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Reassessing the Contributions of Black Inventors to the Golden Age of Innovation[1]

Michael J. Andrews, University of Maryland Baltimore County, mandrews@umbc.edu
Jonathan T. Rothwell, Principal Economist at Gallup, Nonresident Senior Fellow at the Brookings Institution, Jonathan_Rothwell@gallup.com

Abstract

During the Second Industrial Revolution and subsequently, it is widely believed that Black Americans contributed disproportionately little to the economic development of the United States, especially in comparison to European Americans and immigrants from Europe. Yet, Black Americans tended to live in entirely different institutional environments than other Americans, particularly in the South under Jim Crow laws. Using a new database that matches inventors to census records, we find that patenting rates for Black Americans living in the North were very similar to patenting rates for White Americans from 1870 to 1940; in some decades and states, Northern Black patenting rates exceeded the patenting rate for White Americans. In the South, patenting rates were low for both Black and White Americans, while patenting rates for Northern Black residents were far higher than those for Southern White residents. We additionally find that Black Americans from all regions were responsible for more patents than immigrants from all but two countries (Germany and England). In total, we estimate that African Americans invented more than 50,000 patents over the period. Thus, when freed of extreme political oppression, Black Americans demonstrated a level of inventiveness that matched the most inventive groups in US history.

JEL Classifications: N0, N8, N3, O3, O34, J15.

Keywords: Patents, Innovation, Race, Economic Geography.

[1] A shorter version of this article, written for a general audience, was published as Rothwell, Andre Perry, and Andrews (2020).

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Introduction

The late-nineteenth and early-twentieth centuries are known as the "Golden Age" of US innovation (Robert J. Gordon 2016; Ufuk Akcigit, John Grigsby, and Tom Nicholas 2017), setting the stage for dramatic improvements in the standard of living over the next several decades. Many innovators from the Golden Age—almost all of them White—have become household names. It is commonly believed that Black inventors contributed little to US invention during this period. In this article, we reassess this belief using newly-available data on inventor demographics.

Investigating the role of inventors of different races has long proven difficult because the US Patent and Trademark Office (USPTO) does not record patentees' demographic information when they file for a patent. While the topic is therefore difficult to study, scholars and policymakers have long been interested in creating counts of patents by Black inventors. In 1894, Representative George Washington Murray, who was a former slave, inventor, and at the time the only African American in the US Congress, entered a partial list of inventions by Black Americans into the Congressional Record (Murray 1894).[2] A few years later, Black patent examiner Henry Baker undertook one of the most ambitious early attempts to catalog Black inventors by surveying patent attorneys to ask about their Black clients, finding 1,200 inventions attributed to Black Americans and confirming about 1000 of them (Henry Baker 1913, 1917). More recently, patent agent and former patent examiner Patricia Carter Sluby (1987, 2004) and librarian Margaret Collins (2008) have compiled lists of known Black inventors. Lisa Cook supplemented Baker (1913, 1917) with numerous additional sources to identify more Black patentees (Cook 2011, 2014; Cook and Chaleampong Kongcharoen 2010). The USPTO has also recently shown revived interest in assessing this research to draw conclusions about patenting by underrepresented groups (Andrew Iancu and Laura A. Peter 2019). These sources provide a view into Black American's participation in the inventive process, but they may fail to identify patents by less prestigious Black inventors. We utilize a recent dataset by Sarada, Michael J. Andrews, and Nicolas L. Ziebarth (2019) that links patentee names to US decennial population census records for the years 1870-1940 to get the most comprehensive and systematic view yet of patenting by different demographic groups during the Golden Age of Innovation.[3]

Consistent with the conventional view of US history, we find that patenting rates for Black Americans were substantially lower than those for White Americans. This aggregate difference masks substantial geographic heterogeneity, however. Indeed, geography is a much stronger predictor of patenting rates than is race: Black Americans living in the North have patenting rates much more similar to Northern White residents than to Southern Black residents; likewise Southern White residents have patenting rates much more similar Southern Black residents than to Northern White residents.[4] The fact that the vast majority of the Black population lived in the low-patenting South accounts for the large observed difference in aggregate patenting rates between White and Black Americans. Simply controlling for geography in regressions of patenting rates on race can explain up to 75 percent of the racial gap in patenting.

[2] See Kara Swanson (2020) and especially John F. Marszalek (2006) for more context on Murray and his list of Black inventors.

[3] Due to the changing classifications of race in the US censuses, the Sarada et al. (2019) data identify non-White inventors but do not create separate identifiers for distinct non-White races. In this article, for clarity of exposition we refer to all non-White inventors as Black. Given the demographic composition of the US during the time period we study, we believe this is unlikely to affect interpretation of our results. We discuss this and other features of the Sarada et al. (2019) data in the next section.

[4] For expositional simplicity, in this article we use the term "North" to simply mean all non-Southern states. Later we investigate the effects of geography in various ways and find that this conclusion is still true when comparing the South to specific census regions.

What accounts for the differences in patenting rates across regions? Obviously, the North and South during the late-nineteenth and early-twentieth centuries had very different economic, institutional, and social environments (Stanley L. Engerman and Kenneth L. Sokoloff 2002; John Majewski 2016). The North had long been more populous, industrialized, and innovative (B. Zorina Khan 2005; Majewski 2016; Sokoloff 1988), with invention concentrated in northern innovation hubs (Andrews and Alexander Whalley 2022). But conditions in the South were especially deleterious for invention for Black residents. While our period of study begins after the end of slavery and the Civil War, following the end of Reconstruction in 1877 and the withdrawal of the federal military, White-supremacy terrorist groups such as the Ku-Klux-Klan regained power and influence in the South (Eric Foner 1988). The postwar educational efforts made by freed Black slaves and Northern White allies were undermined by the defunding of public education for Black children, restrictions on occupations, lending, and residence. In addition to these policies, Black people in the South lived under a reign of intimidation and oppression (C. Vann Woodward 1955). Toward the end of the Great Migration and during a time of widely accepted White Supremacy, the North would eventually adopt many of these practices as well, but for most of our study period conditions were especially brutal in the southern states. Thus, while the culture and institutions in the North were more conducive for invention than those in the South for both races, the difference was especially large for Black residents. As additional suggestive evidence that the different institutional environment was a primary driver of the Black-White gap in patenting rates, we show that patenting rates for both races tended to respond similarly to changes in local conditions.

We are not the first to notice that Black inventors tended to live in the North even though 86 percent of the Black population was in the South (Steven Ruggles, Sarah Flood, Ronald Goeken, Josiah Grover, Erin Meyer, Jose Pacas, and Matthew Sobek 2020). For instance, Collins (2008) finds that only 26 percent of the 985 identified Black inventors during the Golden Age lived in the South. Cook (2014, 251) similarly notes that “African Americans during this period did not patent where most African Americans live … Before 1940, most African American inventors obtained patents in northern states rather than in southern states”. Examples of well-known Black inventors also suggest a geographic pattern similar to what we find. Garrett Morgan, inventor of an early traffic light and gas mask, was born in Kentucky but moved to Ohio when he was a teenager and finally settled in Cleveland (Encyclopedia of Cleveland History; Cook 2012). Elijah McCoy, inventor of a widely-used lubrication system for steam engines and likely subject of the phrase “the real McCoy” was born in Canada to a family of escaped slaves from Kentucky but did his invention in Ypsilanti, Michigan (Albert P. Marshall 1989). Madame C.J. Walker, inventor of hair care and cosmetic products and the first known female African American millionaire, was born in Louisiana, moved to St. Louis as an adult, and then lived in several northern cities, including Pittsburgh, Indianapolis, and Harlem (A’Lelia Bundles 2001). The prolific inventor Granville Woods was born in Ohio and did most of his invention in Ohio and New York, while Lewis Latimer was born in Massachusetts and would go on to work with several prominent northern inventors, including Alexander Graham Bell and Thomas Edison, in addition to creating many inventions as an independent (Rayvon Fouche 2005). Another famous Black innovator from the Golden Age, George Washington Carver, is the exception that proves the rule: Carver began his innovative career while at Iowa State University, and did the majority of his most famous work at one of the few locations in the South with the institutional structure in place to support innovative activity, the Tuskegee Institute (Christina Vella 2015); the earliest research universities and corporate research labs

were much more common in the North.[5] We are able to move beyond these anecdotes and quantify the extent of the geographic differences in invention.

To further put Black invention into perspective, we compare their patenting rate to patenting rates of immigrant groups, which are frequently seen as highly innovative and vital to American technological progress (William R. Kerr 2018; Giovanni Peri 2016). We find that Black inventors accounted for a larger total number of patent than did inventors from every other origin country except for England and Germany. Finally, we use the Black patenting rates in our data to extrapolate the total number of patents likely created by Black Americans during the Golden Age. We estimate that a total of 50,772 patents issued to Black inventors over all years from 1870 to 1940, far more than have presently been identified in the literature.

In all, we believe that our results overturn—or at least provide crucial context to—more than a century's worth of assumptions about the contributions of Black Americans to US innovation. We highlight resiliency and creativity in the face of Jim Crow and other racist policies, as well as pointing to the possibility that good institutions facilitate innovation even for historically marginalized groups. In the process, we contribute to the large literature on the determinants of innovation, technological change, and economic growth (e.g., Charles I. Jones 2016) and the political economy of inequality and growth (Daron Acemoglu, Simon Johnson, and James A. Robinson 2001; Acemoglu and Robinson 2012; Rothwell 2019). Recent work has found that societal barriers that prevent individuals from making the best use of their talents can have first order effects on economic growth (Chang-Tai Hsieh, Erik Hurst, Charles I. Jones, and Peter J. Klenow 2019; Rothwell 2019), and we document stark differences in rates of Black invention across race-specific institutional regimes during an important era of US technological change.

As a final contribution of this article, we demonstrate how new datasets made possible by large-scale automated record linkage procedures can be used to answer important and longstanding questions in the fields of history, race, and economics. It is our hope that other scholars will continue to use and improve on these data sources, all of which are publicly available.[6]

Following this introduction, we describe the database and analytic methods. Then, we show results of inventions per capita by state and region of residence. In the next section, we compare these baseline results to those by birthplace. Here, we include a discussion of inventors born abroad and compare aggregate and per capita rates to Black Americans. In the final section, we attempt to estimate the total number of patents by Black Americans living in the North and South. In the concluding discussion, we argue that this evidence should prompt a re-thinking of the role of Black people to American history and provide further evidence that institutional features of political economy play important roles in shaping social outcomes.

Data and Methods

It is typically difficult to ascertain an inventor's race. A patent contains an inventor's name and location of residence, but no information about race, ethnicity, or other demographic characteristics. To overcome this challenge, we use data from Sarada et al. (2019) who match the names and locations of inventors to the same information in US decennial population

[5] While Carver is rightfully famous as an innovator, he only obtained three patents, all issued between 1925 and 1927 when he was in his 60s (Heleigh Bostwick 2021). Carver is most known for creating new plant products, especially related to peanuts, which were unlikely to be eligible for patent protection (Matthew S. Clancy and GianCarlo Moschini 2017).

[6] The data used in this article are from Ziebarth, Sarada, and Andrews (2019) and are available for download at: https://www.openicpsr.org/openicpsr/project/193421/version/V1/view.

census records, which includes demographic information for each individual.[7] US census records are kept confidential for 72 years, so Sarada et al. examine patentees in seven decennial census years from 1870 through 1940 (the 1890 census records were destroyed in a fire, so it is not possible to match patentees to the census for that year). These decades constitute some of the most important in the history of US invention (Gordon 2016).

The patent data is collected from Annual Reports of the Commissioner of Patents and Annual Indices of Patents, which list each patent granted by the USPTO in each year. Andrews (2021) provides much more information on the quality and completeness of this historical patent data source. Sarada et al. (2019) link the names and locations of patentees to individuals in the census. More specifically, they use "fuzzy matching" techniques that match a patent record to a census record if the inventors' first and last names and town of residence are sufficiently similar to the individuals' name and town in the census, blocking on state. Fuzzy matching techniques are important when working with these kinds of historical records because transcription and optical character recognition errors can introduce numerous errors into the recorded names and locations.

A given patentee record may plausibly link to several different records in the census, and these records may contain different demographic information, making it difficult to determine the patentee's race. As a concrete example, suppose an individual named "John Smith" obtained a patent in New York City, NY, in 1900. Further suppose that there are three individuals in the census named "John Smith" and living in New York City in 1900, with one of those individuals being Black and the other two White. There are numerous ways to record the race of this patentee. One approach is to assign a weighted average, so that 1/3 of the patent is credited to a Black inventor and 2/3 to a White inventor. This approach assumes that, conditional on having the same name and location, a patent is equally likely to belong to either race. A second approach creates an upper bound on Black inventors by crediting 100 percent of the patent to Black inventor, while a third approach creates a lower bound by crediting 0 percent to a Black inventor.[8] Aggregate counts for weighted averages, upper bounds, and lower bounds of patents by race are calculated by summing up the respective value over all patents. In this article, we present results using weighted average by race; in the Appendix we verify that all patterns and broad conclusions are similar when using either the upper or lower bounds.[9]

The census used numerous different names for individuals of African or Caribbean descent, with terms varying both between censuses and for individuals with different appearance within the same census (Sharon M. Lee 1993; C. Matthew Snipp 2003). We follow Sarada et al. (2019) in sidestepping these often-arbitrary racial distinctions and classify

[7] Akcigit et al. (2017) use a similar approach to match patentees to decennial census records, although as of this writing their data is not publicly available. Their data is based on digitized patent records, while Sarada et al. (2019) is built using Annual Reports of the Commissioner of Patents, which include names and residences of inventors for all patents issued in each year but do not contain the text of each patent.

[8] Sarada et al. (2019) also present results using only patent records that match to exactly one individual in the census and using only casing when the name and location in the patent are identical to those in the census, called exact matches. Demographic patterns of patenting are nearly identical when using weighted averages, unique matches, or exact matches.

[9] About 77 percent of inventors in our sample match to only one individual in the US census. However, conditional on at least one matched individual in the census being Black, only about 27 percent of patents match to exactly one individual in the census. We prefer to use weighted averages for our results because that measure takes into account the fact that there is more uncertainty about an inventors' demographics when they match to multiple individuals in the census, and we can be less confident about the inventors' race when the candidate matches in the census are split almost evenly between White and Black Americans. We find it encouraging that our main conclusions do not depend on which method we use to match inventors to individuals in the census.

patentees as either “White” or “Non-white”. For expositional clarity, we refer to all non-White inventors as “Black” throughout this article. Individuals from non-White and non-Black ethnic groups, such as those of Asian, Latin American, or American Indian descent, likely accounted for a tiny share of patents prior to the second half of the twentieth century.

