Summer 2017

Fuel of interest and fire of genius: essays on the economic history of innovation

Michael Jeffrey Andrews
University of Iowa

FUEL OF INTEREST AND FIRE OF GENIUS: ESSAYS ON THE ECONOMIC HISTORY OF INNOVATION

by

Michael Jeffrey Andrews

A thesis submitted in partial fulfillment of the
requirements for the Doctor of Philosophy
degree in Economics
in the Graduate College of
The University of Iowa

August 2017

Thesis Supervisor: Assistant Professor Nicolas Ziebarth

Graduate College
The University of Iowa
Iowa City, Iowa

CERTIFICATE OF APPROVAL

PH.D. THESIS

This is to certify that the Ph.D. thesis of

Michael Jeffrey Andrews

has been approved by the Examining Committee for the thesis requirement for the Doctor of Philosophy degree in Economics at the August 2017 graduation.

Thesis Committee: ______________________________
Nicolas Ziebarth, Thesis Supervisor

____
Joel Mokyr

____
Martin Gervais

____
Alice Schoonbroodt

____
Julia Garlick

To the anonymous inventors who created our world but whose names have been lost to history

Before [the establishment of the patent system], any man might instantly use what another had invented; so that the inventor had no special advantage from his own invention. The patent system changed this; secured to the inventor, for a limited time, the exclusive use of his invention; and thereby added the fuel of interest to the fire of genius, in the discovery and production of new and useful things.

Abraham Lincoln,
Lecture on Discoveries and Inventions, 1858

ACKNOWLEDGEMENTS

First and foremost, I want to thank my advisor, Nicolas Ziebarth, for his guidance, his insight, and, often, his patience. I would also like to thank all of the members of my committee: Joel Mokyr, who acted as a second advisor to me while I was visiting Northwestern University; Alice Schoonbroodt; Martin Gervais; and Julia Garlick. In addition to the members of my committee, I am especially grateful to Teddy Kim and Michael Choi. I have learned a lot from the entire economics department at the University of Iowa, and almost everyone has been extremely generous with their time. I have learned the most from my fellow graduate students. A list of all of the students to whom I am indebted would consist of the entire grad student directory.

I am also very grateful to the Kauffman Foundation, NSF Doctoral Dissertation Grant #1661421, the Balzan Foundation, and the Northwestern Center for Economic History for financial support.

No acknowledgement from a Tippie College of Business dissertation would be complete without thanking Renea Jay, because no Tippie student would be able to complete their dissertation without Renea's constant help and support. When I first arrived in Iowa, I was told that Renea was "the department mom." I now realize that, if anything, such a description understates the work Renea does for her students.

Last and certainly not least, I am eternally grateful to my parents, Jeff and Adair, for constant support and encouragement.

ABSTRACT

This dissertation, which consists of four chapters, uses historical patent data to understand invention in the United States. The first chapter studies how institutions of higher education affect invention. The second chapter seeks to understand the importance of informal social interactions for the creation of new ideas. The third chapter answers the question of what types of individuals are most likely to become inventors. The fourth chapter discusses various historical patent datasets in detail.

In Chapter 1, I exploit historical natural experiments to identify the causal effect of the establishment of new colleges on local patenting. Using losing finalist counties that did not receive a new college as counterfactuals, I find that the establishment of a new college caused 33% more patents per year in college counties relative to the losing finalists. To understand the role of a college education in driving patenting in college towns, I use a novel dataset of graduates from college yearbooks and find that a college's graduates and faculty account for a very small share of the patents granted in that college's county. Changes in county population account for 45-65% of the increase in patenting in college counties.

In Chapter 2, I exploit a different historical policy to understand the importance of informal social interactions for invention. More specifically, I examine the effects of state-level alcohol prohibition in the U.S. Prior to the enactment of statewide alcohol laws, each county determined its own alcohol policies. Thus, statewide prohibition differentially treated counties depending on whether they were wet or dry prior

to statewide adoption. The imposition of statewide prohibition reduces the number of patents by 15% per year in previously wet counties relative to previously dry counties. The effect is largest in the first three years after the imposition of prohibition and diminishes thereafter. Consistent with this decrease being driven by a disruption of informal social interactions, the patenting rate for men decreased more than that for women in previously wet counties.

In Chapter 3, my coauthors and I match the Annual Reports of the Commissioner of Patents from 1870 to 1940 to the corresponding U.S. Federal Population Censuses. This matching procedure provides a rich set of demographic information on a comprehensive set of inventors, allowing us to answer the fundamental question of who invents. We first document that patentees are more likely to be older, white, male and to be living in a state other than the one in which they were born. These patterns are very persistent over space and time. We then attempt to identify correlates of the demographics of patentees focusing on county-level economic and demographic characteristics. Beyond the most obvious, such as the fraction of a particular demographic group in that county, very little explains differences in the demographics of inventors across counties.

In Chapter 4, I compare the strengths and weaknesses of four historical patent datasets and consider the suitability of each for use in economic research. I describe in detail differences in terms of the type and reliability of included information and potential sample selection issues. I show that while there are differences across datasets, overall they paint a remarkably consistent picture of invention in U.S. history.

PUBLIC ABSTRACT

Innovation is the key driver of economic growth. Despite its importance, surprisingly little is known about the identities of inventors, how they create new ideas, or how policy can promote invention. Each chapter of my dissertation uses historical data to answer these questions.

Chapter 1 studies how colleges promote invention. Commercial innovation often occurs near colleges, but determining whether colleges cause those innovations is difficult. Comparing places that get a college to runner-up sites that almost received the new institution, I find that establishing a college causes one-third more patents per year. These additional patents do not tend to come from a college's graduates or faculty; instead, colleges attract inventive people to the area. Controlling for population explains up to two-thirds of the increase in invention.

In Chapter 2, I test how important informal social interactions - that is, people serendipitously bumping into one another - are for invention. I exploit a historical event in which one avenue of informal interactions is eliminated: alcohol prohibition in U.S. states. Shuttering saloons reduces patenting by 15%. The effect is strongest immediately after the imposition of prohibition, before people have time to find other venues in which to interact.

In Chapter 3, my coauthors and I link the patent record to U.S. censuses from 1870 to 1940. We document that women and African Americans are persistently underrepresented in the patent data. In Chapter 4, I discuss the accuracy and com-

pleteness of various primary sources of historical patent data used in the preceding chapters.

TABLE OF CONTENTS

LIST OF TABLES

Table

LIST OF FIGURES

Figure

PREFACE

In his 1858 "Lecture on Discoveries and Inventions," quoted in the epigraph above, Abraham Lincoln concludes that the patent system added "the fuel of interest to the fire of genius." As is so often the case with Lincoln's writings, a great deal of wisdom is packed into a few eloquent words. Lincoln recognized that bringing new inventions to market requires at least two ingredients: an initial creative spark (the fire of genius), and an economic incentive to develop the new idea (the fuel of interest). Economists have spent a great deal of time studying this second ingredient; see Cohen 2010 for a recent survey. Much less is known about the first ingredient. Where does the inventive spark come from? What types of individuals are most likely to carry the fire of genius? And is there any way for policymakers to fan the flames, or for institutions to create the conditions for combustion? Each of the first three chapters of this thesis explore the fire of genius in new ways.

In addition to supplying the "fuel of interest," the patent system has one major function not mentioned by Lincoln: patents provide an official record of past invention. Throughout his lecture, Lincoln frequently remarks that the names of many of the great inventors of the past, the people who created everything from agriculture to the sail, are forever lost to history. This changed with the introduction of the first patent system in 1624. From then onward, the names of inventors and a description of their inventions are recorded. To be sure, patents are an imperfect measure of the totality of invention. Many important innovations are never patented, and many patents are for inventions of little utility. At present, however, patents represent the most complete and systematic count of inventions available. Each of the first three chapters of my dissertation uses patent data to proxy invention throughout U.S. history. The results are therefore only as credible as the underlying historical patent datasets. The fourth chapter of the dissertation describes the available datasets in detail and discusses the strengths and weaknesses of each.

Using historical data, as I do in this thesis, has a number of advantages. Most obviously, historical data allows for the study of long run effects and provides a perspective missing when using exclusively recent data. Just as importantly, history provides a much larger laboratory in which empirical researchers can explore natural experiments. I exploit two such experiments in Chapters 1 and 2. Finally, in many cases, historical data provides information that is not available in contemporary data for confidentiality reasons. As a concrete example, the microdata for each U.S. decennial census is sealed for 72 years. The 100% census manuscripts are therefore only available for the decennial censuses in 1940 or earlier. The focus of Chapter 3 is on merging individual names from the patent record to these decennial censuses. Without access to this census information, it is very difficult to learn anything about the demographics of inventors. Thus, in spite of their importance for economic growth, the median inventor is currently an anonymous figure, shrouded in mystery.

My hope is that this thesis removes that shroud of mystery, presenting compelling new facts about who invents and how invention can be encouraged or impeded. At risk of burning out Lincoln's metaphor, the fires of genius have been illuminating the physical world for thousands of years; it is high time for economists to shed some light of their own onto the geniuses who set those fires.

CHAPTER 1
THE ROLE OF UNIVERSITIES IN LOCAL INVENTION: EVIDENCE FROM THE ESTABLISHMENT OF U.S. COLLEGES

1.1 Introduction

In his survey of the literature on ideas and growth, Jones 2005 concludes, "The more inventors we have, the more ideas we discover, and the richer we all are" (Jones 2005, p. 1107). But how to make more inventors? Many point to the relationship between education and income to argue that education is the key to producing the innovations that drive economic growth.[1] At a micro level, several recent papers show that highly educated individuals are more likely to invent (Bell et al. 2016, Aghion et al. 2016, Akcigit, Grigsby, and Nicholas 2017, Bianchi and Giorcelli 2017). And a large literature, dating to Jaffe 1989, documents that corporate patenting is more intense close to colleges and universities, and that this relationship is strongest near the most research-intensive institutions. While all of these correlations are suggestive, identifying the causal effects of colleges on innovation has proven difficult, not least because there may be any number of local factors that attract both commercial firms and led to a college's establishment in the first place.[2] As Hausman puts it in a recent paper: "To understand local industry effects of universities, one would ideally like to

[1]See, for instance, Barro 1991, Benhabib and Spiegel 1994, Krueger and Lindahl 2001, and, more recently, Valero and Van Reenen 2016. In a cautionary paper, Bils and Klenow 2000 show that the correlation between education and income could be due to reverse causality: high income countries can more easily afford better educational systems.

[2]Throughout this paper, I use the term "college" to refer to any institution of higher education. For most of U.S. history, trying to draw a clean distinction between colleges and universities produces more confusion than elucidation.

randomly allocate universities to locations and measure related industry activity in those locations after the universities arrived relative to before...Of course, in reality universities exist non-randomly from their locations, and areas with universities differ from those without" (Hausman 2013, p. 10).

In this paper, I approximate this ideal experiment using data on the establishment of new colleges in the U.S. spanning the years 1839-1954, most of which were founded during what Goldin and Katz 1999 call "the formative years" of U.S. higher education. By exploring the narrative historical record, I am able to identify "losing finalist" sites that were strongly considered to become the site of a new college but, after selection processes fraught with random events and close calls, were not chosen for plausibly exogenous reasons. I show that the losing finalist counties appear very similar to the winning college counties in the years before college establishment, and that these losing finalist are more similar than simply assuming that new colleges were located at random. Using the losing finalists as counterfactuals for the winning college counties, I find that establishing a new college causes 33% more patents per year in the winning county relative to the losing finalists.[3] While 33% more patents accounts for only about 1.2 additional patents per year in 1870 around the time that many public colleges were established, by 2010 this translates to more than six ad-

[3]Throughout, I treat "patents" and "invention" as synonymous. Of course, patents are a highly imperfect proxy for inventive activity. Many important inventions do not receive patents, and many patents do not cover meaningful inventions; Moser 2005 makes this point persuasively using data on inventions at the 1851 and 1876 World's Fairs. Nevertheless, the evidence suggests that patents tend to be highly correlated with invention. See the surveys in Griliches 1990, Nagaoka, Motohashi, and Goto 2010, and Moser 2016 and the recent work by Igami and Subrahmanyam 2015 for the link between patents and innovation with more recent data.

ditional patents per year. This effect tends to increase over time and also to "spill over" and increase patenting in neighboring counties.

A concrete example of a college site selection experiments may be useful. Georgia School of Technology, now known as the Georgia Institute of Technology or simply Georgia Tech, was founded in Atlanta in 1886. Prominent citizens in Georgia wanted a technical college, but there was no consensus about where to put it. A number of cities vied to receive the new school. Two of the main rivals were Atlanta and Macon. Both were known primarily as railway depots located in the interior of the state; the two cities also looked similar along a number of observable dimensions. In October 1886, a site selection committee assembled to vote on the location of the college. For the first 23 ballots, neither Atlanta nor Macon obtained the requisite majority of votes. Finally, on the 24th ballot, Atlanta won over Macon by one vote. It is thus very easy to believe that Georgia Tech University could have been located in Macon instead of Atlanta. For more details on the Georgia Tech site selection process, see McMath Jr. et al. 1985, p. 24-32. While it may be too much to attribute all of Atlanta's subsequent growth relative to Macon to its securing of Georgia Tech, obtaining the technical college was no doubt an important step in establishing Atlanta's reputation as the premier industrial center of the state. Nor was the case of Georgia Tech an isolated incident: while voting was typically less dramatic, these kinds of college site selection experiments were occurring all across the United States, in large towns and small, during the second half of the nineteenth century and first half of the twentieth. Examples of a few other cases to illustrate the methodology are discussed in the sections below, and much more detail is presented in Appendix B.

Having established a causal effect of colleges on local patenting, I next investigate the mechanisms by which colleges increase patenting. A college can increase local invention in many ways. Most obviously, colleges may fulfill Jones's goal by training future inventors. After acknowledging that the direct effects of education likely play an important role, Goldin and Katz 2008 write:

> But there are also various indirect effects...A better educated workforce facilitates the adoption and diffusion of new technologies. Finally, education contributes to innovation and technological advance because scientists, engineers, and other highly educated workers are instrumental to the research and development (R&D) sector as well as to the creation and application of new ideas. Although it is difficult to quantify these indirect contributions of education to economic growth, they are bound to have been quite large.

In addition, colleges may act as hubs for creative individuals or increasing city size to reap the benefits of agglomeration economies.

To determine the "direct effect" of colleges on patenting, I utilize a novel dataset of college yearbooks from 1900 to 1940 to link the names of graduates to the patent record. I find that graduates of a particular college account for less than 2% of overall patenting in that college's county. College faculty likewise contribute negligibly to overall patenting in college counties. While small, such a share is not too surprising given that most colleges began as very small institutions that did not graduate many students or keep many faculty. So, even if a college education made an individual much more likely to become an inventor, the number of graduates was too small to account for much of the invention going on close to colleges. It is important to note that this result does not mean that colleges had no effect in producing more inventors; but, even if graduates did become more inventive, their invention was taking place in different counties than their alma maters, and so graduate patenting does not explain much of the increase in local invention in college counties.

Additionally, if the direct effect of colleges on patenting were large, then colleges that focus on more technical skills, such as agriculture or machinery, should see much larger increases in patenting than colleges that focus on a classical education, teaching subjects like Greek and the classics. While colleges with a practical focus produce slightly more patents per year than the classical colleges, this difference is modest and not statistically significant. Moreover, I show that colleges that are especially focused in particular areas (for instance, agriculture in land grant colleges or mining in technical schools) do not produce an increased share of patents in those areas after the establishment of the college. Instead, college counties produce a more diverse array of patents rather than concentrating in particular topics emphasized by the colleges.

By controlling for changes in county population, I find that the fact that colleges attract more people to a county can plausibly explain 45-65% of the increase in patenting in college counties relative to the counterfactuals. I also show that counties whose population grew the most tended have the highest estimated coefficients on patenting. Conversely, counties had very small estimated effects when the counterfactual counties were also induced to increase their population by receiving other forms of state institutions. Future work will investigate in more detail what kinds of individuals migrated to college counties relative to the losing finalist counties.

This paper builds on a large literature that seeks to understand the causal effects of colleges. Furman and MacGarvie 2007 show that university research attracted pharmaceutical firms and, simultaneously, commercial pharmaceutical research led to more academic biological research. Aghion et al. 2009, using changes in Congressional committee assignments as instruments for local education spending, find a causal effect of higher education spending on growth rates. Cantoni and Yuchtman 2014 find a causal effect of the establishment of medieval German universities on market creation. Moretti 2004 and Kantor and Whalley 2014 show, respectively, that more college graduates and more college expenditures in a given area cause higher wages. Liu 2015 uses a synthetic control method to show that the establishment of new public colleges led to greater population density and productivity. More directly focusing on the link between colleges and patents, Hausman 2013 shows that the 1980 Bayh-Dole Act led to more patenting in industries doing work closely related to technological strengths of co-located research universities.

While the literature that seeks to understand the relationship between colleges and invention is large, a number of studies look specifically at the establishment of new colleges and how the creation of a new institution of higher education affects local economies. These include Currie and Moretti 2003, Moretti 2004, Andersson, Quigley, and Wilhelmsson 2004, Andersson, Quigley, and Wilhelmsson 2009, Frenette 2009, Cowan and Zinovyeva 2013, and Toivanen and Väänänen 2016. Each assumes that new colleges are located at random, so that individuals in places that get a new college can be compared to people in places that do not. The historical record strongly refutes this assumption. As Gumprecht 2003 points out, college towns differ from other places both in ways that are easily detected in economic statistics and in ways that are more subtle, making comparisons difficult. To solve this problem, I use the losing finalist strategy described above. Greenstone, Hornbeck, and Moretti 2010 pioneer a similar site selection methodology to find counterfactual towns for large manufacturing plants constructed from 1970-1999 and Kantor and Whalley 2016 use a similar approach in a robustness test to identify finalist sites for select land grant colleges. The key idea behind this methodology is that, when selecting where to locate a major investment, be it a college or a manufacturing plant, thousands of possible candidates are considered and iteratively eliminated, so that by the time only a few finalists are left they are likely similar along both observable and unobservable dimensions.

While this “losing finalists” methodology works well in the context of Greenstone, Hornbeck, and Moretti 2010, the identifying assumption can fail if only a small number of locations were ever considered and the finalists are very different from one another. To account for this, I refine the methodology by using the narrative record to restrict the sample to cases in which I can verify that the site selection decision was not based on either observable or unobservable local characteristics and thus very nearly approximates random assignment. By combining disparate narrative sources regarding the foundation of U.S. colleges into one place and documenting similarities and differences across them, this paper contributes to the literature on the history of U.S. higher education as well.

This paper is organized as follows. Section 2.3 describes the data, including an in depth explanation of the college site selection experiments as well as the patent and other data sources used, and presents the empirical specification. Section 1.3.1 presents the baseline results of the creation of a new college on patenting and documents how the effect changes over time and spills over to neighboring areas. Section 1.4 conducts additional analysis to understand the mechanisms by which colleges increase invention, including documenting the share of patents from college graduates, how different types of colleges patent differently, and whether changes in population is a meaningful channel through which colleges affect invention. Section 4.5 concludes.

1.2 Data and Empirical Model

1.2.1 The College Site Selection Experiments

The mid-19th to mid-20th centuries saw an explosion in the number of colleges and universities in the U.S. Goldin and Katz 2008 refer to the 20th century as the "human capital century" due to the large increase in schooling. In other work, they calculate that roughly 630 new colleges were opened from 1890 to 1940 Goldin and Katz 1999. The six decades prior to 1890 also saw the establishment of numerous new colleges and universities, most notably the establishment of public universities in most states, a process supplemented and accelerated by the passage of the Morrill Land Grant Colleges Act in 1862.

To study the local effects of creating a new college, it is important to identify counterfactual locations that did not receive a collage but are otherwise similar to college counties. Several authors claim that the locations of new colleges were essentially random.[4] While it may be difficult to determine why colleges are in their current locations by looking at modern data, a great deal of thought went into the site selection decision at the time they occurred. Horace Bushnell, a theologian who played a central role in locating both the University of California and the University of Illinois, summed up how thoughtfully the site selection decision was approached: "The site of a university is to be chosen but once. Once planted, it can never be removed; and if any mistake is made, that mistake rests on the institution as a burden to the end of time" (quoted in Ferrier 1930, p. 162). Moreover, many localities wanted to secure a new college, and any prestige and economic benefits that went along with it, for themselves, ensuring that the site selection decision often became quite contentious. Further complicating the site selection decision is the fact that new colleges had particular infrastructure needs. In the case of land grant universities, for example, the Morrill Act of 1862 explicitly prohibited states from using their land grant fund to construct buildings. This forced states to locate land grant colleges in

[4] Moretti 2004, p. 190-191, focusing exclusively on land grant colleges, argues that, "Land-grant colleges were often established in rural areas, and their location was not dependent on natural resources or other factors that could make an area wealthier. In fact, judged from today's point of view, the geographical location of land-grant colleges seems close to random."

towns with unused buildings large enough for a college or in localities willing to raise the funds for construction. There was also significant tension between locating new colleges in rural areas, where it was thought that the mostly uneducated agricultural families could most benefit from easy access to higher education, versus cities with ready access to urban amenities. As one author writes, many questioned "the naive American assumption that small towns in the forests were as suitable for the life of the mind as large cities." (Miller 1961, p. xxiv). Perlman 2015 shows that the expansion of transportation networks increased local patenting, so to the extent new colleges were placed in accessible parts of the state, any changes in patenting may simply reflect the role of accessibility rather than the college.

To identify counterfactual sites, I find historical information, often in narrative form, regarding the college site selection process. From studying the site selection process, it is often possible to identify losing "finalist" counties that did not receive the college. Throughout, I refer to counties that received a new college as "treatment" counties and the losing finalists as "control" counties. Kantor and Whalley 2016 adopt a similar approach to identify finalist sites to land grant colleges in the Northeast and Midwest. One drawback to this approach is that it identifies all finalists, regardless of how similar the winning and losing sites are or how close the site selection process was to random assignment. To mitigate this problem, I only include cases in which the site selection decision is plausibly exogenous; I refer to these as "high quality" college selection experiments.

The Georgia Tech example described above illustrates one example of a high quality experiment. As another example of high quality site selection experiments, in several instances states solicited bids from localities, with the college going to the place with the highest bid. If two counties submit nearly identical bids, this is strong evidence that their citizens value a college roughly equally and they have similar capacity to support the school. As a further example, in North Dakota, the state drew lots to choose among several cities that wanted to receive the state university, so the college was literally randomly assigned. In other cases, quirky historical events conspired to locate a college in one location rather than another. For example, Ezra Cornell and Andrew White would go on to establish Cornell University, New York's land grant college. They knew they wanted to establish the college in one of their home towns. Ezra Cornell was from Ithaca, while Andrew White was from Syracuse. However, Cornell had been robbed of his wages as a young man in Syracuse and he refused to put locate the college there. Consequently, Cornell University is located in Ithaca.[5]

Restricting the sample to only the high quality college site selection experiments excludes a large number of potential experiments. Often, losing finalists were not strong contenders to receive the college. For example, while several counties submitted bids to receive Michigan State University, the legislature had always intended to locate the college close to Lansing, both to be near the state capital and as a com-

[5]Syracuse would, of course, get its own university several years later. I have been unable to find any evidence that Syracuse either had higher crime rates than Ithaca or that it tended to have citizens of a lower moral characters; as far as I can tell, Syracuse and Ithaca were very similar along observable dimensions before the establishment of Cornell University.

promise among the numerous competing interests. In this case, the losing bidders do not appear very similar to East Lansing and do not form valid counterfactuals. In Appendix B, I describe each college site selection experiment in detail, including the rationale for classifying the experiment as high versus low quality.[6] I include results using both the high and low quality experiments as a robustness check in Table 1.3. Obviously, the decision of whether or not a particular experiment is high or low quality is somewhat subjective. Appendix A.3 discusses the general types of experiments that tend to occur in many of the high quality cases; I show that the results are not sensitive to looking at a particular kind of experiment.

The approach described here builds on a large literature in economics that uses losing finalists as controls for a treated group. For example, Aizer et al. 2016, Wachter, Song, and Manchester 2011, and Bound 1989 use rejected applicants to estimate the impact of various social insurance programs. Dale and Krueger 2002 use rejected "finalist" applicants to selective colleges to estimate the return to attending such a college. One potential weakness of these studies is that, while both the accepted and rejected applicants are likely similar in terms of difficult-to-measure characteristics such as motivation and knowledge of social insurance programs, they may be very different in the eyes of the program administrators. Using the high quality experiments, on the other hand, ensures that both the winning and losing

[6]Both high and low quality experiments are described in Appendix B. It is my hope that, although the low quality experiments may not be useful for identifying causal effects, compiling a broad collection of college site selection experiments may be of independent historical interest.

sites saw themselves as strong contenders *and* were viewed as similar by the site selection committees. Another series of papers (Olenski, Abola, and B.Jena 2015, Borgschulte 2014, and Olshansky 2011) uses losing political candidates as counterfactuals for winning candidates and find that election winners have a shorter life expectancy. However, Borgschulte and Vogler 2016 show in a larger sample that this effect disappears when attention is restricted to very close elections. In a similar vein, the high quality experiments ensure that the contest was "close" and that therefore the winners and losers are more comparable.

The study most similar in spirit to the process of identifying high quality losing finalists used here is Greenstone, Hornbeck, and Moretti 2010, who identify the winning and losing counties in contests to receive new large manufacturing plants. The authors argue that, because manufacturing firms considered a very large number of potential sites, by the time they whittled their list down to a few finalists, these finalist locations are likely to be very similar. In the college site selection experiments, in contrast, it need not be the case that a very large number of initial sites were considered before a list of vetted finalists was compiled. This is one reason why it is important to restrict attention to the high quality experiments: it ensures that the winning and losing counties are similar along both observable and unobservable dimensions. I next discuss the other data sources used, before describing the winning and losing counterfactual counties in more detail.

