Violence and Economic Activity: Evidence from African American Patents, 1870 to 1940

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ABSTRACT

Recent studies have examined the effect of political conflict and domestic terrorism on economic and political outcomes. New data on patents obtained by African Americans from 1870 to 1940 provide a natural experiment for determining the impact of ethnic and political violence on economic activity. Violent acts are found to account for over 1100 missing patents over this period. Valuable patents respond negatively to major riots and segregation laws. In a placebo study, absence of the rule of law covaries with declines in patent productivity for white and black inventors but is significant only for African American inventors. Patenting responds positively to declines in violence. These findings imply that ethnic and political conflict may persistently affect the level, direction, and quality of invention and economic growth.

The causes and effects of political instability and violence have received much attention in the empirical and theoretical literature recently. Using a cross section of countries, Barro (1991), Mauro (1995), Alesina, Ozler, Roubini, and Swagel (1996), and Acemoglu and Robinson (2001) find a negative relation between political instability and economic growth. Similarly, Venieris and Gupta (1986) and Alesina and Perotti (1996) find a negative relation between political unrest and savings and investment across countries. Abadie and Gardeazabal (2003) use GDP and stock-performance data to test the effects of domestic terrorism on economic growth in the Basque region. They find that terrorist activities reduce economic performance by 10 percent. Ferguson (2006) examines the relation between the concentration of violence in Central and Eastern Europe, Manchuria, and Korea and economic volatility, among other factors, in the 20th century. Donohue and Levitt (1998) assess the effect of violence on human behavior in the absence of property-rights enforcement. Fryer and Levitt (2007) use internal records of the Ku Klux Klan to analyze the organization's structure and its effect on electoral outcomes. They find that, while a segment of the Klan may have behaved as terrorists, the organization was primarily social and was successful at selling bundles of goods and services, some of which were related to racial and religious intolerance, and less successful at affecting election outcomes. Glaeser (2005) explores the determinants of the supply and demand functions of hate. He demonstrates that hatred is produced by politicians for political gain and that hatred is accepted and repeated by voters until there is a private incentive, e.g., economic interactions with minorities, to scrutinize politicians' hate-related activity.

The major contribution of this paper is to extend this literature by identifying a shock to the rule of law and personal security that is independent of standard determinants of patenting activity or productivity, and by establishing a link between this shock and economic outcomes. Specifically, I examine hate-related violence and patenting activity in the late 19th and early 20th centuries in the U.S. Between 1870 and 1940, race-related violence increased dramatically. Major race riots peaked in 1919 and 1921; lynchings, in 1892 and 1893; and passage of state segregation laws, in 1908, 1928, and 1933. Hate-

related actions provide a natural experiment for testing the extent to which a shock to personal security and property rights can affect economic prosperity. While this shock of violence is external to the inventive process, it affected inventors, as it did other economic agents. I use patents as both an indicator of inventive activity and economic activity.

My empirical strategy is three-pronged. First, with time-series data, I use the implementation of state and federal practices promoting segregation and condoning violence as a natural experiment to estimate the effects of changes in hate-related violence on patenting outcomes. I find that extrajudicial killings and loss of personal security depress relative economic activity among blacks by more than 15 percent annually. Productive activity increases after the cessation of violence. Second, I account for regional heterogeneity by estimating the effects of increased violence using state-level data. I find that patenting in states with more riots and laws promoting segregation is lower than in other states and that these factors account for approximately 1131 missing patents over the period. Further, economically meaningful patents respond more negatively to conditions of greater violence compared to those with less violence. Third, two "counterfactual" exercises are executed. A placebo study with a constructed comparable sample of white inventors shows a negative effect of hate-related violence on both black and white inventors but a negative and significant effect on black inventors. Then, by obtaining estimated effects on African American patent activity, I examine the "counterfactual" effect on patenting among whites. I find that a similar shock of increased hate-related violence would have depressed U.S. patenting activity by 40 percent and ostensibly would have resulted in significantly greater volatility in technological change. Alternative explanations are tested but fail to explain observed outcomes. These findings are consistent with data on other forms of economic activity, such as newspaper creation, and with evidence from similar studies.

Critical to this analysis is a unique and novel data set I constructed on African American patents and patentees. Collection of these data is non-trivial, because race is not recorded in patent records. From historical surveys, archival data, Census data, company histories, and directories of inventors and

potential inventors, among other sources, I created a data set of patents obtained by African American inventors between 1870 and 1940. It is the largest effort of its kind to date, and this paper represents the first systematic analysis attempted using these data. Patent data offer a unique window on economic activity, because they contain systematic data on commercial transactions, as well as inventive output. The economic significance of the findings in this paper implies that, then and now, conflict and hate-related violence, and the resulting uncertainty in property-rights enforcement, may persistently affect the level, direction, and quality of inventive activity and economic growth.

I. Violence and Inventive Activity, 1870-1940

Violence and Segregation

Following the emancipation of slaves, race-related violence began escalating in the South in the 1870's and spread to other parts of the country by the end of the 19th century. Such conflict was often related to the absence or diminished enforcement of the rule of law.[1]

One indicator of hate-related violence is major race riots. As is reported in Table 1, these events were occasionally politically motivated and were sometimes contemporaneous with mob violence and election disputes.[2] However, in the historical literature there is no universally accepted set of sufficient conditions that would predict race riots during this period. Only riots considered major in the historical literature, i.e., resulting in significant violence and loss of life and property and receiving national media

[1] Interest in this period of conflict has spread considerably among economists and other scholars recently. Jaspin (2007) investigates sudden and dramatic shifts in racial composition in many U.S. counties. Using county-level Census data between 1864 and 1923 and current Census data, he observes that violent episodes of "racial cleansing" occurred throughout the U.S. and resulted in all-white or nearly all-white counties that have persisted over time. Norrell (2009) presents a new history of segregation in America with an especial emphasis on hate-related violence and African American leader, Booker T. Washington. Interest among policymakers and the popular press has also increased. Allen, et al. (2000) chronicle the history of lynching through photographs and postcards, and the exhibit based on these visual images at the New York Historical Society and at other venues has received much attention (see Smith (2000)). In the last decade, a number of newspapers, such as the *Waco Tribune-Herald (2006)*, have issued apologies for their role in fomenting riots and lynchings through "lynch journalism" during this period.

[2] Blacks were commonly, but not the only, targets of race riots.

coverage, are considered in this paper.[3] Table 1 describes selected major race-related civil disturbances. Race riots frequently had legal and political consequences, such as the imposition of martial law and the ousting of democratically-elected black and moderate white officials, along with economic consequences, such as looting of black business districts and destruction of entire black farms, firms, and residential neighborhoods. Riots were largely concentrated in the South prior to 1900 but were primarily in northern states from 1900. The effects of violence would have been both direct, e.g., black inventors' workshops were located in the affected business districts, and indirect, e.g., riots lower the value of commercial and residential property, as found for later riots by Collins and Margo (2003), which would lower financing opportunities and increase operating costs.

Riots often had consequences far beyond their cities and states of origin. The East St. Louis race riot in May and July 1917 involved a mob of nearly 3,000 white men, several lynchings, 45-150 black deaths, and extensive damage to black homes and white firms, including a warehouse of the Southern Railway Company.[4] In support of the victims and in protest of the failure of the East St. Louis and other authorities to protect their citizens, the National Association for the Advancement of Colored People (NAACP), the large civil rights organization, organized a "silent march" of 15,000 people down Fifth Avenue in New York City in late July 1917. In his seminal work historian John Hope Franklin writes, "It was the epidemic of race riots that swept the country early in the century that aroused the greatest anxiety and discomfort among the African-American population. …Riots were perceptibly increasing, and their dramatic nature had the effect of emphasizing the insecurity of blacks throughout the country."[5]

As a form of extralegal mob violence, lynching also may be considered a proxy for absence of the rule of law.[6] Whereas race riots involved opposing groups, lynchings typically involved a group taking

[3] Not all race riots are included in the analysis. There were many smaller, local riots whose effects were more geographically limited than those related to major riots and are excluded in the analysis.
[4] *New York Times* (1917) and Marcus Garvey (1917/1983).
[5] Franklin and Moss (1994), p. 313.
[6] There is some debate in the literature about whether the motives for lynching were relatively more political or economic. For example, see Darity and Price (2003) for an extensive discussion of this debate.

action against a specific individual or individuals. In addition to killing the victim, often a secondary objective was the externality a lynching produced – intimidation of the victim's family, community, or ethnic or racial group.[7] A lynching would signal that violent groups were active in a given area and that personal security may not be guaranteed, and, as a result, inventors and other economic agents may not fully engage in productive economic activity.[8] Table 1 shows that lynchings peaked for black and white victims in the 1890's.[9] Most lynchings occurred in the South, and most lynching victims were African American. The average number of lynchings with African American victims each year varied greatly, from none in Massachusetts and New Hampshire to one in Missouri, seven in Texas, five in Florida, and 10 in Mississippi. While data on lynching are recorded through 1968, the practice had largely stopped by 1930.

For much of the 19th century, lynchings often received local coverage in black- and white-owned newspapers. The practice began receiving national attention through newspapers in major urban areas, publications of the NAACP and other national civil-rights organizations, and nascent anti-lynching movements.[10] International attention grew through newspapers and organizations, including the British Anti-Lynching Committee formed in 1894 to protest the lynchings of southern blacks. While the direct effect of lynching was likely primarily local, the indirect effect, a growing and general sense of

[7] Some scholars argue that the 1955 lynching of Emmett Till, whose motive was to intimidate northern and southern blacks, was a catalyst for the civil rights movement. See accounts of the Emmett Till lynching in Metress (2002) and in U.S. Department of Justice (2004).

[8] While there are no reports of lynchings of inventors in the biographical data collected, there is anecdotal evidence that African American inventors, particularly those who manufactured their inventions, were targeted more than their white counterparts by arsonists and firebombers. For example, Haber (1970) includes an account of two firebombings that occurred at the home of Percy Julian, a chemist. The direct and indirect effects of arson and firebombing are likely equivalent to those of riots, e.g., through property destruction, and of lynching, e.g., with respect to threats to personal security and the rule of law and with respect to its demonstration effects.

[9] Historical American Lynching (HAL) Data Collection Project data on lynchings are often used in empirical studies. These data are based on and nearly identical to the Tolnay and Beck (1995) data. Because Tolnay and Beck (1995) data are limited geographically – coverage of southern states only – and temporally – spanning 1882 to 1930, the lynching series used here and in estimation combines the Tolnay and Beck (1995) data for selected southern states and lynching data collected by Tuskegee University (2004) and Ginzburg (1962) for non-southern states. Both black and white lynchings, especially in northern states are undercounted. Data on white lynchings contain victims who are of all racial groups other than black, including those of Chinese and Mexican descent.

[10] In 1895, Ida B. Wells-Barnett, an early civil-rights and anti-lynching activist who helped to found the NAACP, published the *Red Record*, which contained the first systematic data on lynchings in the U.S., and *Southern Horrors: Lynch Law in All Its Phases*, both of which were nationally and internationally circulated. By the early 1900's, regional and national, including Congressional, debates on lynching were also receiving attention across the U.S. and beyond.

diminishing protection in the courts and among law-enforcement bodies, was an added effect for African Americans close in proximity and farther away.[11]

The timing and extent of segregation, or Jim Crow, legislation, which often legitimated acts of violence and created or reflected the social and political environment in which these acts took place, is another measure associated with violence. Laws imposing racial separation were enacted in some states during or immediately following the Civil War to restrict movement of former slaves and, it was argued by segregation's proponents, to maintain social order. In 1881, Tennessee passed the first law mandating segregated public transportation. In deference to state and local governments, in 1883, the Supreme Court invalidated sections of the 1875 Civil Rights Act prohibiting segregated facilities. As is reported in Table 1, laws promoting segregation were primarily related to education and public facilities.[12]

The direct effect of segregation laws was two-fold. First, and most importantly, they may be considered proxies for latent violence. Jim Crow legislation formalized customary practices and allowed few legal safeguards for minorities. Residents of a given state understood that violence would be the punishment if these laws were not obeyed. Litwack's (1998) argument is that violent acts, such as race riots and lynchings, were the logical extension of laws promoting segregation. In his view, lynch mobs and the courts were enforcers of Jim Crow laws.[13] In explaining "racial cleansings" in which blacks were abruptly driven out of counties in the South and in the North, Jaspin (2007) offers an additional effect of segregation laws. He argues that the greater the number of and adherence to Jim Crow laws, the fewer the encounters between African Americans and whites and the greater the degree

[11] This is a negative externality cited in apologies for lynching by both U.S. Houses of Congress in 2008 and 2009.

[12] It is anticipated that data on passage of segregation laws may understate the extent of racial segregation and isolation and their effect on property-rights enforcement. Supreme Court rulings and local, including residential, segregation laws are excluded from the data. For example, using Census data, Cutler, Glaeser, and Vigdor (1999) develop indices of segregation and isolation from 1890 to 1990 and consider the importance of residential segregation in explaining the variation in segregation over time. Legislation related to miscegenation and employment is included in the "other" category in Table 1. As well, policies, customs, and practices will not necessarily be fully captured by state legislation.

[13] Specifically, he argues, "Once previous customs became lodged in the statute books, it was imperative that any breaches be swiftly punished as examples to others of how the new order would be implemented. … To forestall lynch mobs, courts often speeded the conviction and execution of black defendants, distorting whatever semblance of constitutional protection remained for them."(pp. 256-7).

of anxiety, mistrust, and suspicion between the races, which could lead to spontaneous outbreaks of violence.[14] In this case, the number of segregation laws is included to capture the taste for and degree of segregation and latent violence across states.

Second, laws mandating segregation decreased access to patenting institutions and to social networks and institutions that support invention and innovation.[15] "White-only" commercial districts, where patent attorneys (all white at the time) would have their offices, hindered application for patents by African American inventors. With limited access to the legal system, African Americans would have found it difficult to defend against patent infringement, despite representation by white attorneys.[16] Segregation of public buildings led to "Negro Day" during major scientific fairs or "Negro fairs" that were completely separated from major exhibitions.[17] Either implied that inventions by African American inventors received limited attention from their peers and potential clients. The largest number of state segregation laws passed related to education, which would become increasingly important to patenting over the 20th century. As is well known, evidence presented by the plaintiffs in the 1954 *Brown v. Board of Education* Supreme Court ruling demonstrated that African Americans had unequal access to education due to segregation.