Overall, our database accounts for 16.3 percent of patents (34,221 patents overall) issued during the seven years: 1870, 1880, 1900, 1910, 1920, 1930, and 1940.[10] Of these, Black inventors accounted for 927, or about 2.7 percent of matched patents. In order to view these results as presenting an accurate picture of Black patenting rates, it must be the case that, conditional on being listed as an inventor in the patent data, Black patentee names match to the census at the same rate as White patentee names. In other words, matching an inventor’s name to Census records is neither more nor less likely if the inventor is Black. This is untestable, since we don’t know the true distribution of Black and White inventors. Sarada et al. (2019) do show that whether a patent record is linked to the census database is random with respect to features of the inventors’ names, providing suggestive evidence that the matches are credible.[11]

We present statistics for the Black and White inventors separately in Table 1. Black inventors from this period are slightly younger than White inventors and more likely to be native-born and female. The mean age for Black inventors is 37.5 versus 41.6 for White inventors. 14 percent of Black inventors are women compared to only five percent of White inventors. Hence, the rate of female patenting among Black inventors during the Golden Age of Innovation is comparable to the overall patenting rate for females today (Alex Bell, Raj Chetty, Xavier Jaravel, Neviana Petkova, and John Van Reenen 2019; Jessica Milli, Emma Williams-Baron, Meika Berlan, Jenny Xia, and Barbara Gault 2016; Andrew A. Toole, Stefano Breschi, Ernest Miguelez, Amanda Myers, Edoardo Ferrucci, Valerio Sterzi, Charles A. W. DeGrazia, Francesco Lissoni, and Gianluca Tarasconi 2019). Black and White inventors are similar in their propensity to migrate across state lines (roughly 60 percent of both), but Black inventors are much less likely to be born outside the United States (15 percent vs 25 percent). To calculate per capita patenting rates over time, we need data on total population, which we obtain by state and census year from IPUMS USA (Ruggles et al 2020). Since the patents were matched to Census data, it is straightforward to match state population levels of each year of database, which encompasses the seven decennial years with available data. We aggregate population totals by state of residence, race, and year and by state of birth, race, and year. Birthplace data in the Census report the state of birth for those born in the United States and the country of birth for immigrants. This allows us to calculate how Black patenting differs between state of residence and state of birth and compare patenting by US-born Black residents to immigrant groups by country source.

[10] We cannot match all patents for two reasons. First, it was not possible to successfully parse inventor name and location from the text of the Annual Reports of the Commissioner of Patent for all patents. Second, it was not possible to find all patent records in the decennial censuses. A sizable literature in economic history focuses on record linkage practices; see Martha Bailey, Connor Cole, Morgan Henderson, and Catherine Massey (2020) for a recent review of common techniques. In contrast to linkage practices in other contexts, patent-to-census matching is particularly fraught because the only information available to match on is name and location; in contrast census-to-census matching can rely on age, birthplace, and parental information to aid in the matching process. The match rates in Sarada et al. (2019) tend to be a bit lower than match rates discussed in Bailey et al. (2020), but the match rates are difficult to conclusively compare given the different contexts, different variables used in the matching process, and different image quality of the original records.

[11] In particular, see Sarada et al. (2019) Appendix Section 2 and Appendix Figures 2-4 and Appendix Figure 6.

Table 1
Summary Demographic Information of Inventors Matched in Census, 1870-1940

	All Patentees	Black Patentees	White Patentees
Mean Age	41.5	37.5	41.6
Share Female	4.9	14.0	4.6
Share Interstate Migrant	59.9	61.4	59.9
Share Born Outside US	25.1	14.9	25.3

Sources: Ziebarth et al. (2019).

Limitations and Comparisons to Other Methods of Identifying Black Inventors

Perhaps the earliest attempt to systematically count the number of patents created by Black inventors is by Baker (1913), who sent surveys to 75 percent of practicing patent agents and attorneys to see if they had Black clients. Cook (2011, 2014) supplements this data collection effort by further consulting numerous other sources searching for mentions of Black inventors; these sources include "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 before 1940; census data; and online company-history searches" (Cook 2014, 228-229).[12] Other attempts to discover the background of inventors relies on small random samples (Sokoloff 1988; Sokoloff and Khan 1990) or highly selected samples of inventors about whom additional background information can be ascertained from other sources (Khan and Sokoloff 1993). While an impressive array of sources and techniques have thus been utilized to determine the background of inventors, including their race, it is unclear how representative these samples are or how many patents by Black inventors are overlooked.

Through the use of large-scale digitized data sources and automated linking methods, we are able to identify a much larger number of Black inventors relative to these earlier approaches. As one comparison to the previous state of the art, Cook (2011, 2014) finds 726 patents by Black inventors over the seventy years from 1870 to 1940, or about 10.4 patents per year; Sarada et al. (2019) find 927 over the seven census years, or about 132 patents per year, more than an order of magnitude increase.

A potential concern with the methodology in Sarada et al. (2019) that we use in this article is that it finds "too many" Black patents, that is, it may erroneously identify an inventor as Black when in fact the inventor was White. Bailey et al. (2020) argue that in many automated linkage contexts, false positive matches can be very common. To be sure, no automated data linkage exercise is likely to correctly classify every individual, but we believe the large number of patents by Black residents identified even when using the lower bounds constructed by Sarada et al. (2019) (counting an inventor as a Black individual only if no White individuals with a similar name resided in the same location and year) suggest that these concerns are minimal. Moreover, even if we misclassify some White inventors as Black inventors, the prior approaches almost surely undercount Black patents by only identifying Black inventors who managed to publicize information about their inventive accomplishments

[12] Cook (2014) also attempts to locate Black inventors in the decennial population censuses by identifying uniquely Black names, but notes that this approach was not very effective due to the fact that White and Black individuals tended to have similar names during this period. See Appendix II of Cook (2014) for more information on the myriad sources she scours to compile here data on Black inventors.

and their race in other sources (e.g., newspaper obituaries, published biographies, directories of notable individuals, archived correspondences, public exhibitions). These prior approaches are more likely to identify the most successful and prestigious inventors, but we believe the methods in Sarada et al. (2019) are much more likely to account for patents by the vast majority of inventors who toil in relative anonymity. Additionally, because we identify inventor race from a single source (the US census), we are less subject to biased time series resulting from changes in the availability and completeness of the myriad sources over time (although the quality of the census records may change over time, as we discuss below). Both the census and patent data are publicly available, making the Sarada et al. (2019) method replicable, and we hope future researchers will continue to improve the linking methodology and validate or refute individual proposed matches.

While we therefore believe that the data from Sarada et al. (2019) paints a more accurate picture of Black patenting than has previously been provided, it is worth exploring in more detail the ways in which this methodology may fail to identify Black inventors. Missing Black inventors can occur for three reasons: if Black inventors are less likely than White inventors to be in the census records, if Black inventors are less likely than White inventors to appear in the patent records, or if the automated linking methods are less likely to find a match for Black inventors than for White inventors. Several scholars raise the possibility that Black people are less likely to appear to in the census records. Mariam L. King and Diana L. Magnuson (1995) argue that Black people were likely more under-enumerated than White people for all census years, although the degree of under-enumeration fell over time, particularly after systematic Census reforms following the 1870 Census (Magnuson and King 1995). A related issue occurs if Black people "pass" as White, listing "White" as their race in the censuses. It is difficult to know how common the phenomenon of passing was, although Ricardo Dahis, Emily Nix, and Nancy Qian (2020) argue it was likely common, nor whether inventors were more or less likely to pass than average or whether individuals who pass in the censuses would be identifiable as Black in other records.[13]

We likewise have no reason to believe that Sarada et al. (2019) systematically fail to parse patents by Black inventors at a higher rate than those of White inventors. A more likely and pernicious source of error is that Black people are systematically less likely to obtain patents for their inventions in the first place. These cases, which Swanson (2022) refers to as "archival silences", would occur if Black people were less likely to file for intellectual property protection for their inventions for fear that their property rights would not be respected (Cook 2014) or if White Americans exploited these fears by filing for patents invented by Black people but listing a White person as the inventor. It is impossible to quantify how often these scenarios occur. Khan (2000) argues that the latter action in particular was likely quite rare, since the penalties for falsely listing oneself as an inventor were severe and included invalidity of the patent, but Swanson (2022) locates some anecdotes in the historical record and argues that they may have been far more common. Given this concern, it is best to think of the metrics presented in this article as documenting the extent to which individuals of different races were able to take advantage of the legal intellectual property system, rather than measuring the extent of invention per se.[14] We also stress that, while these kinds of errors are almost certainly present in our data, they also afflict all other studies that attempt to identify Black inventors.

[13] See Elliot Jaspin (2007) and Allyson Hobbs (2014) for the phenomenon of passing more broadly.

[14] A special case of "archival silence" would occur if Black Americans were more likely than White Americans to produce inventions that are not patentable under US patent law. This would be the case if, for instance, Black innovators were more likely than White innovators to produce agricultural innovations, which were not typically patentable (Clancy and Moschini 2017). Alan L. Olmstead and Paul W. Rhode (2008) emphasize the importance of generally non-patentable biological and agricultural innovations for the development of the American South, but to the best of our knowledge little is known

Finally, we have no reason to believe that, conditional on an individual appearing in both the census and patent data, Black residents are less likely to match than are White residents. As evidence of this, Sarada et al. (2019) compare the distribution of matched and unmatched names by race and find no systematic differences across races in the types of patentee names that match to the censuses.

A final difference between the data in Sarada et al. (2019) and prior studies is that the Sarada et al. data only link patents that are issued during the decennial census years (patents issued in 1870 link to the 1870 census, patents issued in 1880 to the 1880 census, etc.). While this method can be useful in presenting long-run changes in patterns of patenting, it is silent on short-term fluctuations in patenting. Other work such as Cook (2011, 2014), on the other hand, attempts to construct counts of Black patents for all years, not just the census years, and is interested in year-over-year changes in Black patenting. It would be inappropriate to use this data for such an analysis. A further implication of this methodological difference is that when we estimate total counts of Black patents in the article's penultimate section below, we must make assumptions about patenting rates in the intra-census years; we discuss the assumptions we make in more detail below.

Rates of Invention by Decade and Region of Residence or Birth

Broad Regional Patterns

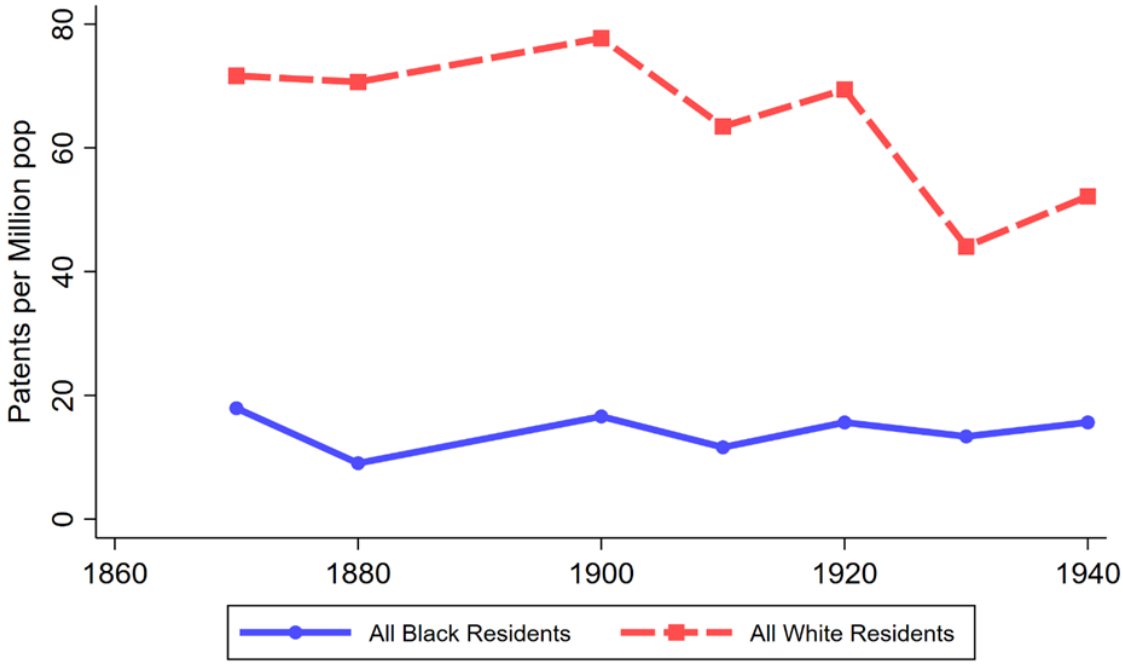
We start by showing the broad pattern in patenting by race from 1870 to 1940. We define patenting rates for individuals belonging to group *g* by:

$$Patenting\ Rate_g = \frac{\#\ Patents\ Known\ to\ Belong\ to\ Group_g}{Population_g},$$

where *g* could be a racial group, a particular geographic area, or a racial group within a geographic area. For Black inventors, this definition means that the Black patenting rate is given by the number of Black patentees identified in the US census divided by the Black population. Above, we noted that we matched only about 16 percent of patentees to the census; assuming some of the unmatched patentees were Black inventors, this means that our reported Black patenting rates must be too low (and likewise for the patenting rate for White inventors). We report patenting rates this way so that our patenting rates may be comparable to, e.g., Cook (2014), which calculates the Black patenting rate by dividing the number of patents with identified Black inventors to the total Black population; the fact that our reported Black patenting rates are about two orders of magnitude larger than those in Cook (2014) reflects the fact that we identify a much larger number of Black patentees through the process of matching to the US census. In a separate section below, we provide estimates of Black patenting rates when correcting for the fact that the majority of patents fail to match to the US census.

White American were 4.3 times more likely to patent than Black Americans during the period (Figure 1). That rate fluctuated somewhat, shrinking after 1920 while White patenting (and overall levels of US patenting) fell while patenting by Black residents remained roughly constant (Zvi Griliches 1990), but even in the last few decades White Americans patented at substantially higher rates than Black Americans.

about the relative propensities of Black and White Americans to create agricultural innovations relative to other types of patentable inventions.



