Indeed, across measures, we find that the effects of DNA laws on Blacks' total exonerations is substantially larger in states with more racial animus. A one-standard deviation higher level of historical lynchings of Blacks is associated with a *doubling* of the effect of DNA laws on Blacks' exonerations, relative to non-Blacks; effects of DNA laws for Blacks are more than tripled in Confederate states and VRA states compared to others.

We next explore institutional dimensions that may have enhanced the impact of DNA laws. First, DNA laws may have been particularly valuable to wrongfully convicted Blacks where there also existed effective legal representation. One proxy for the presence of effective legal representation for wrongfully convicted Blacks is an active "innocence organization" in the state in which they are convicted.[2] The National Registry of Exonerations database reports whether an innocence organization was involved in the exoneration of an individual, allowing us to identify states with active organizations prior to the passage of DNA laws. If DNA technology and legal representation are complements, we would expect larger effects of the laws where innocence organizations were active. Indeed, we find that the effects of DNA laws on Blacks' total exonerations is substantially larger in states with innocence organizations active prior to the laws' passage. We also exploit variation across DNA laws in the requirement of the provision of counsel to petitioners prior to their motion. We find substantially larger effects where the provision of counsel is mandated under the DNA law, again suggesting that DNA laws had their largest effects on Blacks' exoneration where they had access to better legal representation.

State DNA laws differed along several other important dimensions (Brooks and Simpson, 2010). First, some laws were limited in scope, depending on the conviction offense or the defendant's plea. We find that laws without such scope restrictions were associated with substantially larger differential effects of DNA laws on Blacks. Second, some laws imposed financial costs on petitioners. We find that laws not imposing such costs were also associated with substantially

[2] Such 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/`.

larger effects of DNA laws on Blacks. Finally, there exists variation across states' DNA laws in the provision of access to different databases of (potentially exonerating) DNA samples.[3] In particular, some states' laws provided streamlined access to the US federal government's Combined DNA Index System (CODIS) database of DNA samples. While we find economically and statistically significant effects of DNA laws that do not provide access to the CODIS database on Blacks' exonerations, the effect of DNA laws is four times larger when laws provide access to CODIS.

We next consider the effects of these laws on the *rate* of exoneration — the time lapse from conviction to exoneration. Reflecting the more general racial disparities in the criminal justice system, wrongfully convicted Blacks in our dataset spend around four years longer in prison prior to exoneration than non-Blacks. We conduct a survival analysis controlling for state, year, and year of conviction fixed effects. Examining all exonerated individuals regardless of race, we find almost no effect of DNA laws on the speed of 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 rate of exoneration for Blacks and substantial convergence of exoneration rates across races following the laws.[4] When we control for the age and gender of the wrongfully convicted individual and for characteristics of the wrongful conviction (e.g., whether it involved a forced confession) and of the exoneration (e.g., whether an innocence organization was involved), we continue to find a statistically and economically significant increase in Blacks' rate of exoneration.

This raises the question of whether increased exoneration rates for Blacks reflect differential effects of DNA laws across particular types of cases: for example, some crimes may leave more physical evidence with which to exonerate a wrongfully convicted individual, and DNA laws may have a particularly large effect on these offenses. If Blacks were disproportionately wrongfully convicted of offenses such as these, then the convergence in exoneration rates post-DNA laws may reflect these crime-specific effects, rather than racial differences *per se*. To address this possibility, we estimate our survival analysis model, but controlling for conviction offense. This does not

[3] The larger the database of DNA to which one can match evidence, the more likely a match identifying the true guilty party.

[4] 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 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 reduce the rate of exoneration for others, meaning the qualitative finding of convergence is valid.

affect our estimates. Next, we allow DNA laws to affect exoneration rates in a manner that is varying with the conviction offense (i.e., controlling for crime fixed effects interacted with a post-DNA law indicator). These time$\times$crime varying controls do not affect our results.

To quantify the increased rate of exoneration of wrongfully convicted Blacks, we simulate their counterfactual exonerations had there been no DNA laws. To do so, we estimate a survival function for Blacks prior to the DNA laws' passage using their demographic characteristics, state of wrongful conviction, and case characteristics (conviction offense fixed effects, contributing factors that led to a wrongful conviction, and exoneration technology). 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 the 145 wrongfully convicted Blacks — convicted prior to the DNA laws' passage, and not yet exonerated — we simulate the time to exoneration 1,000 times based on the individual-specific predicted hazard ratio. We find that on average, only around 30% of the 145 actually exonerated Blacks are exonerated in our counterfactual simulations prior to the 39 year total prison time that the US government considers a full term for a life sentence.[5] That is, we estimate that in the absence of DNA laws, around 100 wrongfully convicted Black Americans would have spent the rest of their lives behind bars. We estimate that the average time spent in prison — prior to simulated exoneration or up to the 39 year total prison term for those not exonerated in the simulation — would have been nearly 13 years longer in the absence of the DNA laws. Multiplied by the 145 wrongfully convicted individuals, this amounts to over 1,800 person$\times$years of additional prison time in the absence of the laws.

Our analyses most directly contribute to a broad social science literature on wrongful convictions and exonerations. Overviews include Gross et al. (2004), Gross and O'Brien (2008), Gould and Leo (2010). Quantitative work on these topics remains relatively limited; there is a small empirical literature examining the frequency of wrongful conviction (Bjerk and Helland, 2020) and correlates of exoneration (Saber et al., 2021). To this literature we contribute causal evidence on the effects of DNA laws on exoneration, and also provide an analysis of racial differences in exoneration rates (suggested by Smith and Hattery, 2011).

[5]This is based on the life expectancy of the prison population and the average age at conviction (and 144 of the 145 individuals we study were exonerated within 39 years of their conviction). See US Sentencing Commission (2015). Applying a maximum time in prison that is based on an individual's age does not meaningfully affect our conclusions.

Our findings thus contribute to the more general empirical literature on racial inequality in the criminal justice system (see Lang and Kahn-Lang Spitzer, 2020 for a review). 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, 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 criminal justice: in addition to identifying actual culprits, it can also thereby exonerate the falsely convicted. We also highlight the heterogeneity in the impact of technology depending on complementary 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.

In what follows, in Section 2, we describe the institutional setting of our study; in Section 3, we present a simple, informal conceptual framework that guides our empirical analysis; 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.[6] 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 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.[7] 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

[6] 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.

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

(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."

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.[8]

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).

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

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. It is important to note that these statutes are not identical in their content across US states. Important dimensions along which these laws vary include[9]:

- 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.
- Matching to DNA databases: some state laws provide for the matching of evidence to the US Federal Combined DNA Index System ("CODIS"), a DNA database with national scope.

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.[10]

3 Conceptual Framework

We motivate our empirical analyses with the predictions of a simple conceptual framework. The framework illustrates how DNA laws may affect: (*i*) DNA based, non-DNA, and total exonerations; (*ii*) exonerations differentially by race; and, (*iii*) exonerations differentially by legal and institutional context.

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

[10] In Online Appendix Tables A.1–A.2 we provide information on state DNA laws along the dimensions outlined above.

3.1 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).

3.2 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, and as such, the technology should have been widely adopted following DNA laws' passage. We thus assume that $p_{DNA,post} < p_{non-DNA}$, and so expect DNA laws to produce an increase in *DNA-based* exonerations.

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 available to wrongfully convicted individuals at a low enough cost to ensure their exoneration. Suppose there is a distribution, $f()$, of wrongfully convicted individuals' ability to pay for exoneration technology. Consider the era prior to the passage of DNA laws, with $p_{non-DNA} < p_{DNA,pre}$. Then, individuals will generally choose non-DNA exoneration technology (given its lower cost), and will be exonerated if their ability to pay, defined by f, is greater than $p_{non-DNA}$.

When DNA laws lower the least-cost exoneration technology to $p_{DNA,post} < p_{non-DNA}$, the condition to purchase exoneration technology is now an ability to pay greater than $p_{DNA,post}$, which is less strict an inequality. If all individuals had ability to pay greater than $p_{non-DNA}$, the relaxation of the inequality will not change the total number of exonerations, but will only change the technology adopted. Intuitively, some exonerations after the DNA laws would be substitutes for exonerations that would have occurred in the absence of the laws. However, if some individuals have ability to pay in the range $(p_{DNA,post}, p_{non-DNA})$, these individuals will be exonerated only after DNA laws' passage, thus producing an increase in *total* exonerations (see Figure 2, Panel A, for a graphical depiction). This discussion suggests that the 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 able to gain access to some exoneration technology after the passage of the laws.

3.3 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. More formally, suppose that $p_{non-DNA,Black} > p_{non-DNA,non-Black}$. 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 Blacks 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. This implies fewer pre-law exonerations for Blacks, and slower exonerations as well. Importantly, because racism does not so easily distort scientific interpretation of forensic DNA, we assume that $p_{DNA,post}$ does not differ by race.

Given the costly access to non-DNA exoneration technology for Blacks, the increased DNA-based exoneration following the passage of DNA laws would have reflected much less substitution from other technologies of exoneration, and much more exoneration that would not otherwise have occurred.[11] Graphically, one can see in Figure 2, Panel B, that the range $(p_{DNA,post}, p_{non-DNA,Black})$ is greater than the range $(p_{DNA,post}, p_{non-DNA,non-Black})$. Under reasonable assumptions about the distribution of abilities to pay, this will imply a larger effect of DNA laws on total exonerations for Blacks than for non-Blacks. We thus expect that DNA laws should have increased total exoneration for Blacks, while DNA laws' passage *may* have increased total exoneration for others.

3.4 Variation in Legal and Institutional Context

One would expect that DNA laws should have the largest differential effect on total exonerations (driven by a larger gap between $p_{non-DNA,Black}$ and $p_{DNA,post}$) for Black Americans where they faced the highest obstacles to accessing non-DNA exoneration technology. One particularly important obstacle was racism, which could have biased decisions regarding the appeals of wrongfully convicted Blacks, increasing the cost of non-DNA exoneration technologies. Importantly, racism does not as easily distort the interpretation of forensic DNA evidence. This suggests that DNA laws' passage would matter most for Blacks' total exonerations where racial animus was greatest.

One may also expect the differential effects of DNA laws by race to be largest where wrongfully convicted Blacks had access to effective legal representation that allowed them to utilize the new technology: DNA technology was made more accessible under the laws, but legal representation was still valuable. This legal representation could either arise from civil society (e.g., the activity of an innocence organization), or from the legal requirement that counsel be appointed to petitioners even prior to their motion.[12] In our conceptual framework, effective legal representation could lower $p_{DNA,post}$, which would generally magnify the effects of DNA laws. One could also extend

[11] This depends on the distributions of the ability to pay for exoneration, but holds for a wide range of distributions, and in particular if Blacks and non-Blacks have the same ability to pay distributions, but face different prices of exoneration technologies.

[12] This assumes a complementarity between legal representation and DNA technology. Theoretically, they could also be substitutes. We examine this empirically below.

the framework to have $p_{DNA,post}$ vary by race; Blacks' historical disadvantages in the US legal system might make provision of counsel or the presence of innocence organizations especially valuable to them (i.e., reducing $p_{DNA,post,Black}$).

Other characteristics of the DNA laws could also shape the impact of the laws on wrongfully convicted Blacks. In particular, laws with a narrower scope would naturally reduce the differential impact on Blacks, because (as discussed above) Blacks faced a higher cost of exoneration through non-DNA technology, and thus were more reliant on DNA technology for exoneration. Limits on scope acted as increases in $p_{DNA,post}$ in our conceptual framework, which would differentially affect wrongfully convicted Blacks. Laws imposing financial costs on petitioners could have reduced the impact of DNA laws for Blacks, as they also acted as increases in $p_{DNA,post}$ in our framework. Finally, one would expect a larger impact of the laws where they provided access to larger databases that increased the likelihood that collected DNA will be matched to the (actual) guilty party. A better exoneration technology would be analogous to a fall in $p_{DNA,post}$ in our conceptual framework.