1.2.2 Patent and County Data

Patent data for the years 1836-2010 come from four sources. The Annual Reports of the Commissioner of Patents covers a plurality of the years, from 1870 to 1942. The annual reports provide information on every patent granted by the United State Patent and Trademark Office (USPTO) in a given year. For each granted patent, the report includes the inventor's first and last name, town and state of residence, and the invention name, patent number, and issue date. The annual reports were digitized by Google, and while the transfer to digital format is overall very good, it is not perfect. Hence, not all patents listed in the physical copies of the annual reports make it into my dataset. However Sarada, Andrews, and Ziebarth 2017 show that there are no systematic errors in the digital recreation of this data; any missing patents appear to be randomly distributed.

For the years 1836-1870, I use patent data collected in the Subject-Matter Index of Patents for Inventions Issued by the United States Patent Office from 1790 to 1873 (Leggett 1874a), compiled by Dr. Jim Shaw of Hutchinson, KS.[7] The years 1942 to 1975 come from the HistPat dataset compiled by Petralia, Balland, and Rigby 2016a.[8] This dataset, constructed from digitized Google Patents documents, contains the same information as the Annual Reports.

Finally, for the years 1975 to 2010, contemporary digitized patent data sources can be used. I utilize the data created for Li et al. 2014, which, taken a commonly

[7] See Miller 2016a and Miller 2016b for more information on how this dataset is compiled.

[8] See Petralia, Balland, and Rigby 2016b for details on the construction of this dataset.

used abbreviation from the authors, I refer to as the InvPat dataset. Unlike other commonly used modern datasets such as the NBER Patent Dataset (Hall, Jaffe, and Trajtenberg 2001), which was built with an eye towards linking patents to the names of firms and so focuses on inventions that include assignees, the InvPat data focuses on ensuring the quality of the names of inventors for all patents from 1975-2010.

Together, these datasets provide information on the location and inventor names of every patent granted to a U.S. inventor from 1836 to 2010. The fact that different years use different patent datasets does not pose a problem for this analysis, as every regression specification below includes year effects, which control for any change in the propensity to patent driven by the source of patent data. The results would be biased if, for instance, one patent dataset systematically recorded more patents from college counties than control counties. While Andrews 2017a documents that the HistPat data undersamples inventors in rural areas relative to the Annual Reports data, the fact that the control counties appear very similar to control counties along observable dimensions, including population and urbanization, minimizes the risks that this is a problem. Patent data from before 1836 is not useful for analysis, as 1836 marked a major change in the U.S. patent system, essentially changing from a registration system to an examination system.In addition, a major fire at the U.S. Patent Office in 1836 destroyed most of the patents from the early United States. While efforts have been made to rebuild a record of early patenting from other sources (these are enticingly known as the "X-patent" datasets; see Andrews 2017a for more information), it is unknown how complete these data are or whether they represent a random sample of all pre-1836 patents.

For each year, I sum up all patents granted in each town. Using U.S. decennial censuses, I associate each town and state with its county.[9] Summing the number of patents for each town within a county produces the county-level patent counts. In Appendix A.4, I show results using other sources of patent data and alternative techniques to match town names to counties; in all cases the results are qualitatively similar to the baseline results presented below.

County-level data comes from the National Historic Geographic Information System (NHGIS), which provides decennial census data aggregated at the county level. The NHGIS data allows me to compare counties along a number of useful dimensions including population; composition of the county population along racial, gender, immigration, and age dimensions; urbanization; and wages and production in both agricultural and manufacturing sectors. Because county names and boundaries change over time, I aggregate counties to their largest historical boundaries, adopting a method similar to Hornbeck 2010 and Perlman 2015. Data on residential segregation at the county level is from Logan and Parman 2017.

[9] In several cases, a town's boundaries lie in several counties. Alternatively, there may be states with multiple towns of the same name. In these cases when a town is associated with multiple counties, I assume each patent has an equal probability of belonging to each county and divide the number of patents by the number of towns to find a mean number of patents. I also construct an upper bound, assuming that every patent belongs to a particular county, and a lower bound that assumes that no patents belong to a particular county. All results below use the mean patent count, but results are nearly identical when using the upper and lower bounds.

1.2.3 The Winning and Losing Counties

In total, I examine histories of 219 colleges from all 50 U.S. states. Of these, in 136 cases I am able to identify losing finalist locations. I consider 73 of these to be high quality experiments. These high quality experiments form the baseline sample used in the analysis below. The data are summarized in Table 1.1, which lists every college experiment in the sample as well as the year in which the experiment took place and the college type. To give a sense of the type of colleges involved in the study, I classify colleges into one of seven mutually exclusive groups: land grant colleges, technical colleges, normal schools, historically black colleges and universities (HBCUs), military academies, other public colleges, and other private colleges.[10] A majority of the college experiments involve land grant colleges. Three experiments involve technical colleges, three involve normal schools, two involve HBCUs, and three involve military academies. Six public colleges are classified as "other," while one private college is classified as such. There are on average slightly less than two control counties for each treatment county.

Table 1.2 compares the treatment and control counties and shows that the

[10]Technical colleges include schools focused on engineering, mining, and industrial arts. Normal schools are colleges focused on teacher training; many of these have evolved to become directional state universities. Other public and private universities include all public and private, respectively, schools that do not fit into any of the other classifications. For instance, the University of Texas is classified as an "other public" college in the sample; Texas also has two other state-wide (that is, not "directional states" targeted to a particular region within Texas) public universities, a land grant college (Texas A&M) and a technical college (Texas Tech), both of which are also in my sample. In some cases, a college may fall into multiple categories. For example, many HBCUs are also state land grant colleges. For clarity, in Table 1.1, I place each college into its "best" category. Note that all results are insensitive to reclassifying colleges.

Experiment Year	College	Exp. Abbrev.	County, State	College Type
1839	University of Missouri	UMo1	Boone, MO	Other Public
1841	University of Mississippi	UMs	Lafayette, MS	Other Public
1849	Michigan State Normal College	MiSNC	Washtenaw, MI	Normal School
1855	Pennsylvania State University	PaSU1	Centre, PA	Land Grant
1855	State Normal School of New Jersey	SNSNJ	Mercer, NJ	Normal School
1857	University of California	UCa	Alameda, CA	Land Grant
1859	Iowa State University	IaSU	Story, IA	Land Grant
1863	Kansas State University	UKs	Riley, KS	Land Grant
1863	University of Kansas	UKs	Douglas, KS	Other Public
1865	Cornell University	CornU	Tompkins, NY	Land Grant
1866	University of Maine	UMe	Penobscot, ME	Land Grant
1866	University of Wisconsin	UWi2	Dane, WI	Land Grant
1867	University of Illinois	UIUC	Champaign, IL	Land Grant
1867	West Virginia University	WVU	Monongalia, WV	Land Grant
1868	Oregon State University	OrSU	Benton, OR	Land Grant
1869	Purdue University	PurdU	Tippecanoe, IN	Land Grant
1869	Southern Illinois University	SIlU	Jackson, IL	Normal School
1869	University of Tennessee	UTn2	Knox, TN	Land Grant
1870	Louisiana State University	LaSU	East Baton Rouge	Land Grant
1870	Missouri School of Mines & Metallurgy	MoSMM	Phelps, MO	Land Grant
1870	University of Missouri	UMo2	Boone, MO	Land Grant
1871	Texas A&M University	TxAMU	Brazos, TX	Land Grant
1871	University of Arkansas	UAr	Washington, AR	Land Grant
1872	Auburn University	AubU	Lee, AL	Land Grant
1872	University of Oregon	UOr	Lane, OR	Other Public
1872	Virginia Tech University	VaT	Montgomery, VA	Land Grant
1874	University of Colorado	UCo	Boulder, CO	Land Grant
1881	University of Texas	UTx	Travis, TX	Other Public
1883	North Dakota State University	UND	Cass, ND	Land Grant
1883	University of North Dakota	UND	Grand Forks, ND	Other Public
1885	University of Arizona	UAz	Pima, AZ	Other Public
1885	Arizona State University	UAz	Maricopa, AZ	Land Grant
1885	University of Nevada	UNv	Washoe, NV	Land Grant
1886	Georgia Tech University	GaT	Fulton, GA	Technical School
1886	Kentucky State University	KySU	Franklin, KY	HBCU
1886	North Carolina State University	NCSU	Wake, NC	Land Grant
1887	Florida A&M University	FAMU	Leon, FL	HBCU
1888	Utah State University	UtSU	Cache, UT	Land Grant
1889	Clemson University	ClemU	Pickens, SC	Land Grant
1889	University of New Mexico	NMSU	Bernalillo, NM	Other Public
1889	New Mexico Tech	NMSU	Socorro, NM	Technical School
1889	New Mexico State University	NMSU	Dona Ana, NM	Land Grant
1889	University of Idaho	UId	Latah, ID	Land Grant
1891	University of New Hampshire	UNH	Strafford, NH	Land Grant
1891	Washington State University	WaSU	Whitman, WA	Land Grant
1892	North Carolina A&T University	NCAT	Guilford, NC	HBCU
1895	Eastern Illinois University	EIlSU	Coles, IL	Normal School
1895	Northern Illinois University	NIlSU	DeKalb, IL	Normal School
1899	Western Illinois University	WIlSU	McDonough, IL	Normal School
1903	Nebraska State Normal School Kearney	NeSNSK	Buffalo, NE	Normal School
1905	University of Florida	UFl2	Leon, FL	Other Public
1909	Middle Tennessee Normal School	MTnNS	Rutherford, TN	Normal School
1910	Kent State University	KentSU	Portage, OH	Normal School
1910	Southern Mississippi University	SMsU	Forrest, MS	Normal School
1922	Florida Southern College	FSC	Polk, FL	Other Private
1923	Texas Tech	TxT	Lubbock, TX	Technical School
1941	Maine Maritime Academy	MeMA	Hancock, ME	Military Academy
1941	U.S. Merchant Marine Academy	USMMA	Nassau, NY	Military Academy
1954	U.S. Air Force Academy	USAFA	El Paso, CO	Military Academy

Table 1.1: List of all high quality college site selection experiment in the dataset in chronological order of the experiment date. Also included is the abbreviation of each experiment used in following results, the county and state of each college, and the college type of each experiment.

control counties are a better match for the treatment counties than are the non-experimental counties. Columns 1 and 2 display the mean and standard deviations of the treatment and control counties, respectively, in the last U.S. census year before the college was established.[11] Column 3 subtracts the mean of the control counties from the mean of the treatment counties, and shows the standard errors of the difference. For a battery of patenting, demographic, and economic variables, the means of the treatment and control counties are statistically indistinguishable and remarkably similar in magnitude.

Column 4 shows the mean and standard deviation for the non-experimental counties, which are the counties in each state that are not classified as either treatment or control counties. Column 5 shows the differences in means and corresponding standard error between the treatment and non-experimental counties. The treatment and non-experimental counties also tend to be similar along most dimensions, making Moretti's claim that colleges were located "close to random" understandable. But the treatment counties do have a statistically larger population, are more urbanized, have a larger share of interstate migrants, more manufacturing workers, greater manufacturing product and wages, and higher farm wages. While not statistically different from zero, the non-experimental counties do have a much larger number of patents but a smaller $log(Num.Patents+1)$ than the treatment county. This reflects the fact that the non-experimental counties also contain a number of outlier counties, namely

[11] I use census years because most of the demographic and economic variables are collected with the decennial census. So if, for example, a college was established in 1874, the results in Table 1.2 reflect the state of counties in 1869-1870, when the census was collected.

large cities that acted as early innovation hubs and especially skew results regarding patenting; getting rid of these outliers is a major benefit of the losing finalists methodology. Appendix A.1 provides additional balance checks and placebo tests to verify that the losing finalists are valid counterfactual counties.

	Treatment	Controls	Treat. - Cont.	Non-Experiment	Treat. - Non-Exp.
log(Patents + 1)	0.68	0.61	0.0688	0.45	0.2306**
	(0.97)	(0.92)	(0.1442)	(0.85)	(0.1083)
Num. Patents	2.70	2.51	0.1868	4.39	-1.6870
	(5.92)	(6.52)	(0.9756)	(67.19)	(8.4667)
log(Total Pop.)	9.85	9.43	0.4238*	9.18	0.6689***
	(0.96)	(1.56)	(0.2193)	(1.37)	(0.1777)
Frac. Urban	0.15	0.14	0.0129	0.08	0.0767***
	(0.20)	(0.20)	(0.0324)	(0.17)	(0.0223)
Frac. Foreign Immigrant	0.09	0.11	-0.0154	0.13	-0.0341
	(0.09)	(0.10)	(0.0208)	(0.15)	(0.0259)
Frac. Male	0.52	0.51	0.0066	0.52	-0.0034
	(0.12)	(0.13)	(0.0207)	(0.11)	(0.0145)
Frac. White	0.78	0.77	0.0137	0.81	-0.0254
	(0.26)	(0.28)	(0.0474)	(0.24)	(0.0342)
Mean Age	29.77	29.04	0.7330	31.00	-1.2282
	(8.02)	(7.76)	(1.3722)	(6.16)	(0.8899)
Frac. Interstate Migrants	0.60	0.58	0.0163	0.50	0.0981**
	(0.35)	(0.35)	(0.0602)	(0.31)	(0.0446)
log(Manuf. Employment)	4.72	4.53	0.1908	3.84	0.8769**
	(2.35)	(2.45)	(0.4727)	(2.46)	(0.3917)
log(Value Manuf. Output)	12.55	11.98	0.5660	11.20	1.3455***
	(1.83)	(2.90)	(0.4395)	(3.51)	(0.4829)
log(Manuf. Wages)	9.10	8.83	0.2720	7.57	1.5302*
	(4.72)	(4.67)	(0.9181)	(4.98)	(0.7934)
log(Value Farm Product)	13.28	13.06	0.2238	13.02	0.2623
	(1.36)	(1.43)	(0.2448)	(2.29)	(0.3276)
log(Farm Wages)	11.50	11.15	0.3493	10.36	1.1338**
	(0.82)	(1.08)	(0.3219)	(1.79)	(0.4631)
log(Value Farms)	14.58	14.27	0.3018	14.18	0.3979
	(1.39)	(2.00)	(0.3063)	(2.26)	(0.3110)

Table 1.2: T-tests comparing the means of the treatment counties, control counties, and non-experimental counties.

In Appendix A.2, I provide further evidence that restricting attention to very similar control counties is important for the results. For several college site selection experiments, it is possible to create ordinal rankings of the finalists, either by using the valuations of each finalists' bid or by the number of votes each finalist receives. I show that including only the losing finalists that submit the second-highest bids or receive the second-most votes look the most similar to the winning counties along a number of dimensions. Furthermore, in regressions that include lower ranked finalists, estimated effects of establishing a new college are larger, suggesting that including lower quality losing finalists inflates the observed effect of establishing a new college.

1.2.4 Empirical Model

I estimate a straightforward differences-in-differences equation with grouped observations. That is, in county i associated with college j at time t, the number of patents is given by

$$\begin{aligned}\log(NumPat_{ijt}+1) =& \delta_0 + \delta_1 Treatment_{ij} * PostTreatment_{jt} + \delta_2 PostTreatment_{jt} \\ &+ \alpha_i + \gamma_t + \epsilon_{ijt}, \end{aligned} \tag{1.1}$$

where $Treatment_{ij}$ is an indicator variable equal to one if county i associated with college experiment j receives the treatment, $PostTreatment_{jt}$ is an indicator variable equal to one if year t is after college j has been founded, α_i is a county fixed effect, γ_t is a year effect, and ϵ_{ict} is a county-college-year varying error term.[12] In this context,

[12]It may also be desirable to include an experiment-specific fixed effect, λ_j. In practice, however, there are very few counties that appear in multiple experiments. The collinear-

the treatment is receiving the new college. With only a single experiment, the term $PostTreatment_{jt}$ would be redundant because the post-treatment dummy is perfectly co-linear with the year effects. There are multiple experiments in the dataset, however, with each college being established in different years, and so each group j will be in the post-treatment period in different years. The year effects therefore control for nationwide time-variant changes in patenting, while $PostTreatment_{jt}$ controls for changes that occur within a state after establishing a college within its borders. In the graphs that follow, for each new college, I normalize the year in which the college is founded to year 0. I use logged patents as the independent variable to limit the impact of outlier counties that have a large number of patents and to ease in the interpretation of the coefficient. Because many counties have zero patents in a given year, I add one to the number of patents before taking the log.

Equation (2.1) provides an easy-to-interpret estimate of the mean difference in logged patents per year in treatment counties relative to control counties following the establishment of a new college. I also estimate several variations of Equation (2.1) to probe the robustness of the baseline results. When an alternative estimating equation is used, I describe it in the text below. In all cases, standard errors are clustered at the county level unless otherwise noted.

---

ity between the λ_j and α_i terms are thus very strong, so the λ_js are omitted from most regressions that follow.

1.3 Results

In this section, I present the results of the college site selection experiments. I first estimate Equation (2.1) as well as a number of alternative specifications. I next show that the effect of colleges increases over time, but is not driven solely by recent trends. Finally, I present evidence for geographic spillovers between college counties and their neighboring counties. In Section 1.4, I probe these results even further and bring in additional data to understand the mechanisms by which colleges affect patenting.

1.3.1 Baseline Results

Figure 1.1 plots the raw patent data for treatment, control, and "non-experimental" counties separately. The non-experimental counties are counties in the same state as a new college but which are neither the college county nor one of the nearly-chosen finalists used as a control. The year in which a new college is established is normalized to be year 0 for all experiments. Figure 1.2 presents the same data after smoothing the data and controlling for time effects.[13] Both figures contain a balanced set of college experiments in the sense that counties are included only if they have at least 20 years of pre-treatment and 80 years of post-treatment data available. Graphs using

[13]Figure 1.2 is constructed by regressing $log(NumPat_{ijt} + 1)$ on year effects γ_t and then plotting the residuals using local mean smoothing with an Epanechnikov kernel function (see Fan and Gijbels 1996). Removing time effects is useful because, as Griliches 1990 shows, there has been a secular increase in patenting overtime as well as country-wide cyclical fluctuations in patenting that coincide with business cycles and changes in the administration of the Patent Office; failure to control for these factors makes interpreting the graph more difficult.

all college experiments are nearly identical.

Three results are immediately clear. First, new colleges do not appear to be randomly located; there is a large difference between the treatment and control counties on one hand and the non-experimental counties on the other, both in the level and growth rate of patenting. It appears that, in choosing potential sites for a new college, the desire to locate the college where new ideas grew rapidly outweighed any accessibility concerns that might lead a site selection committee to place the college in backwater areas without much invention. Second, the treatment and control counties patented similarly in pre-treatment years, suggesting that the experimental design is valid. Third, after the establishment of a new college, the treatment and control counties diverged, with treatment counties patenting more. The difference between the treatment and control counties is especially pronounced after several decades; there is no evidence from these figures that patenting in treatment and control counties converge as more time passes since the establishment of a college.

Figures 1.1 and 1.2 also present some more intriguing patterns. First, while treatment and control counties are both increasing their patenting at approximately the same rate in the twenty or more years before the establishment of a new college, after the college is established the increase in patenting in the control counties levels off. The cause for this is unclear, but there are at least two possibilities. First, this can be taken as evidence that site selection committees were indeed targeting rapidly growing counties. A college allowed winning counties to continue their growth, while the losing finalists reverted to a mean patenting rate. Second, the pattern could be due to inventive individuals from previously fast growing control counties moving to the winning treatment counties, and hence that the establishment of a new college served primarily to reallocate inventors rather than produce new ones. Such a result is less plausible since there is no noticeable increase in the growth rate of patenting in the treatment counties. In Section 1.3.3 I present additional suggestive evidence that new colleges increased patenting rather than simply moving it around. A second intriguing pattern is the decline in patenting that occurs 30-60 years after the establishment of a new college. At present I am aware of no likely candidate explanations for such a pattern.

Table 1.3 formalizes the intuition in Figures 1.1 and 1.2. The columns show different regression specifications. For all tables in the paper, each estimated coefficient is presented in two ways: first by a percentage change in patenting (/100), and second by the change in the number of patents.[14] Standard errors for each are corrected using the delta method. To get the change in number of additional patents when the dependent variable is $\log(NumPatents_{ijt} + 1)$, the percentage increase is multiplied by the average number of patents per county in the U.S. in the year 1870, the first census year after the passage of the 1862 Land Grant Colleges Act and during a wave of new college openings.[15] When the dependent variable is $NumPatents_{ijt}$,

[14] More precisely, because the variables of interest are indicators that are either equal to zero or one, the estimated coefficient must be adjusted to give the percentage increase in patenting using the equation $\%ChangeinPatents = e^{\hat{\delta_1} - \frac{1}{2}Var(\hat{\delta})} - 1$, where δ_1 is the coefficient of interest from Equation (2.1); see Halvorsen and Palmquist 1980 and Kennedy 1981. This adjusted coefficient is presented in the table.

[15] Using a later baseline year, when average patenting in the U.S. was higher, leads to a larger estimated change in the number of patents. Likewise, earlier baseline years results in

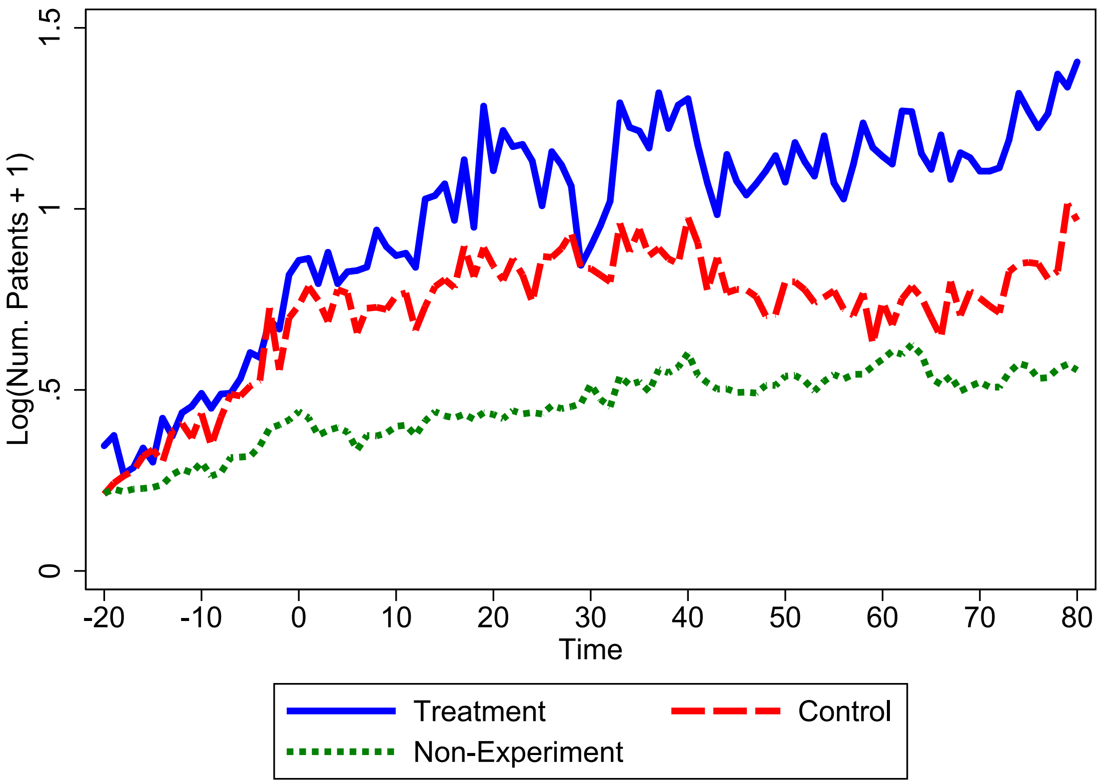


Figure 1.1: Unconditional mean patenting in treatment and control counties. The x-axis shows the number of years since the college experiment. The year of the college experiment is normalized to year 0. Everything left of year 0 shows pre-treatment means; everything to the right shows post-treatment means. The y-axis shows $log(Patents + 1)$. The treatment counties are represented by the blue solid line. The control counties are represented by the red dashed line. The non-experimental counties are represented by the green short-dashed line.

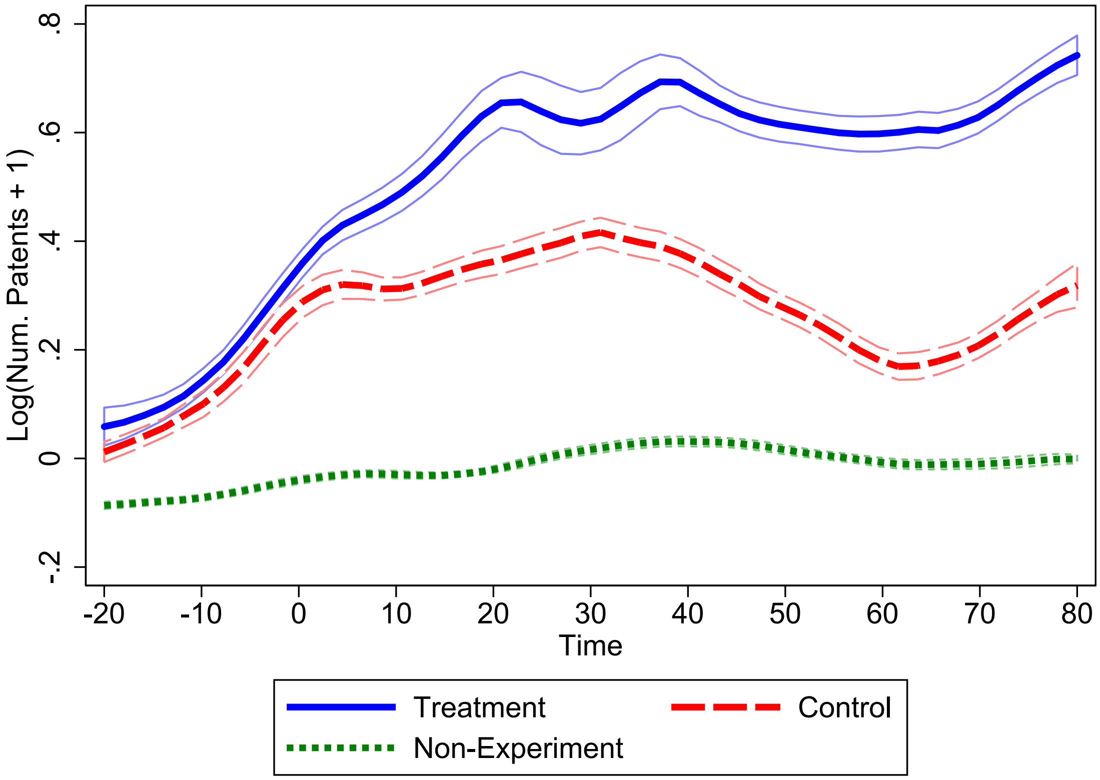


Figure 1.2: Mean patenting in treatment and control counties after controlling for year effects. Counties are excluded if less than five years of pre-treatment patent data is available. The x-axis shows the number of years since the college experiment. The year of the college experiment is normalized to year 0. Everything left of year 0 shows pre-treatment means; everything to the right shows post-treatment means. The y-axis shows smoothed $log(Patents + 1)$. The smoothed patenting is constructed by regressing $log(Patents + 1)$ on year effects and then plotting the residuals using local mean smoothing with an Epanechnikov kernel function. The treatment counties are represented by the blue solid line. The control counties are represented by the red long-dashed line. The non-experimental counties are represented by the green short-dashed line.

the change in the number of patents can be observed directly; the percentage change is simply calculated as $\frac{\Delta NumPatents}{NumPatents_{1870}}$, again using 1870 as a baseline year. For all tables in the paper and all columns, standard errors are clustered at the county level.[16] The coefficient of interest is displayed in Row 1 and shows the percentage and number of estimated additional patents generated in the treatment county relative to the control county resulting from the establishment of the new college.