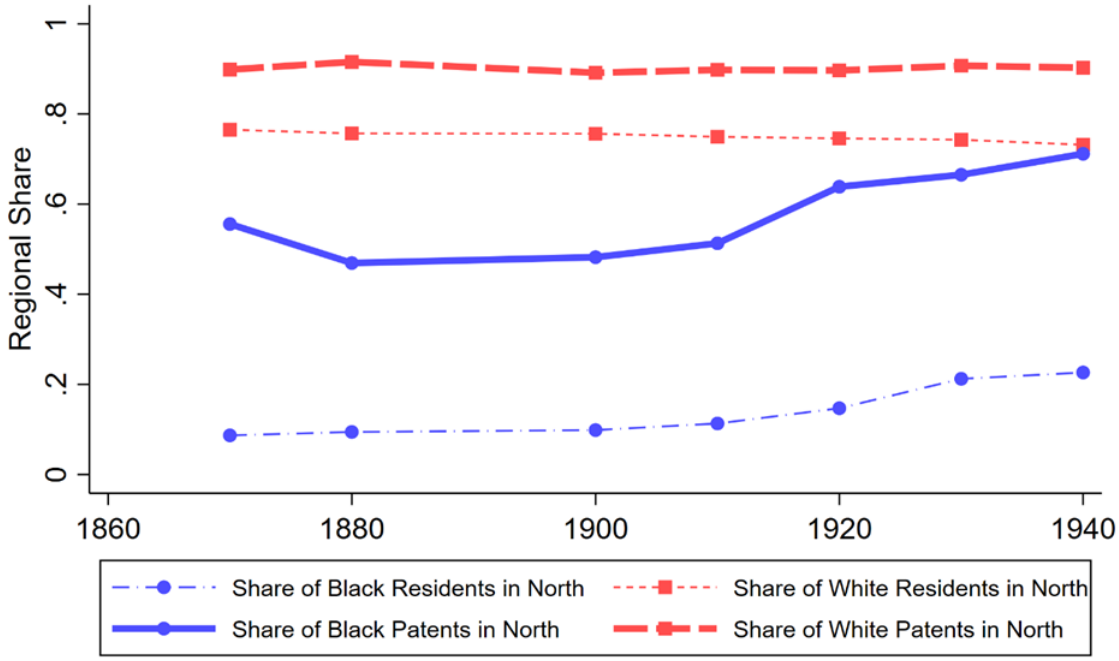
Source data: Ziebarth, Nicolas, X, Sarada, and Andrews, Michael. American Inventors, 1870-1940. Ann Arbor, MI: Inter-university Consortium for Political and Social Research [distributor], 2019-06-03. https://doi.org/10.3886/E109970V2

Figure 1
Patents per Million Residents by Race and Decennial Year, 1870-1940

Underlying this pattern are stark differences in the geography of where Black and White Americans were born and resided. The vast majority of Black Americans were born and raised in the US South, where the institutional environment was radically different for most of this period with respect to both race and invention (Figure 2).[15] The share of Black Americans living in the South went from 90 percent in 1870 to 77 percent in 1940. Meanwhile, only one-quarter (26 percent) of White Americans lived in the South throughout the period. Despite the lopsided share of Black Americans living in the South, the majority of patents by Black inventors were issued to those who lived in the North (58 percent is the average for the entire period), with the northern patenting share reaching 71 percent by 1940. Most patents issued to White Americans also came from Northern residents (90 percent), reflecting regional differences in education and industrial concentrations.

These regional patterns raise a simple question: At what rate did Northern Black residents patent, and how does that compare to White Americans? The question is more profound when re-stated to reflect the differing institutional environments: how did varying economic, demographic, or social conditions affect invention?

[15] We use the US Census Bureau's South Region for our definition of "the South": Delaware, the District of Columbia, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, West Virginia, Alabama, Kentucky, Mississippi, Tennessee, Arkansas, Louisiana, Oklahoma, and Texas. For expositional simplicity, we label any non-Southern state as part of "the North". Below, we present regression results using alternative definitions of geographic areas, including examining former slave states, states in the former Confederacy, and splitting up the North into different Census regions.

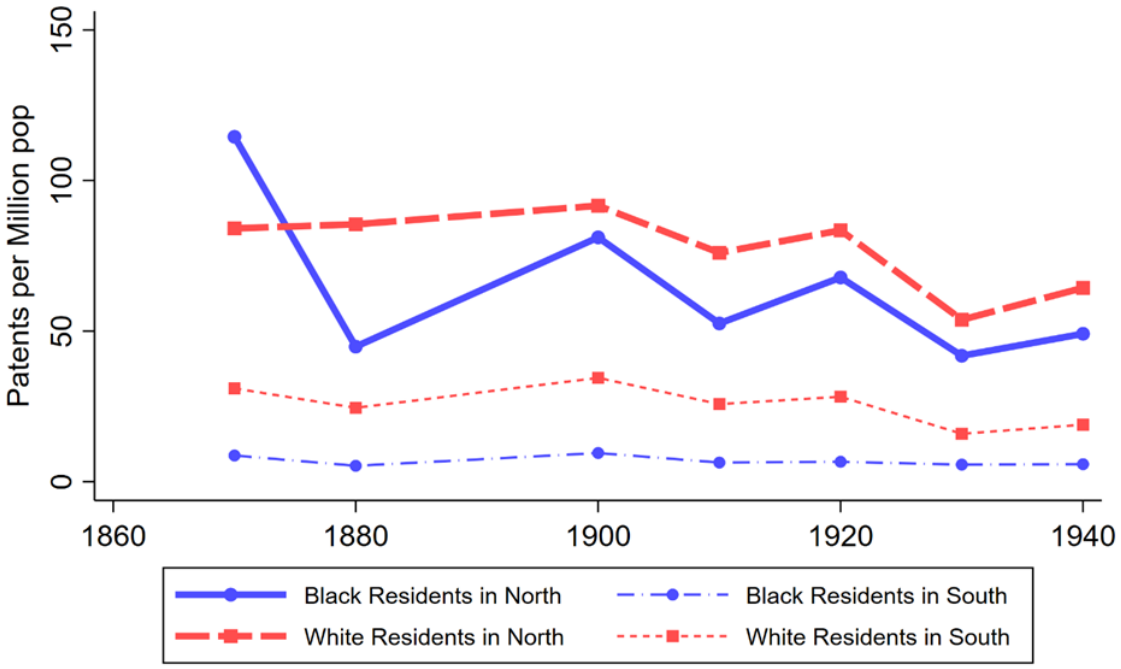


Source data: Ziebarth, Nicolas, X, Sarada, and Andrews, Michael. American Inventors, 1870-1940. Ann Arbor, MI: Inter-university Consortium for Political and Social Research [distributor], 2019-06-03. https://doi.org/10.3886/E109970V2

Figure 2
Northern Share of Residents and Patents by Race by Year, 1870-1940

The data suggest quite a dramatic difference, as shown in Figure 3.[16] Across the period, Black people living in Northern US states were 8.3 times more likely to patent than Black people living in Southern states. The regional gap for White inventors is also large (northern White people were 3.1 times more likely to patent than their Southern counterparts), but the difference is much larger for Black invention. A simple interpretation of these facts is that poor institutional, social, and economic resources that affected both races (e.g., lack of education, research and development funding, and industry) reduced invention in the South by a factor of three, whereas anti-Black policies and culture in the Jim Crow South (occupational discrimination, curtailment of civil rights, heightened levels of racial violence, etc.) had an additional adverse effect on invention—albeit only for the Black population. Black people in the North were almost as likely to obtain a patent as Northern White people and far more likely to patent than Southern White people.

[16] 1870 stands out as a clear outlier in Figure 3 in which northern Black residents patented at a higher rate than northern White residents. One possibility is that this reflects a severe undercount of Black Americans in the 1870 census, leading to an artificially low denominator when calculating Black patenting rates. This is plausible, since systematic efforts to improve the completeness and reliability of the census began in 1880 (Magnuson and King 1995), making the 1870 census the least reliable in our sample. Most concerns regarding the 1870 census, however, relate to an undercount of Black residents in the South (Judith Giesberg 2021), and J. David Hacker (2016) concludes that the 1870 census severely undercounted native-born White Americans as well. A second possibility is that the northern Black patenting rate declined in later decades as increasing numbers of southern Blacks with a low propensity to patent migrated to the North.



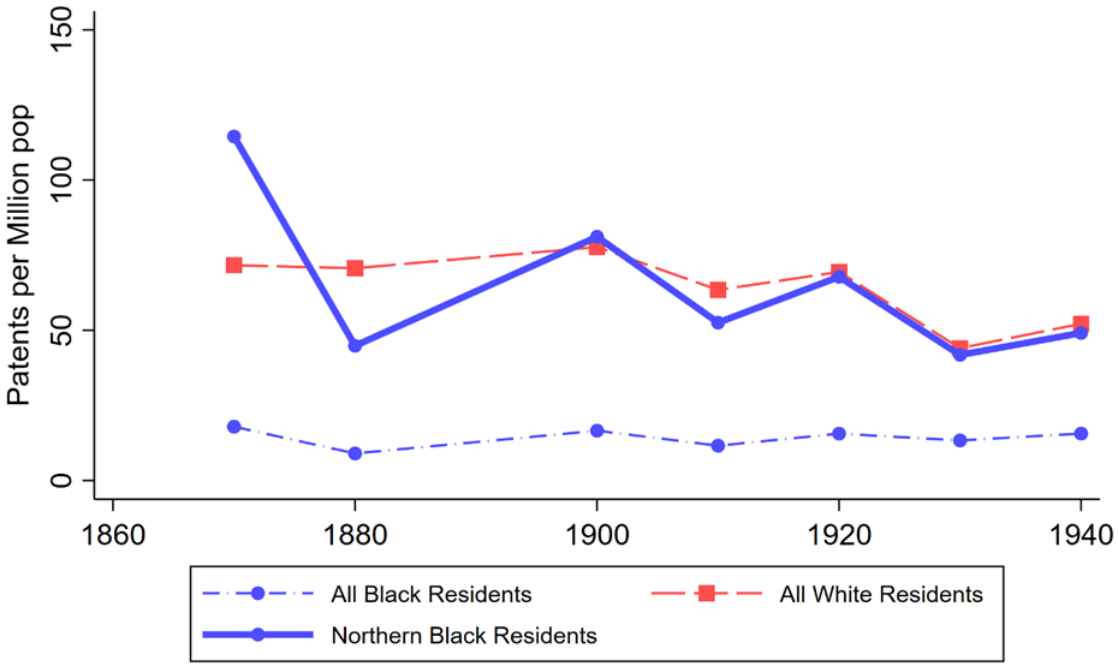
Source data: Ziebarth, Nicolas, X, Sarada, and Andrews, Michael. American Inventors, 1870-1940. Ann Arbor, MI: Inter-university Consortium for Political and Social Research [distributor], 2019-06-03. https://doi.org/10.3886/E109970V2

Figure 3
Patents per million residents by region by race, 1870-1940

Examining Figures 1-3 together puts Black invention into context with other broad historical trends. As noted above, the nationwide Black and White patenting rates slowly began to converge starting around 1910 (shown in Figure 1 and noted in Sarada et al. 2019).[17] Figure 3 shows some narrowing between White and Black patenting rates within regions, but this narrowing is small relative to the convergence in nationwide White and Black patenting rates. Figure 2 provides an explanation for the majority of this convergence: starting around 1910 and taking off especially after World War One, the share of the Black population living in the high-patenting North increased during the Great Migration (William J. Collins 1997, Isabel Wilkerson 2010). The changing geographic composition of the Black population is reflected in the declining nationwide racial gap in patenting rates.

To further put the patenting of Northern Black people in the decades after the end of slavery into perspective, consider that patenting in Northern Black communities was virtually identical to White Americans nationally (Figure 4). The United States during this era was arguably the most inventive place on earth, and this was arguably the most inventive era in world history. This puts northern Black people in the global vanguard of invention in the late nineteenth and early twentieth Century.

[17] Figure 1 makes clear that this convergence is driven by a decline in White patenting rates rather than an increase in Black patenting rates. This is a period, however, in which the overall number of issued patenting in the US was stable or declining in spite of a rapidly growing population (Griliches 1990), and hence nationwide patenting rates were undergoing a secular decline. The fact that Black patenting rates were remaining roughly stable highlights the inventive accomplishments of Black Americans during this time period.



Source data: Ziebarth, Nicolas, X, Sarada, and Andrews, Michael. American Inventors, 1870-1940. Ann Arbor, MI: Inter-university Consortium for Political and Social Research [distributor], 2019-06-03. https://doi.org/10.3886/E109970V2

Figure 4
Patents per Million Residents for Black People Living in North and White People Living in All Regions, 1870-1940

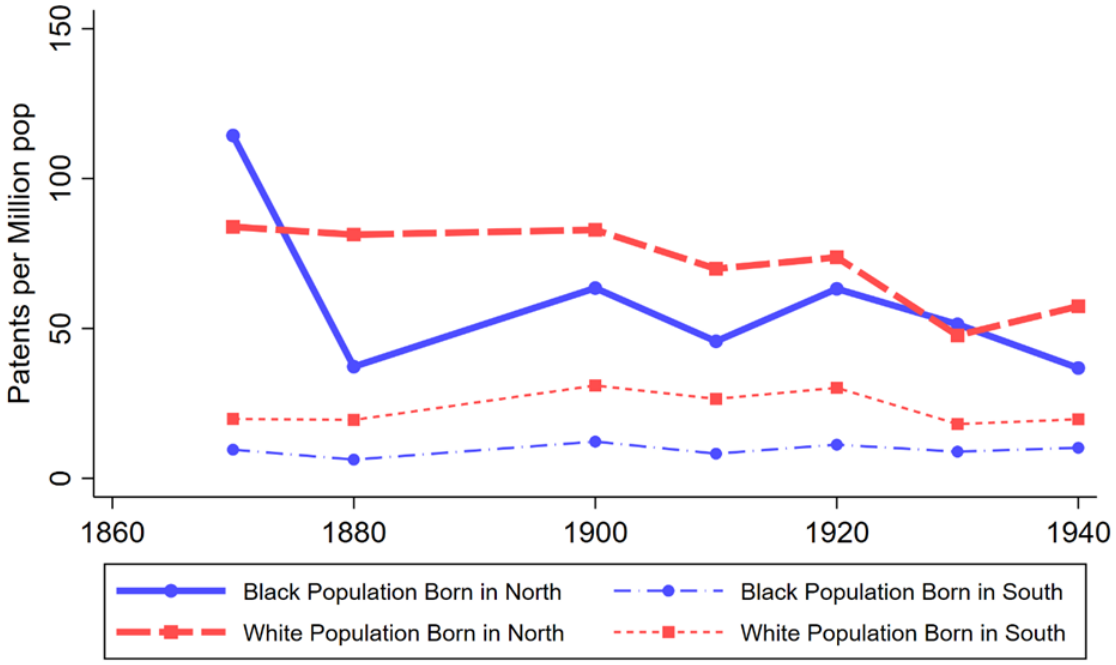
Patenting Rates by Region of Birth

We also consider what these patenting rates look like by place of birth. The latter distinction is important in analyzing the causes of different patenting rates by region. A state could be better at providing Black people learning opportunities while they are young, practice opportunities later in life, or both. A state that provides only practice opportunities may provide no advantages to people born there but may be a welcoming destination to highly-skilled migrants raised elsewhere. The historical censuses record each individual's state of birth (although not county or town of birth), so we can plot patenting rates by race for individuals who were born in northern vs. southern states.