Patenting Activity, 1870-1940

[14] See Jaspin (2007), p. 8. Data on racial cleansings are not available to the author and, hence, are beyond the scope of the current paper.

[15] See Thomson (2009) for a rich discussion of the importance of social ties and networks for invention and patenting in the 19th century.

[16] Suing a white person was one of the offenses reported for victims in the HAL lynching data set. Also, there is some anecdotal evidence that abrogation of intellectual property rights was not unusual. A letter in the Carter G. Woodson Papers contains testimony from the son of an African American inventor whose patent rights were illegally assumed by a firm when his father was temporarily sent on assignment abroad. However, no systematic evidence of such abrogation exists to the author's knowledge. Similarly, there is anecdotal evidence concerning greater rejection rates of patents received from applicants suspected of being African American. Only one known instance of this behavior is found in the literature, and a comparison of a sample of similar patents obtained by white and African American inventors shows that the time between patent application and grant for the two groups was not significantly different, 1.4 years in each case. The implication is that patent examiners did not treat patent applications from the two groups of inventors differently once the decision to grant the patent was made. Application rejection rates would need to be analyzed to examine Patent-Office behavior more fully, and this is beyond the scope of the current paper.

[17] For example, Foner (1978) reports that Joseph H. Dickinson, a prolific inventor of musical and mechanical instruments, could only display his inventions and view other exhibits at the Centennial Exposition in Philadelphia in 1876 in the "Negro building." As a result, there were extra costs associated with marketing his inventions.

Figure 1 shows that, prior to the early 1900's, patenting rates among African Americans followed a pattern increasingly similar to that of the larger inventor population, albeit at a much lower level, and were procyclical.[18] Black patent activity became countercyclical at the turn of the century. To which incentives were black inventors responding that did not affect other inventors? Figure 2 suggests that a rise in race-related violence, i.e., riots and lynchings, coincided with greater divergence in patenting rates between black and white inventors. While the graphical analysis is suggestive, I test this apparent correlation statistically using the new data on African American inventors described below.

II. Data

The central task in data collection was to identify black patentees, since race is not recorded in patent records. A first strategy was to take advantage of little-known surveys conducted by Henry E. Baker on behalf of the U.S. Patent Office in 1900 and 1913. Surveys were sent to 9,000 of the 12,000 patent attorneys and agents in the U.S., and they were asked if they had clients who were or if they knew of any African American patentees. Data collected from these surveys constitute approximately 65 percent of the data set. The Baker data, however, are incomplete. He mistakenly identifies the first African American known to receive a patent, and the data terminate in 1914, 26 years short of the period of interest.[19] Other approaches were invoked to correct and extend these data.

A second strategy was to match patent records to Census data. While matching nearly two million patents to Census records is an onerous task, a more onerous task is to distinguish African American from non-African American patentees. First, as is evident from Table 2, African Americans obtained patents in locations where African Americans did not traditionally live, i.e., the South. Second, with the

[18] Throughout the paper the terms "patent" and "utility patent" will be used interchangeably. A utility patent is issued for any new and useful process, machine, manufacture, composition of matter, or any new and useful improvement thereof. From 1995, utility patents are effective for 20 years from the date of application. Utility patents constitute over 95 percent of all patents granted African Americans. While it is standard to use patents as a proxy for innovation and inventive activity, it should be recognized that this measure has limitations as, for instance, not all inventions are patentable or patented. However, direct measurement of invention is not generally possible and, in particular, not available, given the limitation of historical data needed for this study.

[19] See Data Appendix for an explanation of approaches to identification of African American inventors, including the Baker survey.

exception of a few well-known inventors and three easily identified names, African American inventors' names were indistinguishable from those of other American, particularly British-born, inventors.[20] Modern patent records include more information on addresses than solely the city or town of residence, which would be useful, if not necessary, to obtain unique matches. Patentees, such as James Young, cannot be uniquely identified as African American. Other census-based approaches, including those exploiting the recent literature related to "black names", were attempted and are described in Appendix II.

The final, third-best, strategy was to identify African Americans among the population of inventors and likely inventors from other sources and to match them to patent records. This was accomplished by collecting names from modern and historical directories of African American scientists, engineers, and medical doctors; archives, including correspondence of the noted African American historian, Carter G. Woodson, and the Garrett Morgan Papers; obituaries in local newspapers; published biographies and collections of biographies; programs from the "Negro Building" or "Negro Day" at fairs and exhibitions related to science and invention prior to 1940; Census data; and online company-history searches. While better-known inventors may appear in directories and biographies, newspaper and obituary searches and programs from fairs and exhibitions capture lesser-known inventors. A more detailed description of these sources appears in Appendix II. Additional patents of inventors appearing in the Baker data were obtained by searching USPTO and EPO databases.

The data set I constructed extends from 1870 to 1940 and includes 726 utility patents granted to African Americans during this period. The data comprise the patent number; inventor's full name, full names of co-inventors, and order of appearance of names of inventors; location of the inventor; title of the patent; dates of application and issue; assignment status; assignee's name and location; current

[20] The easily identifiable names were based on the post-slavery practice of adopting the names of American presidents as first and middle names. The inventors using this convention were Andrew Jackson Beard, George Washington Carver, and George Washington Murray.

USPTO patent class and sub-class; and NBER-Hall, Jaffe, and Trajtenberg two-digit technological class.[21]

Recall from Figure 1 that trends in inventive activity, though not number of inventions, by race were roughly similar prior to the early 1900's.[22] Up to 1930, two of the three major fields in which the two groups patented were the same: manufacturing and transportation. Table 2 reports other data on invention by technological category.

Each patent-holder was issued approximately two patents, on average, which is consistent with the findings of Hall, Jaffe, and Trajtenberg (2001) for the entire population of utility-patent-holders from 1963 to 1999 but is much lower than the average computed by Khan and Sokoloff (1993) for patentees up to 1846.[23] Two thirds of black patentees have one patent. However, four percent have four or five patents, and three percent have 10 or more patents. Examples of patented inventions in the data set are presented in Table 3. This sample of inventions reflects the significant variation across technical classes and geography among African American inventors of this era. While patent activity occurred in all regions of the country, the Midwest and Mid-Atlantic states, including New York and New Jersey, accounted for 64 percent of this activity, which mirrors general patterns among white inventors at this time. Consistent with the practice of the day, African American inventors were largely individual inventors. Nonetheless, a number of patent-holders were members of well-known research teams.[24]

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[21] Biographical data, including patentee education, training, and property-ownership status are only available and have been collected for a group of 26 prolific inventors prior to 1930. This group is the subject of Cook (2007). Application data were not recorded for patents obtained between 1870 and 1873. Technological classes created by Hall, Jaffe, and Trajtenberg (2001) are designed as an alternative to the USPTO technical classification to capture broad technological categories of innovation. Patents collected are matched to broad one-digit categories and more specific two-digit sub-categories. Citations, a typical measure of quality of invention, are only publicly available from 1975. Patents granted between 1870 and 1930 and cited from 1975 will be rare, since older inventions will have been incorporated into newer inventions. Therefore, citations are not used in the present analysis.

[22] Patents obtained by black inventors have been subtracted from total patents granted to obtain patents granted to white inventors. Non-black patent-holders will therefore be included among white inventors. While the precise ethnic composition of patent-holders is unknown, it is reasonable to assume that the majority of non-black patent-holders is white.

[23] The average is two per patentee in the period 1821 to 2004. The Hall, Jaffe, and Trajtenberg (2001) sample is drawn between 1963 and 1999. During the same period, the average for African American patentees is 6.2, and the median is two.

[24] Lewis Latimer was a member of Thomas Edison's research team, the "Edison Pioneers." Granville T. Woods, who obtained 45 patents, mainly related to electricity and transportation, was asked by Edison to join Edison's Pioneers but declined and preferred to invent alone or with his brother.

One potential problem in the data is that there may be an undercount for the period during which African Americans relied heavily upon patent intermediaries. Baker's task of verifying patentees was complicated by a widespread perception that African American patents might be undervalued if the inventor's race were revealed.[25] Truncation due to undercounting would be difficult to measure and to account for in estimation. Nonetheless, the number of "missing blacks" would have to be large to obtain the magnitude of decline apparent in Figure 1. Further, prolific inventors entered and exited the data set throughout the period of study. Because the data set is dominated by inventors with one patent (unlike the U.S. data for this period), the deaths or retirements of several prolific inventors would need to have occurred simultaneously to account for such a large and sustained decline, and this is not observed in the data. Finally, the population of inventors is heterogeneous and extends beyond those who are highly skilled and in the sciences, particularly in the period prior to the early 20th century when specialized skills became more useful. As a result, the data set likely under-represents inventors with fewer or different skills. Upon inspection of related data, e.g., Sluby (2004), these potential problems appear to be minor and should not significantly affect results from estimation.

III. Estimation

Does economic activity, namely the level of innovative output, change in response to changes in hate-related violence? Do the quality and direction of economic activity change in response to changes in property rights resulting from hate-related violence? The goal of this section is to assess the economic impact of conflict and violence on innovative activity, as measured by patents.

[25] This was likely more broadly observed than just among inventors. There is anecdotal and empirical evidence during the period of heightened racial tension that race may have been endogenized, if physically possible. See Jaspin (2007) for an account of blacks who left counties due to "racial cleansing", who migrated to different counties, and who appeared in subsequent Census years as white.

Values of variables typically associated with innovative activity at the beginning of the period are reported in Table 4 to establish a baseline. Table 5 reports the means and standard deviations of variables, for blacks and whites jointly and separately.[26]

Much of the increase in productivity in the mid-19th century occurred in the manufacturing and transportation sectors. According to Margo (1990), African Americans were represented in greater proportions in durable manufacturing and in transportation employment relative to whites, as was the case in agriculture. Illiteracy and school-attendance gaps were large, a fact that may have become more relevant when patenting began to require better education and more specialized skills in the early 1900's. The illiteracy gap fell consistently between 1870 and 1940, from a difference of 68 percent to one of 12 percent. In general, patenting activity occurs in regions with relatively more robust economic activity and with significant urban populations.[27] Relative to their white counterparts, blacks were concentrated in the least productive areas for patented innovation: rural areas and in the South. As Table 2 shows, however, three-quarters of black patent activity took place *outside* the South.

My analysis employs three different empirical strategies. First, with time-series data, I use the implementation of state and federal practices promoting segregation and condoning violence as a natural experiment to estimate the effects of changes in hate-related violence on patenting outcomes.[28] Second, I account for regional heterogeneity by estimating the effects of increased violence on state-level data for African American inventors. Third, a placebo of white inventors is randomly drawn, and I examine the "counterfactual" effect on patenting among whites.

[26] Other potential explanatory variables, e.g., wage differentials and quality of schooling, are also not available for the entire period or for all regions. Margo (1990) uses earnings data for blacks and whites from 1900 to 1940 in the South. State school-quality data as used in Card and Krueger (1992) are available from 1919. Rates of illiteracy are available throughout the period of interest and are included in estimation. Other potential indicators, e.g., socioeconomic status, are highly correlated with race in the period 1870 to 1940 and would be dropped due to multicollinearity in estimation.

[27] This observation is consistent with the findings of economists who have examined the relation between innovation and expected profits and demand, e.g., Gilfillan (1930), Griliches (1957), Schmookler (1962, 1966), Sokoloff (1988), and Khan and Sokoloff (1993).

[28] The term "natural experiment" is used in this paper, since traditional models of patent activity do not include measures related to violence. For example, seminal work by Griliches (1957) and related subsequent work relate patent activity to demand and R&D spending. Factors like violence and rule of law are not included in these traditional models.

Time Series Estimation

To begin statistical inference on the impact of hate-related violence on inventive activity, the basic equation follows Gilfillan (1930), Griliches (1957), Schmookler (1962, 1966), and Sokoloff (1988) who find a relation between economic activity and innovation and includes positive and negative correlates of innovation – industrial production and unemployment.[29] To this model conflict-related indicators are added:

$$\log(patents_{it}) = \beta_0 + \delta_1 t + \beta_1 \log(lynch_{it}) + \beta_2 riot_t + \beta_3 seglaw_t + \beta_4 unem_t + \beta_5 \log(indprod_t) + \alpha_1 race_i + \delta_2 (t*race_i) + \mathbf{z}_{it}\gamma + u_{it}, \quad (1)$$

where the observation $patents_{it}$ is total utility patents per capita applied for in year t and granted to individuals of race i; $lynch_{it}$ is lynchings per capita by race of victim in year t; $riot_t$ is number of major riots in year t; $seglaw_t$ is total new state segregation laws passed by year t or total new state and federal segregation laws related to education, housing, and public accommodations passed by year t; $unem_t$ is the Lebergott (1964) unemployment series in year t; $indprod_t$ is the Miron-Romer index of industrial production in year t; $\mathbf{z}_{it}$ is a vector of controls; and u_{it} is a stochastic error term.[30] The elements of $\mathbf{z}_{it}$ are year dummies for peaks and troughs of economic activity, a year dummy for the structural break that occurs in 1900 ("year ≥ 1899"), and the interaction term $riot_t*lynch_{it}$.[31] Aggregate and race-specific time

[29] In estimation, formal inclusion of specific determinants of the knowledge production function used by these and similar researchers will not be possible in this study. For example, Griliches (1957) and Kortum (1997) posit a relation between patenting and R&D expenditure. Many studying the modern era test this relation. Using R&D spending data would be outside the scope of this research, since such data are not collected by the National Science Foundation until 1940, which is the last year of the period under review in this paper.

[30] In estimation, the 1913 executive order by President Wilson to segregate the civil service is considered a state law affecting Washington, DC, although its effects were likely more geographically extensive. It is the only federal law included among the segregation laws used in this analysis. The unemployment and industrial-production series are highly correlated and therefore used alternately in estimation.