Column 1 shows the results of estimating Equation (2.1). Treatment counties have about 33% more patents per year than control counties, or roughly 1.2 additional patents every year. This result is significant at the 1% level. In Column 2, I also estimate how the establishment of a new college affects the trend of patenting across

smaller estimated changes in the number of patents. In all cases, the story is qualitatively the same. I choose 1870 because it represents the state of patenting in America just before the beginning of the golden age of U.S. higher education (Goldin and Katz 2008).

[16] I also cluster at the state, experiment, and county×experiment levels. I additionally cluster at multiple levels as proposed in Cameron, Gelbach, and Miller 2011 using the estimator described in Correia 2016: I cluster at the county and year; state and year; experiment and year; and county, state, experiment, and year levels. Clustering at the county level as is done in the tables produces the largest standard errors, but the standard errors are virtually identical at every level and none of the inferences change. Additionally, clustering at the county level is preferred because in a small number of cases, the same county may appear as a control for multiple experiments; clustering at the county rather than experiment or county×experiment level ensures that multiple cross sectional appearances of the same county are not treated as independent of one another. For more discussion on the best level at which to cluster standard errors, see Cameron and Miller 2015.

counties. This is estimated by

$$
\begin{aligned}
\log(NumPat_{ijt}+1) =& \beta_0 + \beta_1 Treatment_{ij} * PostTreatment_{jt} \\
&+ \beta_2 PostTreatment_{jt} \\
&+ \beta_3 time_j + \beta_4 time_j * PostTreatment_{jt} \\
&+ \beta_5 time_j * Treatment_{ij} * PostTreatment_{jt} + \pi_i + \kappa_t + \xi_{ijt},
\end{aligned} \tag{1.2}
$$

where $time_j$ is a college-specific linear time trend, π_i are county fixed effects, and κ_t are year effects. So β_4 captures how the trend in patenting changed after a college was established. β_5 captures the change in the slope of patenting in treatment counties relative to control counties after a new college is established, while β_1 captures the change in intercept. Not surprisingly given Figure 1.2, the trend between the treatment and control counties is extremely close to zero. The estimated level change in Column 2 is very similar to that in Column 1.

	log(Patents +1)	log(Patents + 1)	Alt. log(Patents)	Num. Patents	Neg. Binomial	log(Patents + 1)
Treat.County * HighQual. * PostTreatment: (% Change)	0.3274***	0.3125*	0.1601**	1.2032	0.3769	-0.1135
	(0.1231)	(0.1700)	(0.0808)	(0.9419)	(0.1823)	(0.0836)
(# Change)	1.1767***	1.1231*	0.5754**	4.3247	1.3548	-0.4079
	(0.4425)	(0.6112)	(0.2905)	(3.3854)	(0.6553)	(0.3006)
PostTreatment: (% Change)	0.0277	0.0220	-0.0779*	-0.6607	1.4033	-0.0057
	(0.0693)	(0.0788)	(0.0409)	(0.6654)	(0.6009)	(0.0094)
(# Change)	0.0996	0.0791	-0.2799*	-2.3749	5.0440	-0.0206
	(0.2490)	(0.2831)	(0.1470)	(2.3919)	(2.1599)	(0.0340)
Treat.County * Trend * PostTreatment: (% Change)		0.0001				
		(0.0015)				
(# Change)		0.0003				
		(0.0054)				
Trend * PostTreatment: (% Change)		-0.0006				
		(0.0035)				
(# Change)		-0.0023				
		(0.0126)				
Trend: (% Change)		0.0012				
		(0.0028)				
(# Change)		0.0043				
		(0.0099)				
Zero Patents Dummy: (% Change)			-0.7403***			
			(0.0125)			
(# Change)			-2.6608***			
			(0.0450)			
HighQual. * PostTreatment: (% Change)						0.1407**
						(0.0575)
(# Change)						0.5059**
						(0.2067)
Treat.County * PostTreatment: (% Change)						0.4874***
						(0.0303)
(# Change)						1.7517***
						(0.1089)
County Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes	Yes	Yes	Yes
Cnty-Year Obs.	34,194	34,194	34,194	34,194	34,194	763,106
# Counties	197	197	197	197		5,963
# Experiments	64	64	64	64	64	64
Adj. R-Sqr.	0.3428	0.3428	0.6160	0.0757	0.2488	0.2148

Table 1.3: Baseline regression results.

Column 3 shows results using an alternative calculation of logged patents as proposed by Blundell, Griffith, and Reenen 1995. Rather than adding a positive constant before taking the log of patents, this alternative method uses $log(patents)$ as the dependent variable. Whenever $patents = 0$, a dummy variable is set to one and $log(0)$ is replaced with 0. In this specification, establishing a new college leads to a roughly 16% more patents per year, or about an extra half patent per year.

Column 4 uses the absolute number of patents as the dependent variable and finds that establishing a new college leads to 4.4 additional patents per year, a 120% increase over an 1870 baseline, but the coefficient is imprecisely estimated. This is larger than the baseline estimate. The logged estimates limit the impact of outliers. The fact that the estimate using the number of patents is so much larger suggests that outliers are playing a large role. Column 5 uses the fact that the number of patents takes on integer values and presents estimates of a negative binomial regression.[17] In this specification, establishing a new college leads to a 38% increase in patenting, very close to the baseline estimate of 33%. As in the case when the number of patents is

[17] I use negative binomial regression in this setting because the variance in patenting is much larger than the mean. The standard approach to fixed effects negative binomial regression is to estimate using conditional maximum likelihood as proposed by Hausman, Hall, and Griliches 1984. In Stata, this is done with the xtnbreg command. However several authors (Allison and Waterman 2002, Greene 2005, Guimaraes 2008) note that this procedure does not actually control for cross-sectional time-invariant effects; more precisely, the overdispersion term is demeaned, but the full conditional mean is not. To correct for this, I estimate a negative binomial model using Stata's nbreg command and include a dummy variable for each cross-sectional observation. Allison and Waterman 2002 show in simulation studies that the incidental parameters problem does not appear to be a problem in negative binomial regressions. Estimates using other count data models, including Poisson and zero-inflated Poisson (the incidental parameter problem does not occur in standard Poisson regression), give qualitatively similar results.

treated as continuous, the estimated coefficient is imprecisely estimated.

In Column 6, I include all of the patent data from the U.S. for each year. This includes the "low-quality" experiments which are not included in the baseline results as well as every county that is not included in an experiment; these other counties are included as "non-experimental" counties. Instead of estimating Equation (2.1), I now estimate a triple-difference equation of the form

$$\begin{aligned}\log(NumPat_{ijt}+1) =& \beta_0 + \beta_1 Treatment_{ij} * HighQuality_{ij} * PostTreatment_{jt} \\ &+ \beta_2 PostTreatment_{jt} \\ &+ \beta_3 HighQuality_{ij} * PostTreatment_{jt} \\ &+ \beta_4 Treatment_{ij} * PostTreatment_{jt} \\ &+ \gamma_t + \alpha_i + \epsilon_{ict}. \end{aligned} \tag{1.3}$$

The indices mean the same as in the previous equations. Now $HighQuality_{ij}$ is equal to one if county i is included in the original list of high quality experiment j counties used for the baseline results, and zero otherwise.

In this new equation, the coefficient of the triple-interaction term β_1 measures how much larger the difference-in-differences estimator between high quality treatment and control counties is compared to the difference-in-differences estimator between all other treatment and all other counties. This coefficient is negative, although not statistically significant, indicating that if anything, there is negative selection into the college experiments; that is, the difference between the treatment and control counties is smaller for high quality experiments than for counties not included in the baseline results. This result shows why restricting attention to high quality experiments is important: otherwise, the effect of colleges on patenting would be overstated.β_2 has the same interpretation as before and simply measures the increase in patenting after establishment of a new college. β_3 estimates the change in patenting in high quality treatment and control counties after the establishment of a college relative to low quality treatment and control counties. Finally, β_4 estimates the increase in patenting in *all* treatment counties relative to *all* control counties after establishing a new college; this is analogous to the interaction term in Equation (2.1) if the low quality experiments and non-experimental control counties were included in those regressions. The estimate of β_4 is positive and significant, so the qualitative conclusions of the baseline specification in Column 1 would still be true even if the low quality experiments were included.

The increase in patenting in high quality treatment counties over high quality control counties after establishment of a new college (that is, the same quantity as estimated by δ_1 in Equation (2.1)) is given by $\beta_1 + \beta_4$.[18] Combining these coefficients reveals that high quality treatment counties increased patenting by 37% (standard

[18] Let $y = \log(NumPatents + 1)$. Then, abusing notation and ignoring the fixed effects and error terms, the coefficient of interest is

$$\begin{aligned}(y_{Treat.,HighQual.,Post} - y_{Treat.,HighQual.,Pre}) \\ - (y_{Cont.,HighQual.,Post} - y_{Cont.,HighQual.,Pre}) \\ =&[\beta_0 + \beta_1 + \beta_2 + \beta_3 + \beta_4] \\ &- [\beta_0] - [\beta_0 + \beta_2 + \beta_4] + [\beta_0] \\ =&\beta_1 + \beta_4.\end{aligned}$$

error= .082), which is significant at the 1% level. This estimate is very similar to the baseline coefficients presented in Column 1.

Figure 1.3 estimates Equation (2.1) with a separate interaction term for each experiment, orders the coefficients from lowest to highest, and then plots the coefficients.[19] In about 60% of the experiments, the estimated coefficient is positive, and in more than 70% of these, the coefficient is statistically different from zero at the 5% level. Even when the coefficient is negative, it tends to be close to zero in magnitude, and in 40% of these cases the estimated coefficient is not statistically different from zero. In a majority of the college site selection experiments, the estimated coefficients are in line with the coefficients estimated in Table 1.3.

[19]Formally, I estimate

$$\begin{aligned}\log(NumPat_{ijt}+1) =&\delta_0 \\ &+\sum_{j\in J}[\delta_{1j}Treatment_{ij} * PostTreatment_{jt} + \delta_{2j}PostTreatment_{jt}] \\ &+\alpha_i+\gamma_t+\epsilon_{ijt}, \end{aligned} \tag{1.4}$$

where J is the number of college site selection experiments.

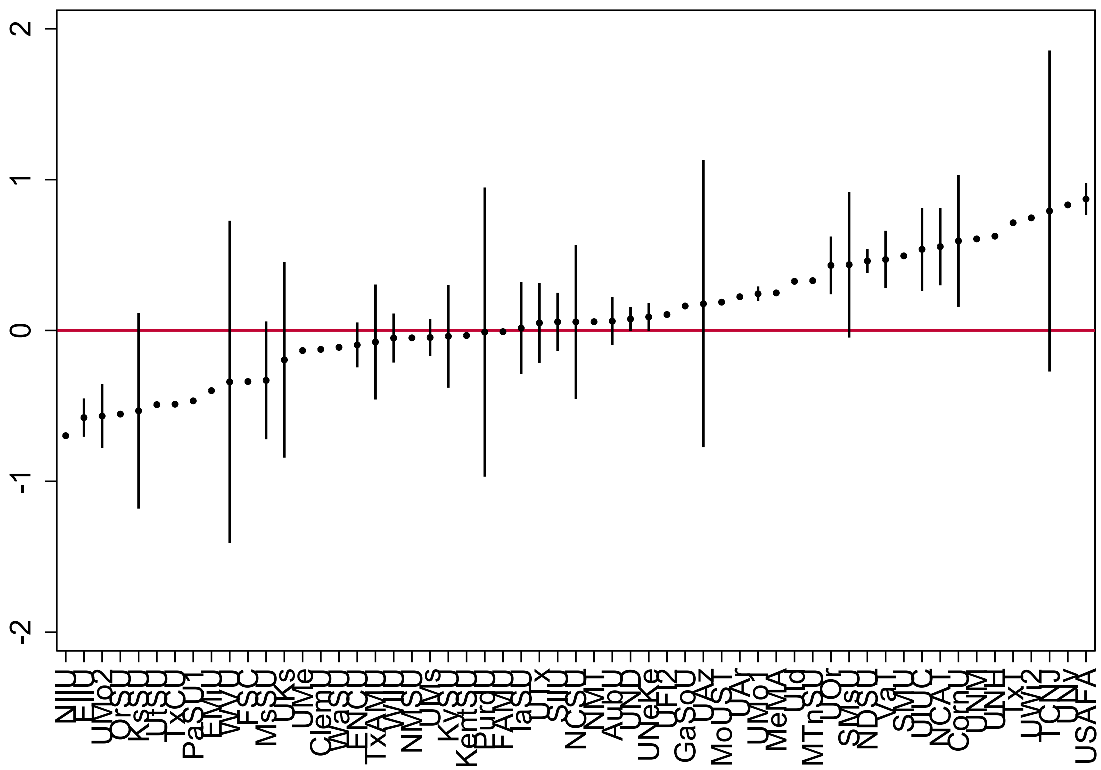


Figure 1.3: Estimated coefficient of the level shift in patenting in treatment counties relative to control counties after establishments of a new college with a separate interaction term estimated for each college experiment. Coefficients are ordered from smallest to largest and then plotted, along with 95% confidence bands.

Appendix A presents numerous other robustness checks, including re-estimating the baseline results with different patent datasets, using town- instead of county-level data, and examining the results separately by different types of college site selection experiments. Beyond these, I verify that the baseline results are insensitive to using alternative dates for the college experiments (for instance, using the date on which classes began rather than the date when the college site was selected), using various assumptions about the patent grant delay (the length of time between when a patent is filed and granted), using different regression specifications (for instance, looking at the extensive margin of patenting or using various other count data models), and using numerous subsets of the college experiments. All these results are available upon request.

1.3.2 Dynamics

As Figures 1.1 and 1.2 make clear, the effect of a college changed over time. In Figure 1.4 I interact the effect of a college by ranges of years.[20] Each plotted coefficient represents the percentage increase in patenting in the treatment counties relative to the control counties in the respective bin of years since the college establishment.

---

[20]More precisely, I estimate

$$\begin{aligned}\log(NumPat_{ijt}+1) =& \delta_0 + \sum_{\tau\in T}[\delta_{1\tau} Treatment_{ij} * TimeBin_{j\tau} + \delta_{2\tau} TimeBin_{j\tau}] \\ &+ \alpha_i + \gamma_t + \epsilon_{ijt},\end{aligned}$$

where $\tau \in T$ represent "bins of years" (i.e., 0-10 years after the college is established, 10-20 years after the college is established, etc.) and $TimeBin_{j\tau}$ is an indicator variable that is equal to one if $t \in \tau$ and 0 otherwise. $Time_{j\tau}$ is an indicator variable that is equal to one if $t = \tau$ and 0 otherwise. Results are nearly identical using different groupings of years and beginning or ending year cutoffs.

Confirming the intuition shown in the raw data, there is no significant difference between the treatment and control counties in any of the years before the establishment of each college and the estimated coefficients are very close to zero in magnitude. After the establishment of a new college, the coefficients begin increasing dramatically.

One concern, highlighted by the fact that the treatment counties tend to out-patent the control counties the most 70-80 years after the establishment of a new college, is that the baseline results are largely driven by changes in the patent law that differentially encourage patenting in college counties relative to the controls. Indeed, just such a change occurred in 1980 with the passage of the Bayh-Dole Act. Prior to the passage of the Bayh-Dole Act, any patent obtained while the inventors were funded by a federal grant or research contract had to be assigned to the U.S. federal government. The Act instead gave ownership of these patent rights to the inventors or their institutions, including universities. As Sampat 2006 and Hausman 2013 show, this led to a dramatic increase in patents assigned to universities. The results after dropping all patent data from 1980 or later are actually larger than the baseline results presented in Table 1.3, suggesting that if anything the difference between treatment and control counties was even larger in the years before Bayh-Dole.

Other authors have suggested different years in which the relationship between colleges and invention change. Bound and Turner 2002 and Goldin and Katz 1999 point to the end of World War II as a time when the demand for technical skills to be taught in colleges increased, in part driven by the 1944 G.I. Bill. Furman

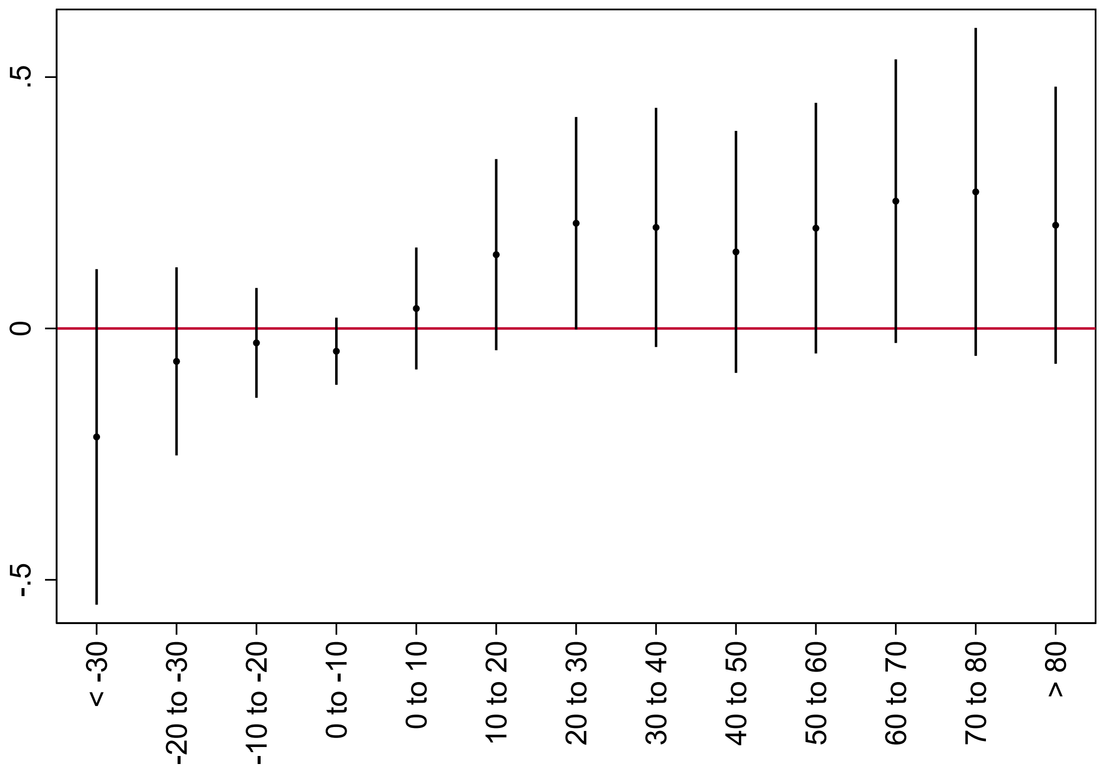


Figure 1.4: Estimated coefficient of the level shift in patenting in treatment counties relative to control counties after establishments of a new college with a separate interaction term estimated for each time bin, along with 95% confidence bands. Time bins are are dummy variables that are equal to one for treatment counties in every ten year period before and after the establishment of the new college.

and MacGarvie 2007 claim that the onset of World War I necessitated new chemical and biological innovations for the military, leading to the creation of biochemistry and similar departments in many universities, and that a second wave of biochemical departments opened in universities in order to support the pharmaceutical industry beginning in 1927. I verify that discarding all data after 1944, 1927, and 1917 also does not materially alter the baseline findings.[21] These results are available upon request.

1.3.3 Geographic Spillovers

It is possible that the positive and significant coefficient estimated in Section 1.3.1 is due to high ability individuals from nearby areas moving to the new college town, either as students, faculty, or simply because a college acts as a focal point to attract educated people. In this section, I provide evidence to suggest that these concerns are unfounded.[22]

In Table 1.4, I present results by the distance from the treatment county to control counties. Column 1 compares treatment counties to control counties that are "far away" from the treatment county in the sense that they are in the same state but do not share a common border. The treatment counties increase their patenting by

[21]When all post-1917 data is discarded, the sample is much smaller and therefore, not surprisingly, the result is no longer statistically significant. But the magnitudes of the estimated coefficients are in line with the baseline estimates.

[22]A full exploration of the general equilibrium effects of establishing a new college is beyond the scope of the present paper. In addition to determining whether or not college counties attract potential inventors from other locations, it also necessitates the estimation of agglomeration elasticities as in Kline and Moretti 2014a and Kline and Moretti 2014b.

41% relative to these far away controls, larger than the baseline estimate in Table 1.3. In Column 2, I compare treatment counties to counties that do share a common border, which I refer to as adjacent counties. In this column, the estimated increase in patenting from the establishment of a new college is only less than 40% of the magnitude of the estimated increase in column 1 and is not statistically different from zero. These results show that the treatment counties increase patenting much more than distant controls, but are statistically indistinguishable from their closer neighbors. This suggests that, instead of a new college having negative spillovers on neighboring areas by pulling all of the local talent away, colleges have positive geographic spillovers, benefiting neighboring areas as well as the county that actually receives the college.

In Columns 3 and 4, I extend this result to compare the treatment counties to *all* non-treatment counties; I no longer restrict attention to the control counties. Column 3 compares the treatment counties to far away counties in the same state and finds that treatment counties increase patenting by 51%. Column 4 compares the treatment counties to all counties that share a border; in this case, the treatment counties only increase patenting by 39%. Thus, even when attention is not restricted to the counterfactual sites, which may not be randomly distributed across a state, it appears that the treatment counties grow somewhat similarly to their neighbors, but increase patenting by much more than far away locations.[23]

[23]One concern is that county size varies across the U.S.; it may not make sense to compare adjacent and far away counties in Massachusetts to Nevada. To account for this, I also verify that this result holds separately in each region of the U.S. Results are available upon request.

	No Adjacent Controls	Adjacent Controls	No Adjacent Counties	Adjacent Counties
Treat.County * HighQual. * PostTreatment: (% Change)	0.4104***	0.1618	0.5108***	0.3898***
	(0.1450)	(0.1302)	(0.1276)	(0.1231)
(# Change)	1.4750***	0.5814	1.8359***	1.4011***
	(0.5213)	(0.4680)	(0.4587)	(0.4423)
PostTreatment: (% Change)	-0.0359	0.0979	-0.0017	-0.0363
	(0.0820)	(0.1038)	(0.0099)	(0.0459)
(# Change)	-0.1291	0.3519	-0.0063	-0.1307
	(0.2948)	(0.3732)	(0.0354)	(0.1650)
County Fixed Effects	Yes	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes	Yes
Cnty-Year Obs.	26,669	18,725	710,375	64,106
# Counties	154	107	5,589	439
# Experiments	64	64	64	64
Adj. R-Sqr.	0.3424	0.3751	0.2139	0.2611

Table 1.4: Regression results by distance to control counties.

1.4 How Do Colleges Affect Patenting?

In the previous section, I document the basic facts of the college site selection experiments: counties that receive colleges tend to patent more than the control counties after establishment of a new college, the effect tends to increase in magnitude over time, and the effects appear to spill over and affect neighboring counties as well.

In this section, I further probe these baseline results to gain a deeper understanding of the mechanisms by which colleges affect patenting. Colleges can affect invention through many different channels. Most directly, students obtain technical skills that allow them to invent. But colleges can also increase invention in more subtle ways, for instance by attracting talented individuals to a county and by promoting social interactions that lead to new ideas. Disentangling which of these channels is most important is difficult, but I offer preliminary evidence in this section.

I first test for this direct effect of colleges. I find that college graduates account for a very small share of the additional patents in the county from which they obtained their degree. To further test whether or not the skills taught within a particular college are important drivers of local invention, I examine whether colleges that teach different kinds of skills promote different amounts or types of patents; the evidence for such an effect is very limited. I next examine the same question from the opposite direction: if there is little evidence that college graduates are patenting at high rates, is there evidence that individuals outside of the college patent more? I show that individuals that are not affiliated with the college also patent more after the establishment of a new college, suggesting the presence of knowledge spillovers.

Finally, I examine demographic and economic dimensions through which colleges can affect a county which may act as channels through which colleges increase patenting.