The patenting rates by region of birth are largely consistent with patenting by region of residence. For both races, patenting rates are slightly higher by region of residence, consistent there being both learning and practice opportunity effects in northern states (Figure 5). Whether using state of birth or residence, the broad regional distinctions are still evident, and the data are clear that northern Black patenting rates were high by either definition.

Figure 6 further plots patenting rates by region of birth and residence. We thus have four groups: those born in the north and residing in the north, those born in the north and residing in the south, those born in the south and residing in the south, and those born in the south and residing in the north. Panel A plots patenting rates for these four groups for Black inventors, and Panel B for White inventors. For Black Americans, in most decades those who are born

in the South but live in the North have the highest patenting rates, consistent with positively selected migration to the North as well as the North providing more practice opportunities.[18]

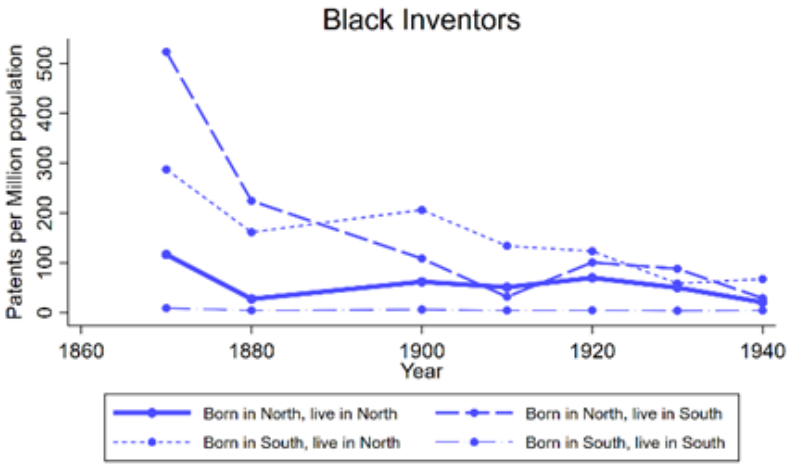


Source data: Ziebarth, Nicolas, X, Sarada, and Andrews, Michael. American Inventors, 1870-1940. Ann Arbor, MI: Inter-university Consortium for Political and Social Research [distributor], 2019-06-03. https://doi.org/10.3886/E109970V2

Figure 5
Patents per Million Population by Region of Birth by Race, 1870-1940

In 1870, 1880, 1900, 1930, and 1940, the highest or second highest patenting rates surprising belong to those born in the North but residing in the South; this is consistent with positively selected migrants, but we also caution that there are relatively few of these individuals and hence these patenting rates are driven in part by a small denominator. In 1910 and 1920, the second highest patenting rates belong to those born in the North and residing in the North, consistent with learning and practice opportunities in the North. From 1900 to 1920, the patenting rates for Black people who managed to move from the South to the North are substantially higher than those for all other groups, whereas the patenting rates for the other three groups are quite similar. In all years, the lowest patenting rates are for those born and residing in the South. The patterns are quite different for White Americans. For White inventors, the highest patenting rates in all years belong to migrants, either those born in the South and living in the North or born in the North and living in the South; moreover, those rates are typically much higher than the rates for those born and residing in the same region. The patenting rates for those born and residing in the South are again the lowest in all years.

[18] Collins and Marianne H. Wanamaker (2014) find evidence of positive selection in population flows of Black Americans from the South to the North during the Great Migration. A full exploration of the relative importance of selective migration in explaining differences in patenting rates by region is beyond the scope of this article.



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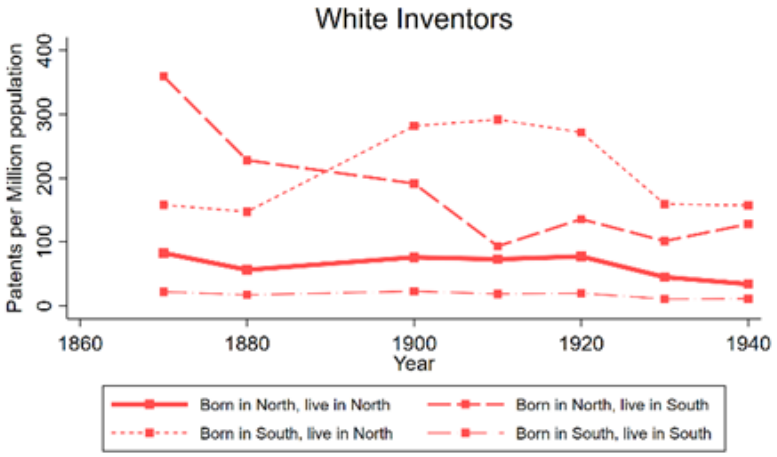

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Figure 6
Patents per Million Population by Region of Birth and Residence by Race, 1870-1940

Patenting Rates by State

We now turn to state-specific estimates of patenting rates by state for Black and White people and consider patents by residence and state of birth. On average, Black patenting rates are lower than White patenting rates in the same state, but there are several notable exceptions (Table 2). In New York, Washington, Maine, Pennsylvania, and Indiana both patenting rates by current residents and patenting rates by those born in the state are higher for Black people. In Wisconsin, Black patenting rates are roughly the same as White patenting rates for residents, but Black patenting is much higher by birth, suggesting Wisconsin provided especially advantageous learning opportunities. In Colorado, Black patenting rates were higher than those for White residents, but were slightly smaller by birth. In Michigan, and Ohio patenting rates were fairly similar between Black and White people, whether by residence or birth.

In Southern states, patenting is almost uniformly lower for White and Black people, but some of the within-race comparisons are instructive. In states with large historical slave

populations, such as Alabama, South Carolina, Georgia, and Mississippi, the patenting rate was several times higher for Black people who were born there than patenting by residence, suggesting these states were especially bad at providing practice opportunities, but many Black people born in these states achieved inventive success elsewhere after migrating.

Table 2
Patents per Million Population by Race and State of Residence and Birth, 1870-1940 (Cumulative)

State	Black Patents per Million Pop by State of		Black Ratio	White Patents per Million Pop by State of		White Ratio
	Residence	Birth		Residence	Birth	
District of Columbia	205.6	155.6	1.3	479.0	277.4	1.7
Massachusetts	177.1	98.1	1.8	222.7	178.9	1.2
Washington	136.5	171.2	0.8	86.5	34.6	2.5
Maine	111.4	201.8	0.6	65.1	138.6	0.5
New York	102.0	100.3	1.0	97.3	96.3	1.0
Connecticut	97.6	101.7	1.0	293.7	227.4	1.3
Colorado	87.3	46.8	1.9	70.4	52.4	1.3
Delaware	76.1	61.3	1.2	170.9	112.8	1.5
California	61.6	11.0	5.6	83.4	52.0	1.6
Pennsylvania	60.3	68.1	0.9	49.2	52.7	0.9
New Jersey	59.5	63.6	0.9	218.8	122.2	1.8
Illinois	57.8	43.2	1.3	53.3	43.6	1.2
Maryland	50.0	47.3	1.1	132.9	114.2	1.2
Michigan	41.3	39.9	1.0	47.9	44.1	1.1
Ohio	36.0	45.5	0.8	45.4	50.8	0.9
Wisconsin	35.6	94.0	0.4	38.5	39.4	1.0
Indiana	32.1	43.1	0.7	26.8	35.0	0.8
Utah	22.6	241.9	0.1	84.8	53.9	1.6
Kansas	20.0	14.7	1.4	12.8	35.5	0.4
Minnesota	15.7	47.1	0.3	29.0	31.2	0.9
Missouri	13.3	13.2	1.0	24.5	29.6	0.8
Iowa	8.9	59.9	0.1	16.2	27.5	0.6
Tennessee	6.4	11.4	0.6	11.9	14.3	0.8
Florida	6.3	8.3	0.8	29.2	23.0	1.3
Louisiana	6.2	6.1	1.0	25.8	23.7	1.1
Oklahoma	6.1	8.1	0.8	17.9	9.4	1.9
Oregon	6.0	0.0		80.6	48.2	1.7
Kentucky	4.7	8.7	0.5	10.4	19.4	0.5
Alabama	2.8	5.5	0.5	10.3	14.0	0.7
Texas	1.9	2.5	0.8	7.5	9.5	0.8
South Carolina	1.6	6.2	0.3	15.3	21.5	0.7
Mississippi	1.4	5.2	0.3	8.8	12.8	0.7
Georgia	1.0	4.6	0.2	7.7	13.4	0.6
Arkansas	1.0	3.8	0.3	6.1	8.1	0.7
North Carolina	0.4	5.4	0.1	7.0	12.6	0.6
Virginia	0.0	20.8	0.0	0.0	30.5	0.0

Table 2 (continued)

State	Black Patents per Million Pop by State of		Black Ratio	White Patents per Million Pop by State of		
	Residence	Birth		Residence	Birth	
Wyoming	0.0	0.0		43.5	50.2	0.9
Rhode Island	0.0	30.6	0.0	0.0	68.0	0.0
Idaho	0.0	0.0		41.0	21.8	1.9
South Dakota	0.0	78.7	0.0	15.2	23.6	0.6
Montana	0.0	145.3	0.0	0.0	36.3	0.0
West Virginia	0.0	11.0	0.0	1.1	13.8	0.1
New Hampshire	0.0	353.9	0.0	78.8	184.3	0.4
Nevada	0.0	0.0		70.5	83.8	0.8
New Mexico	0.0	0.0		19.3	10.0	1.9
Vermont	0.0	170.3	0.0	87.3	143.9	0.6
Nebraska	0.0	11.2	0.0	12.1	25.1	0.5
North Dakota	0.0	0.0		18.8	19.7	1.0
Arizona	0.0	17.1	0.0	32.7	29.3	1.1
Alaska		0.0			1,059.7	
Hawaii		0.0			101.9	

Sources: Ziebarth et al. (2019), Ruggles et al. (2020).

Usually for both races, patenting rates were higher for residents than those born in the state for states in the North, and patenting rates for residents were higher for those born in the state than migrants for states in the South. Comparing the ratio of patenting rates for residents to those born in a state for Black Americans relative to White Americans does not reveal a clear pattern in the North, but in the states of the former Confederacy this ratio is always lower for Black Americans than White Americans. This is consistent with the idea that local conditions in the South were more likely to drive out inventive Black Americans than inventive White Americans.

Statistical Analysis of Patent Rates by Region and Race

The results in Figures 2-6 are highly suggestive that differences in the geography of residence explains a large portion of the racial gap in patenting rates during the Golden Age of Innovation. We next test this idea statistically. More specifically, we estimate regressions of the form

$$PatentingRate_{crt} = \beta_1 Black_r + \beta_2 Geography_c + Year_t + \varepsilon_{crt},$$

where *c* indexes counties, *r* indexes race, and *t* indexes years. $Geography_c$ is an indicator for a geographic region or a set of region fixed effects, depending on the specification. $Year_t$ is a year fixed effect for each census year in our sample. Notice that each observation in these regressions is at the county-by-race-by-year level, so that each county and year consists of two rows, one for Black residents and one for White residents. The coefficient β_1 indicates whether the Black patenting rate is larger or smaller than the White patenting rate, after conditioning on geographic controls and year fixed effects. Because we observe the same county-race pairs in multiple years, we cluster standard errors by county. Observations are weighted by each race's population in each county and year.

We present results from a series of these regressions in Table 3. Column 1 includes no geographic fixed effects. Without controlling for geography, Black residents have 48 fewer patents per million capita than do White residents. In Column 2, we include an indicator variable that equals one if a county is in a state that joined the Confederacy. The inclusion of this single crude control for geography reduces the difference in Black and White patenting rates substantially, from 48 fewer patents per million capita in Column 1 to only 12 fewer patents per million capita in Column 2. Column 3 includes an indicator variable that equals one for any state with slavery at the start of the Civil War, namely all states that joined the Confederacy plus the border states of Missouri, Kentucky, Maryland, and Delaware and the territories of New Mexico and Arizona; results are similar to those in Column 2. Column 4 includes census region fixed effects, with the South as the omitted category, and finds a similarly smaller racial difference in patenting rates, with Black residents having 18 fewer patents per million capita. Column 5 includes state fixed effects and finds that Black residents have 16 fewer patents per million capita. Finally, Column 6 is a standard "two-way fixed effects" model that includes county fixed effects, and finds that Black residents have 20 fewer patents per million capita.

Table 3

Patenting Rates by Race with Various Geographic Controls

	(1)	(2)	(3)	(4)	(5)	(6)
Black	-47.573***	-12.091***	-15.099***	-18.131***	-16.103***	-19.892***
	(10.094)	(4.324)	(5.047)	(5.972)	(5.002)	(5.075)
Confederate State		-60.907***				
		(11.949)				
Slave State			-56.670***			
			(14.576)			
Northeast				92.776***		
				(29.283)		
Midwest				11.853		
				(10.488)		
West				50.102***		
				(12.043)		
Observations	38067	38067	38067	38067	38067	38060
Year FEs	Yes	Yes	Yes	Yes	Yes	Yes
State FEs					Yes	
County FEs						Yes
Adj. r-squared	0.025	0.071	0.074	0.142	0.344	0.684
White Patenting Rate	60.949	60.949	60.949	60.949	60.949	60.949

Source: Ziebarth et al. (2019), Ruggles et al. (2020).

In sum, simply controlling for location can explain between 58 percent and 75 percent of the Black-White gap in patenting rates from 1870-1940. To be sure, this analysis still finds differences in patenting rates between Black and White Americans that is non-negligible relative to the mean patenting rate for White Americans and statistically significant at conventional levels. But after conditioning for the fact that Black and White people tended to live in very different places, the difference is much smaller than a "naïve" comparison that does not account for geography suggests. Moreover, race alone does not explain very much of the variation in patenting rates relative to geography; in Column 1, when there are no controls for geography and hence race is the only explanatory variable, the adjusted r^2 is only 2.5, whereas in Column 6 after including county fixed effects it is 68.4 percent.