[31] Statistical identification of a structural break in 1900 (and in 1921 below) is the result of estimating time-specific effects across all years in the sample, including adjacent years. These breaks are the most significant in the period of study. We would expect a negative effect from the interaction of riots and lynchings on patenting by African Americans due to the magnified sense of insecurity among African Americans and because of the occasional close proximity of these two events (see Table 1). Therefore, the interaction term $riot_t*lynch_{it}$ has been included in estimation. Lynchings, riots, and segregation laws are largely treated distinctly in the historical literature. Without a similar systematic treatment of the interaction of riots

effects are included in estimation. Table 6a reports parameter estimates from pooled OLS regressions of Equation (1) in levels.[32] Given evidence of both a structural break and a unit root in the patent sample, Driscoll-Kraay (1998) standard errors are estimated and reported for all OLS estimates.[33]

Does hate-related violence covary with patent activity? The results from pooled OLS suggest that African American patenting rates are three orders of magnitude lower than that for white patentees, and we can reject equality between the two series. Major riots appear to be associated with nine- to 10-percent declines in patenting activity for all inventors over time. The relation between passage of segregation-related laws and inventive activity is weak or ambiguous across models. The basic OLS time-series model is also estimated in the white and black subsamples and reported in Table 6b.[34] For white and black inventors, the year 1900 represents a change in opposite directions. Consistent with the graphical analysis in Figure 1, annual patenting activity is estimated to increase for whites and to decline by 1.3 to 1.6 percent for blacks from that year. For white inventors, there is some evidence that segregation laws are positively associated with patenting outcomes, and riots are associated with a decline of 14 to 17 percent in inventive activity. Lynchings are found to be uncorrelated with inventive activity in the full sample and in the white subsample but are negatively and significantly correlated with inventive activity in the black subsample.

The second model extends the basic OLS model. Due to persistence in the patent series, I estimate the basic model in first differences:

$$\Delta\log(patents_{it}) = \delta_1 + \beta_1\Delta\log(lynch_{it}) + \beta_2\Delta riot_t + \beta_3\Delta seglaw_t + \beta_4\Delta unem_t + \beta_5\Delta\log(indprod_t) + \delta_2 race_i + \Delta \mathbf{z}_{it}\gamma + \Delta u_{it}, \quad (2)$$

and lychings in any literature, the interaction term has been included as a control rather than as a critical feature of the model.

[32] As a robustness check, Equation (1) is also estimated as a fixed-effects model to explicitly control for omitted variables that differ between races and that are constant over time. The fixed-effect estimates are identical to those reported.

[33] Zivot and Andrews (1992) and Perron (1989, 1990) tests are used to determine the presence of a unit root with a structural break and intercept (optimal lag lengths from minimized AIC scores). The Driscoll-Kraay standard errors are robust to heteroscedasticity and to cross-sectional dependence.

[34] Newey-West standard errors robust to heteroscedasticity and autocorrelation are reported for estimated coefficients in Tables 6b, 7, and 8.

The differenced model is also estimated in the full sample and in the black and white subsamples.[35] While the results are not reported, the estimated coefficients in the full sample were largely similar to the estimates in Table 6a.[36]

For all models estimated, the coefficient on 1899 is negative and significant in the black subsample, representing a fall of 0.67 percent in patenting annually for blacks from 1899, but positive and significant in the white subsample, representing an increase of 0.12 percent in patent activity annually from 1899. Foreshadowed by Figure 1, this structural break in the black patent series points to the first main finding of this paper. Implemented with a lag in non-southern states, the *Plessy v. Ferguson* decision allowed states to adopt rules that would disrupt previously integrated economic ties and activities.[37] Non-southern states, including Illinois, Ohio, New Jersey, and New York where much of the inventive activity among blacks was taking place, adopted 145 new Jim Crow laws between 1896 and 1940, more than two and a half times the number passed by these states between 1870 and 1895. As aforementioned, increasing formal race-based restrictions in the workplace and in everyday life may have limited blacks' access to patent agents and attorneys and to patent-related resources, e.g., patent journals at public libraries. Therefore, inventors' ability to collaborate, to register patents, to conduct patent searches, and to defend their patents against infringement would have become a binding constraint on patenting activity.[38] Other economic ties were broken.[39] This evidence supports the view

[35] As Equation (2) implies, all regressors should be first-differenced, as well. However, there are many zeroes in the segregation-law and riot series, and they are essentially count variables, which should not be differenced. Estimated coefficients for these variables are reported for both estimation in levels and first differences in Table 7 for the full sample and then only for the estimated level coefficients.

[36] The only coefficient of interest that is different is the estimated coefficient on riots in the black sample, which is positive. However, when controlling for the outlier year of 1921, this coefficient is again consistent with other OLS estimates.

[37] Similar to *Brown v. Board of Education* in 1954, *Plessy* and other Supreme Court rulings are implemented with a lag as legislatures, courts, etc., determine appropriate mechanisms for compliance.

[38] Fouché (2003) recounts in detail the deterioration of the professional inventive career of Shelby Davidson, an African American inventor and official in charge of technology design, maintenance, and procurement at the U.S. Postal Office Division in Washington, D.C. Like other African Americans in the Treasury and Post Office Departments, he was removed from his supervisory position following President Wilson's executive order to segregate the civil service in 1913. He resigned from government service and inventive activity after this event (see pp. 173-176).

[39] Kusmer (1976) reports that, like those in many northern cities, nearly all black-owned firms in Cleveland lost their white clients. As seen in many industrial cities in the North adopting segregationist laws and practices, between 1890 and 1910, property ownership among black residents of Cleveland fell from 14.8 percent to 10.9 percent. Kusmer also finds that, by

that the aforementioned Congressional apologies reflect the intuition of black inventors, and other economic agents of the time, that the federal government had been tacitly condoning race-related violence or actively promoting blockage of federal anti-lynching legislation and erosion of legal protection generally.[40] The implication of this finding in the patent data is that official legitimation of hate-related acts can permit their proliferation and produce long-term declines in inventive and economic activity.

Difference-in-Differences Estimation

Was the difference in patent productivity changing between blacks and whites over time? The second part of the estimation strategy uses the implementation of state and federal policy as a natural experiment to estimate the effects of racial conflict. Patent data can be used to explore more precisely changes in patenting rates following acts of violence that would differentially affect inventors, if not all economic agents, by race. That is, significant changes arise not as a result of violence *per se* but out of a sense that these hate-related acts could be carried out with impunity.

To capture the direct and indirect effects of hate-related acts, I include in estimation two specific years in which state and federal changes in policy would have increased the indirect effects of violence, i.e., years in which policy changes would have signaled that local legal remedies would be final. As before, the year 1900 is included in estimation. The analysis also includes the year 1921. According to the NAACP, the civil rights organization whose major task was to record and protest hate-related violence, the largest race riot in American history, which happened that year in Tulsa, Oklahoma, signaled a

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1930, the percentage of African Americans who were property owners in Cleveland had not recovered their 1890 percentage. Consistent with the evidence from patent data, Higgs (1982, 1984) and Margo (1984) also find patterns of rapid increases in black wealth, as measured by property ownership in southern states, from the 1880's to the mid-1890's and a marked decline beginning around 1896. Unlike black property accumulation during this period, which resumed rapid growth between 1900 and 1905, entrepreneurial and economic activity did not recover quickly. Because these white consumers were wealthier than the black consumers to whom black firms were newly confined and because access to white suppliers was now limited or eliminated altogether, many black-owned firms faced rising cost, falling revenue, and bankruptcy.

[40] Anti-lynching legislation, including the Dyer Anti-Lynching Bill of 1921, was introduced and passed several times in the House of Representatives but rejected by the Senate in the 1920's and 1930's.

major policy shift among the federal and state governments. This event was considered so grave and alarming that it was the first and only time the secretary (president) of the NAACP appealed directly to and met the President of the United States to intervene.[41] Editorials in black and white Tulsa newspapers at the time; accounts published in national and widely-distributed publications, such as the NAACP's *The Crisis*, the *Chicago Defender*, the *New Republic*, and the *New York Times*; historians of the Tulsa riot; and survivors of the Tulsa riot suggest many at the time believed that government failed at all levels, that this was a turning point in federal policy and national practice related to property-rights protection, and that the country may be headed towards racial warfare.[42] Specifically, I estimate

$$\Delta\log(patents_{it}) = \delta_1 + \beta_1\Delta\log(lynch_{it}) + \beta_2\Delta riot_t + \beta_3\Delta seglaw_t + \beta_4\Delta unem_t + \beta_5\Delta\log(indprod_t) + \delta_2 race_i + \alpha_2 d1921_t + \alpha_3 race*d1921_t + \Delta z_{it}\gamma + \Delta u_{it}. \quad (3)$$

Table 7 reports the estimated effects from this estimation, including in the black and white subsamples. The overall effect of the year 1921 is mixed in these regressions, but the interaction for 1921 is negative and significant. Adjusting for other observables, annual patenting by African Americans due to events in 1921 was approximately lower by a factor of 2.2 on average than for whites. The Tulsa riot of 1921 followed a rash of major (and smaller) race riots occurring throughout the country in 1919. After these riots, the major riot in Tulsa was considered a test of state governments and, more importantly, the federal government to intervene to prevent and prosecute crimes related to mass hate-related violence. The Oklahoma Commission to Study the Tulsa Race Riot of 1921 roundly criticizes responses to the riot: "Having access to government, however employed, if employed at all…defined this Oklahoma and was the essence of this power. …Stand back and look at those deeds now. … In none did government prevent the deed. In none did government punish the deed."[43] Coupled with a general sense of frustration associated with unresolved root causes and the riots of 1919 themselves and a

[41] *The Crisis* (1999). Given the significant carnage and damage from the riot, this is also the first instance in which the NAACP sent an official from the organization to examine and report on events. See White (1921). The year 1921 was also determined statistically to be the break year. The Chow F-statistic for the year 1921 was computed, and the Quandt Likelihood Ratio statistic, or maximal Chow statistic, was also computed to confirm that the maximum Chow F-statistic was selected from a range of potential break years.

[42] See *New Republic* (1921) and *New York Times* (1921) for extended coverage the riot received.

[43] Oklahoma Commission to Study the Tulsa Race Riot of 1921 (2001), p. 20.

national conversation initiated by the introduction of federal anti-lynching legislation in 1921, there was a heightened sense among African Americans that personal security and other property-rights protections were being eroded dramatically, and this was the basis upon which Secretary Johnson of the NAACP met President Harding. This suggests, like the *Plessy v. Ferguson* decision, that federal action or inaction with respect to hate-related violence may generate significant declines in security and economic activity, as measured by inventive activity. On a practical level, interaction between whites and blacks for commercial purposes and in professional settings became more constrained during this period, although this effect does not appear directly in the estimated coefficient on promulgation of laws promoting segregation.

From estimation by race, results differ across groups. For whites, major riots are correlated with a decline in patenting of two percent per year, and there is no correlation between the year 1921 and patenting activity. For blacks, the estimated effect of the policy shift in 1921 is negative and significant. A one-percent increase in the growth rate of lynchings per capita is associated with 0.9 percent lower growth rate in black patent activity, and major riots are associated with 13 to 14 percent lower rate of growth in black patent activity.[44]

While laws instituting racial segregation are not significant in time-series estimation, both the structural break and the negative and significant coefficient on the interaction term suggest otherwise. Aggregate data in this instance may also bias the coefficients on segregation laws toward zero. When I exploit variation across states and time below, this result not only has the predicted sign, it is significant.

Random Effects Estimation

[44]A second approach is to instrument for riots. I use three instruments which are correlated with riots and inventive activity but are uncorrelated with other regressors: the unemployment rate from Lebergott (1964), changes in industrial production from the Miron-Romer index of industrial production, and fraction of the population living in the South. (See Data Appendix for descriptions of data used as instruments.) While the instruments are valid, they are weak, as were other instruments tried, such as weather patterns, and this approach does not change the fundamental results.

Do these results vary geographically? Variation in the institutions and opportunities related to patent activity and in patent activity itself, in the rule of law, and in violence was significant across regions between 1882 and 1940. Without state controls parameter estimates may be biased, picking up the influence of omitted region variables that are not explicitly included. Another advantage of more refined data on state patents is that they may be evaluated along technological, geographic, and economic dimensions. Therefore, the second prong of the empirical strategy is to estimate a model using panel data, which contain state-level characteristics of patents (and inventors) and which, therefore, allow me to account better for observed heterogeneity than do the aggregate data. Patent data are organized by state-year and fitted to a random-effects model.[45]

In this model, $patents_{st}$ is the total number of utility patents granted to African American inventors in state s in year t. Applying random effects to Equation (1) implies:

$$patents_{st} = \beta_1 lynch_{st} + \beta_2 riot_{st} + \beta_3 seglaw_{st} + \beta_4 firms_{st} + \beta_5 illit_{st} + \beta_6 particip_{st} + \beta_7 bank_{st} + \beta_8 news_{st} + \mathbf{z}_{st}\gamma + \varepsilon_s + u_{st}, \quad (4)$$

where ε_s is the state-specific error component of the composite error term.