3.5 Predictions

This framework thus generates the following predictions:

Hypothesis 1: The passage of DNA laws will strictly increase *DNA-based* exonerations, regardless of race.

Hypothesis 2: The passage of DNA laws will weakly increase *total* exonerations, regardless of race. The passage of DNA laws may not substantially increase total exoneration among non-Blacks due to substitution from non-DNA to DNA-based exoneration. The passage of DNA laws *will* substantially increase total exoneration among wrongfully convicted Blacks.

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*) an active innocence organization; (*iii*) DNA laws requiring provision of legal counsel; (*iv*) DNA laws unrestricted by crime or plea; (*v*) DNA laws not imposing financial costs on petitioners; and, (*vi*) DNA laws providing access to the

Federal CODIS database.

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 may have no effect on the exoneration rate of others.

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 passage of DNA laws. We describe these datasets in turn, then present descriptive statistics for our sample.

4.1 Exonerations Data

Data on exonerations are retrieved from the National Registry of Exonerations.[13] 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, county, state, and year of conviction of the individual later exonerated for the crime. The database also reports information on the type of crime committed, 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 case.[14]

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

[14] 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.

4.2 State Laws

We gather information about states' post-conviction DNA laws by using the search engine provided by the Innocent 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 Tables A.1 and A.2) as well as specific statute characteristics, discussed above: restrictions on the scope of coverage; requirements for pre-motion legal counsel; financial costs to the petitioner; and, the matching of DNA evidence to samples contained in the CODIS database.[17]

In addition to collecting comprehensive information on the timing of state DNA laws' passage, we also collect information on two additional institutional changes associated with exonerations. First, we identify the establishment of a state's first conviction integrity unit from documentation made available by the National Registry of Exonerations.[18] Second, we identify the establishment of a state's first innocence organization, 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 case characteristics; based on the timing of conviction and exoneration; and, based on the state in which the wrongful conviction occurred. It is important to note that our results are qualitatively identical if we relax any of these sample restrictions (results presented in Online Appendix Tables A.4–A.6). We next discuss these sample restrictions in turn:

Sample restrictions based on case characteristics We focus on the highest-stakes wrongful convictions: those resulting in life sentences.[23] Not only are these the convictions in which the injustice from wrongful conviction arguably imposes the highest costs, but they are also typically convictions for offenses (e.g., homicide, sexual assault, and other offenses) in which physical evidence is present, making forensic DNA analysis particularly relevant.[24]

Sample restrictions based on timing of conviction and exoneration 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 passage of DNA laws. Our baseline analysis will focus on a panel of state×years, in which exonerations occur from 15 years before to 15 years after the passage of DNA laws.[25] Exonerations more than 15 years after a DNA law's passage — including wrongful convictions that have not been overturned — are not included in our sample.

Sample restrictions based on state of conviction As described above, the vast majority of US states adopted post-conviction DNA laws following the release of the 1999 US Department of

sions of historical discrimination in the VRA states.

[23]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. (It is also difficult to quantify counterfactuals in the case of a death penalty, whereas counterfactual years in prison can be estimated.) As noted above, including death penalty cases does not affect our findings.

[24]In Online Appendix Table A.3 we report the counts of conviction offenses for the exonerated individuals in our sample, as well as the counts splitting the sample by race.

[25]To be precise, we include in our pre-law period exonerations from 14 years before the year of a law's passage up to, and including the year of the law's passage, for a total period of 15 years. We include in our post-law period exonerations from the year after the law's passage up to 15 years after, for a total period of 15 years.

Justice (DoJ) report. One might be concerned that the two states that adopted DNA laws prior to the DoJ report (Illinois and New York) did so in a manner endogenous to changes in those states' exonerations of the wrongfully convicted. We thus exclude both Illinois and New York from our baseline analysis. We also exclude the state of Oklahoma, which (again, potentially endogenously) allowed its DNA law to expire in 2005, before enacting a second DNA law in 2013.

Summary statistics for the baseline sample We present summary statistics describing the 435 exonerations in our baseline sample in Table 1, as well as summary statistics splitting the sample by the race of the exonerated individual (219 Black and 216 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. A sizable minority of exonerations (especially large for Blacks) involved the work of an innocence organization, and between one-quarter and one-third were based on DNA. Around 15 years elapsed, on average, prior to exoneration. In Figure 3, we map the number of total exonerations and the number of DNA-based exonerations in our baseline sample by state. 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 general study of the effects of DNA laws on DNA-based exonerations and total exonerations for all individuals (regardless of race). We also examine the timing of DNA laws' passage, considering the possibility of endogenous adoption with respect to exoneration trends as well as the impact of staggered adoption on difference-in-difference estimates (following Goodman-Bacon, 2021, and De Chaisemartin and d'Haultfoeuille, 2020). We then test Hypotheses 1 and 2, examining the heterogeneous effects of the laws for Blacks and non-Blacks. Next, we test Hypothesis 3, exploring mechanisms underlying the heterogeneous effects we find. Finally, we test Hypothesis 4, conducting a survival analysis that examines exoneration rates at the individual level, and allows DNA laws to affect exoneration rates heterogeneously by race. We close by simulating counterfactual exoneration rates in the absence of DNA laws.

5.1 The Effect of DNA Laws on Exoneration

We begin, in Figure 4, by presenting counts of exonerations before and after the passage of DNA laws in the raw data. One can see that DNA-based exonerations jump just after a DNA law's passage, doubling from the five years just before to the five years just after. One can also see that there are no trends in DNA-based exonerations prior to the passage of DNA laws, suggesting that the laws themselves may have caused the increase in DNA-based exoneration. Patterns are more ambiguous for total exonerations, with any effects of the passage of DNA laws more difficult to discern.

To more rigorously identify the effect of DNA laws on exonerations, 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.[26] 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). We include different sets of state$\times$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.

We first estimate the model considering only DNA-based exonerations as the outcome. As discussed above, we hypothesize that DNA laws should significantly increase DNA-based exonerations. We present our findings in Table 2, Panel A. In column 1, we show the estimated effect of DNA laws from a parsimonious model controlling only for state and year fixed effects. One can see that DNA laws increase DNA-based exonerations by 0.13 per state$\times$year, a large effect relative to the pre-law mean of 0.058, amounting to over 75 additional exonerations over the 15 years after DNA laws were passed.

In subsequent columns we explore the robustness of this estimated effect. A first 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, Panel A,

[26] We use the term "state" throughout despite the fact that one jurisdiction in our analysis, Washington, DC, is not a US state.

column 2. 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 possibility 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 column 3, add state-specific quadratic time trends to the baseline model, and this, too, has almost no effect on our estimates.

A different concern is that with exonerations being a rare event, a linear model may not be appropriate. We thus, in Table 2, Panel A, column 4, estimate a Poisson model, and again our results are unchanged. We next consider the possibility that exonerations were artificially low in the year of a law's passage, as lawyers anticipated a lower cost exoneration technology becoming available. Because the year of passage is assigned to the pre-law period in our baseline analysis, this might inflate the estimated effect of the law. To address this concern, in column 5, we estimate our model, but dropping the year of a DNA law's passage from the analysis. Again, results are essentially unchanged. Finally, to address concerns about imbalance in our panel arising from the staggered timing of DNA laws, in column 6 we present estimates from a balanced panel of 48 states from 10 years prior to a DNA law's passage to 6 years post-law. One can see that the estimated effect of the laws is very similar to our baseline estimate. The patterns suggested in the raw data are reinforced by our regression analysis: DNA laws are robustly followed by increased DNA-based exoneration.[27]

We next consider the effects of DNA laws on total exonerations. We estimate the same models presented in Table 2, Panel A, but now considering total exonerations (DNA-based plus non-DNA) at the state$\times$year-level as the outcome. We present our findings in Table 2, Panel B. The baseline effect in the parsimonious specification (column 1) of 0.089 is smaller than the estimated effect on DNA exonerations alone, and is only marginally statistically significant. Depending on the specification, our results sometimes fail to be statistically distinguishable from zero, and effects of DNA laws on total exonerations are generally small relative to the pre-law mean of 0.26 total

[27]Further evidence of the robustness of our findings can be seen in results presented in the Online Appendix. In Table A.4, we explore robustness with respect to our sample choices. We find that our results are essentially unchanged if we: include all states; include all years; include convictions after DNA laws were passed; include death penalty cases; or, if we exclude races/ethnicities other than Black and non-Hispanic white. Finally, in Figure A.1, we present coefficient estimates and 95% confidence intervals when we drop one federal judicial circuit at a time, and we again find that our results are unaffected.

exonerations per state×year.[28]

Evidence on exoneration counts for individuals of all races is consistent with the predictions from our conceptual framework: following the passage of DNA laws, DNA-based exonerations increase substantially and statistically significantly. We also find that total exonerations increase, but the effect is both smaller and less statistically significant. The smaller effects of DNA laws on total exonerations than on DNA-based exonerations are consistent with substitution toward DNA technology from other exoneration technologies that would have been used in the laws' absence.

The Timing of DNA Laws' Passage Causal attribution of changes in DNA-based exonerations to the passage of DNA laws requires further discussion of the timing of the passage of the DNA laws we study. A first concern regards the possible endogenous passage of DNA laws with respect to exoneration. While we controlled for specific, plausibly confounding institutional changes (innocence organizations and conviction integrity units), as well as state-specific trends (in Table 2, columns 2 and 3), one may still wonder whether states that adopted DNA laws in a particular year followed parallel trends to other states just prior to the laws' passage. The raw data presented in Figure 4 suggested no differential trends in DNA-based exonerations prior to DNA laws' passage, but we next subject this to further scrutiny.

We test for parallel pre-law trends in exoneration more formally, estimating the following event-study model:

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

which is analogous to our baseline model estimated in Table 2, column 1, but now estimating 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}). Specifically, we split the 15-year pre-law period (approximately) in half: the period eight or more years before the law and the period from seven years before the law to the year of the law's passage (the latter is the omitted reference period in our analysis). We split the 15-year post-law period (approximately) in half as well: the period covering first eight years post-law, and the seven year period after that.[29] In Figure 5, we present

[28]These patterns, too, are confirmed when we conduct a range of additional robustness exercises: relaxing our sample choices along various dimensions (Online Appendix Table A.4) or dropping federal judicial circuits (Figure A.1).

[29]We acknowledge that the time period bins are quite coarse, reflecting the scarcity of exonerations and our lack of power to estimate more disaggregated time-varying effects. Note that the greater power when specifying coarse bins makes a finding of significant pre-law trends more likely, working against our identification strategy.

the event-study estimates, considering DNA-based exonerations (Panel A) and total exonerations (Panel B). One can see that there is no evidence of any pre-law trends in either DNA-based or total exonerations. Following the passage of a DNA law, both DNA-based and total exonerations increase, matching our findings in Table 2.

A second concern regarding the timing of the DNA laws' passage is that early- and late-adopting states may exhibit heterogeneous treatment effects. Such heterogeneity may distort treatment effect estimates (see Goodman-Bacon, 2021 and De Chaisemartin and d'Haultfoeuille, 2020). 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) separately for early adopters (relative to later adopters) and late adopters (relative to early adopters). One can see in Table 3, columns 2 and 3, that the two subgroups' treatment effects are very similar to each other and to our baseline model (reproduced in Table 3, column 1, for comparison). We next implement the estimator robust to heterogeneous and dynamic effects proposed by De Chaisemartin and d'Haultfoeuille (2020). One can see in Table 3, column 4, that our results are qualitatively unchanged: the effect of DNA laws on DNA-based exonerations remains quantitatively and statistically significant, while the estimated effect on total exonerations is positive, but not statistically significant.

5.2 Heterogeneous Effects of DNA Laws by Race

We next test the predictions of Hypotheses 1 and 2. First, DNA laws should increase DNA-based exonerations regardless of race. Second, effects on *total* exonerations may differ by race: while we expect a significant increase in total exonerations for Blacks, effects on total exonerations for others may be less pronounced, due to substitution from other available exoneration technologies.