Local Conditions and Patenting Rates by Race

Why does controlling for geography remove a large fraction of the difference in Black-White patenting rates? In short, we conjecture that differences in group patenting rates are largely driven by the differing local conditions in places where these groups reside. To shed further light on this, we show that both Black and White patenting rates respond similarly to changes in various local economic, demographic, institutional, and social conditions. This analysis is especially interesting, because there is substantial within-region variation in local conditions and, in many instances, parts of the North and South had quite similar local conditions (Hoyt Bleakley and Paul W. Rhode 2021; Majewski 2016). For this analysis, we repeat the regressions in Column 6 of Table 3 that have county and year fixed effects but we include additional controls for local economic conditions and interact these with race. More specifically, we estimate

$$PatentingRate_{crt} = \beta_1 Black_r + \beta_2 LocalCondition_{ct} + \beta_3 LocalCondition_{ct} * Black_r + County_c + Year_t + \varepsilon_{crt}$$

The coefficient β_2 tells us how much the overall patenting rate within a county is predicted to change when we vary the level of some economic condition. The coefficient β_3 predicts whether that change in patenting rate is larger or smaller for Black inventors relative to White inventors. Summing β_2 and β_3 gives the total predicted change in Black patenting rate following a marginal change in the local condition.

We report results in Table 4, with each column including a different set of local conditions. Data on local conditions at the county level come from the National Historical Geographic Information System (Steven Manson, Jonathan Schroeder, David Van Riper, Tracy Kugler, and Ruggles 2022). The number of observations changes across columns because data on all economic conditions were not recorded in every historical census. Note that this makes comparing coefficients across columns difficult.

In Column 1, we include logged total county population as the local condition. The correlation between population and patenting rates is natural to examine, since theory predicts that agglomeration economies will lead to higher patenting rates when population is larger (Gerald Carlino and William R. Kerr 2015; Antonio Ciccone and Robert E. Hall 1996; Edward L. Glaeser and Joshua D. Gottlieb 2009). As expected, we find that a larger population predicts a higher county patenting rate: a 10 percent larger population is associated with 1.26 more patents per million capita. After controlling for population, the Black patenting rate is statistically significantly larger than the White patenting rate. The interaction term between Black and logged population is negative and statistically significant, raising the possibility that Black residents may not benefit from a larger population as much as White residents, consistent with both explicit discrimination and Black residents being unable to take advantage

Table 4

County Patenting Rates by Race with Controls for Local Economic Conditions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Black	85.334**	77.541*	-5.069	-23.762**	-15.844***	-43.889	-16.054***
	(41.000)	(38.685)	(3.271)	(10.319)	(4.010)	(35.785)	(3.481)
log(Pop.)	12.637***		5.074	12.831**	14.423***	13.130***	12.533***
	(3.736)		(4.396)	(4.803)	(4.462)	(4.804)	(4.130)
Black * log(Pop.)	-9.655**						
	(4.047)						
log(White Pop.)		7.074					
		(5.937)					
log(Black Pop.)		3.382	-0.828	0.910	0.501	0.314	0.299
		(2.507)	(1.219)	(0.904)	(1.089)	(1.031)	(1.025)
Black * log(White Pop.)		-6.343*					
		(3.248)					
Black * log(Black Pop.)		-3.389					
		(3.577)					
log(Frac. Living in Urban Area)			81.508**				
			(33.316)				
Black * log(Frac. Living in Urban Area)			-46.436**				
			(20.506)				
log(Frac. Literate)				-27.493***			
				(8.163)			
Black * log(Frac. Literate)				10.070			
				(19.491)			
log(Value Manufacturing)					-0.780		
					(0.480)		
Black * log(Value Manufacturing)					-0.231		
					(0.267)		
log(Value Agricultural Product)						0.048	
						(2.813)	
Black * log(Value Agricultural Product)						1.758	
						(2.269)	
log(Frac. Foreign Born)							82.832**
							(37.055)
Black * log(Frac. Foreign Born)							-4.543
							(7.978)
Observations	38060	38060	37314	26863	37330	37330	31702
Year and Year FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj. r-squared	0.689	0.689	0.670	0.695	0.667	0.667	0.656
White Patenting Rate	60.949	60.949	54.647	56.795	54.952	54.952	53.768

Source: Ziebarth et al. (2019), Ruggles et al. (2020), Manson et al. (2022).

of White-dominated social networks as would occur under extreme residential segregation (Trevon D. Logan and John M. Parman 2017). We investigate this in more detail in Column 2, including logged White and logged Black population in the regressions. Neither a larger White population nor a larger Black population significantly predicts a higher patenting rate, although both coefficients are positive. The interaction term predicts a higher patenting rate, although both coefficients are positive. The interaction term is negative for both races; it is statistically insignificant for Black but statistically significant at the 10 percent level for White population. In the regressions in Columns 3-7, we continue to control for logged total population and logged Black population, since the population measures are likely to be correlated with the various other local conditions we are interested in.

In Column 3 we include the logged fraction of the county population living in urban areas. This captures the density of the local population, and may also be picking up the provision of local amenities and other public goods that are only provided in cities. The relative size of the urban population likewise strongly predicts a higher overall county patenting rate. After controlling for the fraction living in urban areas, the Black patenting rate is statistically indistinguishable from the White patenting rate and is smaller in magnitude than in all columns in Table 3. The interaction term between Black and logged fraction in urban areas is negative and statistically significant, again suggesting that Black residents are not as able to benefit from urban density or local public goods as are White residents.

In Column 4 we include the logged fraction of the population that is literate. Surprisingly, literacy rates are negatively correlated with patenting. This could be due to the fact that some of the most innovative sectors like manufacturing and mining employed large numbers of illiterate workers. We also caution that literacy rates were high throughout the period we study, and particularly in the twentieth century were close to 100 percent, and so there is relatively little geographic variation in literacy for most of our sample. The interaction term between Black and the logged fraction literate is positive and statistically insignificant.

In Columns 5 and 6 we include measures of local economic output. Column 5 includes manufacturing output, while Column 6 includes agricultural output. The direct effects and interaction terms are statistically insignificant in both cases.

Finally, Column 7 includes the fraction of the population born outside of the United States. Consistent with a great deal of literature on the role of immigrant groups on innovation (Petra Moser and Shmuel San 2020), the coefficient on the logged fraction of the population that is born outside of the US is positive, statistically significant, and large in magnitude. The interaction term between Black and the logged share of foreign born is negative but statistically insignificant and small in magnitude relative to the direct effect of the logged fraction foreign born for the entire population. We therefore do not find any evidence that, when it comes to invention, Black residents and immigrant groups were competing for scarce resources or that Black residents had fewer cross-group interactions with immigrants and hence fewer knowledge spillovers relative to White residents, as suggested by some other studies (Stanley Lieberson 1981; Stewart E. Tolnay 2003).

Overall, for five of the seven specifications, we find no statistically significant differences between Black and White residents in the correlation between patenting rates and local conditions. The only cases when we find negative and statistically significant interaction terms are when we examine total population and urbanization; in both cases, this result is consistent with Black residents being less able to take advantage of productivity advantages in cities than are White residents. We stress that these results are not causal; we are not claiming that changing a particular local condition will cause relative decreases or increases in Black patenting rates, respectively. These correlations do tell us that local conditions are similarly predictive for both Black and White patenting rates. Hence, to understand differences in patenting rates across races, it is probably more useful to ask why different races locate in

places with very different local institutional, economic, demographic, social, and cultural conditions than to ask why particular racial groups cannot take advantage of good conditions.

Comparison between Black and Foreign-Born Inventors

In this section, we compare in more detail the contributions of Black and immigrant inventors. Contemporary literature on innovation and patenting has emphasized the distinct contributions of foreign-born migrants (Kerr 2018; Peri 2016). Yet, comparisons between foreign-born migrants and Black Americans, as to their propensity to invent, are biased by the different institutional arrangements facing those groups. This is especially apparent during the time period being considered here. Foreign-born migrants faced discrimination, in various ways, but nothing like the systemic stifling of educational, social, and professional opportunities that hindered Black Americans from pursuing their optimal line of research or work (Douglas Massey and Nancy A. Denton 1993). These anti-Black restrictions were much more severe in the American South, at least in the beginning of the twentieth Century. As mid-Century approached, local governments in North began adopting more aggressive policies designed to segregate races and classes, as discussed in Rothwell (2019). To partly account for these institutional differences, we compare northern Black patenting rates to those achieved by various groups of immigrants over the period in questions (1870-1940).

Our first finding confirms that patenting rates were relatively high for European immigrants, especially those from England, Scotland, Germany, and Sweden (Table 5). Patenting rates were also high among Canadians. People from these places exhibited measured patenting rates that exceeded 100 per million, compared to 56 among northern Black residents and 74 among northern White residents. In interpretating these differences, one should consider that the denominator is restricted to international migrants, a small subset of people actually living in the countries listed and a group much more likely to contribute to invention than those who do not migrate.

Patenting rates for both northern White and northern Black Americans were roughly comparable to patenting rates for other large European sources of immigration. These include mostly Jewish migrants from Russia and Poland, as well as mostly Catholic migrants from Ireland and Italy. The total number of patents belonging to identified Black Americans exceeds the total number of patents known to belong to immigrants from each origin country except for Germany and England.

Thus, while our results are consistent with the theory that international migrants innovate at relatively high rates, we show that the gap is not so large compared to Northern Black and White Americans, and the dominate source of inventions were done by people born in the United States.

Estimating the Total Number of Patents by Black Inventors, 1870-1940

The strength of our data is that it directly matches patent holders to decennial population census records. One limitation of this approach is that we only match inventors who obtained their patents in the same year that a census was enumerated. An additional limitation, described in the Data and Methods section above, is that Sarada et al. (2019) are only able to successfully link about 16 percent of all patents issued in the census years from the 1870-1940. To get a more complete picture of patenting by Black Americans, we need to account for the years and patents that were impossible to directly match to the historical censuses.

To get an estimate of the total number of patents issued to Black inventors during our period of study, we assume that Black and White patentee names are equally likely to match to the census, and so the share of Black inventors in the matched patents is the same as the share of Black inventors in the universe of patents for the same years. To find the total number of patents by Black inventors, we can then simply multiply the fraction of matched patents that

Table 5
Summary Data from 1870 to 1940 Period of Patenting by Black Americans Compared to European Immigrants and White Americans

	Share of Patents / Share of Pop	Share of Patents (%)	Share of Pop (%)	Patents per Million Pop	Observed Patents
All Black Americans	0.26	2.70	10.56	14.23	927
Northern Black Americans, by residence	1.00	1.62	1.62	55.80	556
Southern Black Americans, by residence	0.12	1.08	8.95	6.72	371
Northern Black Americans, by birth	0.95	0.77	0.81	52.29	263
Southern Black Americans, by birth	0.17	1.68	9.60	9.67	573
Germany	2.44	5.20	2.13	134.82	1,774
England	3.83	3.24	0.85	211.63	1,106
Canada	2.10	2.54	1.21	115.88	867
Russia/USSR	1.55	2.39	1.55	85.61	817
Ireland	1.45	2.20	1.52	80.39	752
Sweden	2.40	1.25	0.52	132.56	425
Scotland	3.61	1.00	0.28	199.53	340
Italy	0.80	0.90	1.12	44.26	306
All White Americans	1.09	97.30	89.04	60.95	33,483
Northern White Americans, by residence	1.32	87.62	66.42	73.58	30,150
Southern White Americans, by residence	0.43	9.67	22.62	23.85	3,329
Northern White Americans, by birth	1.20	64.70	53.78	66.52	22,071
Southern White Americans, by birth	0.42	9.46	22.35	23.41	3,228

Source: Ziebarth et al. (2019), Ruggles et al. (2020).

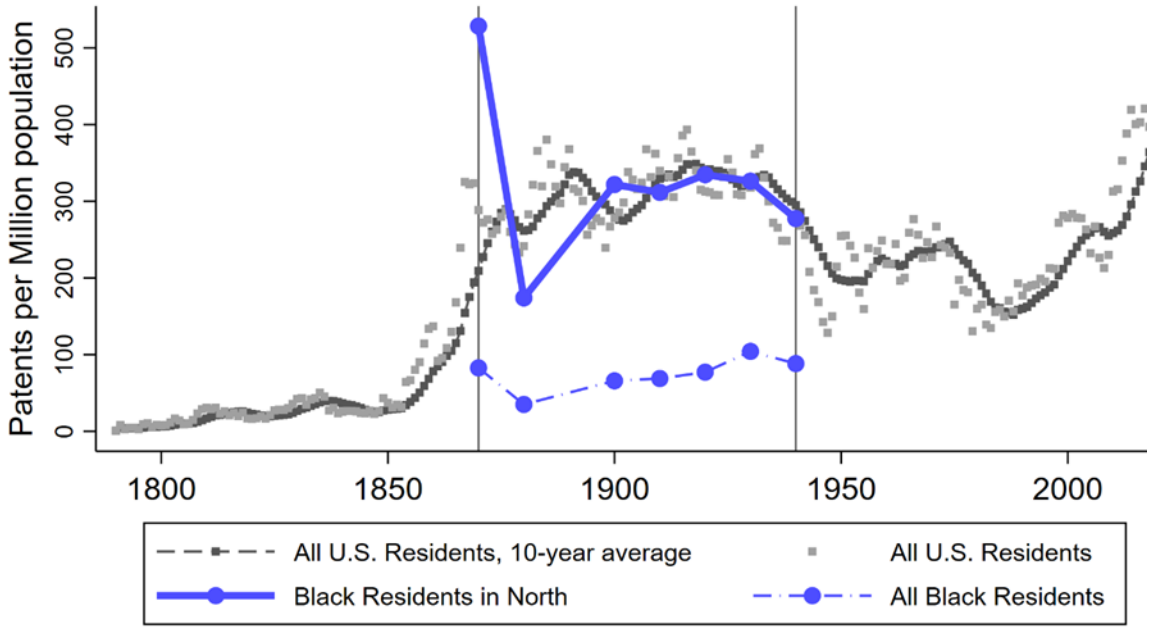
are by Black inventors by the total number of patents issued by the USPTO in the decennial census years.[19] Using this approach, we estimate that 5058 patents were issued to Black inventors during the seven observed census years from 1870-1940.

To interpolate the number of patents by Black inventors in the intra-census years, we likewise assume that the share of patents belonging to Black inventors in each intra-census year is equal to the share in the nearest census year. So, for instance, we obtain the share of Black patents in 1910 and apply that same rate to the total count of patents in for all years from 1906-1909 and 1911-1915. We stress that this method provides a rough "back-of-the-envelope" estimate for the total number of Black patents, as the share of patents belonging to

[19] To ensure that OCR and parsing errors do not lead to an incorrect count of the total number of patents issued by the USPTO each year, we use published USPTO annual patent counts (United States Patent and Trademark Office 2023).