In Equation (4) lynchings are per 100,000 residents in state s in year t. Additional covariates of patenting can be included in the state regressions: $illit_{st}$ is the illiteracy rate in state s in year t; $particip_{st}$ is an average over state s and year t of the percentage of blacks represented in the industry with which patents are associated from Margo (1990); $bank_{st}$ is number of black-owned banks founded in state s by year t; and $news_{st}$ is number of black-owned newspapers founded in state s by year t. Instead of

[45] Both random-effects and fixed-effects models were estimated initially. A Hausman test was executed to compare the consistency of the two models. The results of the Hausman test showed that the random-effects and fixed-effects coefficients are similar, have the same sign, and are not statistically different from one another. The chi-square statistic has a p-value that suggests that the difference in random-effects and fixed-effects models is not significant at conventional levels. We cannot reject the null that the random-effects estimator provides consistent estimates. A robust Hausman test is also executed, since the random-effects estimator may not be fully efficient. Following Wooldridge (2002), a Wald test with cluster-robust standard errors is implemented. Again, we cannot reject the null that the random-effects model is appropriate. Further, it is found that the random-effects estimator is the more efficient estimator, with is consistent with the findings of Taylor (1980).

industrial production and unemployment, the number of firms per capita in state *s* in year *t* taken from the *Census of Manufactures* (1883, 1895, 1933, 1942) will approximate the level of economic activity in each state. Standard errors reported are clustered by state and year.[46] In this model, $\boldsymbol{z}_{st}$ contains the interaction term $riot_{st}*lynch_{st}$, a dummy for the region of the country in which state *s* is located, share of the total black population in the U.S. residing in state *s* in year *t,* year dummies for peaks and troughs of economic activity, and share of patents granted to prolific or "great" inventors in state *s* in year *t*.[47]

The findings employing state-level data and a random-effects specification reported in Table 8 generally support those estimated by pooled OLS models for lynchings. The correlation remains significant between lynchings and patent activity between the black samples, but the size of the estimated coefficient is smaller. When controlling for state effects, the magnitude, direction, and significance of the estimated coefficients on riots and Jim Crow laws change. The riot estimates become larger, negative, and more significant. This is intuitive, given that state data allow for more precise measurement of the effects of sub-national events. On average, one additional riot in a given state in a given year would diminish the state total by nearly half a patent or by 17 patents in a given year for all states. Being in a relatively more segregated state depresses the expected number of patents, but this relation is not significant. Lynchings and riots are associated with an average decline of -0.4 per state per year or 1132 patents between 1882 and 1940, which is roughly equivalent to total patents granted in 1853 or 1854 in the U.S.

I also find that the patterns identified precede large-scale black migration. To account for a rapid increase in black migration from the South that begins after 1917, the sample is split accordingly, and results are reported in columns 5 and 6 of Table 8. The estimated effect of lynchings is larger in the

[46] Tests of the panel data find no evidence of a unit root. Therefore, these data are in levels and not first-differenced. See Maddala and Wu (1999) for unit-root tests in panel data.

[47] The Mid-Atlantic region dummy is the one excluded in estimation. See Data Appendix for information on construction of the newspaper series. Since systematic data on schooling are not systematically available for the period and states of interest, illiteracy rates, which are correlated with schooling variables, are used in estimation. Illiteracy rates are available for Census years only, and the illiteracy rate assigned a specific year is that of the closest Census year. A patent is assigned an industry participation rate based on the technological category of the patent, and the value is determined by the closest year available to the grant year. A control for prolific inventors is included in estimation when data on assigned patents are used (Table 9).

second period, and the estimated effects of riots and segregation laws are smaller and not significantly different from zero in the post-1917 period.

Does hate-related violence covary with economic activity uniformly? These findings also reveal that the effect is not homogeneous across economic, technological, and regional categories. Among the most economically important inventions at the time were patents assigned at issue, an approximate indication of early commercial viability and, to a lesser extent, mechanical and electrical patents.[48] As is reported in Table 9, overtly violent acts are negatively and significantly correlated with lower patent activity for assigned patents. For mechanical and electrical patents, the presence of latent violence, as proxied by segregation laws, is negative and depresses mechanical patents by 0.2 per state year or 579 patents over the period.[49] Again, this finding related to segregation is intuitive, given the ease of mobility required for inventors to be productive.[50]

Are violence-related factors particularly important in the South? The estimated coefficients on correlates of patenting for the South suggest they are. Similar to the case of mechanical and electrical patents, lynching and riots are negatively but not significantly correlated, but the threat of violence is more negatively and significantly correlated with patent outcomes in the South than in these other groups. This result is not surprising. The threat of violence that made Jim Crow laws credible likely forged near-convergence between violent acts and latent violent acts, given the persistence and prevalence of hate-related violence in the South over this period.

Estimating the Effect on Productivity

[48] Assignment of patent rights to a firm or individual is the best available information on value in the patent data. Nonetheless, it is a crude measure of economic value, since patents could be assigned after the patent is granted and assignment could be a noisy indicator of an innovation's economic value.

[49] A broader indicator of economic activity may be patenting in the "miscellaneous" category, which includes widely varied patents and comprises 44 percent of patents by African Americans during the period. Being in a high-lynching state depresses expected miscellaneous patent counts by 29 to 55 percent. This result is significant at all levels of significance.

[50] The estimated coefficient on riots becomes positive and significant when controlling for firms per capita. While it is not significant at conventional levels, it does suggest that states where manufacturing firms are more concentrated are also states in which mechanical patents and riots also occur.

What would have been the productivity of African Americans absent hate-related violence? State-level data will allow us to execute this counterfactual exercise. By collecting a random sample of patents of white inventors similar to those of African American inventors, I can construct a "placebo" study and can compare the productivity of inventors subject to hate-related violence to that of inventors not (or less) subject to hate-related violence. Specifically, a random sample of 714 patents is drawn by application year of the patents obtained by African American inventors from the USPTO database using Google Patents.[51] Summary statistics for the white control group and African American inventors are given in Table 10.[52] The inventors are similar in most respects, e.g., field of invention.

For this estimation, patent counts are organized by state and pooled, and a negative binomial model is fitted to the count data.[53] In this model, TP_s is the number of utility patents granted to individuals in state s which is the count variable. I assume that the number of utility patents that can occur follows a Poisson distribution. Moreover, the Poisson parameter is allowed to vary across states and is assumed to follow a gamma distribution. The number of utility patents granted to individuals in state s follows a negative binomial distribution:

[51] Application dates were not recorded for patents applied for between 1870 and 1873, which diminishes the useable sample size to 714 patents. In fact, two samples are drawn for white inventors. In the first sample that is used in estimation, patents of white inventors are matched only by application year to allow variation in other dimensions, e.g., technology and state or region, which may be exploited in estimation as in Table 9. A second sample that is not used in estimation is drawn by selecting matching patents on state, technology, and application year. The second sample cannot exploit the variation present in the first sample but, as aforementioned, is used to test whether the times between patent application and grant are similar between white and black inventors when controlling for these characteristics, which is what is found.

[52] As in the case of the original data collection, inventors who are not black are considered white in the USPTO data at this time.

[53] The random-effects specification using panel data does not work in the placebo experiment. The Tuskegee data report lynchings of whites for each state over the entire period between 1882 and 1968. Data by state and year are not available, and there is insufficient variation in average lynchings per year for estimation. The Ginzburg (1962) and Tolnay and Beck (1995) state data allow us to minimize this problem in the black series. More importantly, measurement error is more pronounced for white lynchings than for black lynchings. For example, immigrants from Mexico, China, and other countries are recorded as "white" among victims of lynching. Carrigan and Webb (2003) find that mobs lynched nearly 600 Mexicans between 1848 and 1928, which would represent almost half of all white lynchings recorded in the Tuskegee data. The motives for lynching such people would be more heterogeneous than if they were in fact white Americans. Since detailed data are not available on white lynchings outside the South, there is no means of systematically separating whites from non-whites in the white lynching data. To the extent data are available, they are incomplete with respect to ethnic and temporal coverage, e.g., lynchings of people of Mexican origin in the U.S. from 1848 to 1928 examined in Carrigan and Webb (2003). Variation in lynchings by state-year cannot be exploited in the panel framework. However, these errors are less pronounced when data are aggregated by year or by state, and a negative binomial specification is used for both samples, given overdispersion in the white sample. Due to omitted variables and an overcount of actual white lynchings, the estimated coefficient on lynchings for whites will be biased upwards in these (and all) regressions. Finally, measurement error is also problematic in the black sample, as lynchings, especially in northern states, are under-reported, and this biases estimated coefficients on lynchings among blacks toward zero in all regressions.

$$\Pr(TP_s \mid L_s) = \frac{\Gamma(TP_s + \alpha^{-1})}{TP_s!\Gamma(\alpha^{-1})}\left(\frac{\alpha^{-1}}{\alpha^{-1}+\mu_s}\right)^{\alpha^{-1}}\left(\frac{\mu_s}{\alpha^{-1}+\mu_s}\right)^{TP_s}, \; TP_s = 0,1,2,\ldots,49, \tag{5}$$

where μ_s = exp($\mathbf{L_s\lambda}$), Γ is a gamma function, α is degree of dispersion, $\mathbf{L_s}$ is the (*K x S*) matrix of conflict-related and other explanatory variables as in earlier state regressions.[54] The model in Equation (5) is estimated in both samples. Results from the placebo-study regressions are reported in Table 11.

The marginal effect of lynchings, a proxy for the absence of rule of law, is negative for both groups. Yet, it is negative and significant in the African American regressions. Absent race-related violence, the most significant marginal effect is that derived from economic activity, as the aforementioned theory would predict. In sum, the placebo study suggests that differences between African American and white inventors are largely explained by hate-related violence rather than other factors. Since estimated effects of black lynchings are biased toward zero due to under-reporting, the evidence presented likely represents a lower bound on the size and significance on the relation between violence and economic activity.[55]

Garrett Morgan as an Example

Evidence from the Garrett Morgan papers and other sources make the inventor of the modern traffic light (1912) and gas mask (1914), and inductee into the Inventors Hall of Fame, an illustrative example of the transaction costs associated with increased violence and restrictions on economic activity among inventors and other economic agents. In 1904, Springfield, Ohio was one of the first cities north of the Mason-Dixon Line to record a lynching, which was the cause of a major riot (see Table 1). As lynching

[54] The notation follows Long and Freese (2006). Data on industry participation and banks are not available for whites and are therefore excluded in these regressions

[55] These results are consistent with a second counterfactual exercise presented in Appendix III. In this case, parameter estimates from estimation of Equation (3) in in the black subsample are used in the white (non-placebo) subsample. As can be seen in Figure 4, patent output over the period 1882 to 1940 would have been significantly lower and more volatile for white inventors. This estimation does not fully account for pre-existing differences between the two groups. Nonetheless, the results are suggestive that economic activity would be substantially higher and more stable absent hate-related violence.

began to spread across northern states and personal insecurity increased, black groups formed to protect their neighborhoods, families, and property. For this reason Morgan, an inventor and entrepreneur in Cleveland, joined one of these societies and purchased a gun.[56] The papers suggest that segregation laws and customs constrained Morgan's market opportunities. Advertisements for his gas (and fire-safety) mask clearly responded to this problem by employing white or racially-ambiguous figures donning the helmets. As aforementioned, for the purposes of demonstrating his helmet across the country, he posed as a Native American chief who was the "real" inventor of the mask and claimed that Garrett Morgan was in fact his assistant. After fire chiefs in southern cities learned his true identity, orders for his mask in the South fell dramatically.[57]

Similar to the observations in Donohue and Levitt (1998), the empirical and anecdotal evidence suggest that the threat of violence or actual violence may alter incentives and outcomes of economic agents.

IV. Alternative Hypotheses and Robustness

To check the robustness of the above results, I test whether participation in certain industries and literacy explain observed economic outcomes.

Alternative Hypothesis I – "Right Place, Right Time"

Did factors affecting industrial organization adversely affect individual and black inventors, two-thirds of whom were individual inventors? At the time of the Second Industrial Revolution, invention-intensive firms were increasingly internalizing their research activities, such as AT&T and General Electric.[58] Simultaneously, Margo (1990) finds that employment became more racially segregated between 1900 and 1950, particularly among skilled blue-collar workers and in manufacturing. While his

[56] *Garrett Morgan Papers* (2007).
[57] Ibid. The case of Dr. Percy Julian, the developer of cortisone and the first African American to head a major industrial research laboratory (Glidden Industries), is more direct. Julian began his patenting career at the end of the 1930's. During his tenure at Glidden, his home in a predominantly white neighborhood in Oak Park, Illinois, was firebombed twice. Such violence was likely extraordinary in industrial research circles.
[58] See Mowery and Rosenberg (1998) for a comprehensive discussion of the development of R&D activities within firms during the 20th century.

results are for the South, the evidence suggests that outside the South the labor market, through union rules, state legislation, federal legislation, or custom, was becoming more racially isolated.

From this change in industrial organization, there are at least two outcomes of interest to this study. First, the move by firms to incorporate patentees into newly-established research departments may have eroded the possibility of anonymity, which would have had the effect of raising uncertainty and diminishing the incentive to patent for African Americans, who had collaborated with intermediaries in the past.[59] Second, even if it is assumed that black and white inventors had roughly equal access to scientific and invention-related resources, including apprenticeships, prior to this change, the gap between insider-inventors' and outsider-inventors' access to resources should have diverged significantly, particularly if externalities from industrial research groups are captured by the firm.

An appropriate test of the employment hypothesis would be to control for the share of employment in patent-intensive industries. I perform this test using Margo's (1990) industry-participation variable, which is matched to the technological category of the patent in estimation. Industry participation is significantly different from zero in the regressions using mechanical patents. In general, the effect of black representation by industry on innovation is ambiguous.

Alternative Hypothesis II – Education and Illiteracy

Did the increasing requirement of specialized skills for patent activity at the end of the 19th and start of the 20th centuries affect patent outcomes? If differences in literacy, education, and training are observed, explanations related to the level and quality of education may explain the "patent gap." I estimate that 79 percent of blacks were illiterate in 1870. High illiteracy rates are related to low levels of schooling in the Post-Civil War era, as is consistent with the findings of Card and Krueger (1992), who show a high but declining gap in school quality from 1915 and those of Collins and Margo (2003), who find significant but narrowing racial differences in literacy, school attendance, spending per pupil, and

[59] Anecdotal and historical evidence suggest that several inventors were extended jobs as inventors in industrial laboratories as a result of phone interviews, such as Lloyd Hall, but were not allowed to take the positions once their race was known.

other education variables. If patenting activity were increasingly a function of tertiary education in the sciences, blacks would have been at a disadvantage, since the first Ph.D.s in the sciences were awarded to blacks beginning in earnest in the 1920's. Consistent with the historical literature on patenting and with our intuition, illiteracy is negatively correlated with patent activity in more specialized fields, i.e., in the electrical regressions, and is increasingly negatively correlated with patenting over time (Table 9). Nonetheless, the effect of illiteracy is ambiguous across the category regressions. In sum, the evidence supports neither industry participation nor education as a significant determinant of patenting activity across models and subsamples.