1.4.1 Patenting by College Graduates and Faculty

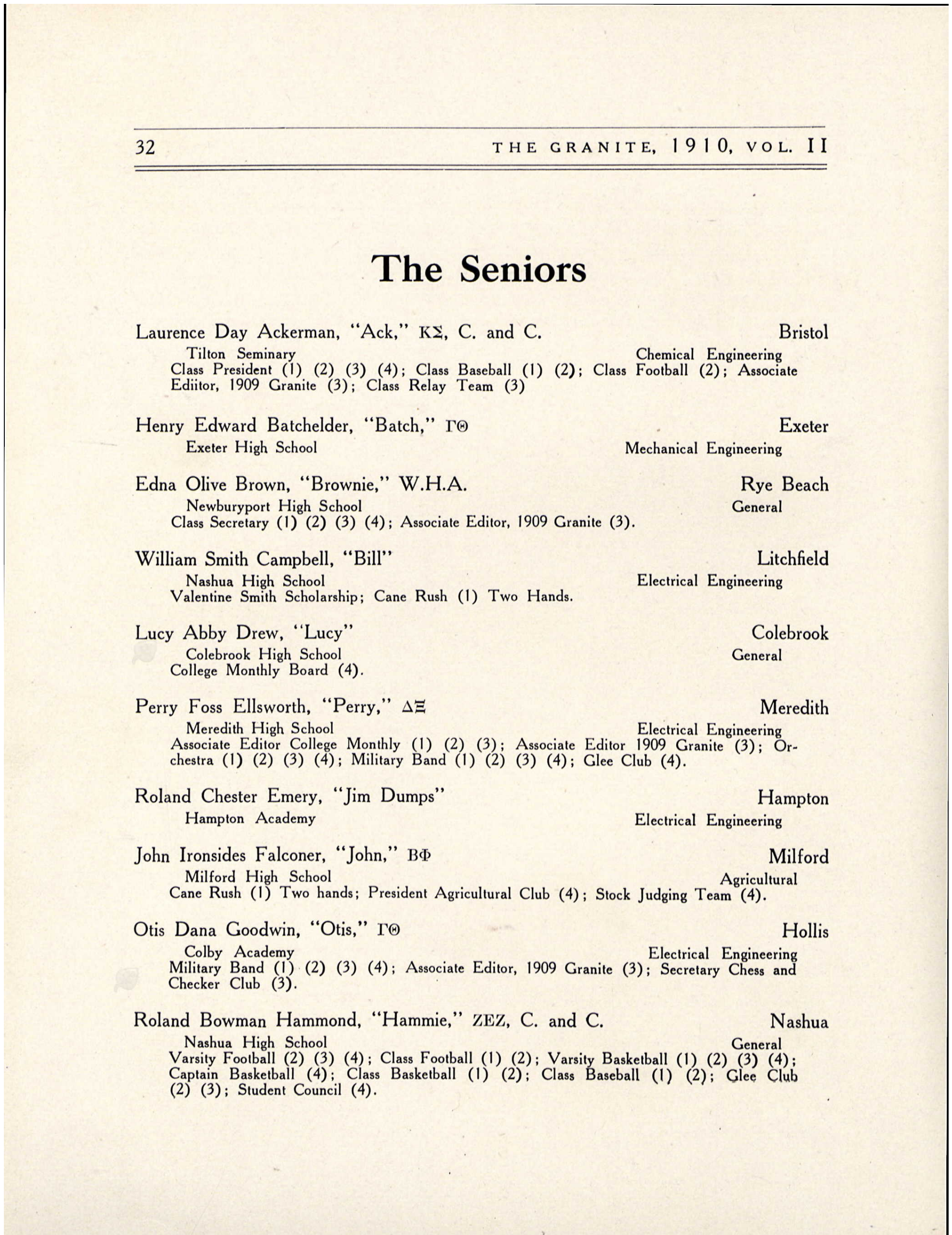
The most obvious explanation for the increase in patenting in college counties relative to the controls is that colleges provide students with an advanced education that enables those students to come up with new inventions. Unfortunately, the direct effect of obtaining a college education on invention is typically difficult to test. One reason for this is that there is no way to link an inventor to a college in the historical data. To overcome this problem, I transcribe college yearbook data for several of the colleges in the sample. The college yearbooks are available from ancestry.com and contain full scans of historical college yearbooks, which include full student names, hometowns, and nicknames, all of which can be used to aid in matching students from yearbooks to other data sources such as the patent record or the US decennial censuses. The college yearbooks also contain a wealth of other interesting information, including students' majors, sports and clubs, and fraternities and sororities. Figure 1.5 shows an example of a college yearbook page. Currently, yearbook data has been transcribed for Georgia Tech University, the University of New Hampshire, the University of Colorado, and Utah State University.[24] Other

[24] For Georgia Tech, yearbooks are available from the years 1917-191, 1922-1924, 1926-1933, 1936, 1938-1940. For the University of New Hampshire, yearbooks are available from 1909-1910, 1914, 1917, 1921, 1925-1927, 1930, 1933, 1937, 1939-1940. For the University of Colorado, yearbooks are available from 1893, 1903, 1908-1912, 1917, 1919-1922, 1924-1929, 1931-1939. For Utah State University, yearbooks are available from 1911, 1928, 1930, 1932, 1939. Due to budget limitations, and due to the fact that future work will link students in the yearbooks to individuals in the U.S. census and the 1940 census is the most recent that

colleges will be added to the data as the data is transcribed. For each yearbook and each of these colleges, I save the names of each college senior. Once matched to the patent record, it is possible to determine what share of patents in a particular college county come from graduates of that college.

To determine whether a particular patent belongs to a college graduate, for each available yearbook I match by first, middle, and last name of college seniors to each succeeding year of the patent data. So, for instance, for a senior found in the 1917 Georgia Tech yearbook, I look for this student's name in the patent data for Georgia Tech's county (Fulton County, GA) for the years 1918, 1919, and so on. I stop searching for matching after 60 years, under the assumption that very few individuals aged 80 and older obtain patents (college seniors are typically from 20-23 years old). To search for name matches between the yearbooks and the census, I use a fuzzy matching algorithm as in Sarada, Andrews, and Ziebarth 2017. More specifically, I use Stata's reclink command, which is a modified bigram string comparator that returns a "distance" (match score) between two strings. Only matches with a sufficiently high match score are retained. Because at this point I am interested in the "most lenient" match of graduates to patents, I keep all plausible matches, regardless of the possibility that graduates living in a college county may share a name with a non-graduate living in the same county. Moreover, this procedure will attribute a patent to a college graduate if the graduate moves to another county but a different individual with the same name obtains a patent in the college county.

is available, no yearbooks have been transcribed for years more recent than 1940.



32 THE GRANITE, 1910, VOL. II

The Seniors

Laurence Day Ackerman, "Ack," KΣ, C. and C. — Bristol
Tilton Seminary — Chemical Engineering
Class President (1) (2) (3) (4); Class Baseball (1) (2); Class Football (2); Associate Ediitor, 1909 Granite (3); Class Relay Team (3)

Henry Edward Batchelder, "Batch," ΓΘ — Exeter
Exeter High School — Mechanical Engineering

Edna Olive Brown, "Brownie," W.H.A. — Rye Beach
Newburyport High School — General
Class Secretary (1) (2) (3) (4); Associate Editor, 1909 Granite (3).

William Smith Campbell, "Bill" — Litchfield
Nashua High School — Electrical Engineering
Valentine Smith Scholarship; Cane Rush (1) Two Hands.

Lucy Abby Drew, "Lucy" — Colebrook
Colebrook High School — General
College Monthly Board (4).

Perry Foss Ellsworth, "Perry," ΔΞ — Meredith
Meredith High School — Electrical Engineering
Associate Editor College Monthly (1) (2) (3); Associate Editor 1909 Granite (3); Orchestra (1) (2) (3) (4); Military Band (1) (2) (3) (4); Glee Club (4).

Roland Chester Emery, "Jim Dumps" — Hampton
Hampton Academy — Electrical Engineering

John Ironsides Falconer, "John," BΦ — Milford
Milford High School — Agricultural
Cane Rush (1) Two hands; President Agricultural Club (4); Stock Judging Team (4).

Otis Dana Goodwin, "Otis," ΓΘ — Hollis
Colby Academy — Electrical Engineering
Military Band (1) (2) (3) (4); Associate Editor, 1909 Granite (3); Secretary Chess and Checker Club (3).

Roland Bowman Hammond, "Hammie," ZEZ, C. and C. — Nashua
Nashua High School — General
Varsity Football (2) (3) (4); Class Football (1) (2); Varsity Basketball (1) (2) (3) (4); Captain Basketball (4); Class Basketball (1) (2); Class Baseball (1) (2); Glee Club (2) (3); Student Council (4).

Figure 1.5: An example page from one of the transcribed college yearbooks. This image is from the 1910 University of New Hampshire yearbook.

To calculate a patenting rate for graduates of a particular college in that college's county, for each senior yearbook student (including those that are not matched to a patent), I count the number of years over which the student can potentially obtain a patent. For a college yearbook from year t, the number of years that a student s can obtain a patent is $\bar{t}_s = \min\{60, 1975 - t\}$, since I assume that no one obtains a patent after age 80. For college i, founded in year t_{0i}, in year t, the patenting rate for graduates is given by

$$Grad.PatentRate_i = \sum_{t=t_{0i}}^{1975} \left[\frac{1}{S_{it}} \sum_{s \in S_{it}} Num.Pat._{st} \right], \tag{1.5}$$

where S_{it} is the set of all students that have graduated from college i at $t_{0s} <= t$ and for whom $t <= t_{0s} + \bar{t}_s$. In words, this is simply the number of patents per graduate per possible patenting year. I compute a similar "overall" patenting rate that is the number of patents per resident per possible patenting year for each college county. For this overall county patenting rate, I only use data from the census years, since these are the only years for which county-level population is known with certainty. So, for the overall county rate, the number of years for which a patent can be obtained is simply the number of census years occurring after the establishment of a college.

Surprisingly, I find that college graduates actually patent at a slower rate than the rest of the college county. College graduates patent at the rate of 1.15 patents per 100,000 graduates per decade, while college counties patent at the rate of 6.10 patents per 100,000 people per decade (that is, $\frac{Grad.PatentRate_i}{OverallPatentRate_i} = \frac{1.15}{6.10}$). Because the population of the college county includes the college graduates, the true patenting rate for non-college graduates is even higher than the rate presented here, although college graduates make up such a small share of the local population that the difference is likely negligible. Thus, the surrounding county patents at least 5.3 times the rate of graduates of the county's college.

Such a result is consistent with findings that college graduates did not account for many inventions during other historical periods. Namely there is little evidence that the college educated were highly inventive after graduating from medieval German universities (Cantoni and Yuchtman 2014) or in Britain during the Industrial Revolution (Mitch 1999), times when college graduates tended to become lawyers or clergy. This result is surprising in the American context, however. It is particularly surprising given that all four colleges are land grant or technical schools, which focus on more practical skills like agriculture and the mechanical arts. This result does not, however, say anything about the causal effects of college attendance on patenting; it could be the case that the college graduates would have patented at an even lower rate had they not attended college.

To get a better sense of the role that a college's graduates play in local patenting, I compute the share of patents in the college county attributable to graduates of that college. If college yearbooks were available for every year, this could be easily accomplished by counting the number of patents matched to seniors from the yearbooks and dividing this by the total number of patents in the county over the same time horizon. Unfortunately, yearbooks are only available for a subset of years. To overcome this problem, I impute the number of college students in each year by regressing the number of students in available yearbooks on the year,

$Num.Students_i = \beta_0 + \beta_1 Year + \epsilon_{it}$. To ensure that there are no years that predict a negative or implausibly small number of students, if any year has a predicted number of students smaller than the smallest class in an available yearbook, I replace the number of students with that smallest class size. I then compute the stock of graduates in each year by summing up the predicted number of students in every preceding year:

$$PredictedStudents_{it} = \sum_{\tau <= t} \max\{\hat{\beta}_0 + \hat{\beta}_1 * t, \min\{Num.Students_i\}\}. \tag{1.6}$$

Finally, I assume that in each year, the predicted stock of graduates all patent at each college's patenting rate calculated above. Then by multiplying the predicted stock of graduates by their patenting rate, I get a predicted number of patents attributable to college graduates:

$$PredictedNum.Patents_{it} = PredictedStudents_{it} * Grad.PatentRate_i \tag{1.7}$$

Using this approach and dividing county i's predicted number of graduate patents in year t by the actual number of patents in county i and year t, I find that college graduates account for only about 1.2% of patents in college counties. Even if one assumes that no patent by a college graduate would have been invented without the establishment of that college, this accounts for only a very small fraction of the estimated additional patents in treatment counties relative to control counties.

Note that this share of patents by graduates in the college county is almost certainly an overestimate. As noted above, the calculation of the graduate patenting rate is inflated by the assumption that every plausible match is obtained by a graduate, and the imputation of the number of seniors in each year is likely to be overstated as well. Moreover, this share does not address the fact that high ability individuals are likely to select into attending college. These individuals are also more likely to become inventors independently of their level of education. At the same time, this only accounts for the share of a college's graduates in producing patents *in the college's county.* This does not account for the fact that college graduates may move away and then patent. Understanding the migration patterns of college graduates after they leave their schools is a subject for future work.

A similar exercise can be conducted to examine patenting by college faculty instead of college graduates. As in the case of college graduates, the fact that yearbooks are not available for all years complicates the analysis. This is an even greater problem for the faculty patenting: the absence of many yearbooks makes it difficult to estimate the faculty turnover from year to year, particularly when the faculty of a particular college was growing rapidly. Moreover, missing faculty members may be particularly prolific inventors. Future versions of this paper will work to refine these techniques. With the preliminary results available, it appears that faculty patent at a higher rate than the rest of the county, but there are so few faculty members that their contribution to overall patenting is negligible.

It is worth noting that these results have been obtained using a small sample of colleges and years. It is possible that the share of patents attributable to a college's graduates is much higher in a larger sample. But at present there is little evidence that a particular college's graduates contribute much to the increase in patenting in that college's county.

1.4.2 College Types and Patent Classes

As an additional check for the importance of a college education on invention, I check for differences in patenting over different types of colleges. If the increase in patenting is driven mainly by the skills students acquire while attending school or the research conducted by faculty, then one should expect to see different effects for different types of colleges since these different institutions had very different curricula. Colleges are classified by type as described in Section 1.2.3. Land grant colleges were required by law to provide instruction on "agricultural and mechanical arts", and technical colleges explicitly focused on skills such as engineering, mining, or industry. At the same time, normal schools train public school teachers, and so typically devote less, if any, attention to technical skills. Other public and private colleges tended to have a less practical focus, providing instruction in classes like the classics or Latin. If the skills developed at college are an important driver of invention, then normal schools and other public and private colleges should produce less patenting than land grant and technical colleges.

I classify each college as either a "practical" or a "classical" college. Practical colleges are land grant colleges or technical schools. Classical colleges are normal schools and other private and public colleges. For some types of colleges, there is much more ambiguity regarding whether or not the college is practical or classical. I also use alternative classifications in which the military academies are included as practical colleges and HBCUs are included as classical colleges. In Columns 1 and 2 of Table 1.5 results, I show results for the effect of establishing different types of colleges. It does appear that practical colleges increase patenting by more than classical colleges, but the difference between the two coefficients is modest and not statistically different from zero. The practical colleges had 28% more patents per year (significant at the 5% level), while the classical colleges had 24% more patents per year (statistically insignificant). This difference is larger when the alternative definitions of practical and classical colleges are used, with practical colleges having 39% more patents per year compared to 24% for classical colleges. It is unclear why the inclusion of military academies changes the estimated effect of practical colleges by so much, especially since the graduates of those schools are commissioned and sent away from the college county, and so are unlikely to remain in the same county and patent.

In Column 3, I exclude all years after 1940 from the data, because following the explosion in the demand for higher education after World War II, the curricula across colleges largely began to converge. In the pre-1940 years, the differences between practical and classical colleges is almost nonexistent: practical colleges saw about 23% more patents per year relative to their control counties, while classical colleges saw 22% more; neither coefficient is individually statistically significant. The fact that the standard errors are typically larger for the classical colleges could simply be indicative of the larger variance in terms of curricula that goes on across these types of colleges. In Appendix A.6, I present results for each college type separately. Because there are very few college experiments for HBCUs, military academies, normal schools, and other private colleges, however, there is insufficient power to draw conclusions from these effects. Even with a finer classification of colleges, the results do not conform to the simple intuition that establishing a more “technical” colleges, however measured, produces more patents. An additional concern is that certain types of colleges appear to have a larger effect on patenting simply because these colleges are typically larger, either in the sense of graduating more students or by attracting a larger number of migrants to the county; I discuss some of these effects in Section 1.4.4.

	Practical vs. Classical Colleges	Practical vs. Classical Colleges, Alt. Definitions	Practical vs. Classical Colleges, Pre-1940	Frac. Ag. Patents	Frac. Ag. Patents, Alt. Definition	Frac. Mining Patents
Practical College Interaction: (% Change)	0.2799**	0.3941**	0.2270			
	(0.1305)	(0.1788)	(0.1683)			
(# Change)	1.0060**	1.4166**	0.8158			
	(0.4690)	(0.6428)	(0.6049)			
Classical College Interaction: (% Change)	0.2425	0.2354	0.2150			
	(0.1883)	(0.1694)	(0.1873)			
(# Change)	0.8716	0.8462	0.7729			
	(0.6769)	(0.6088)	(0.6732)			
Land Grant Interaction: (% Change)				-4.3555	-2.0362	
				(3.0384)	(1.7582)	
(# Change)				-0.0296	-0.0369	
				(0.0206)	(0.0318)	
Non-Land Grant Interaction: (% Change)				-0.1735	-0.1617	
				(1.2817)	(0.7601)	
(# Change)				-0.0012	-0.0029	
				(0.0087)	(0.0138)	
Technical School Interaction: (% Change)						-0.0163
						(0.2759)
(# Change)						-0.0003
						(0.0050)
Non-Technical School Interaction: (% Change)						0.1964
						(0.1679)
(# Change)						0.0036
						(0.0030)
County Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes	Yes	Yes	Yes
Cnty-Year Obs.	34,194	34,194	20,544	10,345	10,345	10,345
# Counties	197	197	197	195	195	195
# Experiments	64	64	64	64	64	64
Adj. R-Sqr.	0.3407	0.3429	0.3092	0.0190	0.0363	0.0143

Table 1.5: Regression results by college type and patent class.

Just as college counties see a large increase in the number of patents, they might also be expected to see a change in the type of patents granted relative to the counterfactual counties. Additionally, even if the type of college does not have a large effect on the number of patents, they might be expected to alter the composition of patent types differently. To get a sense of patent type, I use the patent classes assigned to historical patents by Marco et al. 2015. I do not observe any significant differences in the fraction of patents assigned to NBER one-digit classes between treatment and control counties nor across different types of colleges.[25] Even when looking at more specific patent classes that one might expect to be particularly related to a given college type, I do not observe measurable effects in the predicted direction. Column 4 of Table 1.5 shows that the fraction of agricultural patents does not increase in land grant treatment counties relative to non-land grant treatment counties after establishing the college; in fact, it appears as if the fraction of agricultural patents plummets in counties that get land grant colleges relative to their controls, while there is almost no change in the fraction of agricultural patents in non-land grant treatment counties. I define a patent to be an agricultural patent if it belongs to a three-digit USPTO patent class that is likely affiliated with agriculture.[26] Column 5 uses an

[25]The NBER one-digit patent classes are: chemical, communications, medical, electric, mechanical, other, no class, and missing class.

[26]The one-digit NBER patent classes are much coarser than the USPTO patent classes, so excluding patents related to a specific industry like agriculture are difficult using NBER classes. The USPTO classes also have their issues, namely they are often criticized for being too narrow, not easily mapped to particular industries, and nonsensically organized (Hall, Jaffe, and Trajtenberg 2001). I consider a patent to be an agricultural patent if it belongs to the following classes: 47 "Plant husbandry"; 54 "Harness for working animal"; 56 "Harvesters"; 71 "Chemistry: fertilizers"; 119 "Animal husbandry"; 278 "Land vehicles:

alternative and slightly broader definition of agricultural patent and reaches broadly the same conclusion, although the estimated decrease is smaller.[27] While a naive comparison of land grant and non-land grant colleges reveal that land grant college counties have more agricultural patents, these results show that this is not causal and that establishing a land grant college may actually cause a county to shift away from agricultural patenting. In column 6, I repeat this exercise but using mining patents and comparing technical schools to non-technical schools.[28] The establishment of a technical school does not lead to a higher fraction of mining patents than does the establishment of other types of colleges; in fact, the the estimated magnitude is negative and very close to zero for technical schools, while it is positive for non-technical schools.

The last three columns of Table 1.5 shows that there is little evidence that

---

animal draft appliances"; 449 "Bee culture"; 460 "Crop threshing or separating"; or 504 "Plant protecting and regulating compositions".

[27]In addition to the previously listed classes, the alternative definition also includes: 59 "Chain, staple, and horseshoe making"; 111 "Planting"; 131 "Tobacco"; 171 "Unearthing plants or buried objects"; 185 "Motors: spring, weight, or animal powered"; 231 "Whips and whip apparatus"; 256 "Fences"; 260 "Chemistry of carbon compounds"; 417 "Pumps"; 425 "Plastic article or earthenware shaping or treating: apparatus"; 426 "Food or edible material: processes, compositions, and products"; 435 "Chemistry: molecular biology and microbiology"; 452 "Butchering"; 800 "Multicellular living organisms and unmodified parts thereof and related processes"; and PLT "Plants".

[28]Most of the technical schools in the sample that were founded west of the Mississippi were explicitly mining colleges. This is not the case with technical schools in the east, such as Georgia Tech. In addition to mining, these colleges also taught subjects such as engineering. The curricula in eastern technical schools are still more likely to teach subjects similar to mining than are other colleges, however. I consider a patent to be a mining patent if it belongs to the following classes: 175 "Boring or penetrating the earth"; 299 "Mining or in situ disintegration of hard material"; 405 "Hydraulic and earth engineering"; or 507 "Earth boring, well treating, and oil field chemistry".

college counties become increasingly specialized following the establishment of particular types of colleges. Such a finding is difficult to reconcile with the conjecture that the change in patenting in college counties is driven by the research or education going on within the colleges. In fact, instead of becoming more concentrated in particular fields, patenting becomes more diverse in the college counties after the establishment of a new college. I construct an index of patent concentration, essentially a Herfindahl-Hirschman Index that sums over each patent class the squares of the fraction of a county's patents belonging to that class.[29] I construct this index using three different patent classifications: the one-digit NBER patent classes, the two-digit NBER patent classes, and the three-digit USPTO patent classes. Results are presented in Table 1.6. The estimated coefficient has the same sign and similar magnitudes across all three specifications: a new college causes concentration to fall by 0.10, which is a 40-80% decline in the 1870 baseline concentration measure depending on the patent classifications used. The estimated coefficients are all statistically significant at the 5 or 10% levels. These results suggest that the diversity of ideas patented increased after the creation of a new college; the extra patents produced are not just in the same fields as previous patents in the treatment counties. Such a result is consistent with colleges attracting individuals with new and diverse ideas to the community. In Section 1.4.4, I explore other ways in which colleges can affect their local communities.

[29] More precisely, $Pat.Concent_{it} = \sum_{c \in C_{it}} \left(\frac{Num.Pat_c}{\sum_{k \in C_{it}} Num.Pat_k} \right)^2$ where C_{it} is the set of all patent classes in county i at time t.

	Patent Class Concentration NBER 1 Dig.	Patent Class Concentration NBER 2 Dig.	Patent Class Concentration USPTO classes
Treat.County * HighQual. * PostTreatment: (% Change)	-0.7898*	-0.4162**	-0.4358**
	(0.4446)	(0.1988)	(0.2117)
(# Change)	-0.1126*	-0.1023**	-0.1058**
	(0.0634)	(0.0488)	(0.0514)
PostTreatment: (% Change)	0.1590	0.0928	0.1105
	(0.2218)	(0.1096)	(0.1156)
(# Change)	0.0227	0.0228	0.0268
	(0.0316)	(0.0269)	(0.0281)
County Fixed Effects	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes
Cnty-Year Obs.	7,884	8,173	8,173
# Counties	195	195	195
# Experiments	64	64	64
Adj. R-Sqr.	0.1495	0.1371	0.1238

Table 1.6: Regression results for changes in patent class diversity. The dependent variable is a measure of patent class concentration, similar to a Herfindahl-Hirschman index.

1.4.3 Patenting by Individuals Unaffiliated with a College

The previous two sections show that graduates of a particular college did not account for a large share of that county's patents, and in fact there is little evidence that college curricula mattered either. In this section I provide an estimate for the increase in patenting by individuals who are unaffiliated with a particular college; that is, patenting by individuals in a county for whom it can be determined that they are not graduates or faculty of that county's college. These results can be interpreted as within-county knowledge spillovers as they represent an increase in invention caused by a new college but not completed by individuals who have a direct affiliation with the college. Estimating knowledge spillovers is more complicated than simply estimating the net change in patenting in a treatment county relative to a control county after opening a new college. As Zucker, Darby, and Armstrong 1998 emphasize, it is important not to attribute to spillovers increases in patenting that may be the result of market transactions, for instance graduates patenting while working locally or faculty consulting with co-located firms. In this section, I define knowledge spillovers to be patenting by individuals who do not attend college, but where patenting was facilitated by informal interactions between the patentee and college-educated graduates or faculty. If an individual attends college and subsequently patents, this should not be considered a spillover because the increased probability of becoming an inventor is "priced in" to the individual's decision to attend college.