To do so, we construct a state×year×race panel (where race is Black or non-Black), and estimate the following 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 now a count of exonerations in state s in year t for individuals of race r. The model is identical to that 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.

We first examine the effects of DNA laws by race considering only DNA-based exonerations as the outcome. We present our findings in Table 4, Panel A, presenting specifications analogous to those in Table 3. In our parsimonious specification, column 1, one can see that prior to DNA laws' passage DNA-based exonerations did not meaningfully differ by race — the coefficient on $\mathbf{1}_{r=\text{Black}}$ (β_2) is very small and statistically indistinguishable from 0. This is consistent with DNA exoneration technology being difficult to access, regardless of race, prior to the passage of DNA laws. One can also see in Table 4, Panel A, column 1, that DNA laws' passage significantly increased DNA-based exonerations for both Blacks and for non-Blacks: the coefficient on $Post_{st}$ is statistically significantly greater than 0 and the sum of the coefficients on $Post_{st}$ and $Post_{st} * \mathbf{1}_{r=\text{Black}}$ is significantly greater than 0 as well. We do not find a statistically significant difference in the effect of DNA laws on DNA-based exonerations by race: the coefficient on $Post_{st} * \mathbf{1}_{r=\text{Black}}$ is greater than 0, but is statistically insignificant. These results confirm Hypothesis 1: DNA laws significantly increase DNA-based exonerations for both Blacks and non-Blacks.

In subsequent columns, we explore the robustness of these patterns. One can see that they are unchanged when: we control for the presence of innocence organizations and conviction integrity units (column 2); when we control for state-specific trends (column 3); when we estimate a Poisson model (column 4); when we drop the passage year of laws from our analysis (column 5); or, when we estimate our model using a balanced panel (column 6). Again we provide further evidence of the robustness of our findings in the Online Appendix. In Table A.5, we explore robustness with respect to our sample choices and find that our results are essentially unchanged if we: include all states; include all years; include convictions after DNA laws were passed; include death penalty cases; or, if we exclude races/ethnicities other than Black and non-Hispanic white.

We next examine the effects of DNA laws on total exonerations, by race. We estimate the same models presented in Table 4, Panel A, but now considering total exonerations (DNA-based plus non-DNA) at the state$\times$year$\times$race-level as the outcome. Estimates from our parsimonious specification (Table 4, Panel B, column 1) confirm the predictions of Hypothesis 2. While the effect of DNA laws on total exonerations of non-Blacks (i.e., the coefficient on $Post_{st}$) is economically small and statistically insignificant, the effect of DNA laws on the total exonerations of Blacks is positive and significant (i.e., the sum of the coefficients on $Post_{st}$ and $Post_{st} * \mathbf{1}_{r=\text{Black}}$ is significantly greater than 0). The difference in the laws' effects by race is significant (i.e., the coefficient on $Post_{st} * \mathbf{1}_{r=\text{Black}}$ is significantly greater than 0) as well. One also can see that Blacks' total exonerations were significantly less than non-Blacks' prior to the passage of DNA laws (the coefficient on $\mathbf{1}_{r=\text{Black}}$ is significantly less than 0).

These findings are consistently observed across a range of specifications presented in Table 4, Panel B. We find that DNA laws significantly increased exonerations of Blacks, but not of non-Blacks (and, generally, a significant differential effect of DNA laws by race), when we: control for the presence of innocence organizations and conviction integrity units (column 2); control for state-specific trends (column 3); estimate a Poisson model (column 4); drop the passage year of laws from our analysis (column 5); or, estimate our model using a balanced panel (column 6). In Online Appendix Table A.5, one can see that our findings are also robust with respect to our various sample choices as well.

One naturally wonders whether there existed any pre-DNA law trend in exoneration by racial group, and particularly for Blacks. To examine trends of exoneration by race around the time of DNA laws' passage, we estimate the following event-study model:

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

This is analogous to our baseline model allowing for heterogeneous effects by race, estimated in Table 4, column 1, but we now split the pre-law and post-law periods as we did above (in Figure 5). We plot estimated Black exonerations (the sums of the β_{1T} and β_{2T} coefficients) and non-Black exonerations (the β_{1T} coefficients) relative to the period just before the passage of DNA laws, in Figure 6, panels A and B. One can see in the figure that there is no trend in either Black DNA-based or Black total exonerations prior to the passage of a state's DNA laws; one can also see that in the period just after a law's passage, both DNA-based and total exonerations of Blacks significantly increase (panel A). For non-Blacks (panel B), there is again no pre-law trend in either DNA-based or total exonerations; again, one can see a significant jump in non-Black DNA-based exonerations after a law's passage, but no significant effect on non-Black total exonerations, consistent with our findings above. In Figure 6, panel C, we plot the differential Black exonerations (DNA-based and total) relative to the period just before the passage of a DNA law. One can see no pre-law trend in differential DNA-based exonerations, and a modest increase in Blacks' total exonerations relative to whites, prior to the passage of DNA laws. Following the passage of DNA laws, one sees sustained differential total exonerations for Blacks.

The evidence we find of heterogeneous effects of DNA laws on total exoneration counts by race again matches the predictions from our conceptual framework. Our findings indicate that DNA laws increased DNA-based exonerations as well as total exonerations for Blacks. In contrast, for non-Blacks the increase in DNA-based exonerations to a large extent represented substitution from other technologies of exoneration. These patterns suggest a higher cost of non-DNA exoneration technology facing wrongfully convicted Blacks. We next consider what these higher costs may have been in practice, and thus the mechanisms through which DNA laws worked in exonerating wrongfully convicted Blacks.

5.3 Mechanisms

One possible interpretation of Blacks' higher cost of accessing non-DNA exoneration technology is that it reflects a discriminatory legal environment facing wrongfully convicted Blacks. For example, discrimination may have made it more difficult for Blacks to successfully overturn convictions due to false testimony or to police misconduct. As predicted in Hypothesis 3, part (*i*), by providing streamlined access to a powerful, and arguably less racially biased, exoneration technology, DNA laws may have had a larger differential impact on total Black exonerations in a context of greater racial discrimination. To assess this possibility, we 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. We estimate the following model:

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

where 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* a measure of racial animus in a state, $animus_s$, as well as the lower order terms in this interaction. As discussed above, we consider three measures of racial animus: first, the standardized count of Blacks lynched in a state; second, a dummy variable indicating whether a state belonged to the Confederacy; and, third, a dummy variable indicating whether a state was subject in its entirety to Section 5 of the Voting Rights Act (VRA).

In Figure 7, we plot the differential effects of DNA laws on the total exonerations of Blacks for states with relatively low and relatively high racial animus. In Panel A, we show the differential effect of DNA laws on Black exonerations in states with mean levels of lynchings (this is simply the coefficient on $Post_{st} * \mathbf{1}_{r=\text{Black}}$), and in states with two standard deviations more than the mean (this is the coefficient on $Post_{st} * \mathbf{1}_{r=\text{Black}}$ + two times the coefficient on $Post_{st} * \mathbf{1}_{r=\text{Black}} * animus_s$). One can see in the figure that DNA laws significantly, differentially increased the exoneration of Blacks in states with an average level of historical Black lynchings; one can also see that the effect of DNA laws was nearly three times as large in states with substantial racial animus (i.e., two standard deviations more than the mean level of historical lynchings).[30]

In Figure 7, Panel B, we plot analogous estimates, now showing the differential effect of DNA laws on Black exonerations in states outside the Confederacy (this is simply the coefficient on $Post_{st} * \mathbf{1}_{r=\text{Black}}$), and in states that belonged to the Confederacy (this is the sum of the coefficient on $Post_{st} * \mathbf{1}_{r=\text{Black}}$ and the coefficient on $Post_{st} * \mathbf{1}_{r=\text{Black}} * animus_s$). One can see in the figure that DNA laws marginally significantly, differentially increased the exoneration of Blacks in states outside the Confederacy; one can also see that the effect of DNA laws was more three times as large in states with substantial racial animus (i.e., those in the Confederacy).

Finally, in Figure 7, Panel C, we show the differential effect of DNA laws on Black exonerations in states where Section 5 of the VRA did not apply (this is simply the coefficient on $Post_{st} * \mathbf{1}_{r=\text{Black}}$), and in states where it did (this is the sum of the coefficient on $Post_{st} * \mathbf{1}_{r=\text{Black}}$ and the coefficient on $Post_{st} * \mathbf{1}_{r=\text{Black}} * animus_s$). One can see in the figure that DNA laws significantly, differentially increased the exoneration of Blacks in states outside the scope of Section 5 of the VRA; one can

[30] Regression estimates underlying all panels in Figure 7 are provided in Online Appendix Table A.6.

also see that the effect of DNA laws was around four times as large in states with substantial racial animus. Overall, our findings suggest that a culture of discrimination may have impeded the exoneration of wrongfully convicted Blacks, increasing the impact of DNA laws. It is reassuring that DNA laws have significant effects even in states with a history of racial discrimination, suggesting that technology and public policy can play some role in overcoming this history.

We next explore differences in states' institutional environments that may have contributed to their effects on total exonerations of Black Americans. As predicted in Hypothesis 3, parts (*ii*) and (*iii*), DNA laws and adequate legal representation may be complements in increasing Black exonerations. If so, one would expect particularly large effects of DNA laws on total Black exonerations in states with active innocence organizations and in states with DNA laws requiring provision of legal counsel to petitioners prior to their motion.[31]

To explore these possibilities, we test whether the effects of DNA laws vary *both* by race *and* by access to quality legal representation. We estimate the following model:

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

where 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 a measure of legal representation in a state, $representation_s$, as well as the lower order terms in this interaction. As discussed above, we consider two measures of representation: first, a dummy variable indicating the activity of an innocence organization in a state prior to the passage of a state's DNA law; second, a dummy variable indicating that a state's DNA law required the provision of legal counsel.[32]

We present estimated differential effects of DNA laws on Blacks' total exonerations in Figure 8, Panels A and B.[33] One can see in the Figure that Black total exonerations marginally significantly

[31] As noted above, it is also possible that DNA laws and legal representation are substitutes, which would suggest a differentially large effect of DNA laws in states where adequate legal representation was lacking. Our empirical findings point toward complementarity in the context we study.

[32] We measure the activity of an innocence organization in a state using our exonerations data.

[33] Regression estimates are provided in Online Appendix Table A.7.

differentially increase following the passage of DNA laws in states without our indicators of effective legal counsel. Strikingly, effects of DNA laws are substantially larger in states where there exists adequate counsel, either through the existence of an innocence organization or state requirement.[34]

Finally, we consider whether specific features of state DNA laws shaped their effects on Blacks' total exonerations. This both sheds light on the mechanisms generating the effects we observe and also suggests the importance of the "intensive margin" of policy: the laws' details may matter. Specifically, we test the predictions of Hypothesis 3, parts (*iv*), (*v*), and (*vi*). Namely, that DNA laws should have a particularly large differential effect on Black total exonerations where DNA laws are unrestricted by crime or plea; where they do not impose financial costs on petitioners; and, where they provide access to the Federal CODIS database. To test these predictions, we estimate the following model:

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

where the outcome, $Exoneration_{str}$, is again a count of 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 indicator of a specific feature of a state's DNA law, $feature_s$, as well as the lower order terms in this interaction. As discussed above, we consider four distinct features: no restriction by crime; no restriction by plea; no financial burden on petitioners; and, access to the CODIS database.

We present estimated differential effects of DNA laws on Blacks' total exonerations in Figure 8, Panels C–F.[35] One can see in the Figure (Panel C) that Black total exonerations modestly (insignificantly) differentially increase following the passage of DNA laws in states that impose financial

[34]Part of the very large differential effect of DNA laws in states requiring legal counsel arises from a surprising *negative* effect of DNA laws on non-Black exonerations in these states (see Online Appendix Table A.7, column 2). This is the only dimension of cross-state heterogeneity that exhibits such different effects of DNA laws on Blacks and non-Blacks. In general, absolutely larger effects of DNA laws on Black exonerations closely match differentially larger effects shown here.