More on Robustness

The reader may worry that the direction of causality may be from economic activity to violence rather than violence to economic activity, since violence may be considered both a cause and an effect of economic activity. To review, four empirical reasons suggest that causality runs from violence to economic activity. First, the best evidence available with respect to economic factors related to lynching is the empirical relation between cotton prices and lynching, an association that breaks down after 1905 and is valid for only a fraction of the period of interest. Specifically, the causal relation between labor-market competition between blacks and whites and lynchings has been analyzed by Raper (1933), Hovland and Sears (1940), Tolnay and Beck (1995). This literature finds an inverse relation between cotton prices, and therefore competition for jobs in agriculture, and black lynchings. This relation breaks down beginning in the early 20th century. Darity and Price (2003) examine the relation between racial stigma, or status as a former slave, and lynching activity. Their findings suggest that racial stigma is a relatively less important determinant of lynching activity than labor-market

competition. Evidence on the determinants of lynchings after 1905 is inconclusive in this study, as well.[60] Further, these causal factors are unrelated to traditional determinants of patenting activity.

Second, the violent or violence-related acts are not confined to economically depressed regions. To recall, after 1900, 60 percent of riots took place outside the South, whose output was modest relative to other regions, between 1900 and 1940.

Third, in a systematic review of recorded motives for riots and lynchings, neither type of violent act had a direct economic motive. Contemporaneous newspaper reports, e.g., in Ginzburg (1962/1988); case studies, e.g., Cecelski and Tyson (1998) on the Wilmington riots and Crowe (1968, 1969) on the Atlanta riot; and official government ex-post investigations, such as the *Final Report of the Oklahoma Commission to Study the Tulsa Race Riot of 1921* (2001), rarely cite economic motives for riots. Only two major riots, in New Orleans in 1895 and in East St. Louis in 1917, of the 27 major riots between 1870 and 1940 were documented as having an explicit economic motive. In the HAL lynching data set that includes offenses ostensibly leading to lynching, of 2,806 victims of all races listed, only 98 were lynched for offenses related to possible commercial factors, including two strikebreakers, two men suspected of being foreign workers, one brothel owner, one moonshine producer, and one horse thief.[61]

Finally, a Granger causality test is executed on the riot variable, which is the best-measured violence variable. In the black sample I find that major riots Granger-cause patent activity, whereas I cannot

[60] Other hypotheses related to the causes of lynching have been advanced and tested. Blalock (1967) argues that lynching of blacks was a response to rising political competition between blacks and whites.[60] Inference is difficult, Tolnay, Beck, and Massey (1989) find, since parameter estimates in these models are sensitive to outliers and model misspecification, among other problems. Recently, research has focused on preservation of social norms as an explanation for lynching, e.g., Carden (2009), Feimster (2009), Markovitz (2004), and Wood (2011). Still other evidence suggests that the origins of lynching are economic. "Whitecapping," or the organized efforts of nightriders using violence to drive blacks from their land, was a common practice in the Deep South. See Holmes (1980), Whayne (1996), and Winbush (2003) for an elaboration of the practice of "whitecapping" and the "whitecapping" hypothesis.

[61] HAL (2004). This sum includes 84 thefts and robberies, which may or may not have had an economic motive. These data were also reviewed, along with the data and literature on riots, for political motives. Only 0.4 percent of lynchings and five of 27 riots during this period could be traced to an explicit and documented political motive, e.g., voting. Since lynchings were extralegal killings, it is difficult to know the underlying relation between offenses recorded and actual offenses.

reject the null hypothesis that patent activity has no useful predictive content with respect to riots at the 10 percent level of significance. Simultaneously, in the white sample I cannot reject the null hypotheses that patent activity has no useful predictive content with respect to major riots and that major riots have no useful predictive content with respect to patent activity. Results from the Granger causality test support our intuition that violent acts can predict patent outcomes and not vice versa.

To be sure, the correlation between the variables proxying for violence and the error term will not be zero. For example, the magnitude and full extent of informal segregation and deep psychological factors, such as degree of racial mistrust, are difficult to measure and cannot be included in estimation. Data on minor riots, which may be correlated with major riots and lynchings (and Jim Crow laws), are neither systematically reported nor available and also cannot be included in the regressions. However, the evidence from the data, historical literature, and empirical tests suggests that the direction of causation from violence to economic activity is the one more consistent with the evidence available.

Finally, the quantitative measure of legal segregation, number of new segregation laws passed in a given year, will not fully capture depth and scope of informal segregation, e.g., extent of discriminatory informal customs and practices; quality of legal enforcement; and laws overturned after four years. It is reasonable to assume that informal Jim Crow customs and practices for which there was significant political consensus became embedded in law. Many such practices did not rise to this level of agreement but remained embedded in society. For example, Margo (1990) finds that southern apprenticeship and employment opportunities were considerably restricted by discrimination, not necessarily formal laws on the books, prior to 1950. Customary segregation in the North and in the South led Garrett Morgan, the inventor of the gas mask and the traffic light, to wear Native American gear (or hire a white person) to demonstrate his gas mask to white audiences, according to the *Garrett Morgan Papers*. The segregation variable can measure some informal, but not all informal, segregation.

Are these results unique to patents? The objective of this research is to use the laboratory of economic history to understand the effects of hate-related violence on innovation, and, by extension, real economic activity and living standards. It may be suggested that these data and inventors are unique and the results difficult to generalize. But these data are not special. The data I constructed on the establishment of black newspapers, for example, are quite similar to the patent data.[62] Newspapers have some of the same features of patents, including reliance on the protection of property rights. However, they differ in the sense that newspaper publication is an obviously public act, whereas patenting is not. Newspapers owned or sympathetic to African Americans may attract attention from mobs and individuals, as would any retail firm or independent communications outlet.[63] As can be seen in Figure 3, these data follow largely the same pattern as the patent data. The series increases significantly up to 1899 and falls to a permanently lower rate of increase after 1900. This implies that the findings obtained here may be more generally applicable to productive activity.

V. Conclusion and Future Research

The motive for this research is to contribute to the literature on the economic effects of conflict and political instability. It introduces and analyzes a new data set on patents obtained by African Americans between 1870 and 1940. The evidence from time-series and cross-section estimation suggests that hate-related violence, the reporting of which began nationally during this period, was by itself relatively unimportant. Equally or more important was the sense among economic agents who were African American that hate-related violence would likely not be adjudicated and that the rule of law, typically through federal government intervention, would likely not prevail.

[62] See Data Appendix for a description of the construction of the newspaper series.
[63] Lack of press freedom is common among countries having weak property rights, e.g., China, Russia, and Zimbabwe.

The shock of an increase in the scope and intensity of hate-related violence in the late 19th and early 20th centuries depressed economic activity, as measured by patent activity, by one percent per year, or the equivalent of a year's worth of total U.S. patent activity, among African Americans. This violence would have implied a fall of 40 percent and greater volatility in output among most U.S. inventors during that period. The most valuable patents – assigned, electrical, and mechanical – were sensitive to acts of hate-related violence and to the promulgation of laws promoting racial segregation. I tested alternative theories against my main hypothesis that hate-related violence reduced patent activity, but I find mixed or no support for these theories in the data. By 1936, the effect of conflict indicators on patenting by blacks falls as conflict itself wanes. Using patents as an example, the results suggest that changes in personal security and the rule of law can shift the scale, quality, and direction of technological progress and economic activity. This evidence is consistent with that of the existing literature that considers the relation between conflict and economic outcomes.

The import of this data set goes beyond patenting outcomes. A comparison to newspapers founded by African Americans implies that my results may reflect more general effects on economic activity. These findings would be particularly relevant for countries that are experiencing violence and ethnic conflict and are characterized by weak protection of property rights, but aspiring to catch up to rich countries in economic growth and development.

The limitations of my argument and of the data should be recognized. Given data constraints, the fall in patenting activity with increased violence can be attributed to the direct effect of diminished personal security due to riots, lynchings, and passage of segregation laws; the indirect effect of mistrust of institutions that results from these acts; the direct effect of declines in property values due to the lack of the rule of law (diminishing resources to finance innovation); and the direct effect of informal (or formal but not legislated) segregation, particularly that which placed physical constraints on movement, e.g., segregated neighborhoods, libraries, and commercial districts, that limit protection of intellectual

property due to limited access to patent agents, attorneys, and information. More detailed data on individual characteristics of all inventors, such as property ownership, and on informal or more localized segregation are not available but would be required to disentangle these effects.

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Appendix I: Data

Data Sources

Data on patents obtained by African Americans between 1870 and 1940 come from the author's data set, which extends the Baker (1921) data set. Total patent data are from the U.S. Patent and Trademark Office database. Patents held by white inventors are derived by subtracting patents obtained by black inventors from the total. Data on lynchings by race of victim per year per state in southern states are from Beck and Tolnay (1995). Data on lynchings in other states are from the Tuskegee Institute data set and are averages for the period 1882 to 1930; annual data are not available by state. Data for blacks and whites after 1930 are from the Tuskegee data set. I find that the Tuskegee data underestimate lynchings among blacks and whites in non-southern states. Data from Ginzburg (1988) were added for blacks in non-southern states. Data on major riots and segregation laws are from the House Select Committee on Assassinations (1979); Library of Congress (1998); and "The History of Jim Crow", www.jimcrowhistory.org; and the *Final Report of the Oklahoma Commission to Study the Tulsa Race Riot of 1921* (2001). Aggregate and state illiteracy data are extracted from Integrated Public Use Microdata Series (2004), approximately 50,000 individuals over 10 years old, and from the University of Virginia Library (2004), full sample, individuals over 10 years old). Data on aggregate illiteracy rates in 1890 are taken from Collins and Margo (2003). These data are derived from the population of 10-69 year-olds using the full count. Population data are extracted from U.S. Census (2002). Regions do not conform exactly to Census divisions: Delaware and Maryland are considered Mid-Atlantic states in this paper and are considered South Atlantic states by the U.S. Census Bureau. Data on black banks are from Ammons (1996). Industry and occupation data are from Margo (1990). The industry-participation variable is only available for 1910 and 1940 and is only for the South. Patents obtained up to and including 1900 are assigned industry-segregation values for 1900, and patents obtained after 1900 are assigned values for 1910. Technological categories are taken from NBER-Hall, Jaffe, Trajtenberg (2001). Economic peak and trough data are from the NBER Business Cycle Dating Committee. As many years of abnormal economic activity are controlled for in estimation as possible. Data on unemployment rates are taken from Lebergott (1964) and are available from 1890 to 1940. Data on industrial production are taken from the Miron and Romer (1990) aggregate index of industrial production, which has 13 components. Data on African American newspapers founded in a given year were collected from the University of Georgia (2007), Harvard University (2007), and the Library of Congress (2007). Firm data for each state are collected from U.S. Census Bureau's *Census of Manufactures* (1895, 1883, 1933, 1942).

Variable	*Definition*
Lynchings	Lynchings per million in a given year
Riots	Major riot in a given year
Segregation laws	Laws promoting segregation between races passed in a given year and not overturned within three years
Newspaper	Newspaper established for or by African Americans in a given year
Illiteracy rate	Person can neither read nor write; over 14 male population, by race
Bank	African American banks founded in state by a given year
Great inventor	Prolific inventor as defined in Cook (2007)
Population, south	Proportion of U.S. population living in the South, by race
Industry participation rate	Proportion of employment in given industry, southern blacks only, 1900
Industrial production	Miron-Romer index of industrial production
Unemployment	Annual national rate

Appendix II: Identifying African American Inventors in Patent Data

As aforementioned, it is very difficult to identify the race of a patentee, since it is not recorded in patent records, with only one exception since 1790. The first systematic attempt to identify African American patentees was an effort by the Patent Office, which undertook surveys in 1900 and 1913. The objective of the surveys was to locate African American patentees whose achievements would be featured in the 1900 Paris World's Fair and to commemorate scientific achievements by African Americans in the 50 years following the end of the Civil War. Directed by one of the lead examiners, Henry E. Baker, surveys were sent to 9,000 of the approximately 12,000 patent attorneys and agents. Responses to the survey were collected and analyzed by Baker and published in four volumes (Baker (1921)), a pamphlet (Baker (1913)), and an article in the *Journal of Negro History* (Baker (1917)). A subset of the original responses were donated to Carter G. Woodson, a noted historian, and, in turn, donated by him to the Library of Congress. The Baker data extend from 1834 to 1917. The investigation in this paper required that the data be extended to 1940.

A first strategy to extend the data set was to include patents obtained in 1913 and beyond by inventors already in the data set. These data were collected using the European Patent Office (EPO) search engine, which is searchable by name from 1920. Google Patent Search, which can also conduct historical searches, became available after 2004, when these data were originally collected. Google Patent Search misses some historical patents, and the EPO search is more reliable.

One strategy for identifying additional black inventors would be to match patentees from USPTO data to Census data. This method should work for inventors who are living and patenting in the same place. However, this procedure fails, because African Americans during this period are not patenting where most African Americans live, as Table 2 shows. Before 1940, most African American inventors obtained patents in northern states rather than in southern states. Unlike today, specific addresses were not reported by the Patent Office, just the city or town in which the inventor resided or from which he or she applied for a patent. It is difficult to find a unique first- and last-name match using Census data, because of the proximity of first and last names of African American inventors to those of other inventors, especially inventors of British origin. Eight patentees were identified as African using this method. Only with significant additional biographical data does this method work, and these data are available for a minority of inventors in the data set. And if additional biographical data were introduced, the selection problem would be of greater concern, since biographical information is available for only the most famous and prolific inventors.

Another strategy would be to match common names given to African Americans to patent data. A three-pronged strategy in the spirit of Fryer and Levitt (2004) and Bertrand and Mullainathan (2004) was executed but was not successful in identifying black patentees. This mechanism is described below. A second-best method would be to match known black inventors to names in the patent data. This method was significantly more successful in producing matches. The second method and its limitations are described in the text.