Black inventors is unlikely to be identical from year to year.[20] Using this interpolation, we estimate that a total of 50,772 patents issued to Black inventors over all years from 1870 to 1940. At present, only a few hundred of these more than 50,000 patents have been identified by historians and social scientists (Baker 1917; Cook 2014; Sluby 2004), and much future work is therefore needed to fully flesh out what America's Black innovators were creating and how they contributed to the story of American growth.

We further put the Northern Black patenting rate in perspective by comparing it to the US average for the entire history of the USPTO (Figure 7). Patenting rates from 1870 to 1940 were high compared to other decades, reflecting just how unique the Golden Age of Innovation was by historical standards. Northern Black patenting rates from 1870-1940 in particular were comparable to the national average and hence extraordinarily high relative to US and world history.



Note: Rates are patents per Million population.

Source data for Black rate: Ziebarth, Nicolas, X, Sarada, and Andrews, Michael. American Inventors, 1
Ann Arbor, MI: Inter-university Consortium for Political and Social Research [distributor], 2019-06-03.
https://doi.org/10.3886/E109970V2
Source for U.S. rate: USPTO and MeasuringWorth.Com

Figure 7
Black Patenting during the Golden Age in Historical Perspective

[20] For instance, Cook (2014) argues that Black patenting rates fall in years following racial riots or lynchings. Our data cannot detect these year-over-year fluctuations in patenting rates. Sarada et al. (2019), Appendix Section 4, include an alternative approach to infer patenting by race and gender using inventors' first names, and apply this method to both the census and intra-census year. They find few large year-over-year variations in Black patenting, although as Cook et al. (2014) point out, Black and White names are often quite similar and hence this method is better suited to identifying patenting by gender than patenting by race.

Discussion and Conclusion

For over a century, the contributions of Black Americans to science and invention were assumed to be at best marginal. A common theme in the social science literature and its popular interpretations is that the end of slavery brought, after only a brief respite, the beginning of Jim Crow, and racism was a steady and powerful force holding down the social status of the Black population and preventing Black people from contributing to the history of American growth.

This perspective ignores important distinctions of geography. During the period we study, the vast majority of Black Americans lived in the South. Southern institutions were not conducive to innovation *for individuals of any race* (Majewski 2016). Indeed, we show that patenting rates for both Southern White and Southern Black residents were lower than patenting rates for both Northern White and Northern Black residents. Our data additionally suggest, not surprisingly, that the Jim Crow regime of the South was especially harmful to invention for Black Americans, since the regional differences were even larger for Black Americans than for White Americans. By bringing geography and local institutional opportunities to the forefront, our results also highlight the role that the migration of people, in particular the Great Migration of the Southern Black population to Northern cities, played in narrowing the racial gap in patenting rates from 1900 to 1940 (Collins 1997; Collins and Wanamaker 2014; Wilkerson 2010), and struggles Black residents faced upon arriving to the North may suggest why the racial gap in patenting did not continue to narrow throughout the rest of the twentieth century (Leah Platt Boustan 2017; Ellora Derenoncourt 2022).

Identifying the specific regional institutions that made the North more conducive to innovation than the South is beyond the scope of this article, although numerous authors have attempted to describe the differences in these regional economies. Regarding racial attitudes in the North in particular, Rothwell (2019) argues that a cultural shift occurred among many Northern White people around the time of the Civil War that rejected the racist ideology that Black people were naturally incapable of great achievements and unworthy of educational investments and highly-skilled vocations. This is not to deny that racial discrimination was a problem in the North during this period, but it was not strong enough to prevent thousands of Black inventors from obtaining intellectual property protection for ideas deemed novel and significant enough to warrant approval from the US Patent Office. Other evidence on home ownership, literacy, and cognitive testing conducted during the 1920s finds that northern Black people performed relatively well compared to many European immigrants, consistent with the patenting data (Rothwell 2019).

If we are right that these findings demonstrate the ability of marginalized groups to succeed when given even imperfect access to institutions conducive to innovation, these findings also highlight the opportunities lost, as Jim Crow laws set in in the North, urban residential neighborhoods in Northern cities segregated, and the highly-innovative Northern manufacturing sector went into a period of decline (Eric D. Gould 2021; Brian Purnell, Jeanne Theoharis, and Komozi Woodard 2019; Allison Shertzer, Tate Twinam, and Randall P. Walsh 2022), potentially leading to local conditions far less conducive to innovation for Northern Black people.

We hope future research will do more to uncover the extent to which the North provided special learning opportunities as compared to opportunities to work. Furthermore, we believe more systemic documentation of institutions, laws, and practices by state and how they evolved over this time period would strengthen our historic understanding of the causes and consequences of racial gaps in innovation.

For now, we end by quoting Baker (1913), who shared our research goals over 100 years ago:

> The foregoing facts are here presented as a part only of the record made by the race in the field of invention for the first half century of our national life. We can never know the whole story. But we know enough to feel sure that if others knew the story even as we ourselves know it, it would present us in a somewhat different light to the judgment of our fellow men, and, perhaps, make for us a position of new importance in the industrial activities of our country. This great consummation, devoutly to be wished, may form the story of the next fifty years of our progress along these specific lines, so that someone in the distant future, looking down the rugged pathway of the years, may see this race of ours coming up, step by step, into the fullest possession of our industrial, economic and intellectual emancipation.

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Appendix

In this appendix, we show that the results in Andrews and Rothwell (2023) are robust to using alternative measures of patenting by Black and White inventors. Recall that in Sarada et al. (2019), because individuals' names are often not unique, it is possible for a single patentee to match to multiple potential individuals in the US censuses. Sarada et al. (2019) therefore construct several different measures of inventor demographics. We highlight three of these measures here, for each patent *i*:

$$Mean\ Black\ Patent_i = \frac{\#\ Candidate\ Links\ to\ Black\ Individuals_i}{\#\ Candidate\ Links_i},$$

$$Max\ Black\ Patent_i = \mathbb{1}(At\ Least\ One\ Candidate\ Link\ to\ Black\ Individual_i),$$

and

$$Min\ Black\ Patent_i = 1 - \mathbb{1}(At\ Least\ One\ Candidate\ Link\ to\ White\ Individual_i),$$

where $\mathbb{1}(\cdot)$ is the indicator function. Each of these measures can be summed over all *i* within any arbitrary area, for instance to get the mean, maximum, or minimum number of Black patentees within a county, state, or region. Similar measures can be constructed for White patentees or for any other demographic group.

In the main text, we present all results using mean Black and White patents. In this appendix, we show that we obtain qualitatively similar conclusions when using maximum or minimum counts of Black and White patents instead.

In Appendix Table 1, we show the extent to which our estimates of patenting by Black inventors can vary when using these different matching procedures. The first row presents estimates when using our preferred procedure, using the mean or weighted average number of matches. The second row show estimates when using the maximum number of patents by Black inventors, and the third row shows estimates when using the minimum number. The first column contains the number of patents identified in the seven decennial censuses (1870 to 1940, excluding 1890), and hence presents the number of patents by Black inventors that we can actually locate in our data. Following the discussion in the main article, the second column multiples the total number of patents issued in the US in each of the seven decennial census years by the share of identified patents belonging to Black inventors using each matching procedure. Finally, the third column interpolates the total number of patents belonging to Black inventors to the between-census years. The total number of patents belonging to Black inventors over the period 1870 to 1940 can vary by more than a factor of three, from a low of 30,854 to a high of 109,716. Even the most conservative of these estimates, however, delivers a number of patents belonging to Black inventors far larger than previously recognized.

Table A1: The estimated number of patents by Black inventors using different procedures to match patents to the census.

	Identified in Decennial Census Years	Estimated in Decennial Census Years	Estimated Over All Years 1870-1940
Weighted Average (Preferred Matching Procedure)	927.4	5,057.8	50,771.9
Maximum	1,993.0	10,864.3	109,715.5
Minimum	565.0	3,088.8	30,854.3

Maximum Black and White Patenting Rates

When using upper bounds on both Black and White patents, we find that Black patenting rates in the North are actually higher than both the nationwide White patenting rate and the White patenting rate in the North. Patenting rates for White Southern residents are again higher than patenting rates for Black people in the South. Results are similar when using region of birth rather than region of residence.

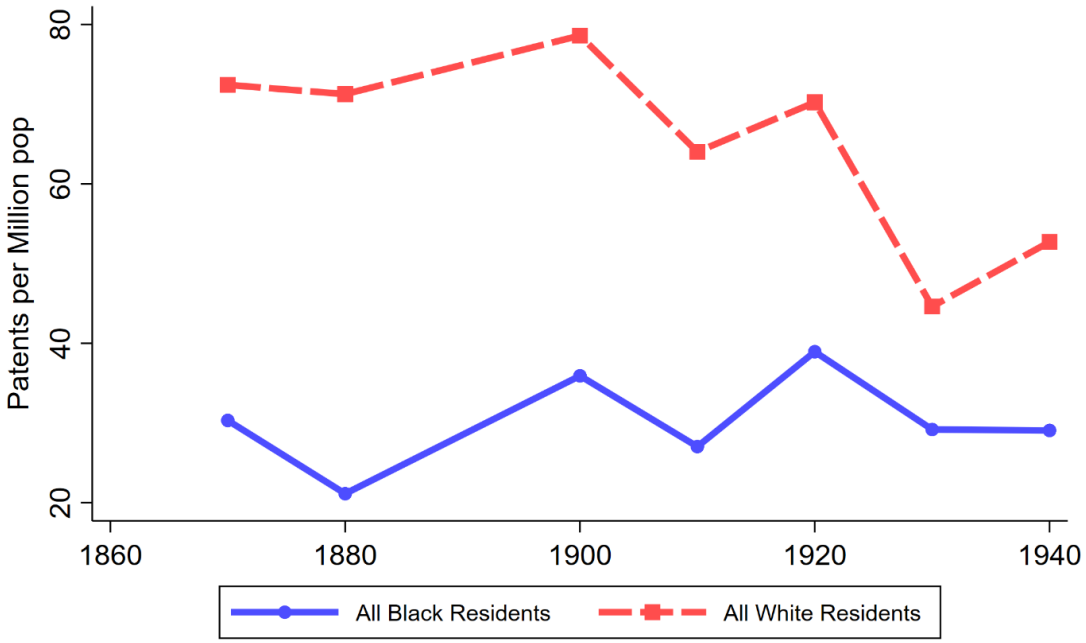
It is not surprising that the results for the North reveal larger increases in the maximum Black patenting rate relatively to the White rate for the South. The North was much more urbanized and had a larger population, meaning there are more likely to be instances in which the same name appears multiple times in the same state in the census.

One caveat with the upper-bound rates presented in this section is that patents are double-counted. That is, we are attributing every patent that could have plausibly been patented to a Black inventor to Black people and every patent that could have plausibly been patented to a White inventor to White people, which entails counting the same patent to each race with a weight of 1. Results would be even more stark if we compared the maximum Black patenting rate to the minimum White patenting rate. Note that this double-counting issue is also an issue with the minimum patenting rates presented below.

When accounting for the fact that we fail to match many patents to the census and extrapolating nationwide Black patenting rates, as we do in the main article, but using the upper bound on Black patents rather than the mean, we find that Northern Black residents plausibly patented at rates far higher than the rest of the United States, making the Northern Black population clearly one of the most innovative groups in history.

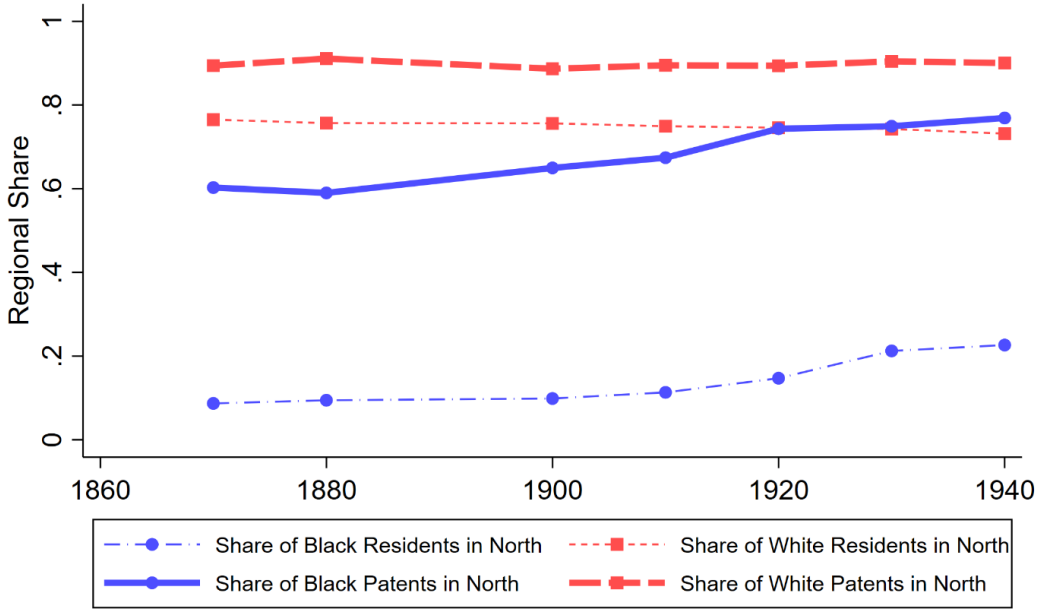
Table A2: Patenting rates by race with various geographic controls, using maximum patenting rates

	(1)	(2)	(3)	(4)	(5)	(6)
Black	-33.831***	1.009	-3.629	-5.567	-2.723	-2.836
	(10.643)	(5.864)	(5.973)	(6.055)	(5.690)	(5.010)
Confederate State		-58.961***				
		(12.493)				
Slave State			-52.100***			
			(15.266)			
Northeast				81.177**		
				(35.334)		
Midwest				16.588		
				(10.422)		
West				54.729***		
				(12.001)		
Observations	37245	37245	37245	37245	37245	37238
Year FEs	Yes	Yes	Yes	Yes	Yes	Yes
State FEs					Yes	
County FEs						Yes
Adj. r-squared	0.016	0.061	0.059	0.102	0.356	0.643
White Patenting Rate	55.277	55.277	55.277	55.277	55.277	55.277