[35]Regression estimates are provided in Online Appendix Tables A.7–A.8.

costs on petitioners; in contrast, effects double in magnitude and become statistically significant in states in which no financial burden is imposed. In Panels D and E, one can also see modest (insignificant) positive differential effects of DNA laws on Black total exonerations in states that restrict access to DNA technology depending on the crime committed or on the defendant's plea. Again, one sees larger, statistically significant differential effects on Black exonerations in states without such restrictions. Finally, in Figure 8, Panel F, one can see a marginally significant effect of DNA laws on differential Black exonerations in states that do not provide access to the CODIS database; one sees an effect that is three times as large (and statistically significant) in the small set of states that provide CODIS access.

We thus find patterns of heterogeneous effects of DNA laws consistent with our conceptual framework. Blacks differentially benefitted from DNA laws in states where there existed more historical injustice toward Blacks, in states where adequate legal representation could be leveraged in the presence of DNA laws, in states with DNA laws that were not limited in their coverage, and in states that provided access to more (possibly exculpatory) data.

5.4 The Effect of DNA Laws on Exoneration Rates

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 estimating the impact of DNA laws on exoneration rates pooling together wrongfully convicted individuals of all races. Specifically, we conduct a "survival analysis," estimating a parsimonious Cox proportional hazard model using individual, exoneree-level data:

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

where the outcome of interest is an exoneration dummy variable, E_{isct}, indicating whether an individual i, who was convicted in state s in year c is exonerated in year t. $E_0(t)$ is the baseline hazard function evaluated in year t; γ_s, δ_t, and λ_c are sets of state, year, and year of conviction fixed effects, respectively. The coefficient of interest is 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, reported as exponentiated coefficients, in Table 5, column 1. Perhaps surprisingly, although exoneration rates slightly increased post-DNA laws (the estimated exponentiated coefficient on *Post* is greater than 1), this effect is not statistically significant (i.e., compared to no change in likelihood, or a coefficient of 1). It seems that, across all exonerees, the passage of DNA laws did not substantially speed up exoneration.

We next test for heterogeneous effects of DNA laws on exoneration rates by the race of the wrongfully convicted individual. As discussed above, DNA laws may have differentially increased exoneration rates for wrongfully convicted Blacks if they had very limited access to non-DNA exoneration technology. To examine this possibility, we estimate the following model:

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

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 $Black_{isct}$ is 0.583, indicating a 40% lower likelihood of exoneration for wrongfully-convicted Blacks prior to the passage of DNA laws. The estimated coefficient on $Post_{isct}$ is less than 1, suggesting slower exoneration rates for non-Blacks, though this is not significantly different from no change in likelihood. Finally, the coefficient on $Post_{isct} * Black_{isct}$ is 1.79 — substantially and statistically significantly greater than 1 — indicating nearly an 80% increase in Blacks' exoneration rates following the passage of DNA laws.

We next consider the possibility that changes in exoneration rates may not reflect racial differences, but rather differences in other characteristics of the wrongfully convicted correlated with race. We thus estimate the model from Table 5, column 2, but adding controls for gender and age at conviction. We also add controls for characteristics of the conviction itself (due to mistaken witness identification, false or misleading forensic evidence, perjury or false accusation, official misconduct, inadequate legal defense, or co-defendant confession) and of the exoneration (whether an innocence organization or a conviction integrity unit was involved, and whether DNA technology was used). In Table 5, column 3, we present estimates from this model. While we no longer find a statistically significant difference in exoneration rates by race prior to the passage of DNA laws, we continue to observe a statistically significant and substantial increase in Blacks' exoneration rates after these laws were passed.

One still may be concerned that increased exoneration rates for Blacks reflect differential effects of DNA laws across particular types of cases. For example, some crimes may leave more physical evidence with which to exonerate a wrongfully convicted individual, and DNA laws may have a particularly large effect on these offenses. If Blacks were disproportionately wrongfully convicted of offenses such as these, then the convergence in exoneration rates post-DNA laws may reflect these crime-specific effects, rather than racial differences. To address this possibility, we estimate the model from Table 5, column 3, but now adding a full set of conviction offense fixed effects.[36] One can see in Table 5, column 4, that our results are essentially unchanged: we continue to observe a substantial and statistically significant increase in Blacks' exoneration rates following the passage of DNA laws. Finally, we allow DNA laws to affect exoneration rates in a manner that is varying with the conviction offense (i.e., controlling for offense fixed effects interacted with a post-DNA law indicator). We present these estimates in Table 5, column 5, and one can see that our results are again unchanged: accounting for a wide range of case characteristics, we find that DNA laws significantly increased the likelihood of exoneration for wrongfully convicted Blacks.[37]

Counterfactual: 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, columns 4–5: state fixed effects, age at conviction, gender, conviction characteristics, exoneration 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.

We then simulate each individual's time to exoneration using their counterfactual predicted hazard rate 1,000 times. Among the 145 wrongfully convicted Blacks convicted prior to the DNA

[36] There are 11 different crimes that we observe in our exonerations dataset, with murder, sexual assault, and child sex abuse the most frequently observed (see Online Appendix Table A.3).

[37] In Online Appendix Table A.9, we explore the robustness of the survival analysis with respect to our sample choices. We find that our results are essentially unchanged if we: include all states; include all years; include convictions after DNA laws were passed; include death penalty cases; or, if we exclude races/ethnicities other than Black and non-Hispanic white.

laws' passage, and not yet exonerated, we find that on average, only around 30% of the 145 actually exonerated Blacks are exonerated in our counterfactual simulations prior to the 39 year total prison time that the US government considers a full term for a life sentence. That is, we estimate that in the absence of DNA laws, around 100 wrongfully convicted Black Americans would have spent the rest of their lives behind bars. We estimate that the average time spent in prison — prior to simulated exoneration or up to the 39 year total prison term for those not exonerated in the simulation — would have been nearly 13 years longer in the absence of the DNA laws (the simulated survival curve for these 145 individuals is plotted alongside their *actual* survival curve in Figure 9). Multiplied by the 145 wrongfully convicted individuals, this amounts to over 1,800 person$\times$years of additional prison time in the absence of the laws. DNA laws providing access to forensic DNA technology played a substantial role in correcting racial injustice.

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. In particular, access to post-conviction DNA testing significantly increased the number of wrongfully convicted Black Americans who were exonerated, and also increased their rate of exoneration. Our evidence suggests that DNA laws helped to overcome historical discrimination; they acted not as a substitute for legal representation, but as a complement to it; and, the details of legislation mattered, with more expansive laws and links to larger databases magnifying DNA laws' effects. We estimate that the passage of DNA laws freed 100 wrongfully convicted Black Americans who would otherwise have died in prison, saving over 1,800 years of prison time.

Our findings have several policy implications. Most specific to our context, we find that particular characteristics of DNA laws make them especially effective in supporting the exoneration of wrongfully convicted Black Americans: broader scope of access to DNA testing; greater provision of legal counsel; a reduced financial burden on the petitioner; and, the ability to link physical evidence to a large-scale federal DNA database all enhanced the impact of DNA laws on exoneration. Our findings suggest that states that have not adopted these provisions do so in the interest of justice for the wrongfully convicted; while some of these provisions imply costs to the state, the returns in terms of reducing racial disparities appear to be significant. More generally, our findings reveal that the existence of a technology that can reduce racial disparities may be insufficient to ensure widespread access to that technology and thus greater equality: systemic changes on multiple margins (e.g., both technological and legal) may be necessary.

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.

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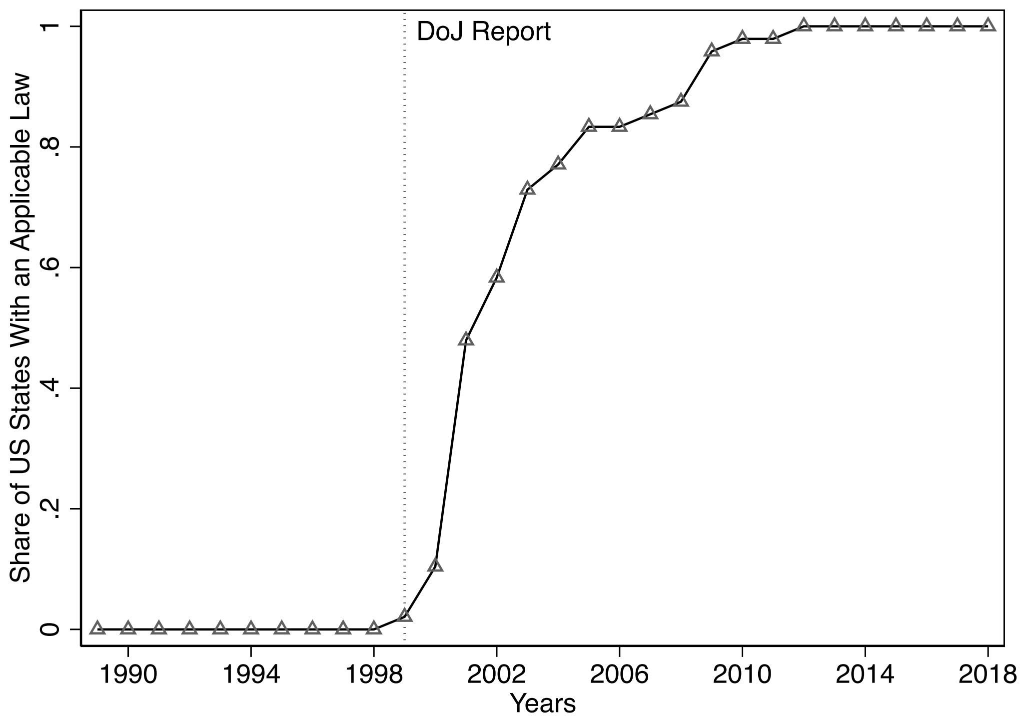
Figures and Tables

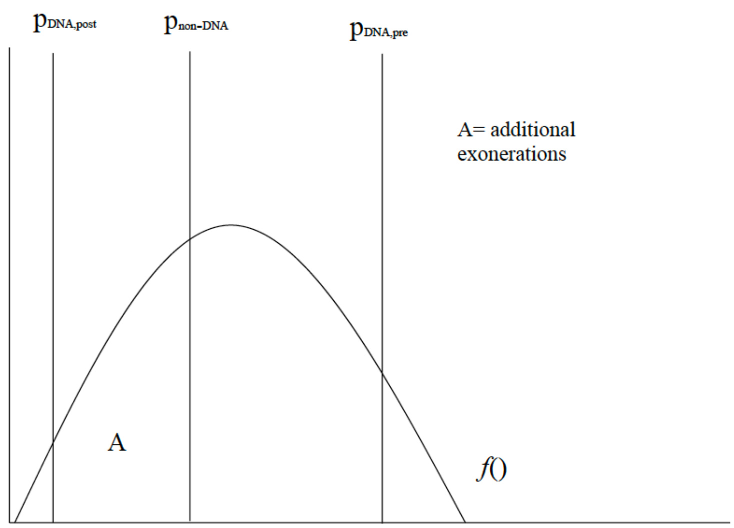
Figure 1: The Rollout of DNA Laws



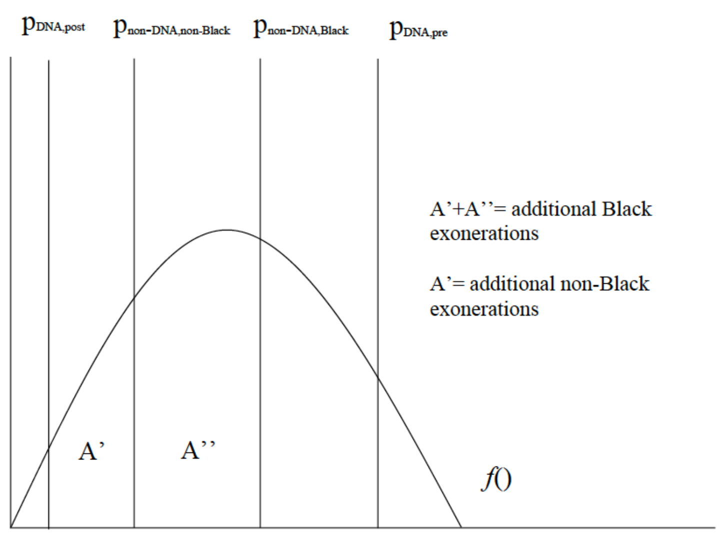
Notes: this figure shows the rollout of DNA laws across US states and Washington, DC for the baseline sample of analysis.