An index of black names for the period 1870 to 1940 was constructed from census data in two ways. The first strategy answered the question: conditional on being black, which names are most likely to be observed? Random samples of black ("Negro"), "mulatto", and "colored" heads of households from the 1870, 1900, and 1920 censuses were drawn for the District of Columbia and three states: Georgia, Michigan, and New York. From these samples, frequencies were calculated for first and last names separately. There were 14 first names and 11 last names that appeared more frequently than the median frequency and were included in the index.

The second strategy answered the question: conditional on observing a certain name, what is the likelihood that the person is black? First and last names of blacks ("Negroes") and whites were extracted from the five-percent IPUMS sample of the 1870 census. Unlike the above samples, names were not restricted to heads of households. From these samples, frequencies were calculated for first and last names separately and by race for names occurring at least 80 total times. Among blacks, there were 27 first names and 20 last names that appeared more frequently than the median frequency for whites or were a larger share of the total names than the black share of the total population and were included in the index.

A third approach was an extension of the second approach and answered the question: conditional on having a name widely adopted by African Americans following the end of slavery, what is the probability that the person is black? This strategy was intended to take advantage of a well-known practice among African Americans of adopting the first and last names of presidents, e.g., George Washington, or famous people in the black community, e.g., Booker T. Washington, as first and middle names. The entire 1900 census was used and also was not restricted to heads of households.

These approaches yielded largely similar results from which an index of "black names" was constructed. Results were nearly identical with respect to surnames.

Yet the composite index was not able to predict matches in the 1880 census sample of the 690 individuals identifying their occupation as "inventor." I was able to predict a small number of black inventors but, with the exception of George Washington Carver and George Washington Murray, not ones that could be matched to a patent. The index significantly under-predicted matches to black inventors and over-predicted matches to white inventors in New England, particularly those born in England, as was the case with the first Census-based approach. Additional location and biographical data would have been required to obtain unique first- and last-name matches. In general, these methods are more suitable for the current rather than historical period.

This highlights a problem associated with occupation identification and reporting among inventors. Many identify themselves as machinists or artisans or engineers rather than inventors, irrespective of race. Thomas Edison, among other "great inventors" who are alive and active as inventors, does not appear in the 1880 sample.

The final strategy to extend the Baker data set was to construct a broad-based data set of African American inventors, i.e., potential patentees, and to match the resulting data to patent data. Among the historical and contemporary sources used to create a pool of potential patentees were searches of

historical newspapers, including obituaries, e.g., from the Ohio Historical Society Newspaper online database and newspaperarchive.com; correspondence from Carter G. Woodson, Henry E. Baker, and patent survey participants (Library of Congress); the Garrett Morgan Papers; historical and contemporary directories of African American medical doctors, scientists, and engineers, e.g., ; academic journals, including the *Journal of Economic History* and the *Journal of Negro History*; historical and contemporary biographies of African American inventors and general biographies, e.g., *Great Negroes Past and Present*; and programs of exhibitors in the African American sections or exhibitions of historical fairs, including the "Exhibit of American Negroes" at the 1900 Paris World's Fair, the 1904 "Great Negro Fair" in Raleigh, North Carolina, and the 1933 Chicago World's Fair "Negro Day". Newspaper and obituary searches and programs of exhibitions allowed the identification of lesser known inventors. A complete list of sources appears in a companion paper. Not all inventors and others in the pool of potential patentees were matched to patent records and were dropped from the data set. Others were dropped if there was not a unique first- and last-name match, e.g., James Young in the patent data. Ultimately, while second best, this process provides a more systematic and less ad hoc means of recovering black patentees to extend the data set.

Appendix III. Estimating the Effect on Productivity Using Black Parameters

Let us consider a second counterfactual exercise. How much lower would inventive activity in the U.S. have been if all inventors operated under violence-related conditions? We can address this question by taking parameter estimates from estimation of Equation 3 in the black subsample and using them in the white subsample. As can be seen in Figure 4, patent output over the period 1882 to 1940 would have been nearly one percent per year, or 40 percent over the period, lower and would have displayed significantly more volatility for white inventors, who constitute the overwhelming majority of inventors at that time. Like Abadie and Gardezeabal (2003), I find that volatility seems to increase in the presence of greater violence. Of course, the comparison using black parameters with the white sample should be interpreted with caution, because it not only reflects the evolution of violence but also pre-violence differences in determinants related to patent or economic activity. There is an imperfect mapping between technological progress and patent activity, and there are other factors that would change in the white subsample, e.g., illiteracy rates. Nonetheless, the results are suggestive that the rate of technical change in the U.S. may have been substantially lower in the absence of the rule of law affecting both races. Further, concomitant improvements in living standards may have increased much more slowly.

Figure 1: Black and White Utility Patents, Per Million, 1870-1940

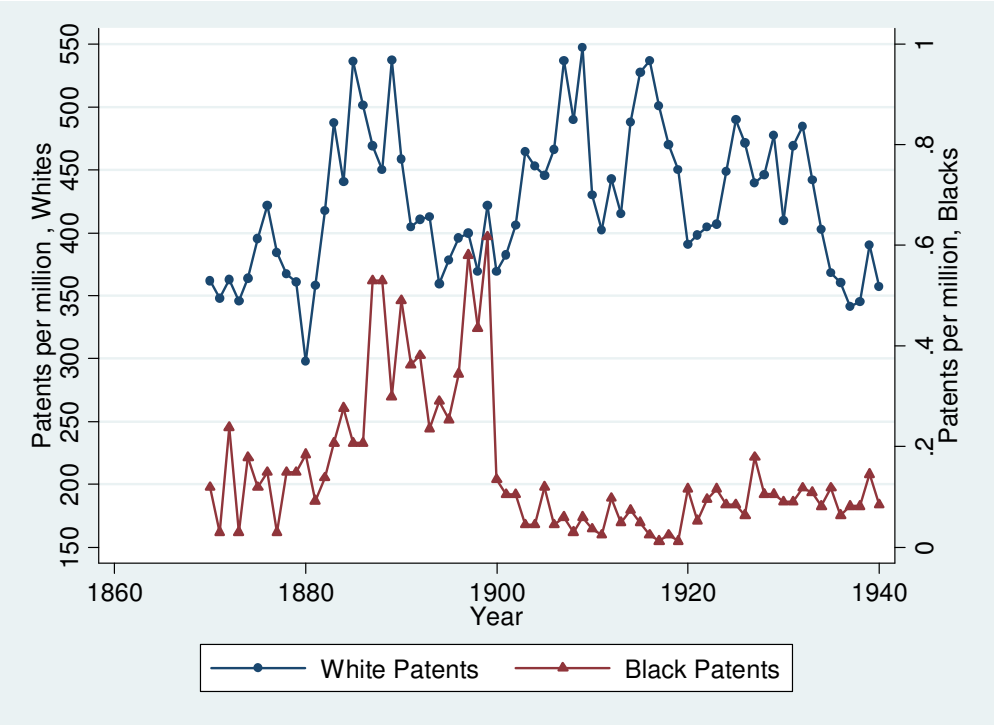
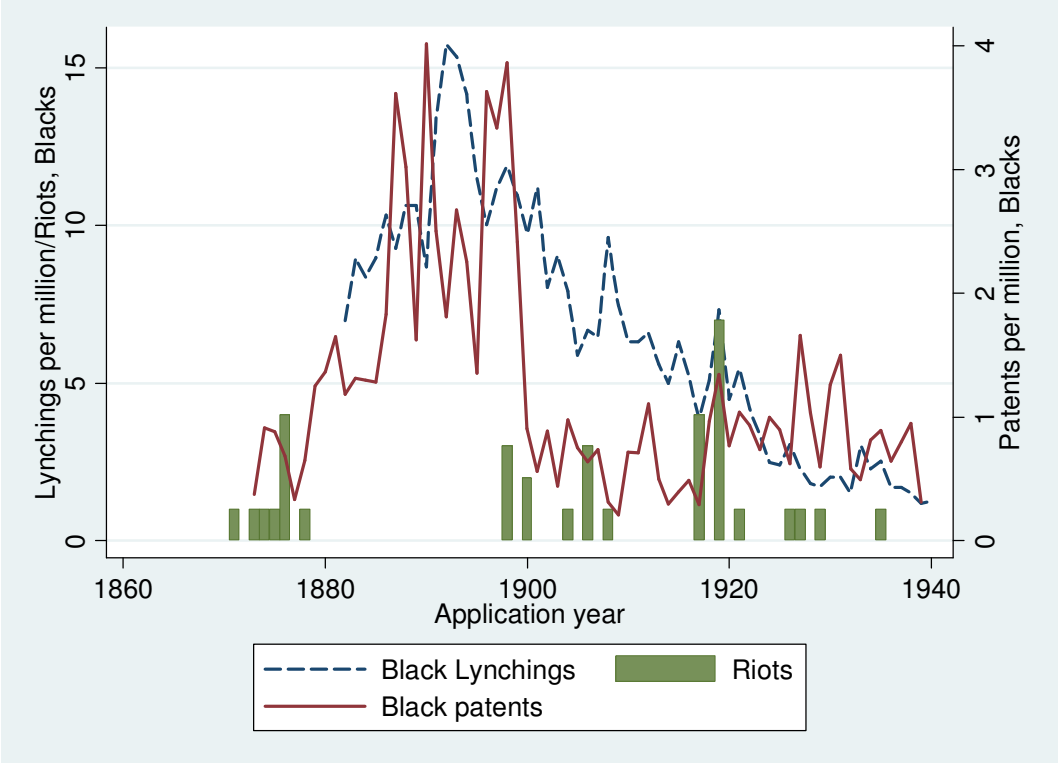


Figure 2: Conflict and Black Inventive Activity, 1870-1940



Source: Cook (2004), EPO, Tolnay and Beck (1995), Tuskegee (2004), USPTO
Note: Patent data in Figure 1 are presented by grant year and in Figure 2 by application year.

Table 1. Conflict, Rule of Law, and Segregation Laws, 1870 to 1940

Panel A -- Riots, Lynchings, New Segregation Laws, 1870-1940

Decade	Major Riots	Lynchings, Black	Lynchings, White	New Segregation Laws				
				Total	Voting	Education	Public	Other
1870-79	10	na	na	39	3	18	2	14
1880-89	1	429	87	30	2	9	6	12
1890-99	4	842	124	38	7	10	13	6
1900-09	7	646	33	63	2	13	29	19
1910-19	11	487	16	30	2	3	7	12
1920-29	4	260	20	54	4	15	10	22
1930-40	1	123	10	36	0	10	11	15

Panel B -- Events Related to Conflict and Rule of Law, Selected Years

Year	Major Riots	Lynchings, By Year*	Location	Event
1874	1	3.0	Vicksburg, MS	Election-related violence, KKK mob violence, deaths of civil-rights leaders
1876	4	5.0	Cainhoy, SC; Charleston, SC; Charleston, SC; Ellenton, SC	Violence instigated by black Republicans after disputed election; murder of black public official; partisan fighting
1878	1	8.0	Caddo Parish, LA	Election violence, KKK mob violence, 40-75 deaths
1883	1	1.7	Danville, VA	Overthrow of democratically-elected, racially-integrated local government, 4 deaths (blacks)
1895	1	4.0	New Orleans, LA	Attack on black workers, death of 6 blacks
1898	2	2.0	Wilmington, NC; Lake City, NC	Assault on professional and working-class blacks following "Declaration of White Independence"
1900	1	0.0	New York, NY	Major race riot
1904	1	0.3	Springfield, OH	Lynching, property destruction, mass exodus by black residents
1906	1	7.0	Atlanta, GA	Major riot, election-related violence, massacre, property damage
1906	1	0.3	Greensburg, IN	Major riot, mob violence, mass property damage
1906	1	7.2	Brownsville, TX	Major riot, army-related violence
1908	1	0.4	Springfield, IL	Lynchings
1917	1	7.2	Houston, TX	Black officers' mutiny following WWI, 18 black soldiers hanged
1917	2	0.1	Chester, PA; Philadelphia, PA	Major race riots
1919	1	0.4	Chicago, IL	Major race riot in reaction to rapid influx of black migrants
1919	1	1.0	Charleston, SC	Outbreak of violence among nearly 1000 sailors; deaths
1919	1	0.0	Washington, DC	Major race riot
1919	1	1.0	Knoxville, TN	Lynching, deaths, injuries, army takeover of city
1921	1	0.8	Tulsa, OK	Mob violence, destruction of 1,256 homes and most businesses, 100 to 300 deaths, mass arrests; martial law imposed
1926	1	0.0	Carterer, NJ	Race riot and mass exodus of black residents
1929	1	0.1	Lincoln, NE	Mob violence, exodus by black residents
1935	1	0.0	New York, NY	Major race riot, police brutality, 3 dead, 60 injured, $200,000 property damage

*Lynching data are for the year and state given or earliest year available, 1882. Data for DC, NE, NJ, NY, OH, OK, PA, TX, and VA are expressed as an average of the years available. Panel B reports data on black victims only.
Lynching data from 1930 to 1940 are extracted from the Tuskegee file only.
Segregation laws are new state laws designed to restrict movement or activities of minorities and not overturned within three years. Not all categories of laws are included separately, but the total includes all laws. See data appendix for sources.