In most cases, it is very difficult to ascertain if a particular patentee is a college graduate. The previous section uses college yearbook data to directly learn names of graduates. In this section, I use a complementary approach to identify people who very likely to be unaffiliated with the college. Historically, large classes of people were systematically prevented from attending public universities for many years. In particular, many colleges in my dataset were segregated when they first opened. This means that any increase in black patenting in these treatment counties relative to control counties must be due to knowledge spillovers; it cannot come from blacks attending college. Likewise, many colleges were initially open only to men. In this section, I estimate the effect of a new college only for these groups that cannot attend college. This means that, when estimating the effect of a new college on the black patenting rate, I keep an experiment in my dataset from the year the college opens until the school desegregates. If a school is desegregated in its first year, it is excluded from the sample. Additionally, HBCUs are excluded from this sample, since blacks always attended these schools. For the results on the patenting rate by women, I keep an experiment in my dataset from the year the college was founded until the year it becomes coeducational.[30]

To determine whether or not a patentee is white or black, I utilize census data on first names. For each state and each census, I calculate the probability of being black for each first name. A similar technique is used in Cook, Logan, and Parman 2014 to identify "distinctively black names," Jung and Ejermo 2014 to infer gender, Jones 2009 to infer age, and Celik 2015 to infer income. To illustrate this process

[30]This explains why the sample size is smaller in Table 1.7 than in other results tables. See Goldin and Katz 2011 for more on the history of coeducation in American colleges.

precisely, for each first name η in state s, I calculate $p_{\eta_s} = Pr(Black|\eta, s)$. Then, for patentee i with name η_i, I impute the probability being black using $p_{\eta_{is}}$. Then the estimate of the expected number of black inventors in county c is given by

$$\sum_{\eta_c} Num_{\eta_c} p_\eta$$

where Num_{η_c} is the number of patentees in county c with first name η_c. This procedure is essentially a split-sample IV procedure (Angrist and Krueger 1992). I calculate the probability that a patentee is female analogously. Because first name data for all individuals in the U.S. census is only available through 1940, I drop all more recent patent data from these regressions.[31]

Table 1.7 shows the effect of a new college on patenting by blacks and females. Column 1 shows the results for blacks. Opening a new segregated college led to about 7.5% more patents by blacks per year in treatment counties relative to control counties and is statistically significant at the 5% level. Thus, the increase in patents for blacks is roughly 20% as large as the increase in overall patenting estimated in Table 1.3. The estimate for women is smaller and imprecisely estimated, but the magnitude suggests that opening a new male-only college led to about 3% more patents by females per year. In spite of these relatively large estimated percentage increases, blacks and women both patented at very low rates for most of the sample period.[32] Using the above method to count patents by blacks and females, in 1870

[31] This is another reason why the sample size is smaller here than in other results table.

[32] See Sarada, Andrews, and Ziebarth 2017 for more detail on patenting by marginalized groups in the historical United States.

blacks were granted only 0.16 patents per year in the average county, while women were granted just over a third of a patent per year.[33] Thus, the establishment of a new college adds only about 0.01 additional patents by black inventors per year and 0.02 patents from female inventors per year. Recall from Table 1.3 that the establishment of a new college led to about 1.2 additional patents per year in treatment counties relative to control counties. These results suggest that blacks and women who were excluded from attending college together account for about 3% of the overall number of additional patents. Due to the difficulty of predicting race and gender by first name and the imprecision of the estimates, this result should be treated with caution, however.

It is worth emphasizing that spillovers to blacks and women who were prohibited from attending college are almost certainly a lower bound on the total spillovers from a new college. The fact that the colleges used for these results were segregated, either by race or gender, suggests that discrimination in these areas was high. Groups that faced less discrimination, such as non-college-attending white males, likely benefited even more from interactions with college-attending individuals. This makes the magnitudes of these coefficients even more surprising. I see this as suggestive, if very tentative, evidence that at least some of the effect of colleges on patenting came not from the accumulation of human capital or academic research, but rather from general urbanization externalities that occurred as high-initiative people moved

[33] Identifying the overall number of black patents by first name can be especially fraught with error, as African American inventors might attempt to "pass for white" to avoid discrimination against their inventions. See Cook 2014, Hobbs 2014, and Jaspin 2007.

to college counties.

		log(Black Patents + 1)	log(Female Patents + 1)
Treat.County * HighQual. * PostTreatment:	(% Change)	0.0748**	0.0293
		(0.0367)	(0.0599)
	(# Change)	0.0099**	0.0043
		(0.0049)	(0.0089)
PostTreatment:	(% Change)	0.0153	0.1003
		(0.0277)	(0.0758)
	(# Change)	0.0020	0.0149
		(0.0037)	(0.0112)
	County Fixed Effects	Yes	Yes
	Year Effects	Yes	Yes
	Cnty-Year Obs.	18,705	7,003
	# Counties	184	168
	# Experiments	61	64
	Adj. R-Sqr.	0.1558	0.1854

Table 1.7: Regression results by black and female patenting.

1.4.4 Demographic and Economic Effects of Colleges

In Table 1.8, I investigate the effects of establishing a new college on several other potential outcome variables. Some of these have been identified by other authors as outcomes that colleges are likely to affect (for instance, Liu 2015), and all could serve as channels through which colleges affect invention.

Because these outcome variables are typically available from the NHGIS data which is published decennially, I restrict the data to observations that occur only the census years: 1840, 1850, 1860, etc. Thus the “time” variable no longer represents the number of years since a college site selection experiment, but rather the number of decades. In Column 1, I reproduce the baseline result on patenting using only patenting in census years. The estimated coefficient is similar to the baseline coefficient estimated in Column 1 of Table 1.3, although slightly smaller, finding that establishing a new college leads to about 23% more patents per year.

Column 2 estimates the effect of a new college on logged county population. If colleges succeeded in driving a large number of people into the treatment county, then any effects on patenting could simply be due to the college county having more people. I find that college counties are 43% larger than the control counties after establishing a college; this effect is statistically significant at the 10% level.

	log(Patents + 1)	log(Total Pop.)	Frac. Urban	Mean Age	Frac. Interstate Migrants	Segregation	Manuf. Productivity
Treat.County * HighQual. * PostTreatment: (% Change)	0.2290*	0.4264*	1.0632**	-0.0006	0.0105	-0.1706	0.0248
	(0.1183)	(0.2417)	(0.4291)	(0.0085)	(0.0552)	(0.1374)	(0.1145)
(# Change)	0.8230*	7,544.6534*	0.0796**	-0.0208	0.0067	-0.0382	1,618.8205
	(0.4253)	(4,277.0109)	(0.0321)	(0.2842)	(0.0353)	(0.0307)	(7,463.4651)
PostTreatment: (% Change)	0.0165	0.3564**	0.0452	-0.0068	0.0708*	0.2547**	0.0069
	(0.0791)	(0.1389)	(0.2773)	(0.0053)	(0.0372)	(0.1090)	(0.0714)
(# Change)	0.0593	6,305.4298**	0.0034	-0.2264	0.0452*	0.0570**	447.9622
	(0.2844)	(2,457.8185)	(0.0208)	(0.1774)	(0.0237)	(0.0244)	(4,650.2522)
County Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cnty-Year Obs.	3,287	3,287	2,509	1,465	1,477	1,077	1,272
# Counties	197	197	197	197	197	194	196
# Experiments	64	64	64	64	64	64	64
Adj. R-Sqr.	0.3307	0.5935	0.4954	0.9850	0.4635	0.3832	0.8659

Table 1.8: Baseline regression results using various demographic and economic dependent variables. Data are from census years only.

Examining the effect of colleges on population in more detail is telling. I estimate the effect of establishing a new college on county population, using the analog to Equation (1.4). Figure 1.6 plots the estimated coefficients for $\log(TotalPop.)$ against the estimated coefficients for $\log(Num.Patents + 1)$ for each college site selection experiment. The 45 degree line is plotted as the gray dashed line in the figure. The estimated slope coefficient is a statistically significant 0.3. Counties that grow more are thus more likely to be the same counties that see a larger increase in patenting. Notably, however, this estimated slope is less than one, so there is no evidence that patenting exhibits increasing returns in population.

In Column 3, I check whether a new college also increases urbanization in treatment counties relative to controls. Following the establishment of a new college, the fraction of a county living in urban areas increases by 8 percentage points in treated counties relative to controls, a large increase that is significant at the 5% level. Column 4 checks whether establishing a new college affects the average age in the treatment county by using mean age as the dependent variable in Equation (2.1); the result is insignificant and small in magnitude. Column 5 finds that treatment counties have about 1% more interstate migrant residents than the control counties after establishing the college, although this result is also not statistically significant. The dependent variable for Column 6 is the measure of residential segregation constructed by Logan and Parman 2017. This measure captures uses census records of the race of each household as well as its neighbors to calculate how segregated a county is relative to a random distribution of households ($Segregation = 0$) and complete segregation

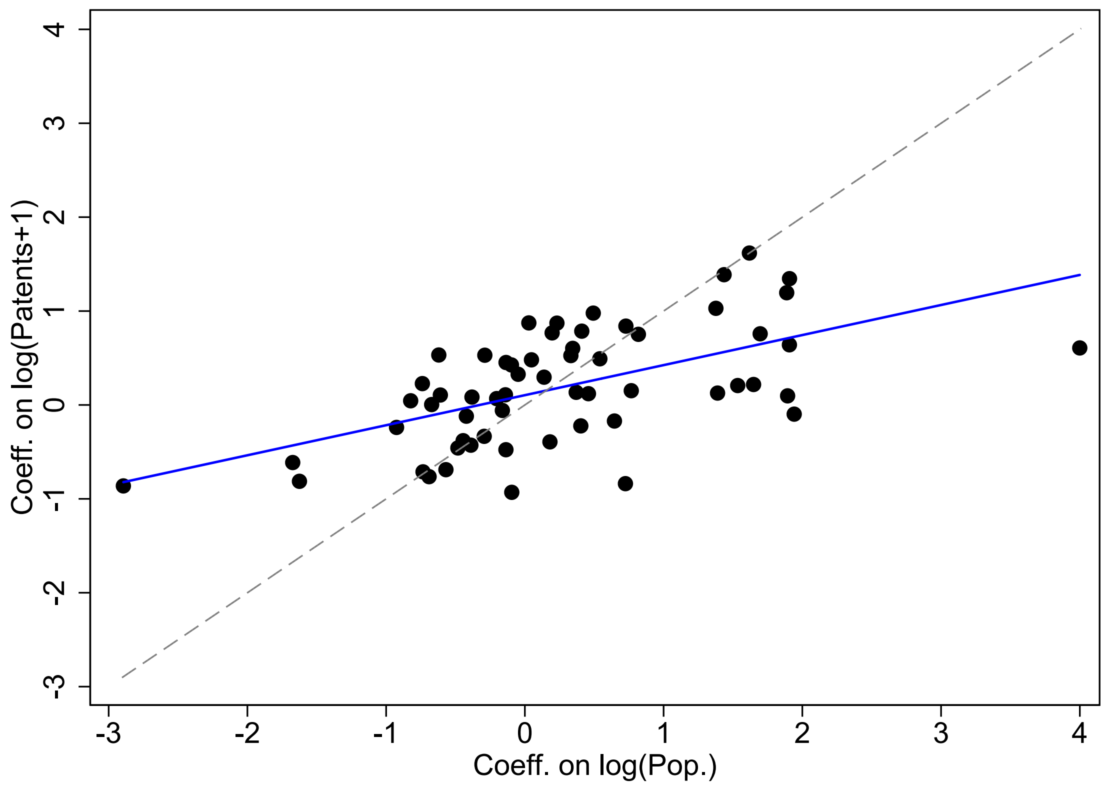


Figure 1.6: Scatter plot of the estimated coefficients for $log(NumPatents{+}1)$ compared to estimated coefficients for $log(TotalPopulation)$ for each college site selection experiment. The blue solid line is the line of best fit. The gray dashed line is the 45 degree line.

($Segregation = 1$), and so the estimated coefficient can be interpreted as a percentage. While segregation appears to decrease after the establishment of a new college in college towns by 17%, the effect is not statistically different from zero. Column 6 uses manufacturing productivity as the dependent variable and finds an insignificant positive result.

A great deal of research suggests that population size and density is crucial for the generation and dissemination of new ideas.[34] For this reason, in Table 1.9, I account for population's effect on patenting in various ways. In Column 1, I estimate the effect of establishing a new college on patenting per capita, which is calculated as the number of patents divided by county population for each county and each census year. Although the estimated coefficient is positive, it is not statistically different from zero. In Column 2, I re-estimate the baseline regression with logged patents as the dependent variable, but include $log(TotalPop)$ as a control. Not surprisingly, county population is highly predictive of county patenting. When including $log(TotalPop)$, the coefficient on the interaction term of interest is only 35% as large as in the baseline estimate, decreasing from 34% in the baseline estimate to 12%, and is no longer statistically significant. Thus changes in county population can plausibly explain roughly two-thirds of the observed increase in patenting in college counties relative to their controls.

The estimated effect of establishing a college on patenting after controlling for

[34]For instance, see Duranton and Puga 2004 and Glaeser and Gottlieb 2009 for surveys of the theoretical literature on population and innovation.

population, shown in Column 2, is likely to be biased however. Any post-treatment confounding variable that affects both population and patenting will bias the estimated treatment effect, which Acharya, Blackwell, and Sen 2016 call "intermediate variable bias." Such bias is almost certain to occur here. Obviously, colleges vary greatly in terms of the number of faculty, number of students, and resources spent on research. Colleges with more faculty and students or more to spend on research likely attract more people to a college county and also produces more patents. Ignoring this will bias downward the estimated treatment effect.[35] I therefore obtain controlled direct effects of colleges on patenting, re-estimating the baseline regression while controlling for population using the sequential g-estimation proposed by Acharya, Blackwell, and Sen 2016, which in turn builds on techniques from the biology literature (Joffe and Greene 2009, Vansteelandt 2009). The sequential g-estimator is a two-stage estimator. The first stage estimates the same model as in Column 2 and saves the estimated coefficient for $log(TotalPop)$ conditional on the treatment and fixed effects. Then, a "demediated" outcome variable $\log(Num.\tilde{Patents}+1)$ is constructed by subtracting the fitted values for $log(TotalPop)$ from $\log(Num.Patents+1)$. In the second stage, the demediated outcome is regressed on the treatment and fixed effects. The second stage estimate of the effect of establishing a new college is consistent because it does not condition on $log(TotalPop)$ or any intermediate variables.

[35]Even if complete data on, for instance, research spending could be obtained over this time period, simply controlling for research spending still leads to biased results because it removes the causal channel through which colleges affect research spending which in turn affects patenting independently of population.

The results are presented in Column 3.The first stage results are already calculated in Column 2, so I do not reproduce them for Column 3. As expected, the coefficient on the treatment effect is larger than in Column 2, although the differences are small. The bootstrapped standard errors are slightly smaller than in Column 2 as well, although still not quite statistically significant at conventional levels.

I repeat this exercise in Columns 4 and 5, controlling for total population and squared total population instead of $log(TotalPop)$. Column 4 presents standard estimates simply controlling for these variables in the regression. The coefficient on the squared term is negative but very close to zero; as in Figure 1.6 I find no evidence that patenting exhibits increasing returns in population. Column 5 repeats the g-estimation procedure as in Column 8. In both columns, establishing a new college leads to roughly 19% more patents per year even after controlling for population and squared population, and the effect is statistically significant (at the 10% level in Column 4 and the 5% level in Column 5). Thus in this specification, controlling for population explains roughly 44% of the increase in patenting.

Controlling for population in various ways still leaves between one third and 60% of the increase in patenting to be explained. Moreover, while establishing a new college leads to a larger population, it is unclear what kinds of individuals colleges are attracting. These are subjects of future work. More specifically, in future versions of this paper I will combine the patent data with the 100% U.S. decennial censuses to learn more about the inventors in the treatment and control counties, including which fraction of patents come from recent migrants and whether the migrants to college counties look different from the migrants to control counties. Finally, I will investigate whether the college creates measurable spillovers to individuals who were in the counties before the college experiment, more directly estimating the knowledge spillovers explored in Section 1.4.3.

	Patents per Capita	log(Patents + 1)		log(Patents + 1)	
Treat.County * HighQual. * PostTreatment: (% Change)	0.0025	0.1273	0.1274	0.1865*	0.1868**
	(0.0031)	(0.0958)	(0.0811)	(0.1101)	(0.0876)
(# Change)	0.0092	0.4575	0.4579	0.6702*	0.6715**
	(0.0111)	(0.3445)	(0.2914)	(0.3956)	(0.3150)
PostTreatment: (% Change)	0.0033	-0.0548	-0.0548	0.0138	0.0138
	(0.0027)	(0.0663)	(0.0576)	(0.0771)	(0.0625)
(# Change)	0.0119	-0.1971	-0.2007	0.0496	0.0456
	(0.0097)	(0.2384)	(0.2062)	(0.2772)	(0.2238)
log(Total Pop.): (% Change)		0.2664***			
		(0.0338)			
(# Change)		0.9574***			
		(0.1214)			
Total Pop.: (% Change)				0.0011**	
				(0.0004)	
(# Change)				0.0038**	
				(0.0015)	
Total. Pop Squared: (% Change)				-0.0000**	
				(0.0000)	
(# Change)				-0.0000**	
				(0.0000)	
County Fixed Effects	Yes	Yes	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes	Yes	Yes
Cnty-Year Obs.	3,286	3,287		3,287	
# Counties	197	197	197	197	197
# Experiments	64	64	64	64	64
Adj. R-Sqr.	0.1785	0.3568	0.3568	0.3429	0.3568

Table 1.9: Regression results after controlling for changes in county population in various ways. Data are from census years only.

1.4.5 Colleges versus Consolation Prizes

In this section, I turn my attention to a subset of the college site selection experiments in which the losing counties, while they did not receive a college, did experience many of the demographic and economic changes described in Section 1.4.4. In some cases, losing finalist counties were not truly "losers": while they may not have obtained a state university, they did obtain some other state institution. I refer to these as "consolation prizes." Consolation prizes are especially common in western states that were largely unsettled and achieved statehood after the passage of the Morrill Act in 1862. In these states, typically many state institutions were allocated at the same time, including the state college, the state prison, the state hospital, and the state insane asylum. While numerous localities may have been lobbying to get a state institution, which locality ended up with which institution was as good as random. For one famous example, the Tuscon delegation set out for Prescott for the Arizona territorial legislature in 1885 intent on getting the state mental hospital. But flooding on the Salt River delayed the delegation. By the time they reached Prescott, the mental hospital had already been spoken for; Tuscon was stuck with state university.

Table 1.10 shows results that explicitly consider the consolation prize counties. In column 1, I compare patenting in the college counties to consolation prize counties. The coefficient is statistically insignificant 20%, smaller than the baseline estimate of 33%. This suggests that college counties do not increase their patenting much faster than counties that received prisons, hospitals, or insane asylums. Consistent with this, column 2 shows that when consolation prize counties are excluded from the sample, a new college increases patenting by about 35%, slightly larger than the 33% baseline estimate. Likewise, in column 3 the consolation prize counties are classified as treatment counties, and the estimated coefficient is positive and statistically significant: in this case, the "treatment" counties patent 30% more than control counties. This column can be thought of as presenting results from an experiment in which the treatment is receiving any state institution.

	Consolation Prize	No Consolation Prize	Cons. Prize as Treated
Treat.County * HighQual. * PostTreatment: (% Change)	0.2034	0.3488***	0.2913**
	(0.2005)	(0.1278)	(0.1151)
(# Change)	0.7312	1.2538***	1.0471**
	(0.7206)	(0.4594)	(0.4139)
PostTreatment: (% Change)	0.0274	0.0056	0.0159
	(0.1777)	(0.0709)	(0.0693)
(# Change)	0.0985	0.0203	0.0572
	(0.6388)	(0.2548)	(0.2490)
County Fixed Effects	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes
Cnty-Year Obs.	14,525	30,869	34,194
# Counties	83	178	197
# Experiments	64	64	64
Adj. R-Sqr.	0.3887	0.3393	0.3423

Table 1.10: Regression results under various assumptions about consolation prize counties.

To make sense of these results, it is important to remember the context in which these experiments took place. Localities actively lobbied for prisons and insane asylums. Instead of repelling highly mobile skilled workers, as these institutions might today, the consolation prizes gave small towns an identity and attracted more people to the area. Figure 1.7 plots the logged county population by decade before and after the establishment of a new college for both the college counties and the consolation prize counties. Both grew nearly identically both before and after the establishment of a new college. While it is possible, although not especially likely, that places like prisons and insane asylums increased invention directly through their activities, this figure is suggestive that the increase is largely due to a broader pattern of urbanization at work in these places. The fact that the pattern is so similar between colleges and the other consolation prize sites presents further suggestive evidence that broad urbanization is a major driver of patenting in the college counties.[36]

1.4.6 Discussion

In this section, I summarize the results from the previous sections and discuss what these results imply about the channels through which colleges affect invention. As noted above, there are numerous potential mechanisms by which colleges can increase local invention. Most directly, colleges give students technical skills, which can be used to produce new inventions. The above analysis finds little evidence that this

[36]The treatment and consolation prize counties continue to look very similar even after controlling for log county population. In these regressions, the coefficient on population is very large in magnitude and reduces the coefficient on $Treatment_{ij} * PostTreatment_{jt}$ to almost zero, qualitatively similar to the results controlling for population in Table 1.8. In the case of consolation prize experiments, the estimated interaction return reduces from a 21% increase to only a 6% increase after controlling for population. This is suggestive of the fact that the experiments in which several institutions were allocated at the same time occurred in particularly undeveloped and unpopulated areas, and that subsequent population growth explains most of the observed differences in these cases. Understanding how the effect of establishing a new college varies with the initial level of development of an area is an important area for future research.

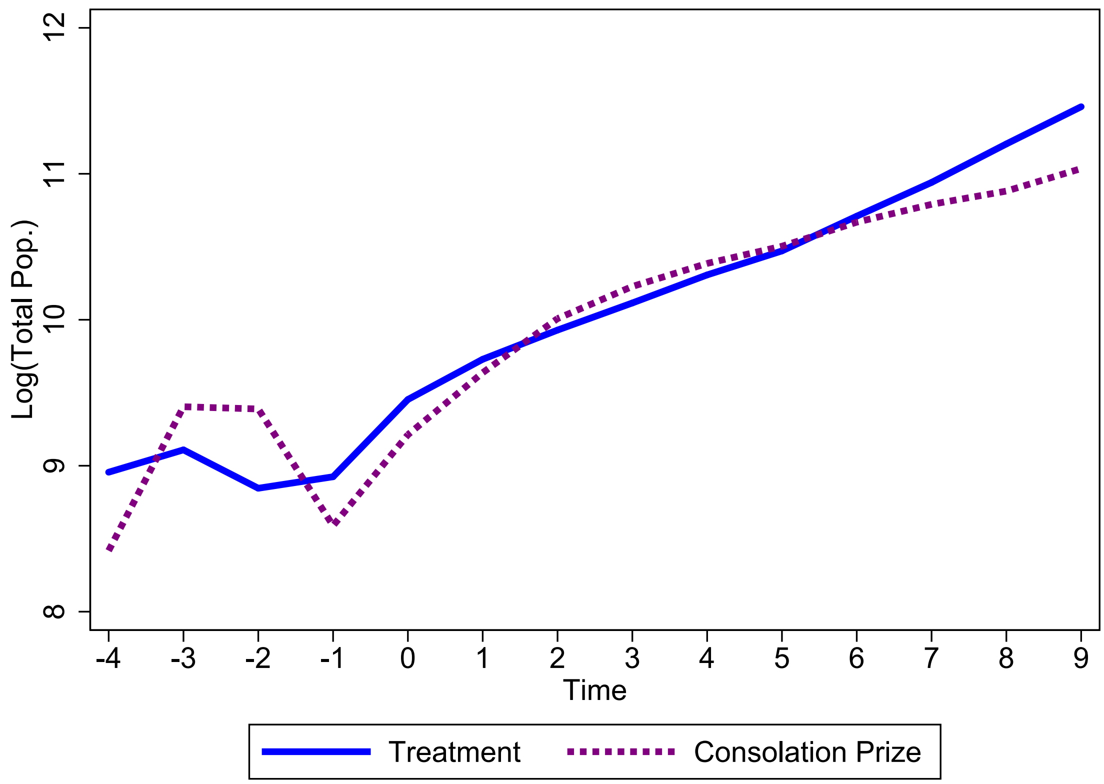


Figure 1.7: Logged total population by decade in the treatment (college) and consolation prize counties. The x-axis shows the number of decades since the college experiment. The ten year period immediately following the establishment of a new college is normalized to decade 0. Everything left of decade 0 shows pre-treatment population; everything to the right shows post-treatment population. The y-axis shows $log(TotalPopulation)$. The treatment counties are represented by the blue solid line. The consolation prize control counties are represented by the purple dashed line.

is the major channel by which colleges promote invention, however.[37] Using a novel dataset connecting college graduates to the patent record, I find that a particular college's graduates account for less than 2% of patents in that college's county. In Appendix A.6, I compare increases in patenting for land grant and technical colleges to schools with less of a technical focus. If the technical skills granted to graduates are indeed the drivers of local patenting, then schools with a technical focus should see larger increases in patenting. While more practically focused colleges produce slightly more additional patents than more classically focused schools, the differences are modest and not statistically significant. Finally, colleges that focus on particular fields, such as agriculture or mining, do not lead to a higher concentration of patents in those fields; if anything, patenting overall becomes more diverse after the establishment of new colleges. Together, these findings do not support the hypothesis that granting skills to graduates is a major driver of local patenting.

While the above analysis shows that graduates of a particular college account for a small share of patents in that college's county, it is less successful in showing what kinds of individuals do produce the lion's share of patents. I explore various avenues through which establishing a college can affect a county: by changing population, the fraction of the population living in urban areas, the age composition of the populace, the share of the population that come from different places, residential segregation, and productivity. While colleges appear to decrease residential segregation

[37]While it is possible that educated individuals were still important producers of patents in the historical U.S., the analysis here suggests that, if it occurred, this invention did not take place close to the college from which these individuals graduated.

and increase manufacturing productivity, none of these effects are statistically significant. Establishing a new college leads to large and statistically significant increases in county population and in the fraction of the county population living in urban areas. In spite of this, I find no evidence that patenting exhibits increasing returns in population. Even after controlling for the increase in population, establishing a new college leads to 13-19% more patents per year in the treatment counties relative to the control counties.