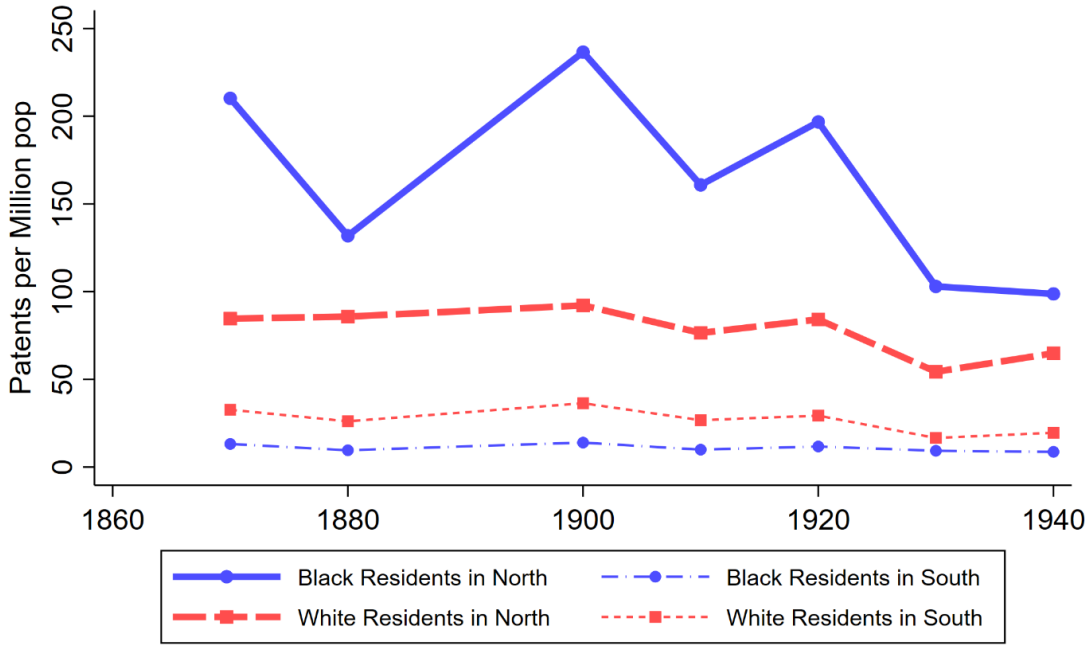
Source data: Ziebarth, Nicolas, X, Sarada, and Andrews, Michael. American Inventors, 1870-1940. Ann Arbor, MI: Inter-university Consortium for Political and Social Research [distributor], 2019-06-03. https://doi.org/10.3886/E109970V2

Figure A1. Patents per million residents by race and decennial year, 1870-1940 using maximum patenting rates



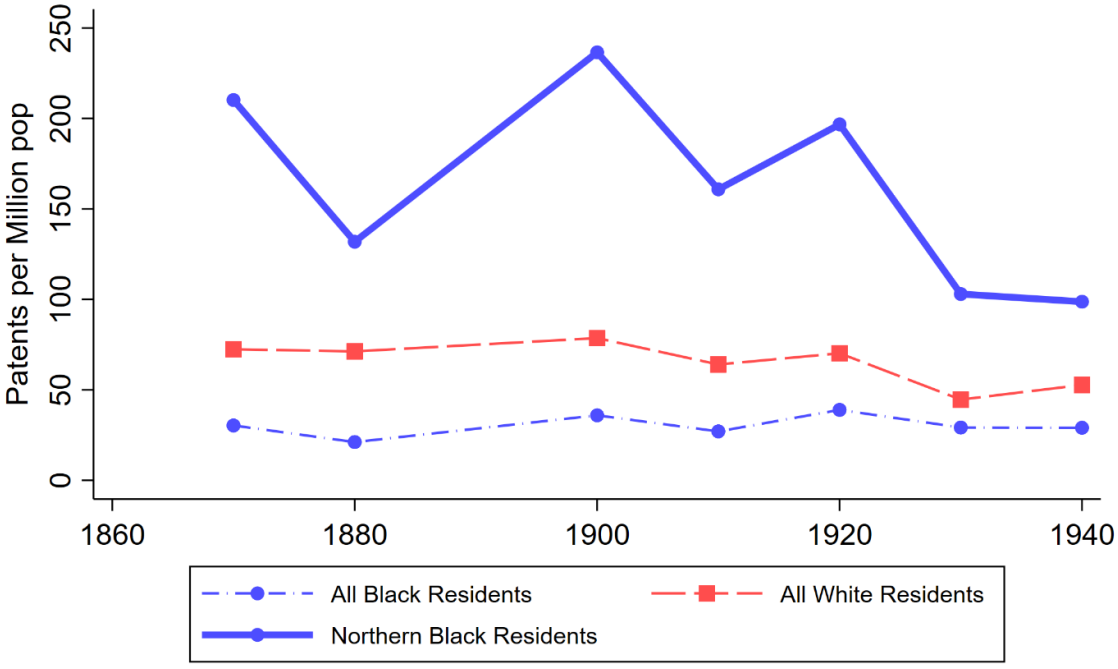
Source data: Ziebarth, Nicolas, X, Sarada, and Andrews, Michael. American Inventors, 1870-1940. Ann Arbor, MI: Inter-university Consortium for Political and Social Research [distributor], 2019-06-03. https://doi.org/10.3886/E109970V2

Figure A2. Northern share of residents and patents by race by year, 1870-1940 using maximum patenting rates



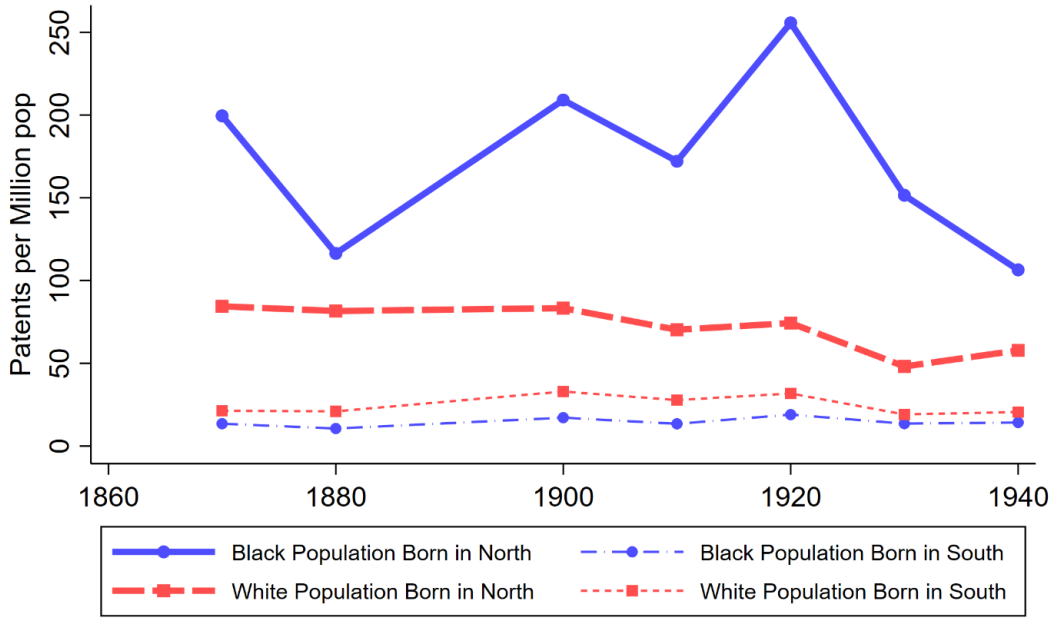
Source data: Ziebarth, Nicolas, X, Sarada, and Andrews, Michael. American Inventors, 1870-1940. Ann Arbor, MI: Inter-university Consortium for Political and Social Research [distributor], 2019-06-03. https://doi.org/10.3886/E109970V2

Figure A3. Patents per million residents by region by race, 1870-1940 using maximum patenting rates



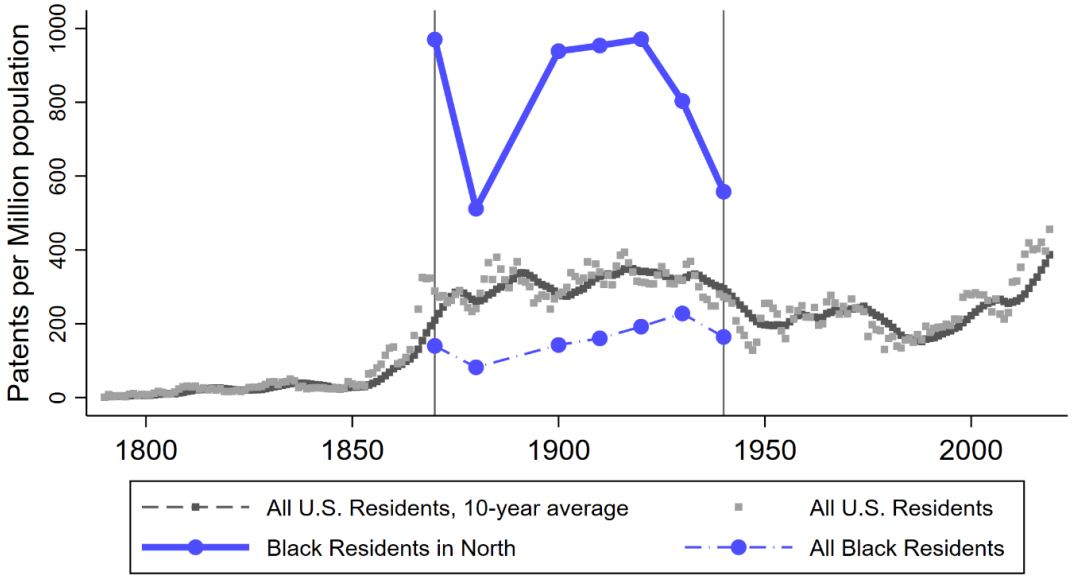
Source data: Ziebarth, Nicolas, X, Sarada, and Andrews, Michael. American Inventors, 1870-1940. Ann Arbor, MI: Inter-university Consortium for Political and Social Research [distributor], 2019-06-03. https://doi.org/10.3886/E109970V2

Figure A4. Patents per million residents for Black people living in North and White people living in all regions, 1870-1940 using maximum patenting rates



Source data: Ziebarth, Nicolas, X, Sarada, and Andrews, Michael. American Inventors, 1870-1940. Ann Arbor, MI: Inter-university Consortium for Political and Social Research [distributor], 2019-06-03. https://doi.org/10.3886/E109970V2

Figure A5. Patents per million population by region of birth by race, 1870-1940 using maximum patenting rates



Note: Rates are patents per Million population.

Source data for Black rate: Ziebarth, Nicolas, X, Sarada, and Andrews, Michael. American Inventors, 1870- Ann Arbor, MI: Inter-university Consortium for Political and Social Research [distributor], 2019-06-03. https://doi.org/10.3886/E109970V2
Source for U.S. rate: USPTO and MeasuringWorth.Com

Figure A6. Black Patenting during the Golden Age in Historical Perspective, using maximum patenting rates

Minimum Black and White Patenting Rates

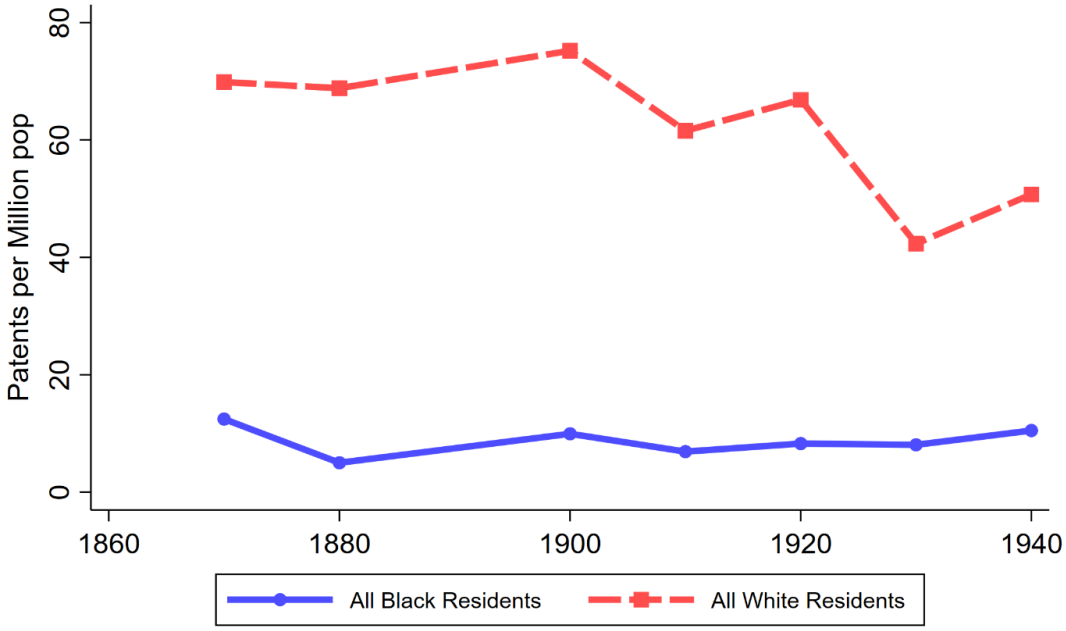
When using minimum patenting rates, Northern Black residents appear to patent much more similar to the population in the South, but even here the order between demographic and regional groups is the same: Northern White residents have a higher patenting rate than Northern Black residents, who have a higher patenting rate than Southern White residents, who have a higher patenting rate than Southern Black residents. For many years, especially after 1920, the Northern Black population still patented at rates closer to the nationwide White population than to the nationwide Black population.

Thus, even when using the most pessimistic patenting rates for Black people, our main conclusions remain: the distribution of the Black and White populations across geographies with very different institutional, economic, and social environments skews our understanding of invention across racial groups, with Northern Black residents substantially outperforming even Southern White residents.

Our results are less consistent when examining region of birth. Here, the Southern White population actually have a higher patenting rate than the Northern Black population in 1910, 1920, and 1940, although the differences are quite small. Likewise, when calculating the total number of Black patents when accounting for the fact that we fail to match many patents to the census, but using the lower bound on Black patents, we find that Northern Black residents patented below the nationwide patenting rate.