Table 2. Total and African American Patentees, 1870-1940

Utility Patents	All	African American
Geographic Distribution (%)		
Mid-Atlantic	40.5	30.3
Midwest	26.5	34.0
New England	24.2	7.6
South	6.6	22.9
West	n/a	5.2
Sectoral Distribution -- Panel A (%)		
Agriculture	1.2	6.0
Construction	7.8	0.7
Electricity, communications	23.5	11.9
Manufacturing	37.6	17.9
Transportation	15.3	35.6
Miscellaneous	14.6	27.8
Sectoral Distribution -- Panel B (%)		
Chemical	n/a	5.1
Communications	n/a	1.4
Drugs, medical	n/a	1.5
Electrical, electronic	n/a	10.3
Mechanical	n/a	34.6
Other	n/a	43.8
Average Patents/Patentee	10.6	2.2
Patentees with 1 career patent (%)	33.2	67.8
Patentees with 4 or 5 career patents (%)	10.3	4.4
Patentees with 10 or more career patents (%)	25.0	3.0
Patents assigned at issue (%)	50.1	36.9
Total Patents	*2,127,079*	*726*

Source: Cook (2004), author's calculations; Sokoloff (1988); Khan and Sokoloff (1993, 2004);
Lamoreaux and Sokoloff (2003); and Lamoreaux, Levenstein, and Sokoloff (2008)
Note: Sectoral distribution data for all patentees are for 1866-1885 (Sokoloff and Khan (2004));
geographic data are for 1846-1865 and were obtained from Khan and Sokoloff (1993).
Midwest and West data are combined, and Mid-Atlantic includes NY and PA for all.
Data in Panel A are organized according to the classification of technological field in Sokoloff (1988); in Panel B, in Hall, Jaffe, Trajtenberg (2001).
Data in Panel A for African Americans are for 1870 to 1930.
Average patents/patentee for all inventors are for 1910-1911 from Sokoloff, Lamoreaux, and Levenstein (2008) for careers of six to ten years.
Average patents/patentee for African American inventors are for all inventors in Cook (2004) between 1870 and 1930 whose patenting careers spanned at least 10 years.
Career patent data for all inventors are for 1790 to 1911 from Sokoloff, Lamoreaux, and Levenstein (2008); data for African American inventors are for 1870 to 1930 from Cook (2004).
Percent patents assigned at issue for all are a weighted average of percent assigned in 1890-91 and 1910-11 in Lamoreaux and Sokoloff (2003).

Table 3. Patented Inventions by African Americans, Selected, 1870 to 1940

Year	Patentee	Inventions	Location
1870	Harde Spears	Improvement in portable shields for infantry	Snow Hill, NC
1872	Elijah McCoy	Automatic lubricator cup	Ypsilanti, MI
1875	Alexander P. Ashbourne	Method of preparing coconut	Oakland, CA
1878	Benjamin H. Taylor	Improvement in rotary engine	Rosedale, MS
1881	Lewis H. Latimer	Carbon filaments for electric incandescent lamp	New York, NY
1883	Jan Ernst Matzeliger	Automatic method for lasting shoes	Lynn, MA
1884	Judy W. Reed	Dough kneader and roller	Washington, DC
1887	Alexander Miles	Elevator	Duluth, MN
1887	Granville T. Woods	Telephone system, electro-mechanical brake, railway telegraphy, third rail	Cincinnati, OH
1890	Frank J. Ferrell	Steam trap, apparatus for melting snow, valve	New York, NY
1894	George W. Murray	Fertilizer distributor, planter, cotton chopper	Sumter, SC
1897	Andrew Jackson Beard	"Jenny" coupler (for train operators), rotary engine	Eastlake, AL
1899	George F. Grant	Tapered golf tee	Boston, MA
1907	Clara C. Frye	Timing device	Tampa, FL
1908	Shelby J. Davidson	Paper-rewind mechanism for adding machines	Washington, DC
1909	Joseph Hunter Dickinson	Motor drive for phonographs, player piano	Larchmont, NY
1914	Oscar Robert Cassell	Flying machine, angle indicator	New York, NY
1915	Garrett A. Morgan	Gas mask, traffic light	Cleveland, OH
1918	Madeleine Turner	Fruit press	Oakland, CA
1919	Clarence Gregg	Machine gun	Pitt Bridge, TX
1924	Charles V. Richey	Spark plug, railway switch	New York, NY
1925	George Washington Carver	Process of producing paints and stains	Tuskegee, AL
1928	David Nelson Crosthwaith, Jr.	Method and apparatus for setting thermostats	Marshalltown, IA
1930	Richard E. S. Toomey	Airplane appliance to prevent ice formation	Miami, FL
1938	Lloyd Augustus Hall	Curing of meats and the like, sterlizing foodstuffs	Chicago, IL
1940	Percy L. Julian	Cortisone, recovery of sterols	Maywood, IL

Source: Baker (1917), USPTO, EPO, Cook (2004)
Note: Year reported is for at least one of the inventions patented by the inventor. All patents obtained by inventors are not necessarily reported, and co-inventors are not reported.

Table 4. Baseline Characteristics, 1870

	Black	White	Gap
Patents, per million	0.820	497.095	496.276
Population by Region (share)			
Mid-Atlantic	0.071	0.250	0.179
Midwest	0.056	0.378	0.322
New England	0.006	0.103	0.097
South	0.865	0.213	-0.652
West	0.001	0.027	0.026
Labor Force Participation, By Industry (share)			
Agriculture	0.624	0.521	-0.103
Transportation, communications, public utilities	0.087	0.082	-0.005
Non-Durable Manufacturing	0.026	0.047	0.021
Durable Manufacturing	0.098	0.075	-0.023
Occupation (share)			
White Collar	0.027	0.163	0.136
Skilled Blue Collar	0.038	0.095	0.057
Semi-skilled Blue Collar	0.049	0.057	0.008
Service	0.042	0.015	-0.027
Unskilled Non-farm Laborer	0.223	0.081	-0.142
Farm Operator	0.376	0.442	0.066
Farm Laborer	0.231	0.415	0.184
Illiteracy (share)	0.787	0.155	0.683
School Attendance, 10-14 (share)	0.153	0.713	0.560

Source: Cook (2004c), black patents; USPTO, patents; Margo (1990), industry and occupation data; U.S. Census (2002), population; IPUMS, illiteracy; Collins and Margo (2003), school attendance

Note: Industry data are for 1910; occupation data are for 1900. The gap is (white - black).

Table 5: Descriptive Statistics

Aggregate Data, Annual, 1870-1940					*State Data, 1870 - 1940*		
		Black	White	All			
Patents,	Mean	0.1560	425.1963	212.6761	Lynchings,	Mean	0.2015
per million	S.D.	(0.1433)	(57.1635)	(217.0424)	per 100,000	S.D.	(1.1962)
	Year=1882	0.1382	417.6903	208.9143			
	N	71	71	142	Patents	Mean	1.6332
Major Riots	Mean	0.4930	0.4930	0.4930		S.D.	(1.3186)
	S.D.	(1.1817)	(1.1817)	(1.1775)			
	Year=1882	0	0	0	Mechanical	Mean	0.5837
	N	71	71	142	patents	S.D.	(0.8143)
Lynchings,	Mean	6.5884	0.3007	3.4446			
per million	S.D.	(3.9203)	(0.1710)	(4.1954)	Electrical	Mean	0.1744
	Year=1882	6.9898	0.5599	3.7748	patent	S.D.	(0.5198)
	N	59	59	118			
Lynchings,	Mean	5.8838	0.3821	3.1329	Assigned	Mean	0.6279
(BT)	S.D.	(4.0548)	(0.5026)	(3.9884)	patent	S.D.	(1.0449)
per million	Year=1882	5.7105	0.8526	3.2816			
	N	59	59	118	Southern	Mean	0.3884
Segregation	Mean	4.0845	4.0845	4.0845	patents	S.D.	(0.7605)
Laws (1)	S.D.	(3.1385)	(3.1385)	(3.1273)			
	Year=1882	3	3	3	Illiteracy Rate	Mean	0.2390
	N	71	71	142		S.D.	(0.1973)
Segregation	Mean	2.6197	2.6197	2.6197			
Laws (2)	S.D.	(2.0309)	(2.0309)	(2.0237)	Industry Share,	Mean	0.1074
	Year=1882	2	2	2	Blacks	S.D.	(0.1307)
	N	71	71	142			
Illiteracy Rate	Mean	0.4458	0.0860	0.2659	Banks	Mean	0.5972
	S.D.	(0.2158)	(0.0376)	(0.2375)		S.D.	(1.5063)
	Year=1882	0.6494	0.1200	0.3847			
	N	71	71	142	Multiple-Patent	Mean	0.3708
U.S. Population	Mean	0.8478	0.2277	0.5378	Inventor, share	S.D.	(0.4566)
in the South,	S.D.	(0.0324)	(0.0086)	(0.3120)			
share	Year=1882	0.8690	0.2230	0.5460	Black Population,	Mean	0.0229
	N	71	71	142	share of total	S.D.	(0.0261)
					U.S. in state		
					N		430
					Number of states		49

Source: See data appendix.
Note: Aggregate data are annual.
Lynching and Lynching (BT) data range from 1882 to 1940.

State data are for black patents and grouped
by state and year.

Table 6a.
OLS Time-Series Models
Dependent Variable: Log Patents per capita

Explanatory Variable	OLS	OLS
Lynchings per capita, log	0.036	-0.053
	(0.304)	(0.312)
Major Riots	-0.097***	-0.093***
	(0.019)	(0.018)
Segregation Laws (1)	0.012	0.015
	(0.017)	(0.013)
Unemployment Rate	0.002	
	(0.011)	
Miron-Romer Industrial Production Index, log		-0.056
		(0.279)
Race	-8.467***	-8.043***
	(1.276)	(1.590)
R^2	0.985	0.985
N	102	114
Riots*Lynchings	Yes	Yes
Year	Yes	Yes
Year ≥ 1899	Yes	Yes
Peak-Trough Effects	Yes	Yes

Note: Results are reported for pooled OLS models.
Robust Driscoll-Kraay standard errors are in parentheses.
A linear control for year, the break year, and
Riots*Lynchings are included in each model.
Controls for peak and trough years are included.

Table 6b.
Pooled OLS Time-Series Models
Dependent Variable: Log Patents per capita

Explanatory Variable	Whites	Whites	Blacks	Blacks
Lynchings per capita, log	-0.112	0.095	-0.877***	-0.380
	(0.075)	(0.103)	(0.338)	(0.280)
Major Riots	-0.142*	-0.166**	-0.547	-0.600*
	(0.081)	(0.080)	(0.421)	(0.352)
Segregation Laws (1)	0.016***	0.010*	0.008	0.024
	(0.005)	(0.005)	(0.036)	(0.028)
Unemployment Rate	-0.008***		0.016	
	(0.003)		(0.025)	
Miron-Romer Industrial Production Index, log		0.155		0.045
		(0.104)		(0.559)
F	57.90	39.80	68.26	80.64
N	51	57	51	57
Riots*Lynchings	Yes	Yes	Yes	Yes
Linear Trend	Yes	Yes	Yes	Yes
Year ≥ 1899	Yes	Yes	Yes	Yes
Peak-Trough Effects	Yes	Yes	Yes	Yes

Note: All models are estimated as pooled OLS models.
Newey-West heteroscedasticity- and autocorrelation-robust standard errors are in parentheses.
Controls for peak and trough years and for the break year are included in each model.
A linear trend and a control for Riots*Lynchings are included in each model.
The sample period is 1882 to 1940. See data appendix for variable descriptions.
Coefficients marked with an asterisk (***) are significant at the 1 percent level of significance; (**), at the 5 percent level; and (*), at the 10 percent level.

Table 7
Difference-in-Differences Models
Dependent Variable: Log Patents per capita

Explanatory Variable	Full		Whites		Blacks	
Lynchings per capita, log	-0.398	-0.342	0.072	0.136**	-0.847*	-0.908**
	(0.245)	(0.216)	(0.078)	(0.069)	(0.474)	(0.461)
Major Riots	-0.085***	-0.085***	-0.020**	-0.021***	-0.137*	-0.132*
	(0.024)	(0.021)	(0.008)	(0.007)	(0.072)	(0.070)
Segregation Laws (1)	0.014	0.013	-0.002	-0.003	0.035	0.036
	(0.014)	(0.010)	(0.005)	(0.004)	(0.033)	(0.026)
Unemployment Rate	-0.008		-0.001		-0.012	
	(0.014)		(0.005)		(0.033)	
Miron-Romer Industrial Production Index, log		0.260		0.005		0.478
		(0.320)		(0.091)		(0.603)
Race	-0.191	-0.141				
	(0.318)	(0.284)				
Year = 1921	0.149*	0.172	0.018	-0.002	-0.614***	-0.538***
	(0.088)	(0.114)	(0.041)	(0.038)	(0.163)	(0.180)
Race x Year = 1921	-0.818***	-0.829***				
	(0.082)	(0.076)				
R^2	0.165	0.153	0.300	0.308	0.279	0.283
N	100	112	50	56	50	56
Year ≥ 1899	Yes	Yes	Yes	Yes	Yes	Yes
Additional Controls	Yes	Yes	Yes	Yes	Yes	Yes

Note: All models are estimated as pooled OLS models in first differences.
Driscoll-Kraay standard errors are in parentheses for columns 1 to 2.
Heteroscedasticity-robust standard errors are in parentheses for columns 3 to 6.
A linear control for the break year is included in each model.
Additional controls for year and peak and trough years are included in each model.
The sample period is 1882 to 1940. See data appendix for variable descriptions.
Coefficients marked with an asterisk (***) are significant at the 1 percent level of significance; (**), at the 5 percent level; and (*), at the 10 percent level.