Speculatively, one possible explanation for all of these findings is that colleges tend to attract particularly high skilled or creative individuals, and the agglomeration of these individuals exhibits increasing returns. Others have argued that the agglomeration of particularly talented individuals was an important driver of innovation during previous historical periods: Mokyr 2002, Mokyr 2005, and Squicciarini and Voigtländer 2015 argue that the presence of a small group of "knowledge elites" spurred the Industrial Revolution in England and France, even while promoting human capital more generally had little effect.[38] Even today, urban scientists argue that cities with intellectually stimulating amenities are more successful at attracting creative talent and can then more easily become innovative hubs (for instance, Florida 2002 and Florida 2005). Understanding the extent to which this story also drove invention in college counties in U.S. history requires a deep exploration of the identities of the inventors and migrants to these counties because the agglomeration

[38] Also see Mitch 1999 for a discussion of the lack of evidence that average human capital played any role in driving the Industrial Revolution in England.

of particular types of individuals may not be apparent in the aggregate data. Such an exploration is possible with detailed patent, census, and college yearbook microdata; I am exploring this issue in more depth in future versions of this paper.

1.5 Conclusion

In this paper, I exploit a natural experiment to identify valid counterfactuals to counties that received a new college in the historical United States. I find that establishing a new college caused roughly 33% more patents per year in college counties relative to control counties. The difference between treatment and control counties tended to get larger over time, and the benefits in treatment counties appear to spill over and affect neighboring counties as well.

I also attempt to understand the mechanisms by which colleges increase patenting. I present results that show that the increase in patenting in a particular college county is likely not driven by graduates of that college. If the technical skills taught by colleges are the primary drivers of innovation, then colleges that teach more "practical" skills such as agriculture and machinery should patent more relative to their control counties than colleges with a more classical focus; the evidence for this is inconclusive. I do find some evidence that increases in population explain some of the increase in patenting, and college counties with the largest increases in population also tend to have the largest increases in patenting. Future work, utilizing a novel dataset of college yearbooks and the detailed microlevel data available from the U.S. censuses, will be used to further explore what types of individuals produce the patents in college counties. Moreover, I introduce two novel datasets: a list of college site selection experiments, and detailed college yearbook data that includes information on students and faculty at various colleges. It is my hope that in the future these data will be used to explore the effects of colleges throughout U.S. history more generally, including their effect on labor markets, innovation, inequality, and economic growth.

CHAPTER 2
BAR TALK: INFORMAL SOCIAL INTERACTIONS, ALCOHOL PROHIBITION, AND INVENTION

2.1 Introduction

In 1890, Marshall 1890 observed that when individuals and firms co-locate:

> [t]he mysteries of trade become no mysteries; but are as it were in the air, and children learn many of them unconsciously. Good work is rightly appreciated, inventions and improvements in machinery, in processes and the general organization of the business have their merits promptly discussed: if one man starts a new idea, it is taken up by others and combined with suggestions of their own; and thus it becomes the source of further new ideas.

But how do ideas get into the air and spread from person to person? 19th century machine tool manufacturer and inventor Richard Roberts suggests that, rather than moving through the air, ideas are transmitted through the tap: "No trade can be kept secret long; a quart of ale will do wonders in that way" (quoted in Dutton 1984, p. 11).

In the 20th and 21st centuries, social scientists have continued to study the importance of interpersonal interactions for the creation and dissemination of new ideas. Allen 1983 and Hippel 1988, chap. 6 argue that most inventions arise collectively, and that informal interactions between individuals can be more important for invention than any formal connections between would-be inventors. Unfortunately, most of what is known about how ideas spread between individuals relies on formal connections. For instance, Song, Almeida, and Wu 2003, Singh 2005, Agrawal, Cockburn, and McHale 2006, Breschi and Lissoni 2009, Marx, Strumsky, and Fleming 2009, and Marx, Singh, and Fleming 2015 all track workers across firms and observe how formal employee relationships affect invention. Even when the literature documents that invention is more likely to occur when inventors co-locate (Jaffe, Trajtenberg, and Henderson 1993) or share ethnic characteristics (Kerr 2008a), it is impossible to know whether this is due to formal or informal links (Zucker, Darby, and Armstrong 1998).

Attempts to measure the importance of informal information transmission, for instance Rogers 2003, Conley and Udry 2010, and Banerjee et al. 2013, require very detailed data about the social network structure that is not available in most cases (Jackson 2011, Jackson and Yariv 2011). And even when the network structure is observed, additional assumptions are needed to estimate the causal effect of informal interactions. Fundamental endogeneity concerns make convincingly estimating the quantitative importance of informal social interactions exceedingly difficult (Blume et al. 2011). Individuals have a great deal of control over their social interactions. People choose where they live, which watering holes to frequent, and who to talk to once they get there. Unobservable individual characteristics are likely to influence these choices as well as an individual's propensity to invent.

In spite of these daunting empirical and theoretical challenges, many authors conjecture that informal interactions have a first order impact on aggregate economic outcomes. A large literature in urban economics seeks to understand the nature of agglomeration spillovers and how they contribute to productivity growth (for instance, Glaeser et al. 1992, Saxenian 1996, and Glaeser and Gottlieb 2009). Weitzman 1998, Lucas and Moll 2014 and Fogli and Veldkamp 2016 study how serendipitous interpersonal interactions and the resulting recombination of ideas can affect economic growth. Sociologists such as Putnam 2000 and Granovetter 2005 recognize the importance of "informal social connections" in building social capital.

The goal of this paper is to identify a historical event in which the introduction of a new policy restricted settings in which individuals could informally interact and use this to estimate the importance of these informal interactions for invention. More specifically, I examine the effects of state-level alcohol prohibition in the United States. Prior to the enactment of national prohibition in 1920, the U.S. operated under the "local option" doctrine which, as the name implies, meant that counties had the right to determine their own alcohol policies. States also frequently passed statewide alcohol prohibition measures that superseded county-level laws. Using data compiled by Sechrist 2012 and Lewis 2008, I observe which counties had decided to either allow or prohibit the sale of alcoholic beverages as well as how individual counties voted in statewide referendums. Counties that were wet prior to the enactment of statewide prohibition and voted against the new law therefore had prohibition imposed upon them. These laws shut down saloons and other environments in which individuals got together to drink socially, closing down one channel through which individuals informally exchange ideas. This paper tests whether closing down this channel has a measurable effect on the creation of new ideas as measured by patents. The nature, magnitude, and exogeneity of the prohibition-induced disruption allow me to estimate the quantitative importance of these informal social interactions in a simple reduced form setup without requiring detailed knowledge of individuals' social networks.

In a differences-in-differences framework, I compare the wet counties to dry counties before and after the enactment of statewide prohibition. In the preferred specification, the imposition of statewide prohibition results in 15% fewer patents in the wet counties per year.[1] This translates to a loss of roughly 1 patent per year on average in each county on which prohibition was imposed.

Throughout history, examples of informal interactions aiding the spread and creation of ideas, often accompanied by drink, are ubiquitous. The role of tea and coffeehouses in spreading the ideas of the Scientific Enlightenment have been well documented. In fact, these institutions were so valued for their role in transmitting knowledge that they became known as "penny universities" (Ellis 1956).[2] In the U.S., tea and coffeehouses never achieved the same role as social hubs for the sharing of information; instead, that role was filled by taverns and saloons. The local bar

[1] I consider several different specifications to attempt to identify the sets of counties in which the imposition of statewide prohibition was most exogenous; the results across all specifications are qualitatively similar.

[2] The first English coffeehouse opened in the university town of Oxford in 1650 as a place for academics to share ideas over a stimulating drink (Standage 2005, p. 157-8). The polymath Robert Hooke frequented more than 60 coffeehouses in London, and recorded in his diary the people he met (many of them also members of the Royal Society), discussions he held, and scientific experiments he conducted all inside those premises (Iliffe 1995; Standage 2005, p. 157-162). For general accounts of the coffeehouses as hubs for exchanging ideas, see Stewart 1999 and Cowan 2005.

continues to play a similar role to this day. Of her beloved Greenwhich Village neighborhood and the drinking establishments therein, Jane Jacobs writes:

> We are fortunate enough...to be gifted not only with a locally supported bar and another around the corner, but also with a famous bar that draws continuous troops of strangers from adjoining neighborhoods and even from out of town...[B]eginning in midafternoon [the bar] takes on a different life, more like a college bull session with beer, combined with a literary cocktail party, and this continues until the early hours of the morning. On a cold winter's night, as you pass the [bar], and the doors open, a solid wave of conversation and animation surges out and hits you; very warming (Jacobs 1961, p. 40).

A large part of the modern computer industry emerged out of the Homebrew Computer Club, an informal group that frequently met at The Oasis bar and grill and included such luminaries as Fred Moore and Steve Wozniak.[3] More recently, events such as Silicon Drinkabout are explicit about their desire to get creative individuals together to swap business ideas over drinks.[4] As Anthony Golbloom of Kaggle puts it, bringing creative people together to exchange ideas "makes serendipity possible" (Economist 2012). The empirical analysis confirms these anecdotal accounts.

---

[3]The Oasis now dubs itself as a "beer garden" and still welcomes students and other creative types (http://theoasisbeergarden.com/aboutus.html). For histories of the Homebrew Club, see Balin 2001 and Wozniak 1984.

[4]See https://silicondrinkabout.com/about for more information and to learn if Silicon Drinkabouts is hosting an event near you.

Of course, alcohol prohibition may affect invention for reasons unrelated to the disruption of informal social interactions.[5] I perform a number of additional exercises that provide evidence that prohibition reduced patenting through disrupting social interactions. First, I find that the decrease in invention is greatest in the years immediately following imposition of prohibition, consistent with the idea that the immediate disruption of social interactions is driving the decrease in patenting. Second, I show that the difference in patenting rates between men and women shrinks after the imposition of prohibition. Since women were typically not welcome to frequent saloons, the imposition of prohibition has a greater direct effect on male patenting, causing the gap in patenting between men and women to shrink. Finally, I show that the reduction in patenting is not driven by the loss of patents in the brewing and distilling industries, which were directly adversely affected by prohibition. I therefore conclude that alcohol prohibition led to a decrease in patenting, and that this is likely driven by the disruption of informal social interactions.

In addition to enhancing the understanding of the role of informal social connections in invention, this paper also builds on the literature examining the quantitative effects of prohibition. For example, see Dills and Miron 2004 for the effect of prohibition on cirrhosis, Bleakley and Owens 2010 on lynchings, Owens 2011 on

[5] For instance, a debate in the pharmacology and creativity literatures centers on whether alcohol consumption increases creativity. While inconclusive, the evidence for such a link appears to be weak. See, for instance, Norlander 1999, Beveridge and Yorston 1999, Plucker, McNeely, and Morgan 2009, or Hicks et al. 2011. Alcohol consumption may also plausibly reduce invention by impairing cognitive skills; Irving Fisher, in a heroic act of extrapolation, computed that eliminating the consumption of alcohol would lead to a sufficiently large improvement in worker performance to increase the level of GDP by at least 10% (Fisher 1927, p. 156-160).

organized crime, Evans et al. 2016 on adult height, Bodenhorn 2016 on homicides, García-Jimeno 2016 on law enforcement, and Jacks, Pendakur, and Shigeoka 2016 on infant mortality.

This paper is organized as follows. Section 2.2 describes the historical background behind the alcohol prohibition movement in the U.S. Section 2.3 describes the data. Section 2.4 presents the results using statewide prohibition. Section 2.5 extends these results to also consider the imposition of national prohibition. Section 4.5 briefly concludes.

2.2 Historical Background

Bars, taverns, pubs, and saloons have long acted as social hubs. Pubs and taverns were the primary social gathering place in England for both the high and low classes until coffeehouses usurped this role for the upper classes in the late 17th century.[6] After the expansion of coffeehouses, pubs were no longer the primary meeting place for intellectuals, but they were still important as the site for commoners to debate political and religious ideas. As Hailwood 2014, p. 74 writes, "[the alehouse] was an arena of vibrant political expression with greater social depth and geographical breadth than the coffeehouse would ever achieve."

Across the Atlantic Ocean, the American revolution was plotted in places like Williamsburg's Raleigh Tavern, Winchester's Black Horse Inn, Boston's Green

[6] In one famous example, London's George's Inn was the preferred watering hole for London's literary elite over several centuries, being frequented by Chaucer, Shakespeare, and Dickens Brown 2014a.

Dragon Tavern, and Philadelphia's City Tavern.[7] Because of their role in fomenting the revolution against England, taverns and saloons became known as the "nurseries of freedom"; drinking at a public house was seen as a patriotic virtue (Rorabaugh 1979, p. 35). Thus, at a time when the upper classes in England were looking down on the pubs as wasteful distractions for the poor and uneducated, in America taverns and saloons were places frequented by rich and poor, educated and uneducated alike. Drinking continued as an unofficial passtime in America, and by the mid-19th century, per capita alcohol consumption reached levels not seen before or since. Consumption of distilled spirits increased from less than three gallons per person per year in 1800 to more than 5 gallons in 1830. In 1830, per capita annual alcohol consumption contained in all alcoholic beverages reached 3.7 gallons.[8] Starting around 1840, per capita alcohol consumption in the U.S. dropped sharply, likely driven in large part by the rise of the temperance movement as described below. But Powers 1999, p. 18 reports that even as late the 1890s, police precincts in both Chicago and Boston tabulated the number of people entering a saloon on a given night to be nearly equal to half of their respective city's population. And the declining per capita numbers likely reflect a growing number of abstainers; for the majority who chose to continue drinking, the saloon remained an important part of the community.

---

[7]See Sismondo 2011 and Cheever 2015 for more information on drinking patterns in colonial America.

[8]These figures are from Rorabaugh 1979, p. 8-10. While travelers to the U.S. were frequently appalled by the level of drinking they observed, there is little evidence that per capita consumption of alcohol from all sources was systematically higher in the U.S. than in the U.K. throughout the 19th century (Rorabaugh 1979, p. 239).

Throughout the 19th century and into the 20th, saloons served the same social functions that taverns had during the colonial era. The social role of saloons was especially valuable for a nation with high geographic mobility: when new information arrived in a town, it, along with its vector, typically stopped first in the local saloon. Okrent 2010, p. 28 writes:

> The typical saloon featured offerings besides drink and companionship, particularly in urban immigrant districts and in the similarly polygot mining and lumber settlements. In these places, where a customer's ties to a neighborhood might be new and tenuous, saloonkeepers cashed paychecks, extended credit, supplied a mailing address or a message drop for men who had not yet found a permanent home, and in some instances provided sleeping space at five cents a night. In port cities on the East Coast and the Great Lakes, the saloonkeeper was often the labor contractor for dock work. Many saloons had the only public toilets or washing facilities in the neighborhood.

When describing the various benefits of the saloon, novelist Jack London listed its value for spreading ideas first and foremost: "Always when men came together to exchange ideas, to laugh and boast and dare, to relax, to forget the dull toil of tiresome nights and days, always they came together over alcohol. The saloon was the place of congregation. Men gathered to it as primitive men gathered about the fire" (London 1913, p. 33).[9] Moreover, the after-work happy hour is not a recent invention: workers

[9] Jack London's life vividly illustrates both the bright and dark sides of the saloon in early

typically met to drink at their favorite spots for after (and sometimes before or during) work (Rorabaugh 1979, p. 132). Nor were drinking establishments exclusively for the workers. The German lager beer gardens, which became popular in the second half of the 19th century, were egalitarian locales where employers drank with their workers and professionals from various fields interacted (Oldenburg 1989, p. 96-97). Notably, this time period is what Sokoloff and Khan 1990 and Khan 2009 refer to as "the democratization of invention": patents tended to come not from an aristocratic elite, but from skilled workers and craftsmen, the same types of individuals likely to meet in their local saloon.

While millions of the nation's men enjoyed the amenities provided by saloons, a growing segment of society was fixated on the dark side of saloons. Okrent 2010, p. 16 again describes the horrors faced by the wives of frequent saloon-goers:

> the wallet emptied into a bottle; the job lost or the farmwork left undone; and, most pitilessly, a scourage that would later in the century be identified by physicians as "syphilis of the innocent" - venereal disease contracted by the wives of drink-sodden husbands who had found something more than liquor lurking in saloons. Saloons were dark and nasty places, and to the wives of the men inside, they were satanic.

Against this backdrop, an anti-alcohol movement steadily gained steam. Temper-

20th century America. Unable to stem his own consumption, London became an unlikely advocate for women's suffrage, famously remarking that, "The moment women get the vote in any community, the first thing they do is close the saloons. In a thousand generations to come men of themselves will not close the saloons. As well expect the morphine victims to legislate the sale of morphine out of existence" (London 1913, p. 204).

ance movements had existed in the U.S. since at least the start of the Washington Movement in 1840 (Okrent 2010, p. 9-10), and likely several decades before that (Rorabaugh 1979, p. 191-2), but this and other similar movements had promoted voluntary abstinence or moderation. The first state to prohibit the sale of alcoholic beverages was Maine in 1851, with 12 states, mostly in the northeast and midwest, following in the next several years. All of these state laws were repealed by the end of the Civil War, however.

A second wave of prohibition sentiment picked up in the late 19th century and continued into the 1920s. Throughout this period, anti-alcohol groups, spearheaded first by the Womens Christian Temperance Union (WCTU) and then by the Anti-Saloon League (ASL), focused their attention on passing alcohol prohibition at the local level. The doctrine of local option meant that each county determined its own liquor laws, unless the state changed the law to supersede the local decisions. By focusing on influencing local laws, the temperance forces were able to establish beachheads of dry support throughout the nation. As documented by Sechrist 2012 and described in more detail below, a large number of U.S. counties adopted local prohibition statutes. It is noteworthy that, while the prohibition movement had begun in New England and the Midwest, the appearance of dry counties was dispersed across the country. Once they had achieved a critical mass of anti-alcohol votes within a state, the prohibition forces pushed for statewide prohibition, either through legislation or, more commonly, through referendums. As Lewis 2008 argues, prohibition campaigns at the local level tended to be focused and directed; the groups might intensively target only a handful of communities within a state. In addition to eliminating legal alcohol sales in the affected counties, local prohibition also depressed wet voter turnout in statewide referendums; Lewis 2008 suggests that this is caused by the elimination of the saloon as a site for political mobilization. The upshot of this strategy is that achieving prohibition on the county level had a disproportionate effect on statewide vote totals for prohibition. Table 2.1, recreated from Lewis 2008, lists the states that adopted prohibition after 1907 as well as the method by which prohibition was enacted.

The efforts of the prohibition forces culminated in the ratification of the 18th Amendment to the U.S. Constitution on January 16, 1919. In only a few decades, the prospects of national prohibition had morphed from a fringe fantasy to near-inevitability. In his account of the Prohibition era, Okrent 2010 is especially lucid in describing the long and effective lobbying efforts of ASL Superintendent Wayne Wheeler, who was masterful in recruiting to Congress and state legislatures individuals who, even if not personally dry, did not dare to vote against the dry interests.

There is little doubt that national prohibition was a hugely disruptive process that altered the nature of informal social interactions in the U.S. In spite of this, several aspects make national prohibition less attractive as a natural experiment than the earlier enactments of state-level prohibition. First, as noted above, by the time the 18th amendment was ratified, it was all but a foregone conclusion that the U.S. would adopt prohibition; the only question was when it would occur.[10] Moreover,

---

[10]In describing Wayne Wheeler and the ASL's seemingly complete control over Ameri-

Year	State	Method of Enactment
1907	Georgia	Statute
	Oklahoma	Referendum
1908	Mississippi	Statute
	North Carolina	Referendum
1909	Alabama	Statute
	Tennessee	Statute
1912	West Virginia	Referendum
1914	Arizona	Referendum
	Colorado	Referendum
	Oregon	Referendum
	Virginia	Referendum
	Washington	Referendum
1915	South Carolina	Referendum
	Iowa	Statute
1916	Arkansas	Referendum
	Idaho	Referendum
	Michigan	Referendum
	Montana	Referendum
	Nebraska	Referendum
	South Dakota	Referendum
1917	New Hampshire	Statute
	New Mexico	Referendum
	Indiana	Statute
1918	Florida	Referendum
	Nevada	Referendum
	Ohio	Referendum
	Texas	Statute
	Utah	Referendum
	Wyoming	Referendum
1919	Kentucky	Referendum

Table 2.1: From Lewis 2008. The years when each state adopted statewide prohibition between 1907 and 1919, along with the method by which statewide prohibition was enacted.

while the 18th amendment was ratified in 1919, the amendment did not go into effect for a full year, beginning on January 16, 1920.[11] And the amendment had initially been proposed in Congress on August 1, 1917, seventeen and a half months before it was ratified. Together, all of these factors mean that individuals had plenty of time to adjust their behavior in anticipation of the arrival of national prohibition. Second, even ignoring the slow arrival of the 18th amendment, it is not clear when to date the start of national prohibition. During World War I, several measures to restrict the manufacture and sale of alcoholic beverages were passed at the federal level, including establishing dry zones around U.S. military sites and placing restrictions on the use of grain that could otherwise be used to make beer and spirits. In his report trumpeting the effectiveness of national prohibition, Irving Fisher considers prohibition to begin in 1917 with the start of "war-time restrictions" (Fisher 1927). Third, because national prohibition went into effect either during or immediately after America's involvement in World War I (depending on whether one uses the start of "war-time restrictions" or the 18th amendment), the effects of prohibition and the war may be confounded. This is especially plausible since the places most likely to be

---

can politics, an associate wrote that Wheeler "controlled six Congresses, dictated to two Presidents..., directed legislation for the most important elective state and federal offices, held the balance of power in both Republican and Democratic parties, distributed more patronage than any dozen other men, supervised a federal bureau from the outside without official authority, and was recognized by friend and foe alike as the most masterful and powerful single individual in the United States (quoted in Okrent 2010, p. 41."

[11] One of the reasons for the year-long delay before the amendment went into effect was to allow saloons, breweries, and distilleries to sell down their existing inventory; the government used this as justification for not compensating these industries for the fact that their products no longer had any legal value (Okrent 2010, p. 92-94).

strongly wet, namely industrial cities with large immigrant populations, were likely to be hardest hit by the war, either in wartime production or sending young men who would otherwise be populating saloons to the front. Finally, by the time the 18th amendment was ratified, a majority of states had already adopted prohibition at the state level. Thus, there is more variation to exploit when examining state-level prohibition. For all these reasons, in the econometric results below, I study the effect of adopting prohibition measures at the state level.

Once passed, statewide prohibition ended the legal operation of the saloons, indiscriminately removing their ability to prey on the vulnerable working class as well as eliminating their role as social hubs. Just how disruptive was the elimination of bars, saloons, and taverns for social interactions? While little work examines the social impact of statewide prohibition, accounts of national prohibition give a flavor of how people responded to the shuttering of the saloons. One of the most important initial effects of prohibition was to shift drinking into the home. This process was exacerbated as households began fermenting grapes and grain for wine and moonshine, respectively, and sellers began marketing "malt syrup" for home production of beer (Okrent 2010, p. 250). Consumption within the home, even if among friends, was unlikely to introduce individuals to the diversity of ideas they were exposed to in a bar surrounded by strangers. While the large breweries were typically able to survive prohibition by shifting into the production of near beers and soda or by supplying raw materials for home brewers, saloons did not fare as well. Prior to prohibition, saloons increasingly were sponsored by and acted as extensions of particular breweries (Okrent 2010, p. 29-30). Known as “tied houses,” many saloons went out of business when their sponsoring breweries could no longer legally provide beer at low rates. While statistics are difficult to come by, anecdotally at least, “the saloon completely vanished from the scene” (Welskopp 2013, p. 27). Over time, many of these buildings were converted into speakeasies, but this transition was not immediate. At first, speakeasy culture was not conducive to exchanging and spreading ideas. Drowne 2005, p. 96 traces the origin of the word “speakeasy” to Mencken, who derives it from the Irish phrase “speak softly shop,” in which drinkers literally kept their voices low to avoid detection of the authorities. Such an arrangement is unlikely to be conducive to the vigorous exchange of ideas across people. Moreover, even once the alcohol was flowing through the same taps and drinkers no longer felt compelled to speak softly, the culture in these establishments had changed: while saloons had always been revelrous, speakeasies were loud, focused on music and dancing, and were seen primarily as a location for men and women to meet (Okrent 2010, p. 207-13). It thus appears very likely that prohibition was highly disruptive of established drinking customs and the social interactions they supported; the activities into which individuals initially substituted after the imposition of prohibition were likely less conducive to the exchange of ideas. In the next two sections, I empirically estimate the importance of this disruption.

2.3 Data

Sechrist 2012 introduces a dataset that documents for each U.S. county whether it was wet or dry in each year, as well as whether or not statewide prohibition was in effect. Data on patents is from Petralia, Balland, and Rigby 2016b.[12] County-level data is from the National Historical Geographic Information Series (NHGIS). Data on religious observation across counties comes from the Census of Religious, conducted in 1906, 1916, 1926, and 1936 and available through the NHGIS.

Table 2.2 shows results of a simple cross-sectional regression comparing patenting in wet and dry counties for several years. Each column uses a different dependent variable for patenting. Column 1 shows the results when the dependent variable is $log(Num.Patents + 1)$. Column 2 shows the results when the dependent variable is $Num.Patents$. In almost all cases, wet counties patent significantly more than dries. Of course, such a comparison is not particularly enlightening, since a county's decision to prohibit alcohol sales within its borders is likely correlated with any number of unobserved traits that also affects invention at the county level. Indeed, Table 2.3 shows that wet and dry counties appear different along a number of observable dimensions, although the differences are typically not statistically significant. Table 2.3 shows the results of t-tests between wet and dry counties in the last census year before the enactment of statewide prohibition. Wet counties appear to be on average larger, more urban, and have a larger share of immigrants. Clearly, differences in patenting

[12]See Petralia, Balland, and Rigby 2016a for details on how the dataset was constructed. Also see Andrews 2017a for the strengths and weaknesses of this patent data.

between wet and dry counties cannot be interpreted as caused by alcohol prohibition. To answer the causal question, I consider cases in which prohibition is imposed at the state level. The imposition of statewide prohibition differentially affects counties, depending on whether they were already wet or dry before statewide prohibition went into effect. As I show below, trends in patenting across wet and dry counties were parallel before imposition of state prohibition, so the higher levels in wet counties difference out in a panel regression.