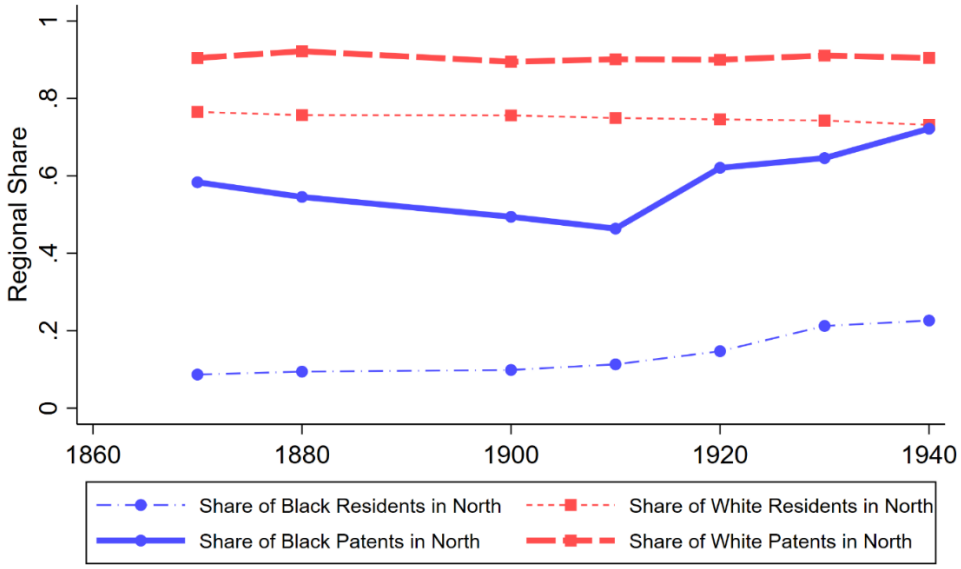
Table A3: Patenting rates by race with various geographic controls, using minimum patenting rates

	(1)	(2)	(3)	(4)	(5)	(6)
Black	-47.286***	-17.649***	-20.269***	-21.641***	-20.636***	-22.007***
	(10.419)	(4.584)	(5.141)	(6.025)	(5.271)	(5.091)
Confederate State		-50.156***				
		(11.620)				
Slave State			-46.605***			
			(14.346)			
Northeast				75.919**		
				(34.454)		
Midwest				12.722		
				(8.780)		
West				51.212***		
				(10.821)		
Observations	37245	37245	37245	37245	37245	37238
Year FEs	Yes	Yes	Yes	Yes	Yes	Yes
State FEs					Yes	
County FEs						Yes
Adj. r-squared	0.030	0.070	0.073	0.126	0.396	0.641
White Patenting Rate	53.383	53.383	53.383	53.383	53.383	53.383



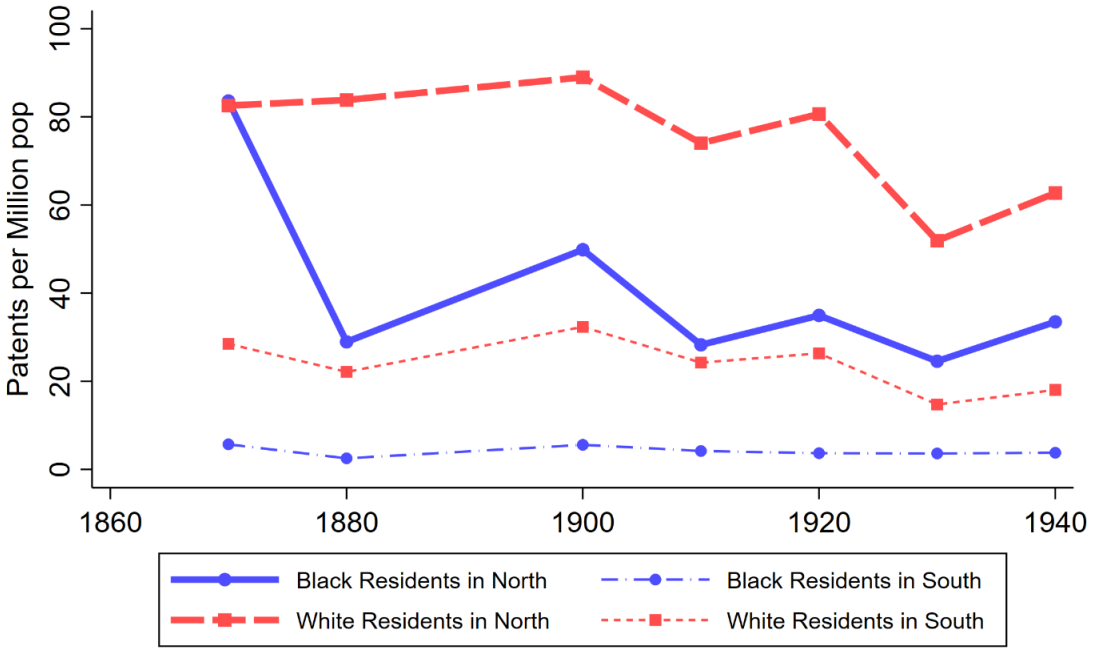
Source data: Ziebarth, Nicolas, X, Sarada, and Andrews, Michael. American Inventors, 1870-1940. Ann Arbor, MI: Inter-university Consortium for Political and Social Research [distributor], 2019-06-03. https://doi.org/10.3886/E109970V2

Figure A7. Patents per million residents by race and decennial year, 1870-1940 using minimum patenting rates



Source data: Ziebarth, Nicolas, X, Sarada, and Andrews, Michael. American Inventors, 1870-1940. Ann Arbor, MI: Inter-university Consortium for Political and Social Research [distributor], 2019-06-03. https://doi.org/10.3886/E109970V2

Figure A8. Northern share of residents and patents by race by year, 1870-1940 using minimum patenting rates

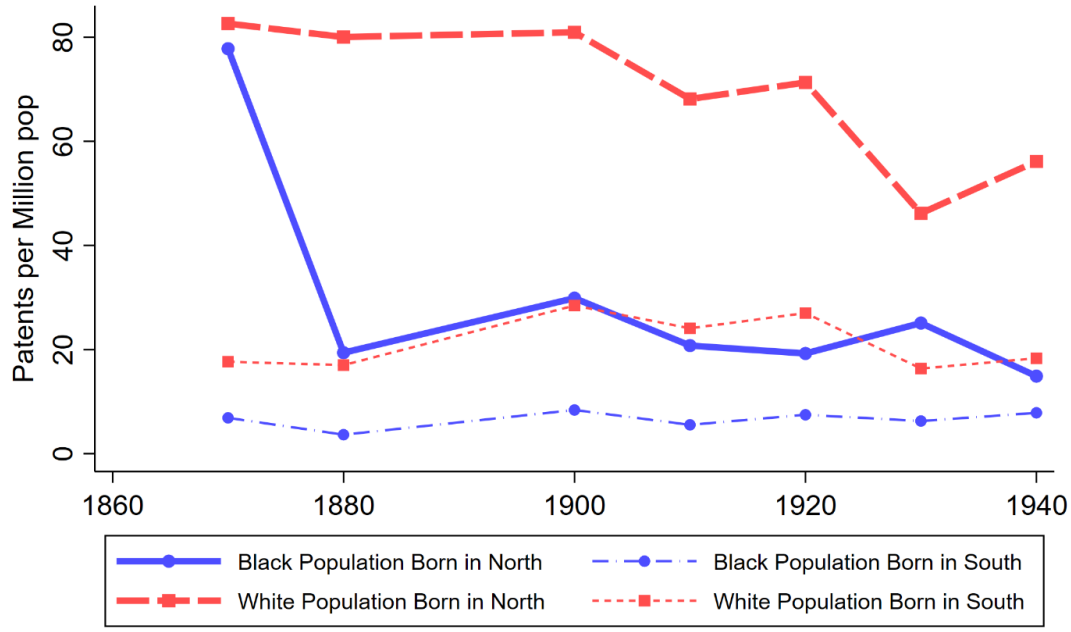


Source data: Ziebarth, Nicolas, X, Sarada, and Andrews, Michael. American Inventors, 1870-1940. Ann Arbor, MI: Inter-university Consortium for Political and Social Research [distributor], 2019-06-03. https://doi.org/10.3886/E109970V2

Figure A9. Patents per million residents by region by race, 1870-1940 using minimum patenting rates

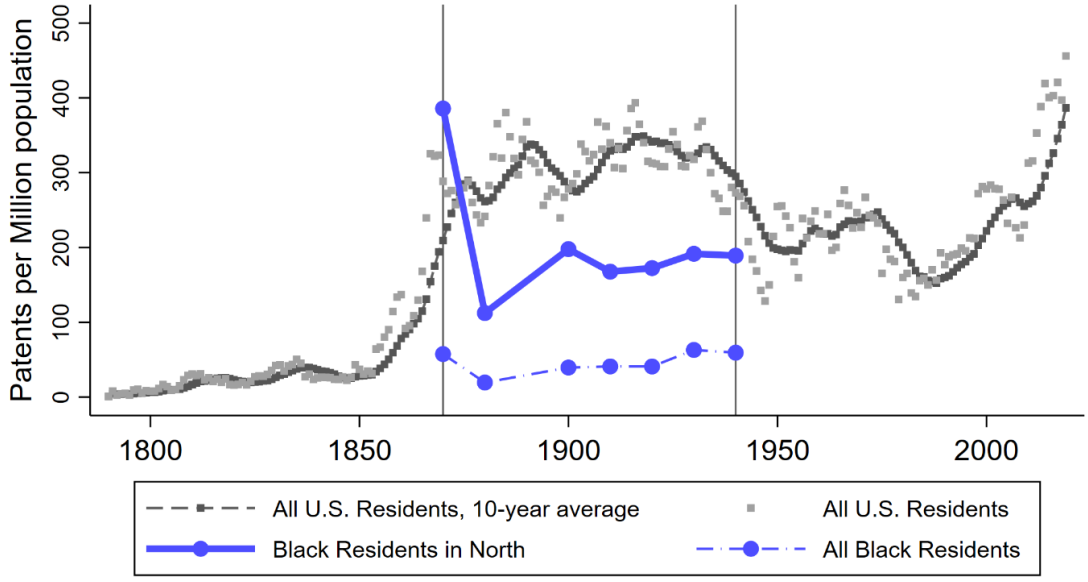
Source data: Ziebarth, Nicolas, X, Sarada, and Andrews, Michael. American Inventors, 1870-1940. Ann Arbor, MI: Inter-university Consortium for Political and Social Research [distributor], 2019-06-03. https://doi.org/10.3886/E109970V2

Figure A10. Patents per million residents for Black people living in North and White people living in all regions, 1870-1940 using minimum patenting rates



Source data: Ziebarth, Nicolas, X, Sarada, and Andrews, Michael. American Inventors, 1870-1940. Ann Arbor, MI: Inter-university Consortium for Political and Social Research [distributor], 2019-06-03. https://doi.org/10.3886/E109970V2

Figure A11. Patents per million population by region of birth by race, 1870-1940 using minimum patenting rates



Note: Rates are patents per Million population.

Source data for Black rate: Ziebarth, Nicolas, X, Sarada, and Andrews, Michael. American Inventors, 1870-
Ann Arbor, MI: Inter-university Consortium for Political and Social Research [distributor], 2019-06-03.
https://doi.org/10.3886/E109970V2
Source for U.S. rate: USPTO and MeasuringWorth.Com

Figure A12. Black Patenting during the Golden Age in Historical Perspective, using minimum patenting rates

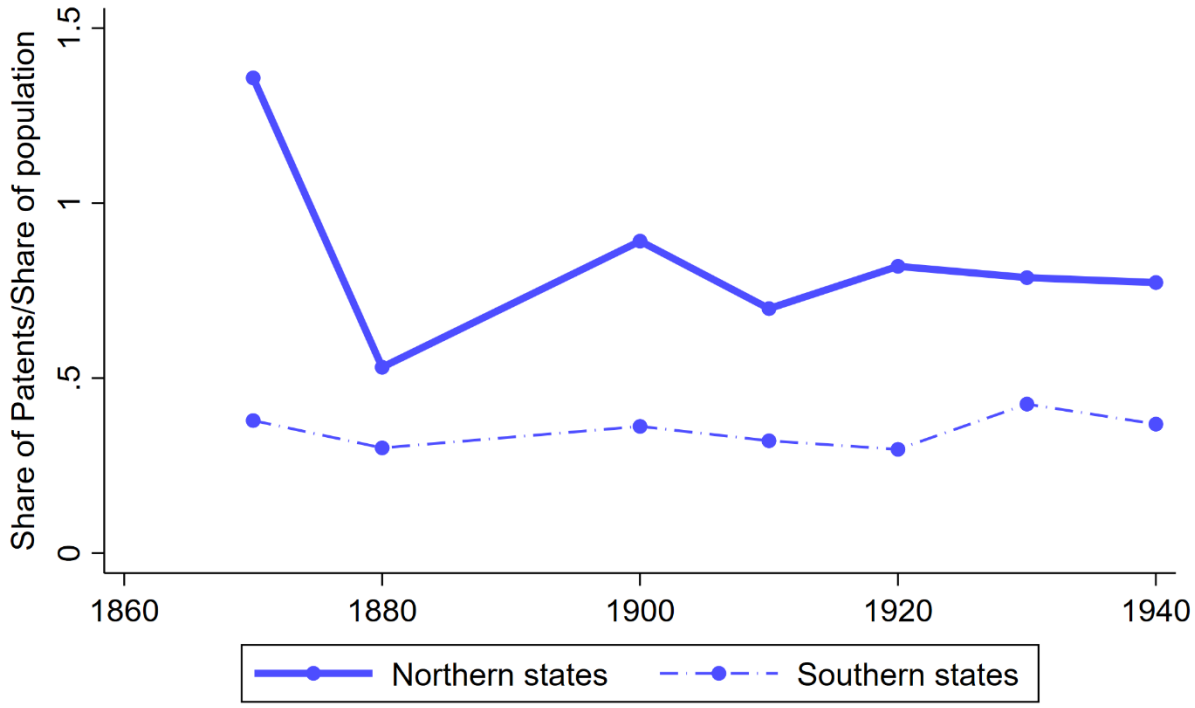
Relative Shares

In this article, we compare patents per million population across races and geographic regions. An alternative way to measure the intensity with which different groups and locations patent is to calculate relative shares, given by

$$Relative\ Share_g = \frac{Share\ of\ Patents_g}{Share\ of\ Population_g},$$

for some group *g*. This is the measure reported throughout Sarada et al. (2019). Following the terminology in Sarada et al. (2019), a group can be considered to be "underrepresented" if the relative share is less than 1 or "overrepresented" if the relative share is greater than 1.

Below, we plot the relative shares for Black residing in the North and the South. With the exception of Northern Black residents in 1870, Black people are always underrepresented. The degree of underrepresentation is much less in the North than the South, however. In the North, for most years Black residents have about 80% as many patents as would be expected based on their share of the population and the nationwide level of patenting; in the South, this figure is typically below 40% and always below 50%. This provides additional evidence that conditions in the South were especially deleterious for Black patenting, and that the Black population in the North were much closer to White population in terms of innovation.



Source data: Ziebarth, Nicolas, X, Sarada, and Andrews, Michael. American Inventors, 1870-1940. Ann Arbor, MI: Inter-university Consortium for Political and Social Research [distributor], 2019-06-03. https://doi.org/10.3886/E109970V2

Figure A13. Relative Shares of Patents by Black Inventors in the North and the South