Figure 2: Conceptual Framework

Panel A



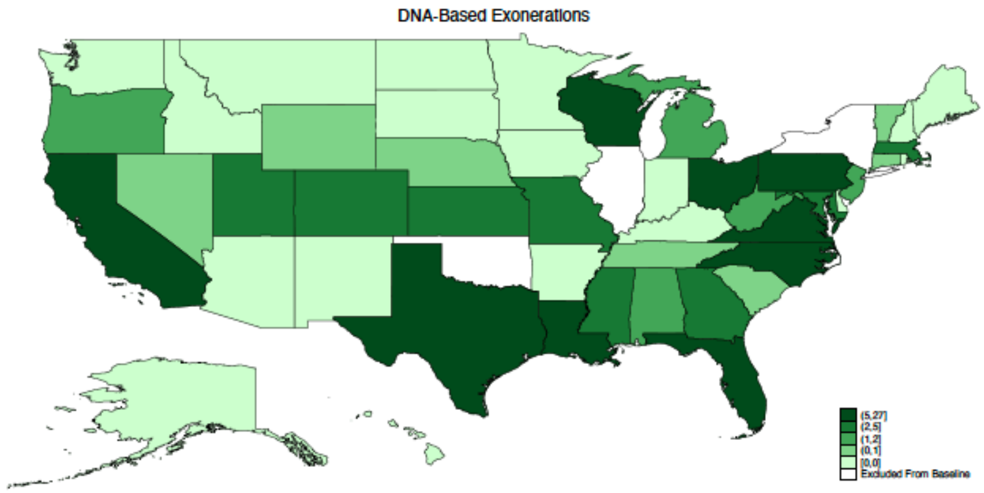
Panel B



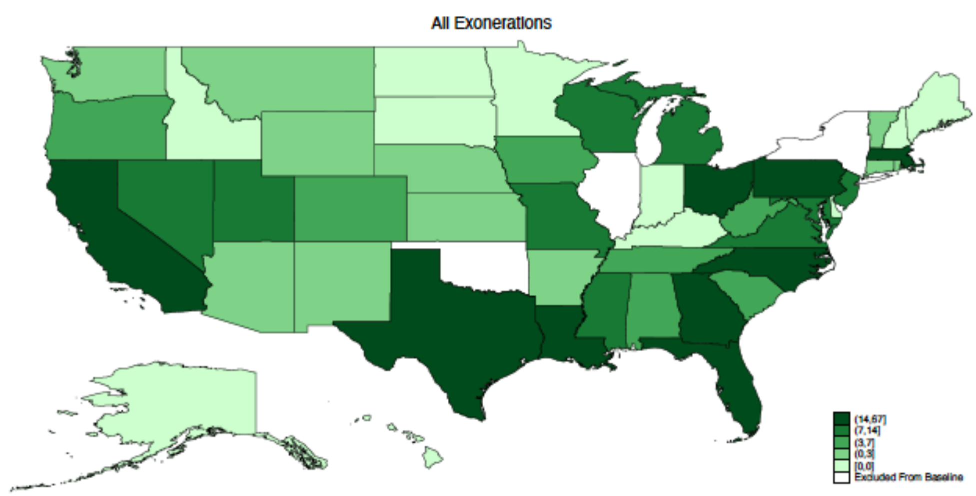
Notes: these figures show the distributions of ability to pay f() of prisoners wrongfully convicted for life sentences. Vertical lines represent prices of exoneration technologies (DNA and non-DNA) in the pre- and post-law periods. As discussed in Section 3, A represents the additional exonerations that would not have occurred without the DNA laws. A' and A'+A" represent the additional non-Black and Black exonerations, respectively, that would not have occurred without the DNA laws.

Figure 3: Map of Exonerations

Panel A

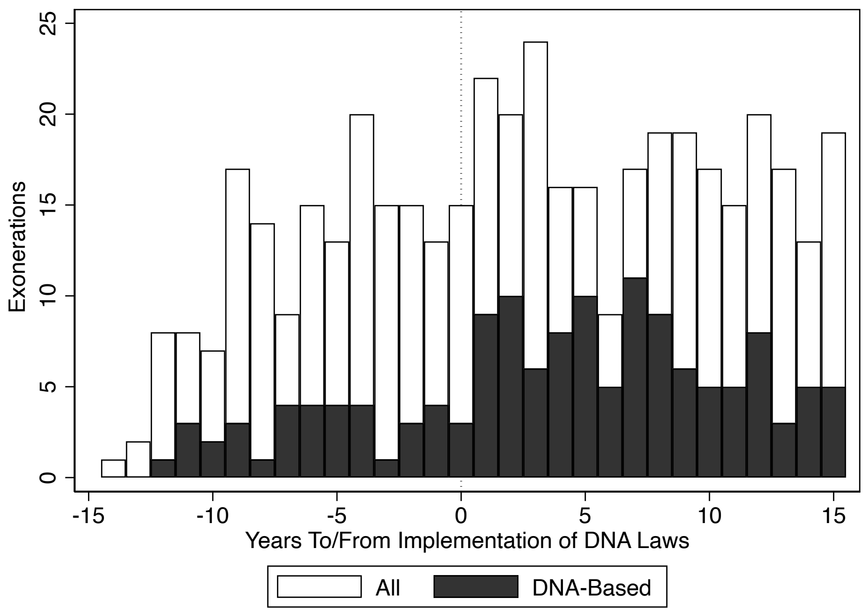


Panel B



Notes: these figures show the geographical distribution of DNA-based (Panel A) and all exonerations (Panel B) across US states and Washington, DC for the baseline sample of analysis.

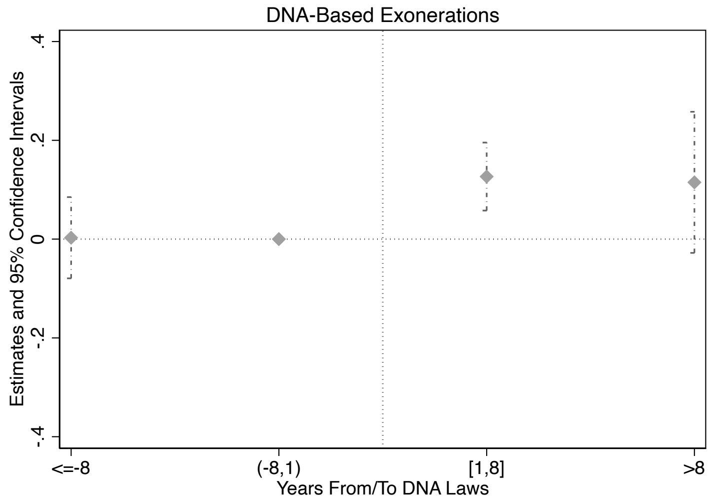
Figure 4: DNA Laws and Exonerations



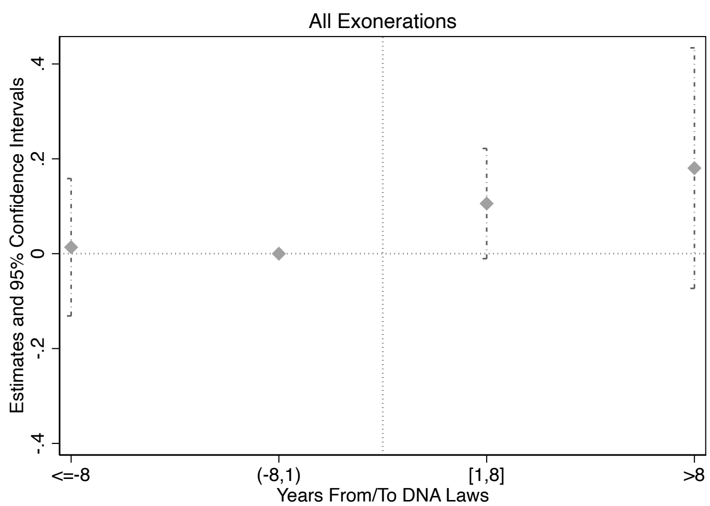
Notes: this figure shows the count of DNA-based and all exonerations relative to the implementation of the DNA laws.

Figure 5: Event Study Analysis: All Races

Panel A



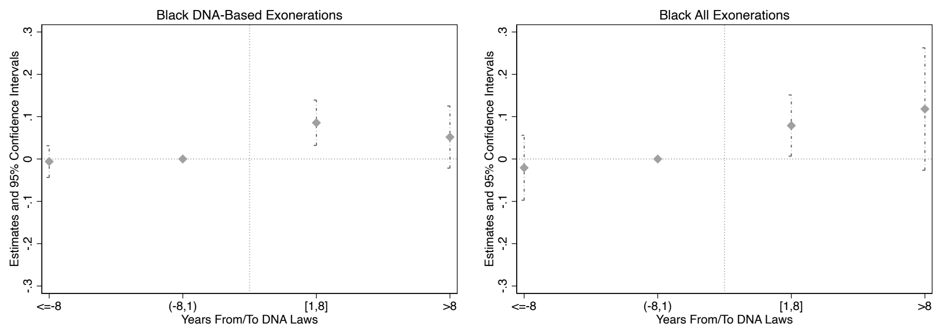
Panel B



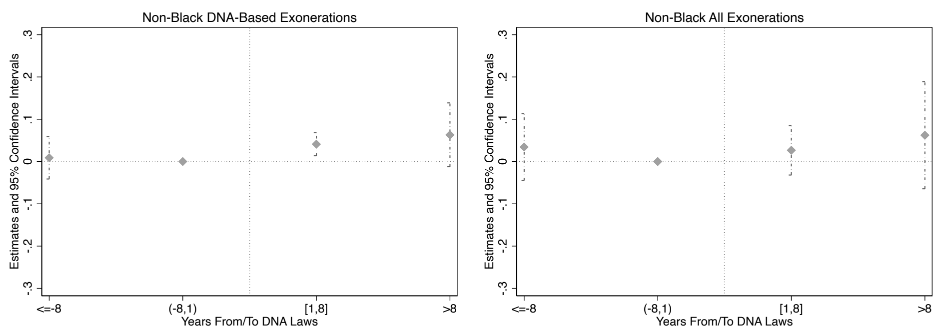
Notes: these figures show event study estimates and 95% confidence intervals of the impact of DNA laws on DNA-based (Panel A) and all exonerations (Panel B).