Because many counties enacted their own dry laws before the imposition of statewide prohibition, this raises the concern that the prohibition movement was also gaining strength in wet counties, and so any difference between the wet and dry counties may be due to an underlying shift in the attitudes of wet counties, even if they themselves did not adopt county prohibition. I minimize this concern in several ways. First, I restrict the sample to only counties that have been wet or dry for an extended period of time before the enactment of statewide prohibition.[13] Table 2.4 lists the times over which each state was dry. These remaining counties were likely to be consistely wet or dry and saw the least within-county change in the run-up to statewide prohibition. In addition to the observed parallel trends between wet and dry counties, Lewis 2008 documents that one effect of a successful county-level prohibition movement was to depress wet voter turnout in those counties when the

[13]Specifically, I restrict the sample to counties that were either wet or dry for 5 years before the enactment of state-level prohibition. Results using counties that were wet or dry for 10 or 15 years before enactment of state-level prohibition are similar although noisier due to the fact that there are fewer counties that were wet or dry for these longer stretches of time.

	log(Num. Pat + 1)	Num. Patents
	1900	
Wet County	0.943***	7.156***
	(0.116)	(1.709)
# Observations	2373	2373
	1905	
Wet County	0.395**	7.576***
	(0.161)	(2.071)
# Observations	2407	2407
	1910	
Wet County	-0.0361	8.768**
	(0.513)	(3.657)
# Observations	1881	1881
	1915	
Wet County	-0.277	11.16*
	(0.743)	(6.335)
# Observations	1776	1776

Standard errors clustered by state and shown in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2.2: Results of regressing patenting on a dummy variable that takes the value of 1 if a county is recorded as wet in a particular year according to Sechrist 2012. Each group of rows shows results from a particular calendar year: 1900, 1905, 1910, and 1915, respectively. Counties are dropped when an entire state is recorded as dry.

	Wet	Dry	Wet - Dry
log(Num. Patents + 1)	0.51	0.14	0.3710
	(0.78)	(0.31)	(0.3491)
Num. Patents	2.00	0.20	1.7958
	(10.06)	(0.45)	(4.5006)
log(Total Pop.)	9.72	9.85	-0.1275
	(0.25)	(0.09)	(0.1098)
Total Pop.	17,217.06	19,050.46	-1,833.4000
	(4,116.01)	(1,798.86)	(1,841.8802)
Frac. Urban	0.06	0.07	-0.0098
	(0.14)	(0.14)	(0.0726)
Frac. Male	0.36	0.56	-0.1983
	(0.26)	(0.06)	(0.1158)
Frac. White	0.51	0.80	-0.2954
	(0.40)	(0.14)	(0.1790)
Mean Age	30.11	33.05	-2.9332
	(6.44)	(1.68)	(2.8802)
Frac. Interstate Migrants	0.53	0.42	0.1146
	(0.35)	(0.26)	(0.1561)
log(Manuf. Employment)	4.78	5.46	-0.6759
	(1.92)	(1.78)	(0.9653)
log(Value Manuf. Output)	11.74	12.64	-0.9001
	(3.29)	(1.58)	(1.6452)
log(Manuf. Wages)	9.85	10.93	-1.0752
	(2.97)	(2.01)	(1.4867)

Table 2.3: T-tests comparing the means of the wet counties to the means of the dry counties in the last census year before the adoption of each state's prohibition.

matter was up for a state referendum. Consequently, growth in prohibition sentiment in only a small number of counties was often enough to make a large difference in state level voting, even if sentiment in most counties did not significantly change.[14]

One drawback of the Sechrist 2012 data is that it does not indicate how a state adopted prohibition. In particular, the possibility exists that a state can be recorded as dry in the Sechrist 2012 data because all counties within a state have voted to prohibit alcohol at the county level.[15] For this reason, I also restrict attention to the 30 states identified in Lewis 2008 as imposing statewide prohibition either by statute (that is, by state-level legislation) or by a statewide referendum.[16] I then further restrict attention only to the cases in which state-level prohibition was passed via referendum. Data on how each county voted in these referendums allows me to additionally use only counties that were solidly wet or dry. Even if a particular county

[14]In future work, I can also check this directly by seeing if the wet counties vary much along a number of dimensions that tend to predict voting patterns: the fraction belonging to evangelical religions, the share of migrants from Ireland and Germany, etc.

[15]At present, I have not been able to find evidence of statewide prohibition laws in all of the states and years that Sechrist 2012 lists as dry. Moreover, the Sechrist 2012 data contain some oddities. For instance, the Sechrist 2012 data lists Oregon as dry from 1844-1849, when historical sources indicate that Maine passed the first statewide prohibition law in 1851. In addition, all Maine counties are reported as dry from 1851 until the end of national prohibition in 1933, while the Maine statewide law was repealed in 1856.

[16]The Lewis 2008 data does not contain any of the states that imposed statewide prohibition before 1907 (Delaware, Illinois, Kansas, Maine, Massachusetts, New York, North Dakota, Rhode Island, and Vermont). In addition, the Lewis 2008 data contains eight states that are not in the Sechrist 2012 data: Florida, Kentucky, Montana, Nebraska, Nevada, New Mexico, Texas, and Wyoming. Because the Sechrist 2012 data allows me to identify which counties are treated by statewide prohibition, these extra are not included in the analysis below. Finally, even when a state appears in both datasets, occasionally each will list a different year in which statewide prohibition was enacted; I used the dates in Sechrist 2012, since that data allows me to verify whether particular counties within the state were wet or dry.

State	Year Range
Alabama	1909-1910, 1915 -
Arizona	1915 -
Arkansas	1915 -
Colorado	1916 -
Delaware	1855 - 1857
Georgia	1908 -
Idaho	1916 -
Illinois	1851 - 1853
Indiana	1855 - 1855
Iowa	1855 - 1892
Kansas	1867-1869, 1881 -
Maine	1851 -
Massachusetts	1852 - 1874
Michigan	1853 - 1875
Mississippi	1909 -
New Hampshire	1855 - 1903
New York	1855 - 1856
North Carolina	1909 -
North Dakota	1888 -
Ohio	1851 - 1892
Oklahoma	1876 -
Oregon	1844-1849, 1914 -
Rhode Island	1852 - 1875
South Carolina	1916 -
South Dakota	1889 -
Tennessee	1909 -
Utah	1917 -
Vermont	1852 - 1903
Virginia	1916 -
Washington	1916 -
West Virginia	1914 -

Table 2.4: Years in which every county within a state was recorded as a dry county from Sechrist 2012.

never adopted prohibition at the county level, the views of its population may be changing over time. So if a county's vote in a statewide referendum is close, this may reflect the fact that a county is becoming, for example, more religious or culturally conservative; this conservatism may have an effect on invention independently of its effect on prohibition. Restricting attention to counties that voted strongly for or against prohibition, which I respectively refer to as "bastions of dry or wet sentiment," minimizes the chance that changes in other county characteristics drive changes in patenting. I consider a county to be a bastion of dry (respectively, wet) sentiment if dry (wet) votes outnumber wet (dry) votes by two-to-one or more. The results are not sensitive to alternative cutoff values. Finally, I restrict attention to wet and dry bastions in states for which the statewide vote was close. A close vote suggests that the outcome was very uncertain, so the imposition of prohibition may be "more exogenous" in these cases and people would be less likely to change their behavior in anticipation of the imposition of prohibition.[17]

2.4 Results

Figure 2.1 plots the raw data for the number of patents granted each year in counties that were wet and dry for extended periods of time before the imposition of state-level prohibition. Since state-level prohibition happened during different

[17] I consider the statewide vote to be close if prohibition passed with less than 67% of the statewide vote. Using a tighter definition, such as 55% or 60%, results in very few states meeting the threshold and thus very noisy estimates. Even this liberal definition of a close statewide vote removes about half of the states from the analysis, suggesting that in many states there was little doubt that statewide prohibition was going to pass.

years in different states, the year variable on the x-axis has been normalized to 0 for the year in which statewide prohibition is enacted. The first thing this figure makes clear is that the trends in patenting in wet and dry counties were remarkably parallel before the imposition of statewide prohibition.In the three years immediately following prohibition, patenting in the formerly wet counties decreases sharply relative to the dries. This decrease halts and almost returns to its initial level in the final two years plotted. I next test for this relationship more formally.

Table 2.5 shows that imposing prohibition laws did indeed reduce patenting in counties that were previously wet for at least 5 years. The equation estimated is a basic differences-in-differences equation,

$$\begin{aligned} Patenting_{it} =& \beta_0 + \beta_1 WetCounty_i * StatewideProhibition_t \\ &+ \beta_2 StatewideProhibition_t + \gamma_i + \delta_t + \epsilon_{it}, \end{aligned} \tag{2.1}$$

where $WetCounty_i$ is a dummy variable that equals 1 if county i was wet for at least 5 years before the imposition of state prohibition laws. $StatewideProhibition_t$ is a dummy variable that equals 1 in all years t after a state imposes statewide prohibition. In this table and all that follow, standard errors are clustered at the county level. As in Table 2.2, column 1 uses $log(Num.Patents + 1)$ as the dependent variable and column 2 uses $Num.Patents$. Each group of rows estimates Equation (2.1) using a different subsample of county data as described in Section 2.3. The first group of rows presents baseline estimates using all counties that have been wet or dry for at least 5 years before the enactment of statewide prohibition according to the Sechrist 2012 data. The second group of rows restricts attention to the 30 states included in the

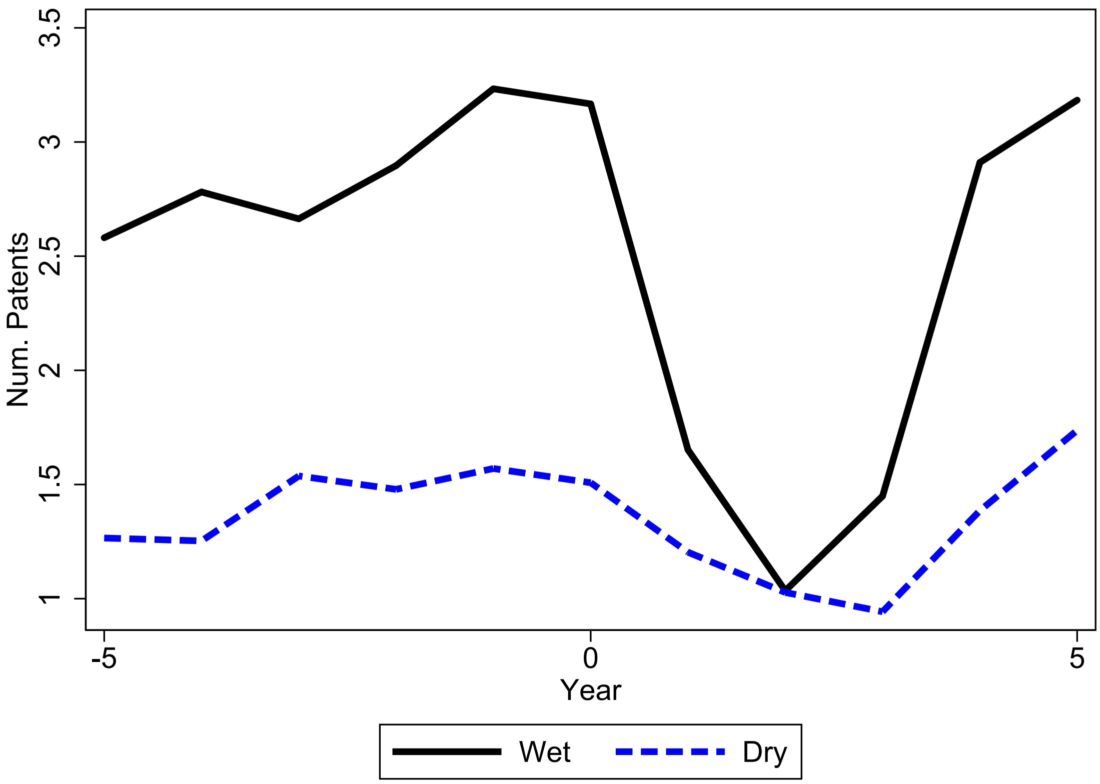


Figure 2.1: Mean patenting in wet (black solid line) and dry (blue dashed line) counties. Counties are listed as wet (dry) if they have been wet (dry) for at least 5 years before the enactment of state-level prohibition according to Sechrist 2012. The x-axis shows the number of years since the enactment of state-level prohibition. The year in which state-level prohibition is enacted is normalized to year 0. Everything left of year 0 shows pre-prohibition means; everything to the right shows post-prohibition means. The y-axis shows the average number of patents granted.

Lewis 2008 data for which information on the circumstances of statewide prohibition can be ascertained. The third group of rows only uses the subsample of states within the Lewis 2008 data for which statewide prohibition was enacted by a referendum. The fourth group of rows restricts attention to the counties voting in the referendum that were bastions of either wet or dry sentiment.

A clear pattern emerges across specifications using all patterns of the data: the enactment of statewide prohibition is associated with an economically and statistically significant decrease in invention. The results range from 6-18% fewer patents per years, depending on the sample of the data used. In the preferred specification, using the bastions of wet and dry support, enacting statewide prohibition decreases patenting by about 16%, or a decrease of about 1 patent per year.[18] Excluding large cities from the sample delivers results that are very similar in terms of both magnitude and statistical significance.

While the baseline results suggest that alcohol prohibition was hugely disruptive, resulting in almost one third fewer patents produced in the counties that were previously wet, individuals should eventually adjust to these disruptions. As Section 2.2 argues, these adjustments may take time, and new venues for informal social interactions may be less conducive to exchanging new ideas than were legalized saloons and taverns. On the other hand, many alternative explanations of how pro-

[18]Comparing across the samples is difficult because they contain different sets of counties. So, for instance, while column 1 indicates a nearly identical percentage decrease in patenting for both the referendum states and the bastions of wet/dry support, the magnitudes in column 2 are very different, reflecting the fact that patenting decreased sharply in large outlier counties that are included in the referendum states but excluded from the bastions of wet/dry support.

	log(Num. Pat + 1)	Num. Patents
Wet/Dry for At Least 5 Years		
Wet County * Statewide Prohibition	-0.0573*	-5.923***
	(0.0332)	(2.031)
Statewide Prohibition	0.129***	1.999***
	(0.0237)	(0.744)
County-Year Observations	36174	36174
Adjusted R^2	0.360	0.076
Lewis 2008 States		
Wet County * Statewide Prohibition	-0.142***	-2.063**
	(0.0237)	(1.006)
Statewide Prohibition	0.0269	0.0313
	(0.0176)	(0.149)
County-Year Observations	28640	28640
Adjusted R^2	0.214	0.023
Referendum States		
Wet County * Statewide Prohibition	-0.183***	-2.882**
	(0.0306)	(1.380)
Statewide Prohibition	0.0597**	0.125
	(0.0261)	(0.298)
County-Year Observations	17745	17745
Adjusted R^2	0.239	0.024
Bastions of Wet/Dry Support		
Wet County * Statewide Prohibition	-0.155**	-0.920
	(0.0701)	(0.624)
Statewide Prohibition	0.0897	-0.0702
	(0.0594)	(0.139)
County-Year Observations	10593	10593
Adjusted R^2	0.215	0.061
Bastions of Wet/Dry Support in Close States		
Wet County * Statewide Prohibition	-0.175	-1.167
	(0.0986)	(1.099)
Statewide Prohibition	0.160*	2.311***
	(0.0805)	(0.688)
County-Year Observations	2070	2070
Adjusted R^2	0.273	0.113

Table 2.5: Baseline regression results. Each group of rows shows results using a different subsample of the data.

hibition might reduce invention, such as by encouraging crime which in turn reduces incentives to patent, would be expected to increase monotonically over time. Figure 2.1 shows that patenting in formerly wet counties does indeed recover to almost its initial level within five years of the imposition of statewide prohibition. I estimate

$$Patenting_{it} = \beta_0 + \sum_{\tau \in T} \left[\beta_{1\tau} WetCounty_i * Time_\tau + \beta_{2\tau} Time_\tau \right] + \gamma_i + \delta_t + \epsilon_{it}, \quad (2.2)$$

where $\beta_{1\tau}$ are interaction terms for the wet counties in each year before and after the imposition of statewide prohibition.[19] The estimated interaction terms for each year are plotted in Figures 2.2 and 2.3. In Figure 2.2, $log(Num.Patents + 1)$ is used as the dependent variable, while in Figure 2.3, $Num.Patents$ is the dependent variable. A horizontal line indicates the estimated additional patents in wet counties relative to dry counties at time 0, the year in which statewide prohibition is introduced. For all years before time 0, the estimated interaction terms are statistically indistinguishable from and very close in magnitude to the interaction term in time 0, giving further evidence for the parallel trends assumption. Beginning in time 1, the magnitude of the estimated coefficient drops sharply, reaching a minimum after three years. Panel (a) demonstrates a more marked rebound in time 4 and 5 than is present in panel (b), but in both cases the estimated magnitudes increase after year 3 but are always statistically different from the estimated magnitude in time 0.

If alcohol prohibition primarily affected invention by restricting the informal social interactions that occurred in saloons and taverns, then groups that did not

[19] I estimate a term $\beta_{2\tau}$ for each year before or after imposition of statewide prohibition as well as a calendar year effect. This is necessary since the imposition of statewide prohibition occurs in different years in different states.

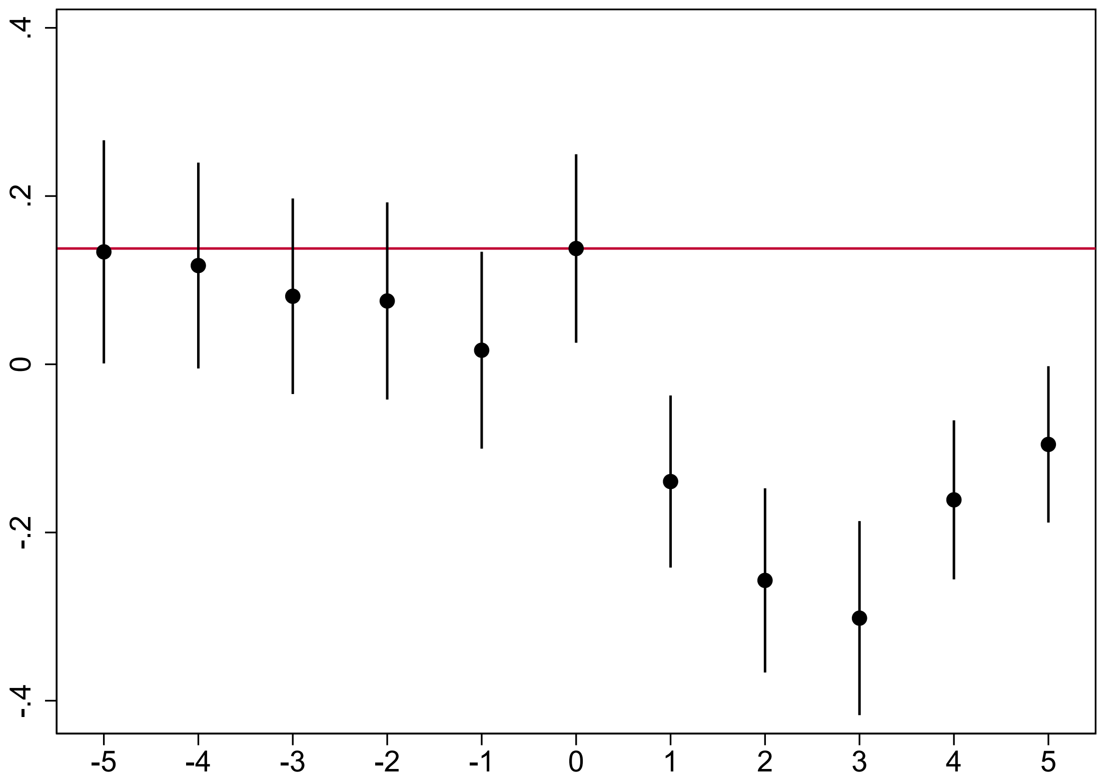


Figure 2.2: Estimates of an interaction term for wet counties times a time dummy for each year before and after the imposition of statewide prohibition. The x-axis shows the number of years since the enactment of state-level prohibition. The year in which state-level prohibition is enacted is normalized to year 0. Everything left of year 0 shows pre-prohibition means; everything to the right shows post-prohibition means. The y-axis plots the dependent variable. The dependent variable is $log(Num.Patents + 1)$. The red horizontal line indicates the level of patenting at year 0.

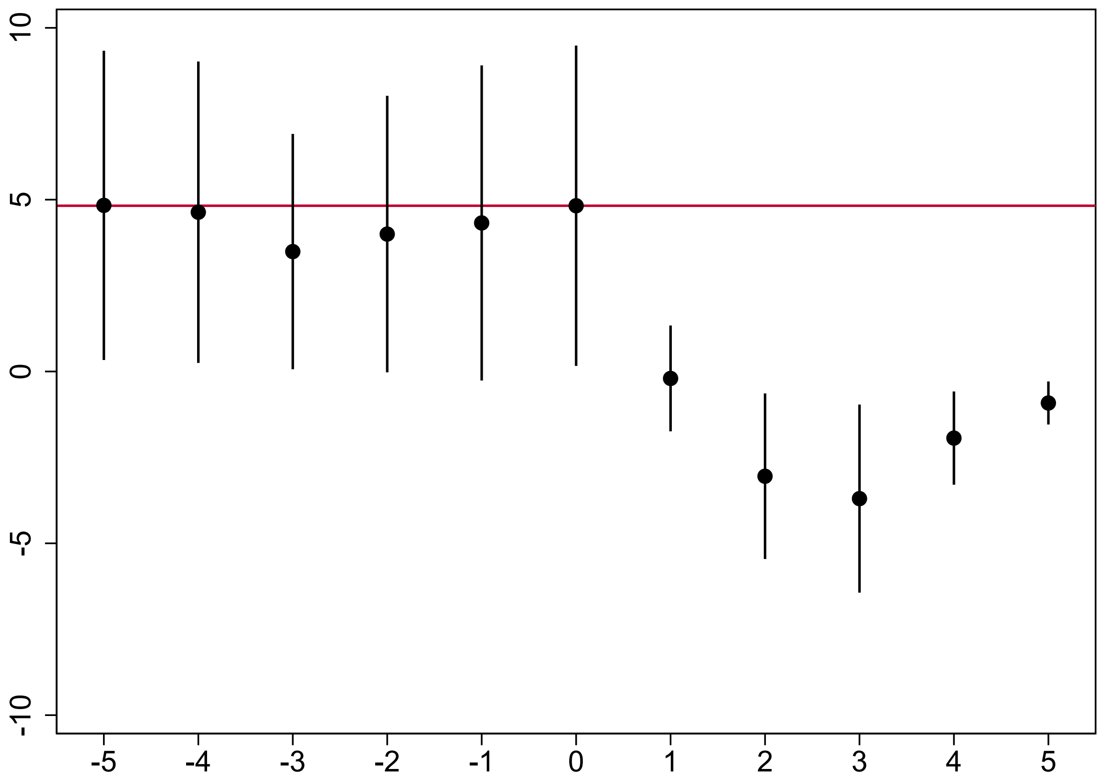


Figure 2.3: Estimates of an interaction term for wet counties times a time dummy for each year before and after the imposition of statewide prohibition. The x-axis shows the number of years since the enactment of state-level prohibition. The year in which state-level prohibition is enacted is normalized to year 0. Everything left of year 0 shows pre-prohibition means; everything to the right shows post-prohibition means. The y-axis plots the dependent variable. The dependent variable is $Num.Patents$. The red horizontal line indicates the level of patenting at year 0.

frequent these establishments should be affected less.[20] From the mid-19th century until the early 1920s, saloons were the domain of men almost exclusively. This means that closing saloons should have little direct effect on female patenting. Using inventors' first names as in Sarada, Andrews, and Ziebarth 2017, I assign each patent a probability of belonging to a male or a female to get the expected number of patents for each gender. I then estimate the following triple difference equation:

$$\begin{aligned} Patenting_{igt} = &\beta_0 + \beta_1 FemalePat_g * WetCounty_i * StatewideProhibition_t + \\ &\beta_2 WetCounty_i * StatewideProhibition_t + \beta_3 StatewideProhibition_t \\ &+ \gamma_i + \delta_t + \epsilon_{it}, \end{aligned} \tag{2.3}$$

where $StatewideProhibition_t$ and $WetCounty_i$ are as before. $FemalePat_g$ is an indicator that equals one for female patents. The dependent variable is a measure of patenting in county i at time t for gender g. Table 2.6 shows the results of estimating this equation. The dependent variable in column 1 is $Num.Patents$ and in column 2 is $log(Num.Patents + 1)$. When using $Num.Patents$, the estimated coefficient for the triple interaction term, $\hat{\beta}_1$ is statistically insignificant for the first three groups but positive and significant at the 1% level for the preferred specification using the bastions of wet and dry sentiment. When using $log(Num.Patents + 1)$, the estimated coefficient for the triple interaction term is positive and highly significant for all four samples of the data. A positive coefficient of the triple interaction term means that

[20]Note that even groups that do not frequent saloons may still become less inventive following the imposition of prohibition if, for instance, they would otherwise have gotten new ideas from other individuals who did themselves frequent saloons.

female patenting increases relative to male patenting by more in the wet counties than the dry counties following the imposition of statewide prohibition. Or, more succinctly, statewide prohibition caused the gap between male and female patenting to shrink by more in the formerly wet counties.[21] This is evidence that statewide prohibition had a stronger effect on the group, men, that frequented saloons and thus had their environments for informal social interactions disrupted more deeply.

Two sectors that were undoubtedly affected directly and dramatically by prohibition were the brewers and distillers.[22] It is possible that most of the decrease in patenting is due to a drop off of invention in these sectors. To check this, I drop from the dataset all patents belonging to the classes that are most commonly associated with brewing or distilling.[23] Results, presented in Table 2.7, are very similar in both

[21]Ignoring how the relative change in female patenting to male patenting, the estimate for the total change in female patenting in wet counties after the imposition of prohibition relative to dry counties is given by $\hat{\beta}_1 + \hat{\beta}_2$. In almost all cases, $\hat{\beta}_1 + \hat{\beta}_2$ is either statistically insignificant, suggesting female patenting changes little, or moves in the same direction as overall patenting, consistent with the intuition that even those who do not frequent saloons may be indirectly harmed by a reduction in the overall spread of new ideas.