Table 8. State Regressions

Dependent Variable: Patents per state per year

Explanatory Variables	(1)	(2)	(3)	(4)	(5)	(6)
Lynchings, per 100,000	-0.058***	-0.055***	-0.031*	-0.028*	-0.035**	-0.069**
	(0.022)	(0.020)	(0.017)	(0.016)	(0.017)	(0.031)
Major Riots	-0.429***	-0.461***	-0.333***	-0.364***	-0.419***	0.017
	(0.077)	(0.111)	(0.056)	(0.074)	(0.149)	(0.295)
Segregation Laws (1)	-0.100	-0.131	-0.053	-0.081	-0.037	-0.081
	(0.101)	(0.101)	(0.121)	(0.127)	(0.178)	(0.163)
Illiteracy Rate	-0.105	-0.407	-1.284***	-1.526***	-2.028***	-4.053*
	(0.400)	(0.416)	(0.478)	(0.515)	(0.696)	(2.160)
Number of Firms, per capita			182.054***	179.098***	166.454***	204.407*
			(45.812)	(45.177)	(58.878)	(122.791)
Industry Participation Rate		0.685		0.623	0.498	0.369
		(0.552)		(0.529)	(0.602)	(1.639)
Bank		-0.018		-0.015	-0.226**	0.018
		(0.057)		(0.040)	(0.092)	(0.038)
Newspaper		0.118		0.089	0.079	-0.303
		(0.185)		(0.179)	(0.173)	(0.293)
N	430	428	425	423	276	147
Number of states	49	49	49	49	49	49
R^2	0.105	0.112	0.173	0.179	0.185	0.174
Riots*Lynchings per 100,000	Yes	Yes	Yes	Yes	Yes	Yes
Region	Yes	Yes	Yes	Yes	Yes	Yes
Share African American in State	Yes	Yes	Yes	Yes	Yes	Yes
Peaks and Troughs	Yes	Yes	Yes	Yes	Yes	Yes

Note: All models are estimated as random-effects models using patents obtained by African American inventors.
Standard errors robust to clustering on state and year are in parentheses.
Column 5 is estimated for the period 1882 to 1917. Column 6 is estimated for the years 1918 to 1940.
Dummies for region and controls for average share of African Americans living in the state over the period of interest, for Riots*Lynchings per 100,000, and for peak and trough years are included in each model.
See data appendix for variable descriptions.
Coefficients marked with an asterisk (***) are significant at the 1 percent level of significance; (**), at the 5 percent level; and (*), at the 10 percent level.

Table 9. State Regressions – Assigned, Technological Category, Region

Dependent Variable: Patents per state per year

	Assigned	Mechanical	Electrical	Southern	Assigned	Mechanical	Electrical	Southern
Explanatory Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Lynchings, per 100,000	0.010	-0.023	-0.013	-0.012	0.011	-0.014	-0.011	-0.010
	(0.019)	(0.017)	(0.009)	(0.013)	(0.020)	(0.015)	(0.010)	(0.011)
Major Riots	-0.526*	0.167	-0.042	-0.123	-0.520*	0.200*	-0.035	-0.117
	(0.290)	(0.121)	(0.120)	(0.108)	(0.287)	(0.112)	(0.129)	(0.113)
Segregation Laws (1)	0.105	-0.214***	-0.042	-0.209***	0.107	-0.200**	-0.040	-0.210***
	(0.084)	(0.080)	(0.036)	(0.063)	(0.086)	(0.087)	(0.037)	(0.065)
Illiteracy Rate	-0.103	0.081	-0.364**	-0.172	-0.217	-0.304	-0.510***	-0.304*
	(0.293)	(0.385)	(0.159)	(0.140)	(0.284)	(0.330)	(0.120)	(0.162)
Number of Firms, per capita					16.867	61.043***	20.325	16.956
					(24.505)	(19.251)	(14.098)	(16.275)
Industry Participation Rate	-0.005	-0.840***	-0.078	0.374	-0.018	-0.859***	-0.086	0.366
	(0.220)	(0.282)	(0.134)	(0.462)	(0.213)	(0.267)	(0.136)	(0.464)
Newspaper	-0.015	0.124	-0.003	0.035	-0.016	0.114	-0.007	0.031
	(0.081)	(0.120)	(0.028)	(0.059)	(0.078)	(0.119)	(0.028)	(0.059)
Bank	0.029	-0.073**	0.005	-0.016	0.016	-0.062*	0.005	-0.015
	(0.070)	(0.037)	(0.015)	(0.014)	(0.057)	(0.034)	(0.015)	(0.015)
Great Inventor	0.788***				0.758***			
	(0.165)				(0.155)			
N	428	428	428	428	423	423	423	423
Number of states	49	49	49	49	49	49	49	49
R^2	0.213	0.083	0.062	0.639	0.207	0.099	0.068	0.640
Riots*Lynchings per 100,000	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Share African American in State	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Peaks and Troughs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: All models are estimated as random-effects models using patents obtained by African American inventors. Standard errors robust to clustering on state and year are in parentheses. Dummies for region and controls for average share of African Americans living in the state over the period of interest, for Riots*Lynchings per 100,000, and for peak and trough years are included in each model. See data appendix for variable descriptions. Coefficients marked with an asterisk (***) are significant at the 1 percent level of significance; (**), at the 5 percent level; and (*), at the 10 percent level.

Table 10. Summary Statistics, African American and White Control Group Patents

Variable	*N*	White				African American			
		Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
Patents per state	49	14.6	29.0	0	164	14.5	24.1	0	119
Assigned patents per state	49	6.0	11.9	0	64	5.8	11.7	0	52
Mechanical patents	49	4.8	10.1	0	60	5.4	9.5	0	47
Electrical patents	49	1.2	2.6	0	14	1.5	3.8	0	22
Southern patents	49	1.1	2.8	0	15	3.4	8.1	0	50
Lynchings per 100,000	49	0.081	0.169	0	1.046	1.153	2.508	0	15.37
Major riots	49	0.027	0.118	0	0.667	0.007	0.030	0	0.20
Segregation law (2)	49	3.559	3.997	0	15.5	3.431	3.397	0	10.82
Illiteracy rate	49	0.064	0.044	0.019	0.182	0.283	0.197	0.00	0.81
Number of firms, per capita	49	0.003 0	0.0018	0.000 7	0.006 8	0.003 0	0.0020	0.000 8	0.009 5
Patent-level data									
Time to patent	714	1.19	1.70	0	12	1.41	1.46	0	10

Source: USPTO, patents; see text or data appendix for sources of other variables

Note: White inventors' patents are randomly selected by application year of African American inventors' patents. Number of firms is number of firms in the state where patent was issued at the time of application scaled by the population of the state.

Distribution of Patents by Technological Category and Race, Percent

Technological Category	White Control Group	African American
Chemical	8.4	5.3
Communications	2.2	1.4
Drugs	1.5	1.5
Electrical	8.5	10.5
Mechanical	32.8	37.1
Other	46.5	44.1
TOTAL	100.0	100.0

Source: USPTO, patents; Hall, Jaffe, Trajtenberg (2001), technological categories

See text or data appendix for sources of other variables.

Note: White inventors' patents are randomly selected by application year of African American inventors' patents.

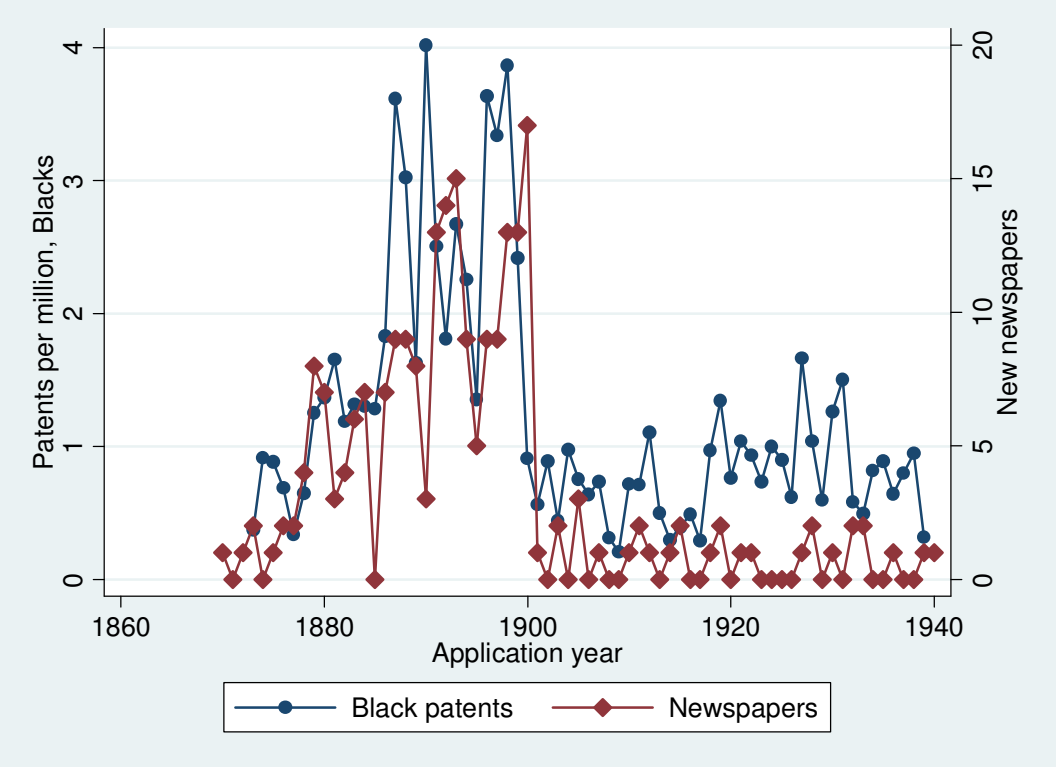
Table 11. State Regressions, African American and White Control Group Inventors

Dependent Variable: Patents per state

			African American					*White Control Group*		
Explanatory Variables	Patents	Assigned	Mechanical	Electrical	South	Patents	Assigned	Mechanical	Electrical	South
Lynchings per 100,000	-12.81846	-5.577573	-7.465934**	-2.669931**	-8.77348**	-11.63882	-58.15853	-161.1914	-5.390287	-3.699285
	(8.269)	(4.913)	(3.514)	(1.202)	(4.185)	(17.350)	(37.973)	(127.278)	(7.045)	(6.814)
Major riot	132.7069	24.46003	-20.0813	39.40848	86.5511	3.878847	17.40536	141.8573	-2.009391	-4.00433
	(176.072)	(93.858)	(61.069)	(24.662)	(77.554)	(50.164)	(20.712)	(119.103)	(5.108)	(4.086)
Segregation laws (2)	1.215058	0.1551016	0.6864781	0.4199321*	2.045711	2.027396*	0.630609	1.061468*	0.1083483	0.5946363
	(1.290)	(0.578)	(0.531)	(0.245)	(1.283)	(1.084)	(0.426)	(0.597)	(0.093)	(0.454)
Illiteracy rate	-20.47612	-14.24807	-5.506664	-12.38277**	33.091	-49.29367	-12.87619	-173.0689	14.46967	4.410311
	(19.283)	(10.235)	(9.132)	(5.943)	(25.116)	(83.810)	(44.933)	(115.121)	(12.888)	(10.195)
Number of firms,	8965.896*	3072.871*	3778.652*	952.7724**	-1855.699	13274.24***	5464.214***	4893.168*	1158.459***	853.7271
per capita	(4570.042)	(1579.991)	(2148.172)	(466.993)	(1935.968)	(4200.694)	(2011.452)	(2494.508)	(444.848)	(705.906)
Wald	118.08	91.26	80.57	78.05	83.85	183.42	142.61	89.04	66.42	30.44
N	49	49	49	49	49	49	49	49	49	49
Region	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No
Riots*Lynchings per 100,000	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: All models are estimated as negative binomial regression models using patents obtained by African American inventors and a random sample of patents obtained by white inventors in the same application years as those of African American inventors. There are 714 patents for each group of inventors. Data are for application years 1882 to 1940. Coefficients in each column are average marginal effects. Heteroscedasticity-robsut standard errors are in parentheses. Dummies for regions and an additional control for Riots*Lynchings per 100,000 are included in each model, with the exception of the models estimated in the southern subsample. Coefficients marked with an asterisk (***) are significant at the 1 percent level of significance; (**), at the 5 percent level; and (*), at the 10 percent level.

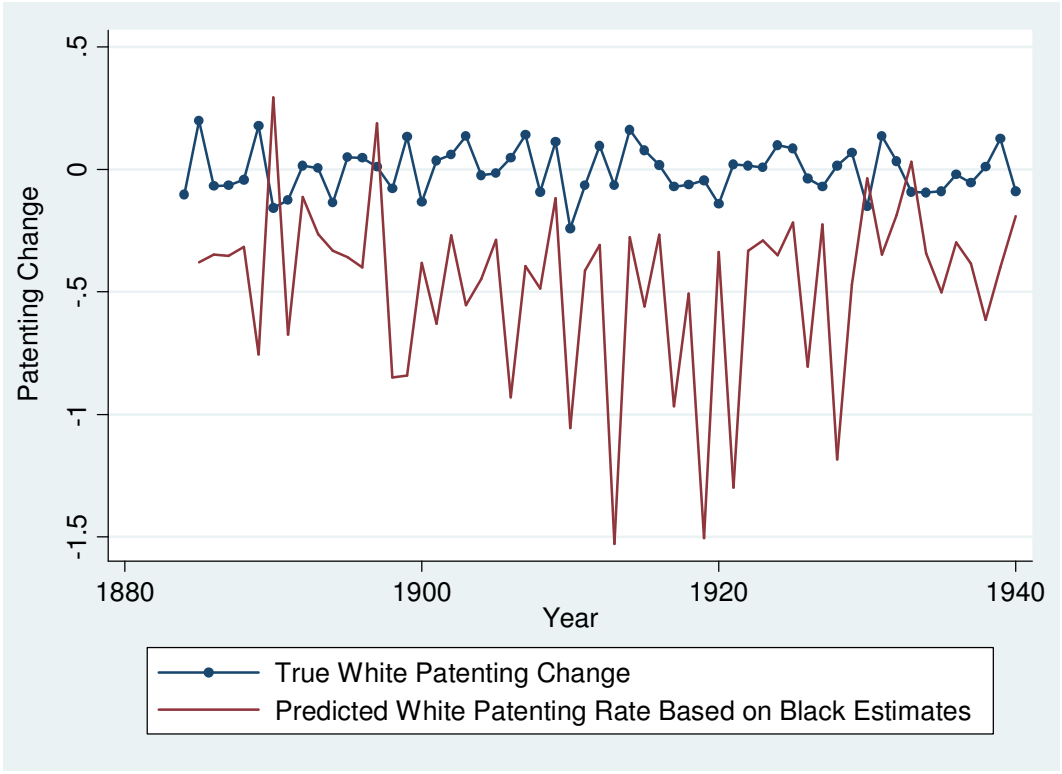
Figure 3: African American Newspapers and Patents, 1870-1940



Source: Author's calculations; see data appendix.

Appendix III.

Figure 4. Predicted White Patent Activity Using African American Estimates



Source: Cook (2004), Author's calculations.
Note: Figure 4 is estimated from Equation (3).