Figure 6: Event Study Analysis, by Race

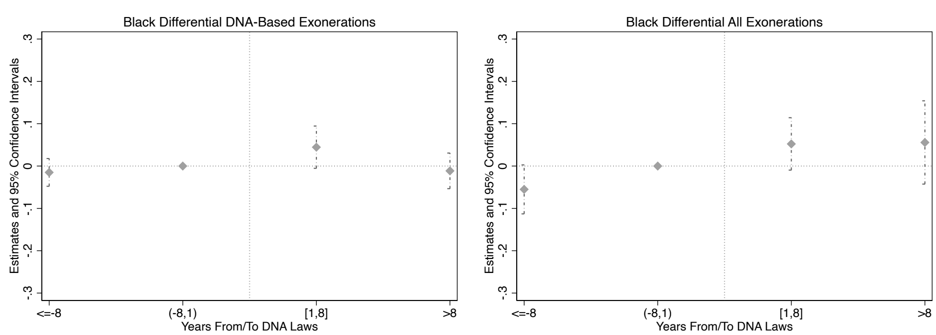
Panel A



Panel B

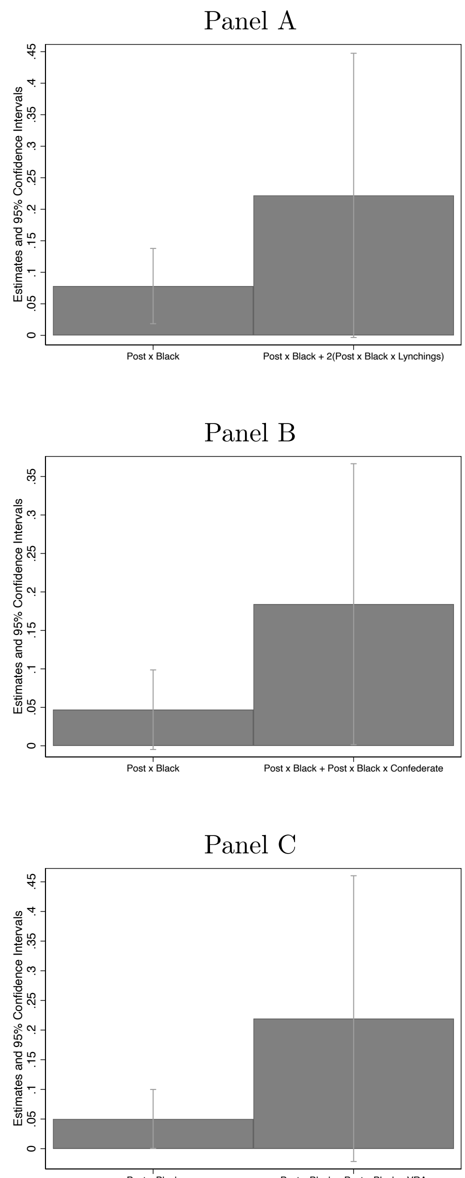


Panel C



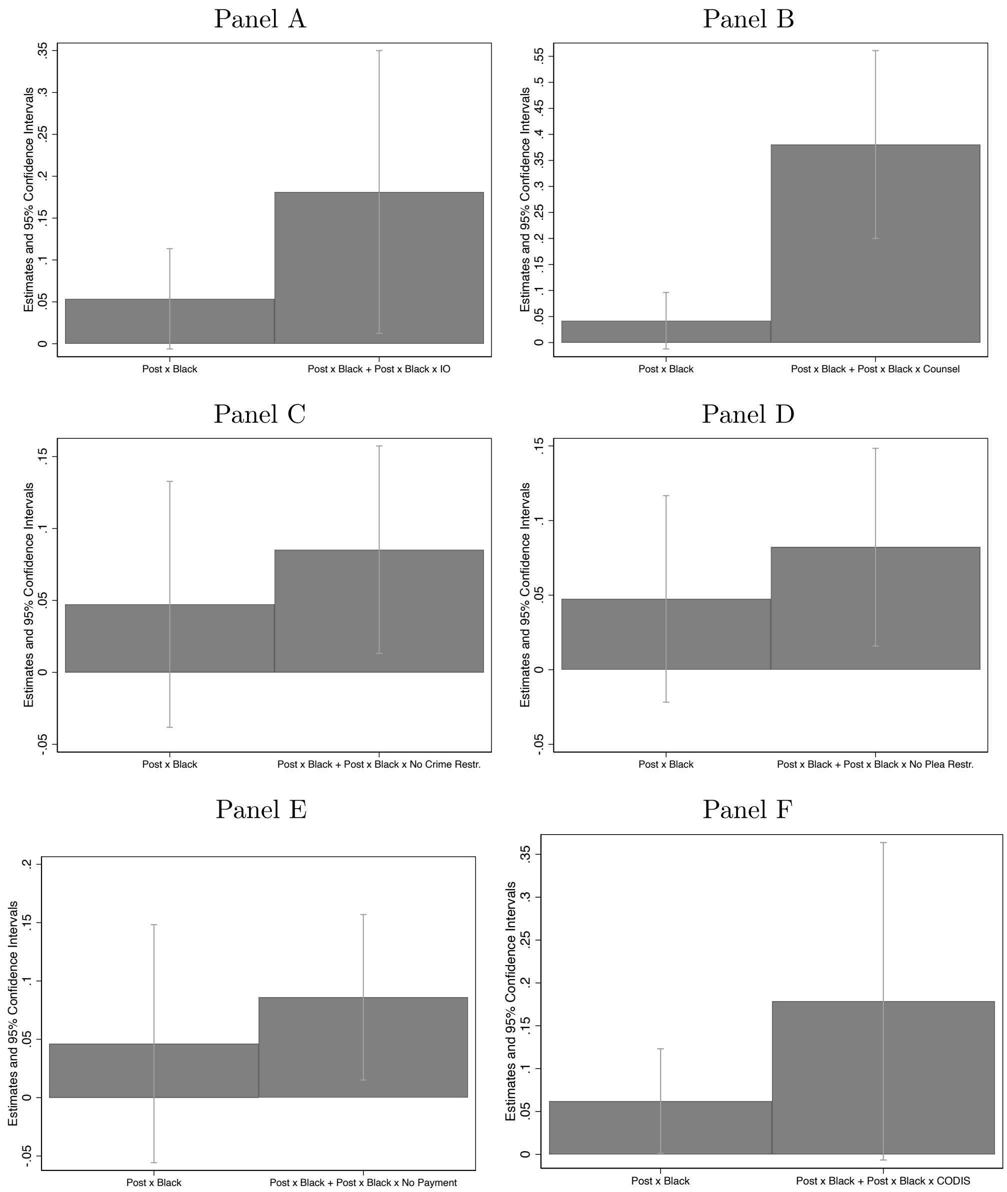
Notes: these figures show event study estimates and 95% confidence intervals of the impact of DNA laws on DNA-based and all exonerations, by race: Blacks (Panel A), non-Blacks (Panel B), and the difference (Panel C).

Figure 7: Heterogeneity by Indicators of Racial Animus



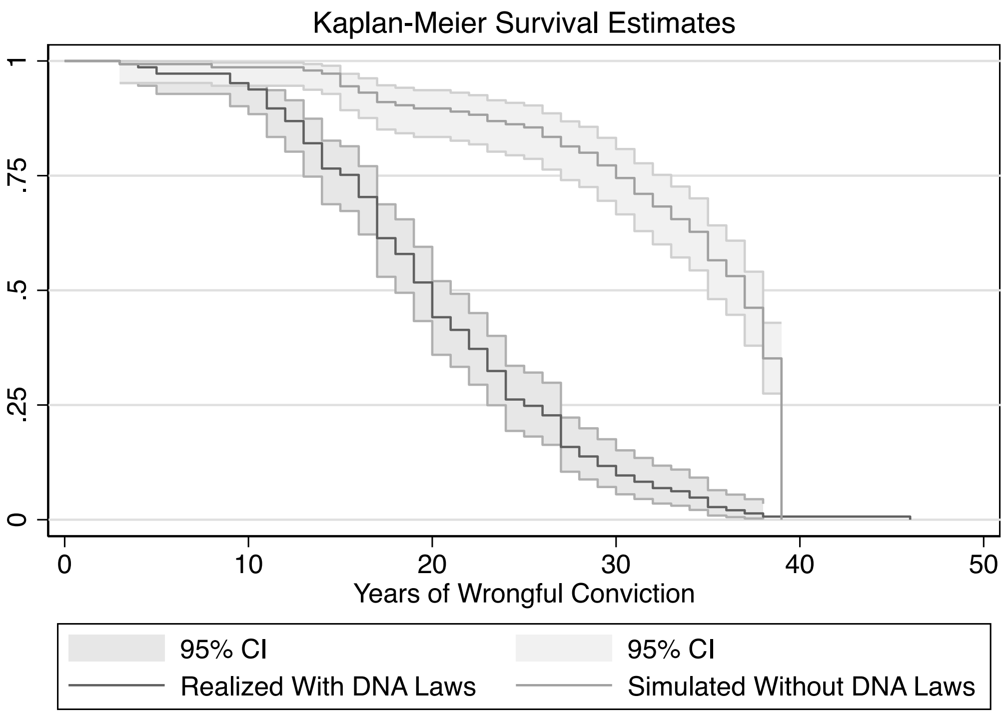
Notes: these figures show estimates and 95% confidence intervals of the heterogeneous effects of DNA laws on Black exonerees by the level of historical racial animus in the state in which an individual was wrongfully convicted. We measure state racial animus in three ways: using historical lynching data (Panel A); using the states of the Confederacy (Panel B); using the states subject in their entirety to Section 5 of the Voting Rights Act (Panel C).

Figure 8: Heterogeneity by Institutional and Legal Characteristics



Notes: these figures show estimates and 95% confidence intervals of the heterogenous effects of DNA laws on Black exonerees. We show results by: whether there is an active innocence organization in the state in which they are convicted (Panel A); whether the law requires the provision of counsel to petitioners prior to their motion (Panel B); whether the laws were not limited in scope depending on the conviction offense (Panel C) or the defendant's plea (Panel D); whether the laws did not impose financial costs on petitioners (Panel E); and, whether the laws provided access to the US federal government's Combined DNA Index System (CODIS) database of DNA samples (Panel F).

Figure 9: Survival Analysis and Counterfactual Simulation



Notes: this figure shows the observed survival curve with DNA laws in operation (dark line) and the counterfactual survival curve simulated without the DNA laws in operation (light line). See Section 5.4 for a discussion of the simulation exercise.

Table 1: Descriptive Statistics

	(1) All Races	(2) Black	(3) Non-Black
Exonerations	435	219	216
Information on exonerees			
Age at wrongful conviction (years)	26.76	24.95	28.58
Male (%)	92.64	97.26	87.96
Information on wrongful conviction (%)			
False confession	11.72	9.59	13.88
Mistaken witness identification	35.63	47.95	23.14
False or misleading forensic evidence	26.20	19.17	33.33
Perjury or false accusation	60.23	54.34	66.20
Official misconduct	62.53	62.56	62.50
Inadequate legal defense	22.06	25.57	18.52
Co-defendant confessed	13.33	12.33	14.35
Guilty plea	5.98	5.48	6.48
Information on exoneration (%)			
Innocence organization	33.56	43.38	23.61
Conviction integrity unit	5.74	10.04	1.39
DNA-based	32.64	36.99	28.24
Time from wrongful conviction to exoneration (days)	5,804.63	6,439.68	5,160.76

Notes: descriptive statistics for the baseline sample of exonerees.

Table 2: The Impact of DNA Laws on Exonerations

	(1) Baseline	(2) IO and CIU Entry	(3) State-Trends	(4) Poisson	(5) No Implementation Year	(6) Balanced Panel
Panel A	DNA-Based Exonerations					
Post	0.131***	0.126***	0.127***	1.314***	0.119***	0.115***
	(0.0285)	(0.0269)	(0.0456)	(0.327)	(0.0296)	(0.0353)
Pre-Laws Outcome Mean: 0.056						
Panel B	All Exonerations					
Post	0.0889*	0.0806	0.155***	0.252	0.0603	0.114**
	(0.0521)	(0.0503)	(0.0586)	(0.180)	(0.0562)	(0.0557)
Pre-Laws Outcome Mean: 0.26						
State FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,326	1,326	1,326	1,326	1,278	816

Notes: this table shows difference-in-differences estimates of the impact of DNA laws on the count of exonerations. Panel A shows results for DNA-based exonerations. Panel B shows results for all exonerations. The variable 'Post' is an indicator set to 1 in the years after the implementation of a DNA law in a state, zero otherwise. All regressions include fixed effects at the state (47 US states plus the District of Columbia) and year level. Standard errors clustered at the state level are shown in parentheses. Column 1 shows the baseline. Column 2 includes dummy variables indicating the entry of innocence organizations and conviction integrity units in a state. Column 3 includes state-specific linear and quadratic trends. Column 4 shows results from a Poisson regression. The implied incident rate ratio is 3.719 for DNA-based exonerations, and 1.287 for all exonerations. Column 5 excludes the year of actual implementation of the DNA law. Column 6 shows the results from a balanced panel of states observed from 10 years before implementation to 6 years after. *** significance at the 1% level, ** significance at the 5% level, * significance at the 10% level.

Table 3: Robustness to Heterogeneous Treatment Effects

	(1) Baseline TWFE	(2) Goodman-Bacon Decomposition	(3)	(4) De Chaisemartin and d'Haultfoeuille (2020)
	Baseline Estimate	Earlier Treated vs. Later Control	Later Treated vs. Earlier Control	Estimate
Panel A		DNA-Based Exonerations		
Coefficient	0.131	0.148	0.124	0.143
Standard Error	(0.0285)	(.)	(.)	(.06371)
Weights	.	0.536	0.464	.
Panel B		All Exonerations		
Coefficient	0.0889	0.079	0.092	0.1117
Standard Error	(0.0521)	(.)	(.)	(0.1489)
Weights	.	0.536	0.464	.

Notes: this table shows baseline two-way fixed effects estimates of the impact of the DNA laws, the Goodman-Bacon decomposition of the effects, and estimates robust to heterogeneous and dynamic effects obtained using the De Chaisemartin and d'Haultfoeuille (2020) method. Regressions include fixed effects at the state and year level. Standard errors are clustered at the state level.

Table 4: The Impact of DNA Laws on Exonerations, by Race

	(1) Baseline	(2) IO and CIU Entry	(3) State-Trends	(4) Poisson	(5) No Implementation Year	(6) Balanced Panel
Panel A			DNA-Based Exonerations			
Black	0.00151	0.00151	0.00151	0.0541	-0.00325	0.00568
	(0.00966)	(0.00966)	(0.00966)	(0.350)	(0.0103)	(0.0108)
Post	0.0517***	0.0496***	0.0501**	1.141***	0.0435***	0.0432***
	(0.0125)	(0.0119)	(0.0233)	(0.349)	(0.0127)	(0.0161)
Post × Black	0.0271	0.0271	0.0271	0.312	0.0319	0.0290
	(0.0192)	(0.0192)	(0.0192)	(0.374)	(0.0205)	(0.0305)
Post + Post × Black	.0788317	.0767547	.0772908	1.453323	.0753976	.0722531
P-Value	0.000	0.000	0.003	0.000	0.001	0.012
Panel B			All Exonerations			
Black	-0.0362*	-0.0362*	-0.0362*	-0.281*	-0.0537**	-0.0322
	(0.0217)	(0.0217)	(0.0217)	(0.160)	(0.0231)	(0.0252)
Post	0.00601	0.00184	0.0389	0.0135	-0.0171	0.0357
	(0.0233)	(0.0230)	(0.0305)	(0.165)	(0.0274)	(0.0279)
Post × Black	0.0769**	0.0769**	0.0769**	0.487***	0.0944***	0.0426
	(0.0304)	(0.0304)	(0.0304)	(0.136)	(0.0335)	(0.0332)
Post + Post × Black	.0829318	.0787615	.1158337	.5004537	.0773204	.0783485
P-Value	0.020	0.023	0.001	0.019	0.038	0.031
State FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,652	2,652	2,652	2,652	2,556	1,632

Notes: this table shows difference-in-differences-in-differences estimates of the impact of DNA laws on the count of exonerations using a state-year-race (Black/non-Black) panel. Panel A shows results for DNA-based exonerations. Panel B shows results for all exonerations. The variable 'Post' is an indicator set to 1 in the years after the implementation of a DNA law in a state, zero otherwise. The variable 'Black' is an indicator set to 1 for Black exonerations, 0 otherwise. All regressions include fixed effects at the state and year level. Standard errors clustered at the state level are shown in parentheses. Column 1 shows the baseline. Column 2 includes dummy variables indicating the entry of innocence organizations and conviction integrity units in a state. Column 3 includes state-specific linear and quadratic trends. Column 4 shows results from a Poisson regression. The implied incident rate ratio is 3.13 (Post) and 1.36 (Post × Black) for DNA-based exonerations and 1.01 (Post) and 1.63 (Post × Black) for all exonerations. Column 5 excludes the year of actual implementation of the DNA law. Column 6 shows the results from a balanced panel of states observed from 10 years before implementation to 6 years after. *** significance at the 1% level, ** significance at the 5% level, * significance at the 10%.

Table 5: Survival Analysis

	(1)	(2)	(3)	(4)	(5)
Black		0.583***	0.823	0.840	0.846
		(0.0903)	(0.108)	(0.111)	(0.114)
Post	1.062	0.786	0.803	0.797	.
	(0.228)	(0.176)	(0.206)	(0.200)	(.)
Post × Black		1.790***	1.777**	1.759**	1.791**
		(0.359)	(0.453)	(0.463)	(0.458)
State FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Year of Conviction FE	Yes	Yes	Yes	Yes	Yes
Demographics	No	No	Yes	Yes	Yes
Conviction & Exoneration Controls	No	No	Yes	Yes	Yes
Crime Controls	No	No	No	Yes	Yes
Crime Controls × Post	No	No	No	No	Yes
Observations	7,329	7,329	7,300	7,300	7,300

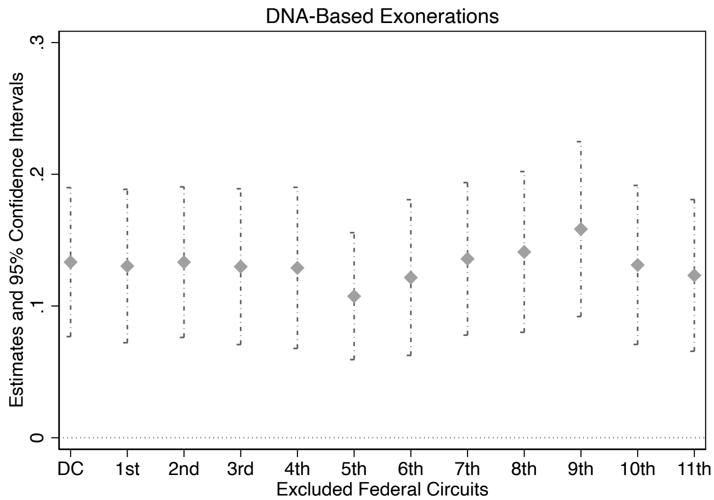
Notes: this table shows hazard ratios as exponentiated coefficients obtained from Cox regressions. Individual-level data for 435 exonerees start in the year of conviction and end in the year of exoneration. The variable 'Post' is an indicator set to 1 in the years after the implementation of a DNA law in a state, zero otherwise. The variable 'Black' indicates the race of the exoneree. All columns include state, year, and year of conviction fixed effects. Column 3 includes demographics (gender and age at conviction), controls for the reasons behind a wrongful conviction (false confession, mistaken witness identification, false or misleading forensic evidence, perjury or false accusation, official misconduct, inadequate legal defence, co-defendant false confession, or guilty plea case) and exoneration characteristics (whether a conviction integrity unit was leading the exoneration, an innocence organization was defending the exoneree, and whether DNA was used for exoneration). The lower number of observations is due to missing age at conviction data for two individuals. Column 4 includes fixed effects for the type of crime that led to a wrongful conviction (murder, sexual assault, robbery, child sex abuse, attempted murder, drug possession or sale, manslaughter, kidnapping, assault, weapon possession or sale, and other non violent felony). Column 5 includes the crime fixed effects interacted with the variable 'Post'. Standard errors clustered at the state level. *** significance at the 1% level, ** significance at the 5% level, * significance at the 10% level.

Supplementary Appendix: For Online Publication

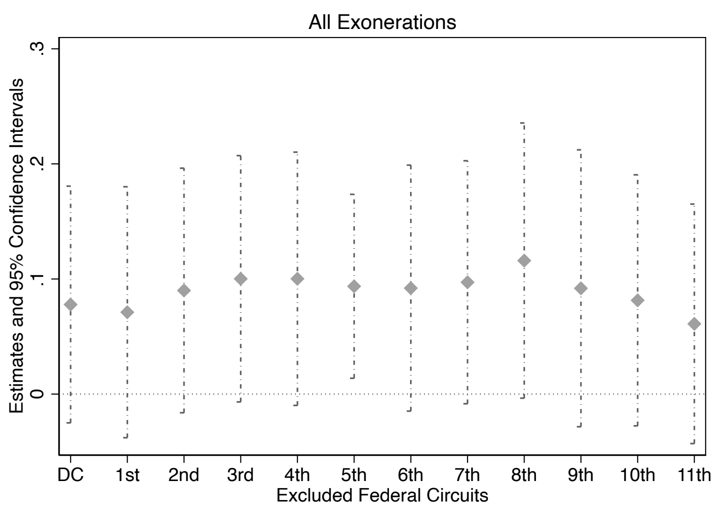
Online Appendix Tables and Figures

Figure A.1: Robustness Checks

Panel A



Panel B



Notes: these figures show difference in differences estimates and 95% confidence intervals from separate regressions studying the impact of DNA laws on DNA-based (Panel A) and all exonerations (Panel B). Each point estimate is obtained by eliminating one federal circuit (indicated on the x-axis) from the sample (following the specification shown in Table 2, column 1).

Table A.1: DNA Law Characteristics

	(1) Implementation Year	(2) Counsel Required Pre-Motion	(3) CODIS	(4) Crime Restrictions	(5) Plea Restrictions	(6) Onus of Payment
New York*	1994		2012		Yes	
Illinois*	1997		2003			
Minnesota	1999					
California	2000	Yes				
Washington	2000					
Arizona	2000					
Delaware	2000					
Oklahoma*	2000; 2013			Yes		
Idaho	2001					
Wisconsin	2001					
Utah	2001					Yes
Virginia	2001					
Louisiana	2001					
North Carolina	2001		2009			Yes
Nebraska	2001					
Michigan	2001					
Indiana	2001			Yes		
Arkansas	2001					Yes
Florida	2001				Yes	
Kansas	2001			Yes		Yes
Oregon	2001	Yes		Yes		
Maryland	2001		2001	Yes		Yes
Maine	2001					
Missouri	2001					Yes
Texas	2001	Yes	2011			
Tennessee	2001			Yes		

Table A.2: (Continued) DNA Law Characteristics

	(1) Implementation Year	(2) Counsel Required Pre-Motion	(3) CODIS	(4) Crime Restrictions	(5) Plea Restrictions	(6) 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		2006		Yes	
Georgia	2003					
Colorado	2003		2009			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		2009			
South Carolina	2009			Yes	Yes	Yes
Alaska	2010			Yes	Yes	
Massachusetts	2012					

Notes:*New York, Illinois and Oklahoma are excluded from baseline sample. Oklahoma enacted a sunset provision in 2000 that expired in 2005, and a new DNA law in 2013. This tables shows the year of DNA laws' enactment; whether the law requires the provision of counsel to petitioners prior to their motion; the year when a state provided access to the US federal government's Combined DNA Index System (CODIS) database of DNA samples; 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 A.3: Descriptive Statistics, Crimes by Race

	(1) All Races	(2) Black	(3) Non-Black
Crime			
Assault	1	1	0
Attempted murder	5	4	1
Child sex abuse	53	19	34
Drug possession or sale	6	6	0
Kidnapping	1	1	0
Manslaughter	1	1	0
Murder	289	136	153
Other nonviolent felony	1	0	1
Robbery	8	6	2
Sexual assault	69	45	24
Weapon possession or sale	1	0	1
Total	435	219	216

Notes: counts of crimes by race for the baseline sample of analysis.

Table A.4: Robustness to Changes in the Sample

	(1) Baseline	(2) All States	(3) All Periods	(4) Post Law Convictions	(5) Death Sentences	(6) Black & White
Panel A			DNA-Based Exonerations			
Post	0.131***	0.134***	0.120***	0.124***	0.138***	0.106***
	(0.0285)	(0.0370)	(0.0264)	(0.0285)	(0.0341)	(0.0272)
Panel B			All Exonerations			
Post	0.0889*	0.0426	0.0726	0.0839	0.0784	0.0336
	(0.0521)	(0.0557)	(0.0515)	(0.0528)	(0.0588)	(0.0545)
State FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,326	1,398	1,440	1,326	1,326	1,326

Notes: this table shows difference-in-differences estimates of the impact of DNA laws on the count of exonerations for life sentences. Panel A shows results for DNA-based exonerations. Panel B shows results for all exonerations. The variable 'Post' is an indicator set to 1 in the years after the implementation of a DNA law in a state, zero otherwise. The variable 'Black' is an indicator set to 1 for black exonerations, 0 otherwise. Column 1 shows the baseline. Column 2 includes all US states. Column 3 includes all available time periods. Column 4 also includes convictions that took place after the implementation of the DNA law. Column 5 includes exonerations for death sentences. Column 6 eliminates Hispanic, Asian, Native Americans and other races or ethnic groups from the sample. All regressions include fixed effects at the state and year level. Standard errors clustered at the state level are shown in parentheses. *** significance at the 1% level, ** significance at the 5% level, * significance at the 10% level.

Table A.5: Robustness to Changes in the Sample, by Race

	(1) Baseline	(2) All States	(3) All Periods	(4) Post Law Convictions	(5) Death Sentences	(6) Black & White
Panel A			DNA-Based Exonerations			
Black	0.00151	-0	0.00139	0.00151	0.00302	0.00301
	(0.00966)	(0.00983)	(0.00890)	(0.00966)	(0.0102)	(0.00999)
Post	0.0517***	0.0477***	0.0467***	0.0514***	0.0568***	0.0358***
	(0.0125)	(0.0148)	(0.0120)	(0.0126)	(0.0165)	(0.01318)
Post × Black	0.0271	0.0381*	0.0264	0.0211	0.0241	0.0347*
	(0.0192)	(0.0211)	(0.0196)	(0.0190)	(0.0183)	(0.0195)
Panel B			All Exonerations			
Black	-0.0362*	-0.0348	-0.0347*	-0.0362*	-0.0468*	-0.0211
	(0.0217)	(0.0223)	(0.0200)	(0.0217)	(0.0248)	(0.01944)
Post	0.00601	-0.0243	-0.00743	0.0141	-0.00758	-0.03070
	(0.0233)	(0.0286)	(0.0246)	(0.0258)	(0.0288)	(0.03113)
Post × Black	0.0769**	0.0913***	0.0875***	0.0558*	0.0935**	0.0950***
	(0.0304)	(0.0342)	(0.0308)	(0.0310)	(0.0364)	(0.0347)
State FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,652	2,796	2,880	2,652	2,652	2,652

Notes: this table shows difference-in-differences-in-differences estimates of the impact of DNA laws on the count of exonerations for life sentences. Panel A shows results for DNA-based exonerations. Panel B shows results for all exonerations. The variable 'Post' is an indicator set to 1 in the years after the implementation of a DNA law in a state, zero otherwise. The variable 'Black' is an indicator set to 1 for black exonerations, 0 otherwise. Column 1 shows the baseline. Column 2 includes all US states. Column 3 includes all available time periods. Column 4 also includes convictions that took place after the implementation of the policy. Column 5 includes exonerations for death sentences. Column 6 eliminates Hispanic, Asian, Native Americans and other races or ethnic groups from the sample. All regressions include fixed effects at the state and year level. Standard errors clustered at the state level are shown in parentheses. *** significance at the 1% level, ** significance at the 5% level, * significance at the 10% level.

Table A.6: Heterogeneity by State Racial Animus (Figure 7)

	(1)	(2)	(3)
		All Exonerations	
Black	-0.0395*	-0.0508**	-0.0466*
	(0.0226)	(0.0248)	(0.0239)
Post	-0.000719	-0.00875	-0.00104
	(0.0286)	(0.0290)	(0.0282)
Post × Lynching	0.00626		
	(0.0165)		
Black × Lynching	0.0368		
	(0.0231)		
Post × Black	0.0781**	0.0469*	0.0502**
	(0.0305)	(0.0264)	(0.0254)
Post × Black × Lynching	0.0719		
	(0.0480)		
Post × Confederate State		0.0553	
		(0.0485)	
Confederate State × Black		0.0640	
		(0.0486)	
Post × Black × Confederate State		0.137	
		(0.0968)	
Post × VRA			-8.95e-05
			(0.0477)
VRA × Black			0.0545
			(0.0550)
Post × Black × VRA			0.169
			(0.126)
Post × Black + Post × Black × Lynching	.1500		
P-Value	0.030		
Post × Black + Post × Black × Confederate State		.18403	
P-Value		0.048	
Post × Black + Post × Black × VRA			.21933
P-Value			0.074
State FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	2,492	2,652	2,652

Notes: this table shows estimates of the impact of DNA laws on the count of all exonerations using a state-year-race (Black/non-Black) panel. The variable 'Post' is an indicator set to 1 in the years after the implementation of a DNA law in a state, zero otherwise. The variable 'Black' is an indicator set to 1 for black exonerations, 0 otherwise. The variable 'Lynching' is the standardized number of lynchings in a state. The variable 'Confederate State' indicates whether a state belonged to the Confederacy. The variable 'VRA' indicate whether a state was entirely covered by Section 5 of the Voting Rights Act. Fewer observations in column 1 are due to the lack of lynching data for Alaska, Hawaii, and District of Columbia. All regressions include fixed effects at the state and year level. Standard errors clustered at the state level are shown in parentheses. *** significance at the 1% level, ** significance at the 5% level, * significance at the 10% level.

Table A.7: Heterogeneity by Institutional and Legal Characteristics (Figure 8)

	(1)	(2)	(3)
		All Exonerations	
Black	-0.0297	-0.0118	-0.0261
	(0.0194)	(0.0178)	(0.0337)
Post	0.00236	0.0226	-0.00557
	(0.0275)	(0.0252)	(0.0379)
Post × IO	0.0145		
	(0.0466)		
Black × IO	-0.0348		
	(0.0816)		
Post × Black	0.0536*	0.0421	0.0473
	(0.0306)	(0.0277)	(0.0436)
Post × Black × IO	0.128		
	(0.0914)		
Post × Counsel		-0.161***	
		(0.0593)	
Counsel × Black		-0.238**	
		(0.108)	
Post × Black × Counsel		0.338***	
		(0.0961)	
Post × No Crime Restrictions			0.0167
			(0.0403)
No Crime Restrictions × Black			-0.0131
			(0.0428)
Post × Black × No Crime Restrictions			0.0380
			(0.0571)
Post × Black + Post × Black × IO	.18118		
P-Value	0.035		
Post × Black + Post × Black × Counsel		.380434	
P-Value		0.000	
Post × Black + Post × Black × No Crime Restrictions			.08528
P-Value			0.020
State FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	2,652	2,652	2,652

Notes: this table shows estimates of the impact of DNA laws on the count of all exonerations using a state-year-race (Black/non-Black) panel. The variable ‘Post’ is an indicator set to 1 in the years after the implementation of a DNA law in a state, zero otherwise. The variable ‘Black’ is an indicator set to 1 for black exonerations, 0 otherwise. The variable ‘IO’ indicates whether an innocence organization was active in a state prior to the implementation of the DNA Law. The variable ‘Counsel’ indicates whether a counsel pre-motion was required by the law. The variable ‘No Crime Restrictions’ indicates whether a state did not restrict the crimes that could be reviewed post-conviction. All regressions include fixed effects at the state and year level. Standard errors clustered at the state level are shown in parentheses. *** significance at the 1% level, ** significance at the 5% level, * significance at the 10% level.

Table A.8: (Continued) Heterogeneity by Institutional and Legal Characteristics (Figure 8)

	(1)	(2)	(3)
		All Exonerations	
Black	0.0114	-0.0132	-0.0484**
	(0.0248)	(0.0463)	(0.0238)
Post	0.0921*	-0.00795	-0.00536
	(0.0496)	(0.0438)	(0.0274)
Post × No Plea Restrictions	-0.105**		
	(0.0493)		
Black × No Plea Restrictions	-0.0548		
	(0.0349)		
Post × Black	0.0475	0.0463	0.0622**
	(0.0353)	(0.0520)	(0.0311)
Post × Black × No Plea Restrictions	0.0347		
	(0.0489)		
Post × No Payment		0.0180	
		(0.0464)	
No Payment × Black		-0.0299	
		(0.0524)	
Post × Black × No Payment		0.0398	
		(0.0634)	
Post × CODIS			0.102***
			(0.0333)
CODIS × Black			0.0960**
			(0.0398)
Post × Black × CODIS			0.116
			(0.0995)
Post × Black + Post × Black × No Plea Restrictions	.08213		
P-Value	0.015		
Post × Black + Post × Black × No Payment		.08602	
P-Value		0.017	
Post × Black + Post × Black × CODIS			.17857
P-Value			0.059
State FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	2,652	2,652	2,652

Notes: this table shows estimates of the impact of DNA laws on the count of all exonerations using a state-year-race (Black/non-Black) panel. The variable 'Post' is an indicator set to 1 in the years after the implementation of a DNA law in a state, zero otherwise. The variable 'Black' is an indicator set to 1 for black exonerations, 0 otherwise. The variable 'No Plea Restrictions' indicates whether a state did not restrict post-conviction DNA testing to petitioners who pled not guilty to the crime. The variable 'No Payment' indicates whether a state did not require the burden of the payment to be on the petitioner. The variable 'CODIS' indicates whether a state allowed the match with the Federal CODIS database. All regressions include fixed effects at the state and year level. Standard errors clustered at the state level are shown in parentheses. *** significance at the 1% level, ** significance at the 5% level, * significance at the 10% level.

Table A.9: Survival Analysis, Robustness to Changes in the Sample

	(1) Baseline	(2) All States	(3) All Periods	(4) Post Law Convictions	(5) Death Sentences	(6) Black & White
Black	0.583***	0.541***	0.625***	0.566***	0.553***	0.573***
	(0.0903)	(0.0773)	(0.0976)	(0.0821)	(0.0689)	(0.0898)
Post	0.786	0.540***	1.136	0.661**	0.630**	0.597*
	(0.176)	(0.119)	(0.185)	(0.129)	(0.133)	(0.182)
Post × Black	1.790***	2.075***	1.570**	1.917***	1.818***	2.073***
	(0.359)	(0.410)	(0.322)	(0.407)	(0.315)	(0.446)
State FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Year of Conviction FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	7,329	8,518	8,132	7,782	8,771	6,889

Notes: this table shows hazard ratios as exponentiated coefficients obtained from Cox regressions. Individual-level data start in the year of conviction and end in the year of exoneration. The variable 'Post' is an indicator set to 1 in the years after the implementation of a DNA law in a state, zero otherwise. The variable 'Black' indicates the race of the exoneree. Column 1 shows the baseline. Column 2 includes all US states. Column 3 includes all available time periods. Column 4 also includes convictions that took place after the implementation of the DNA law. Column 5 includes exonerations for death sentences. Column 6 eliminates Hispanic, Asian, Native Americans and other races or ethnic groups from the sample. All regressions include fixed effects at the state, year, and year of conviction level. Standard errors clustered at the state level are shown in parentheses. *** significance at the 1% level, ** significance at the 5% level, * significance at the 10% level.