[22]Rorabaugh 1979, p. 73 reports that from 1802 to 1875, distilling patents accounted for more than 5% of all patents granted. Unfortunately, patent data from before 1836 is unreliable; see Andrews 2017a.

[23]The US Patent Classifications (USPC) that I drop are 23: "Chemistry: physical processes"; 62: "Refrigeration"; 99: "Foods and beverages: apparatus"; 137: "Fluid handling"; 201: "Distillation: processes, thermolytic"; 202: "Distillation: apparatus"; 203: "Distillation: processes, separatory"; 210: "Liquid purification or separation"; 215: "Bottles and jars"; and 426: "Food or edible materials: processes, compositions, and products". Results are not sensitive to including different subsets of these classes. Results dropping the NBER 2-digit patent classes most likely to be associated with brewing and distilling produce similar results. The NBER classes are much broader than the USPC 3-digit classes, so the NBER classes are more likely to contain patents from industries unrelated to brewing or distilling. The corresponding NBER 2-digit classes are 19, 61, 68, and 69. The USPC classes are often criticized for being too narrow, not easily mapped to particular industries, and nonsensically organized, inspiring the creation of the NBER classes (Hall, Jaffe, and Trajtenberg 2001).

	log(Num. Pat + 1)	Num. Patents
Wet/Dry for At Least 5 Years		
Female Pat. * Wet County * Statewide Prohibition	0.480***	1.239***
	(0.0221)	(0.253)
Wet County * Statewide Prohibition	-0.242***	-3.581***
	(0.0236)	(1.072)
Statewide Prohibition	0.0737***	1.000***
	(0.0131)	(0.372)
Gender-County-Year Observations	71301	72348
Adjusted R^2	0.214	0.025
Lewis 2008 States		
Female Pat. * Wet County * Statewide Prohibition	0.574***	3.086***
	(0.0272)	(0.580)
Wet County * Statewide Prohibition	-0.347***	-2.574***
	(0.0199)	(0.752)
Statewide Prohibition	0.0134	0.0157
	(0.00953)	(0.0744)
Gender-County-Year Observations	57272	57280
Adjusted R^2	0.147	0.019
Referendum States		
Female Pat. * Wet County * Statewide Prohibition	0.605***	3.052***
	(0.0302)	(0.724)
Wet County * Statewide Prohibition	-0.395***	-2.967***
	(0.0246)	(1.029)
Statewide Prohibition	0.0310**	0.0627
	(0.0146)	(0.149)
Gender-County-Year Observations	35485	35490
Adjusted R^2	0.165	0.016
Bastions of Wet/Dry Support		
Female Pat. * Wet County * Statewide Prohibition	0.537***	1.974***
	(0.0946)	(0.653)
Wet County * Statewide Prohibition	-0.342***	-1.447**
	(0.0825)	(0.556)
Statewide Prohibition	0.0454	-0.0351
	(0.0280)	(0.0696)
Gender-County-Year Observations	21185	21186
Adjusted R^2	0.113	0.038
Bastions of Wet/Dry Support in Close States		
Female Pat. * Wet County * Statewide Prohibition	0.608**	2.850*
	(0.184)	(1.352)
Wet County * Statewide Prohibition	-0.382**	-2.008*
	(0.132)	(0.956)
Statewide Prohibition	0.121**	1.156***
	(0.0488)	(0.343)
Gender-County-Year Observations	4140	4140
Adjusted R^2	0.204	0.078

Table 2.6: Results for patenting by females and males. Each group of rows shows results using a different subsample of the data.

magnitude and significance to the baseline results in Table 2.5.

2.5 Nationwide Prohibition

For several of the reasons listed in Section 2.2, the enactment of national prohibition with the ratification of the 18th Amendment and the ensuing Volstead Act is not as clean a natural experiment as is the imposition of statewide prohibition. First, determining the timing at which national prohibition began is nontrivial: wartime restrictions on alcohol were passed at the national level during World War I, the amendment was first proposed in 1917, ratified in 1919, and went into force in 1920. Second, World War I itself may have differentially affected the wet states, which tended to be more industrial and have a larger share of immigrants, and the dry states, confounding the effects of prohibition. Third, by the time the amendment was introduced, much less ratified, there was little doubt that national prohibition was coming to America, and so individuals and saloons had time to prepare. Fourth, since the majority of states had already passed prohibition at the statewide level, there is less variation to use when national prohibition goes into effect.

In spite of these issues, I use data on national prohibition for two purposes: first, as a "placebo test," verifying that once counties have already been "treated" with statewide prohibition, the imposition of national prohibition has almost no effect;

In this case, however, the NBER classes are too broad, containing all chemical or food and beverage patents; the USPC classes, in contrast, allow for easier identification of technologies that are more likely to be exclusively related to beverage manufacturing or checmical processes related to brewing or distilling. Both USPC and NBER patent classes have been attached to each historical U.S. patent through the recent USPTO historical patent data project; see Marco et al. 2015.

	log(Num. Pat + 1)	Num. Patents
Wet/Dry for At Least 5 Years		
Wet County * Statewide Prohibition	-0.0549*	-5.699***
	(0.0331)	(1.950)
Statewide Prohibition	0.128***	1.930***
	(0.0234)	(0.716)
County-Year Observations	36174	36174
Adjusted R^2	0.356	0.077
Lewis 2008 States		
Wet County * Statewide Prohibition	-0.136***	-1.978**
	(0.0236)	(0.963)
Statewide Prohibition	0.0257	0.0274
	(0.0174)	(0.139)
County-Year Observations	28640	28640
Adjusted R^2	0.211	0.023
Referendum States		
Wet County * Statewide Prohibition	-0.177***	-2.753**
	(0.0306)	(1.321)
Statewide Prohibition	0.0585**	0.132
	(0.0257)	(0.278)
County-Year Observations	17745	17745
Adjusted R^2	0.235	0.024
Bastions of Wet/Dry Support		
Wet County * Statewide Prohibition	-0.152**	-0.881
	(0.0701)	(0.598)
Statewide Prohibition	0.0864	-0.0532
	(0.0598)	(0.128)
County-Year Observations	10593	10593
Adjusted R^2	0.213	0.063
Bastions of Wet/Dry Support in Close States		
Wet County * Statewide Prohibition	-0.177	-1.102
	(0.0983)	(1.053)
Statewide Prohibition	0.156*	2.196**
	(0.0823)	(0.676)
County-Year Observations	2070	2070
Adjusted R^2	0.270	0.118

Table 2.7: Baseline regression results excluding all patents that belong to classes most likely to be associated with breweries or distilleries. Each group of rows shows results using a different subsample of the data.

second, as a "sanity check," verifying that national prohibition has a negative effect on previously untreated counties.

Table 2.8 documents the effect of imposing national prohibition in 1920 on counties that were wet prior to their imposition of statewide prohibition. In other words, I use the same samples of previously wet and dry counties as in Tables 2.5-2.7, but now the interaction term of interest is equal to one for these wet counties in years after 1919. In these regressions, there is no $StatewideProhibition$ dummy, because this is completely absorbed by the year effects. While the magnitudes are consistently negative, they are consistently only about half as large as the baseline results presented in Table 2.5 and are not statistically different from zero in the preferred specification.

Next, I exclude all states with statewide prohibition from the data. Instead, I use as the sample of wet counties all counties that had not outlawed the sale of alcoholic prohibition within their borders before 1917, the year of World War I alcohol prohibitions and the introduction of the 18th amendment; the dry counties are counties within those same states who had outlawed the sale of alcohol in prior years. In Figure 2.4, I plot the coefficients for wet counties interacted with each year. There is a large decline in wet counties relative to dry counties starting in 1917, with a clear rebound beginning in 1920. However, the previously wet counties were not back to their pre-1917 level relative to the formerly dry counties until 1924, four years after the 18th amendment went into effect and seven years after it was introduced. Unfortunately, it is very difficult to determine whether this is due to World War I or to the

	log(Num. Pat + 1)	Num. Patents
Wet/Dry for At Least 5 Years		
Wet County * National Prohibition	-0.157***	-1.931***
	(0.0213)	(0.731)
County-Year Observations	36174	36174
Adjusted R^2	0.360	0.071
Lewis 2008 States		
Wet County * National Prohibition	-0.0681***	-1.405*
	(0.0190)	(0.745)
County-Year Observations	28640	28640
Adjusted R^2	0.212	0.021
Referendum States		
Wet County * National Prohibition	-0.0981***	-2.074**
	(0.0234)	(1.013)
County-Year Observations	17745	17745
Adjusted R^2	0.237	0.022
Bastions of Wet/Dry Support		
Wet County * National Prohibition	-0.0517	-0.762
	(0.0474)	(0.479)
County-Year Observations	10593	10593
Adjusted R^2	0.213	0.060
Bastions of Wet/Dry Support in Close States		
Wet County * National Prohibition	-0.108**	-1.040
	(0.0396)	(0.722)
County-Year Observations	2070	2070
Adjusted R^2	0.271	0.109

Table 2.8: Baseline regression results using the enactment of national prohibition as the treatment. Each group of rows shows results using a different subsample of the data.

imposition of national prohibition (or some interaction of the two). Nevertheless, the results are consistent with the baseline results using statewide prohibition discussed above.

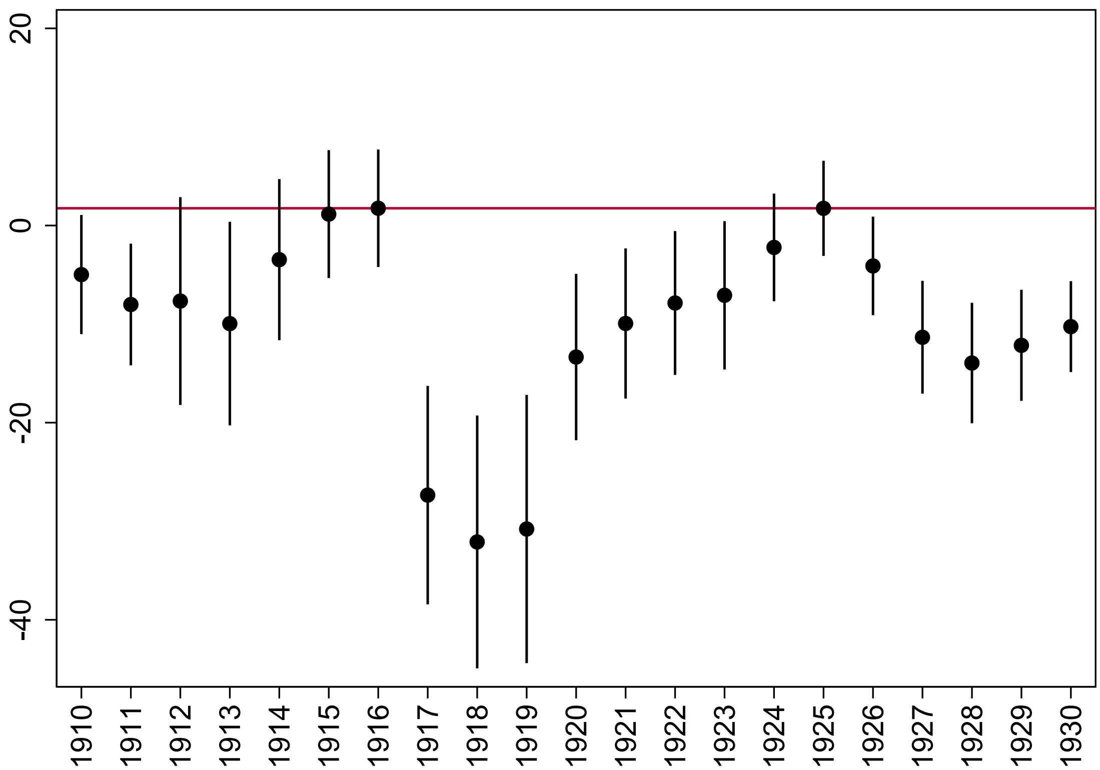


Figure 2.4: Estimates of an interaction term for wet counties times a time dummy for each year from 1910 to 1930. The x-axis shows the calendar year. The y-axis plots $Num.Patents$ as the dependent variable. The red horizontal line indicates the level of patenting in 1916.

2.6 Closing Time

In this paper, I document that imposing statewide alcohol prohibition decreased invention in counties that were persistently wet before the enactment of statewide prohibition. The decrease is large, on the order of a 30% decrease in patenting. Consistent with this effect being driven by a disruption of the kinds of informal social interactions that occur in bars, saloons, and taverns, I find that the effect is largest in the three years immediately following the imposition of prohibition and then patenting recovers slightly in the succeeding years. Women, who did not frequent saloons and thus likely had their social interactions disrupted less by prohibition, decreased their patenting by less than men after the imposition of prohibition. Finally, I show that the decrease in patenting cannot be explained by a reduction in patenting in the industries most directly affected by prohibition, breweries and distillers.

This paper shows that alcohol prohibition in the U.S. had deleterious effects on aspects of society, such as invention, that might at first glance appear unrelated to the manufacture, sale, or consumption alcohol. Moreover I exploit this historical setting to estimate a quantity that is otherwise difficult to identify. While this paper demonstrates one method by which policy can be harmful to invention, it is silent on ways in which policy can promote invention. Additional work is needed to more fully understand the relationship between social interactions and the generation of new ideas and ways in which policymakers can exploit these relationships to encourage innovation.

CHAPTER 3
HISTORICAL CHANGES IN THE DEMOGRAPHICS OF INVENTORS IN THE UNITED STATES

This chapter is coauthored with Nicolas Ziebarth at Auburn University and NBER and Sarada at the University of Wisconsin, Wisconsin School of Business.

3.1 Introduction

Invention is at the root of economic growth. While economists have a rich understanding of the economics of innovation at a theoretical level, much less is known about the individuals who actually generate these innovations. For example, where do inventors come from? What drives marginalized groups to undertake these activities? What institutional features encourage (or discourage) such activity? Understanding these demographic and institutional differences is essential to fostering broad participation in the creative process, which is, in turn, crucial for the process of growth. To shed light on this process, we build a comprehensive dataset by matching people who were granted a patent in the years 1870, 1880, 1900, 1910, 1920, 1930, and 1940 to the corresponding decennial US Population Census. This matching procedure delivers a variety of demographic information on these individuals such as age, race, gender, and family structure. While others have constructed limited samples of historical inventors, our matched dataset provides a richer view of the demographics of historical inventors, covering the entire universe of US patents over a period of 70 years.

First, we find that over the historical period we study, inventors are demographically quite different from the general population. This is true in some obvious ways including the fact that patentees are more likely to be white and male. It is also true in less obvious ways including the fact that they tend be older and to be living in a different state than that of their birth. For the most part, these patterns are stable across our seventy year period, with some variation in these trends across time. In particular, there is a high degree of persistence in the extent to which older individuals and people not living in their state of birth are overrepresented in the patentee population across time. On the other hand, over our timeframe, women go from comprising 5% to comprising around 10% of patentees in a non-monotonic fashion with the fraction reaching a nadir around 1890. For blacks, we observe an increase mainly in 1930 and 1940 with black representation almost reaching their representation in the population overall. At the same time, simply using first names to impute the probability a particular person is black shows almost no change over the whole 70 years.

Women and blacks to this day account for a disproportionately low fraction of inventive activity. Ding, Murray, and Stuart 2006 show, using recent data from the life sciences, that 5.65% of women scientists patented at all (as compared to 13% of male scientists) to hold only about 6% of filed patents. Additionally, Ashcraft and Breitzman 2007 find that in the IT sector only 9% of patents involve any female patentees. When they account for the fact that most patents involving one woman also involve multiple males, this brings the percentage down substantially, to about 5%. While some of these studies such as Ding, Murray, and Stuart 2006 and Frietsch et al.

2009 find declining gender gaps, this catch-up is slower than female engagement in other comparable parts of society such as PhD education in Science and Engineering (Jung and Ejermo 2014), and is far from common across countries and types of inventive activities (patenting vs. academic publishing). More importantly, all studies still find large gender gaps. Similarly, the representation of blacks in patenting activity today remains dismal (Cook 2004). Inventive activity as measured by patents granted or academic papers published seems to fall much closer to finance, which has had a small increase in participation by these marginalized groups e.g. Bertrand, Goldin, and Katz 2010 on women. At the same time, these groups have rapidly increased their representation in other areas requiring high levels of education such as the medical profession (Hsieh et al. 2016) where women, for example, now almost outnumber men in medical school. Hunt et al. 2012 argue, at least, that lower patenting rates for women are not due mainly to low rates of science and engineering degrees but rather, these degrees do not appear to translate into representation in engineering or R&D jobs - presumably where a substantial amount of patenting occurs.

Relative to the pattern we document of little change in average age of patentees, recent work has documented that the age of innovators, according to a number of measures, has been increasing. For example, the age of first time NIH grant recipients has steadily increased from 37 in 1980 to 42 in 2008 (Kaiser 2008). Jones 2009 shows that the age of first invention has been increasing between 1985 and 2000. He attributes this trend, at least in part, to the increased time necessary to acquire the human capital to invent. On this point, Jones 2010 documents that the average doctoral age of Nobel Prize winners in the 20th century has been increasing as well. However, since 2000, the average age of all inventors and first-time inventors has been declining quite rapidly from a peak of just over 46 in 1997 to 43.4 in 2007 as noted by Jung and Ejermo 2014. So perhaps the patterns observed by Jones between the mid 1980s to 2000 were simply transitory and the ages of inventors are returning to something like they were back in 1900 when patentees were just over 15% older than the whole US population translating to an average age of 40.3.

We also find that inventors are much less likely to be living in the state of their birth. We cannot identify (at this point) how long a particular inventor has been living in a particular location before patenting. So right now this fact is simply suggestive that these people are moving to areas with greater opportunities. This pattern echoes a sequence of papers by Bill Kerr and coauthors (Kerr 2008b; Kerr and Lincoln 2010; Kerr 2010; Foley and Kerr 2013) about the large contribution of immigrants to innovation in 20th century America. We document in our 1900 data that individuals with immigrant parents flourish in inventive activity. These are rather striking when contrasted to the obstacles faced by women, blacks and certain types of immigrants - in particular those coming to the US during the Mass Migration (Abramitzky, Boustan, and Eriksson 2012).

After documenting these time patterns, we estimate the relationship between county-level economic and demographic factors and the demographics of patentees. Others have studied correlates of patenting *rates* such as population and transportation networks (Perlman 2015). We find, not surprisingly, that counties with more women (resp. blacks or an older population) tend to have more women (resp. black or older) patentees, but the elasticity is much smaller than 1. So the process by which a particular type of patentee is generated is not simply a random draw from the underlying county population. Other characteristics of the county such as population and the fraction of employment in manufacturing have inconsistent effects across demographic groups and across specifications for the same demographic group. We conclude from this that, at least the most obvious, observable county-characteristics do not explain the differences in the representation of various demographic groups in patenting activity.

So what does explain these differences in patenting across these different groups? We focus on an institution that targeted blacks. In particular, we study the effects of the establishment of a Historically Black College or University (HBCU). These were universities, public and private, that either by law or by custom, were intended to educate blacks. Distributed across the country, these tended to have a more technical focus. Many of these were opened during the early 20th century along with a number of other colleges. Unlike Andrews 2017b, who identifies runner-up counties in competitions to locate colleges, we use a simpler differences-in-differences framework to estimate the effects. We find some evidence that this increased the representation of African-Americans in the innovation process. The estimated effect of HBCUs is much smaller and no longer statistically significant after controlling for county black population, however, suggesting that the positive effect might be largely due to an agglomeration of African Americans in the areas with these colleges. In this case, the total effect might be zero as counties with HBCUs that experience greater African American representation are offset by places that have lower representation.

We also consider the effects of the state level extension of the franchise to women before the 19th amendment drawing on the work of Lott and Kenny 1999. While not directly related to patenting like the provision of higher education in the case of HBCUs, other work has linked female leadership and political power to economic outcomes of women. For example, Beaman et al. 2012 study a policy experiment in India that increased female representation in leadership positions and find that this increased the aspirations and educational attainment for girls. There might be other indirect connections as well from changes in the size and scope of government. Chattopadhyay and Duflo 2004 use the same experiment in India to show that political leaders invest more in public goods that are directly relevant to their own genders. Miller 2008 uses the same state-level variation in suffrage laws to show that female enfranchisement drove the growth of public health spending and an attendant decline in child mortality. That said, we find limited evidence that the franchise matters directly. The point estimate from our difference-in-differences setup is actually negative. However, this masks the heterogeneity in whether a state was an early or late adopter. We find that states that were early adopters had persistently a higher representation of women in inventive activity. We interpret this as evidence that while political representation might not have mattered, the general socioeconomic position of women was reflected in their participation in inventive activity.

One obvious limitation of this work and all work using patents is the extent to which patents really capture the totality of inventive activity in terms of quality and quantity. It may be the case that marginalized populations are equally likely to invent, but simply do not patent - especially if they lack the resources necessary to file and enforce their patent. For the 19th century, Cook 2014 argues that blacks often patented under the white names of their lawyers. Thursby and Thursby 2005 find in their sample of scientists in the late 20th century that, while publication differs slightly across genders, women are much less likely to disclose an invention that could be potentially commercialized (though Cook and Kongcharoen 2010 find similar rates of patent assignment for women and blacks relative to the whole universe of patents granted between 2001 and 2008). We would argue that even in the case where patenting is in some way a flawed measure of innovative activity (as surely is any single measure), differences in patenting rates across demographic groups are still informative as to the perceived returns to patenting by demographic group.

Our work is related to the series of papers by Ken Sokoloff and co-authors (Sokoloff 1988; Sokoloff and Khan 1990; Khan and Sokoloff 1993; Lamoreaux and Sokoloff 2005) that studied patenting rates in 19th century America building on the pioneering work of Schmookler 1957. In his original 1988 work, he constructed a random sample of patent holders from the same primary source covering from 1790 to 1846. He documented some broad patterns such as the pro-cyclicality of patenting and a relationship with the growth of markets during industrialization. Later work extended these data to address questions of entrepreneurship as well as some basic facts about the demographics of the inventors. Perhaps most closely related is the work by Lamoreaux and Sokoloff 2005, who drew three random cross-sectional samples (totaling about 6,600 patents) from the same *Annual Reports of the Commissioner of Patents* for the years 1870-71, 1890-91, and 1910-11. Our innovation is in the number of innovators we obtain demographic information on which allows us to document and comment on the more general trends in the American creative process.[1] The only database comparable to ours is presented in contemporaneous work by Akcigit, Grigsby, and Nicholas 2017.[2]

3.2 Data

We offer a short discussion here of our procedure for building this dataset. More details are available in the appendices. We follow a three step process: (1) obtaining machine readable versions of the *Annual Report of the Patent Commissioners*; (2) parsing those reports into fixed format files; and (3) matching those files against the corresponding Population Census. Issues can arise at all three of these steps that might bias the final sample.

[1]In addition, Cook 2011 constructed a sample of black inventors between 1870 and 1930 based on biographies from the NAACP from the 19th century.

[2]In their work, Akcigit, Grigsby, and Nicholas 2017 match inventors in patent records to the US Population Censuses from 1880 to 1940. Their work is complementary to ours, where while we focus on the determinants of inventor demographics, they study the role of inventors in influencing regional performance, and also explore the role of certain key individual, household and institutional characteristics in determining inventive engagement. In addition, the source of raw patent data is different in our data and theirs. We utilize the *Annual Reports of the Commissioner of Patents*, described below, while they use the patent text available through Google Patents.

3.2.1 Generating a List of Patentee Grantees

First, we obtained a machine readable version of the *Annual Report of the Commissioner of Patents* from HaithTrust and the Smithsonian. These reports include the names of patent grantees, the town and state in which they lived, the invention name, and the type of intellectual property including utility, design, and plant patents. They also contain modifications to earlier patent applications in the form of disclaimers and, in most years, a list of registered trademarks and labels. These volumes were digitized by Google, and while the transfer to digital format appears to have been good, it is not perfect. In particular, the photocopied volumes have a particularly high number of unreadable pages in 1920 and 1930, the two years with the lowest parse rate. In addition, the format in which information about each patent is recorded is not consistent over years, with some years being more amenable to parsing. This second issue is particularly pernicious in 1930 and 1940, resulting in very low match rates. Consequently, results for 1930 and 1940 should be considered extremely preliminary. We are addressing these issues in future iterations of the parsing algorithm. In spite of these difficulties, we believe our parsed results are representative of the overall population of patentees. Overall, as noted in Table 3.1, the parser is able to extract between 36 and 72% of the patents granted each census year between 1870 and 1920 comparing our totals to the totals listed in the *Annual Report*. In this table, total matches is the the total number of *individuals* that match to a patent. Since this need not be 0 or 1, this number can exceed the number of parsed patents. Perfect matches is the number of patents that match exactly to a person's name and county of residence. Note here as well that this need not be a unique match. Unique matches is the number of patents that have a unique match meaning there is no other person in he county of the patent with a name sufficiently close. Note that this match need not be perfect. The average # of matches is the average number of matches in the population data we found for each patent.

Year	1870	1880	1900	1910	1920	1930	1940
Patents	12894	13441	26414	35769	39542	47938	47830
Parsed Patents	8993	7892	14073	18549	14102	14352	28707
Total Matches	8477	7306	15480	15527	12153	7682	12609
Perfect Matches	1747	911	1660	4452	2733	310	785
Unique Matches	4844	4382	3675	9470	6775	2102	3777
Average # Matches	1.4	1.37	2.12	1.35	1.42	2.03	1.93

Table 3.1: Summary statistics comparing initial sample of patentees, our parsed list, and matched sample. Parsed patents is number of patents we are able to parse from the *Annual Reports*.

Given that we do not successfully extract 100% of the inventors listed on the *Annual Reports*, it is natural to ask if there are any systematic biases in our subsample. We are particularly worried about difficulties in the original optical character recognition (OCR) process that produced these machine readable texts. Given the algorithmic nature of the procedure, issues with OCR can generate systematic issues in reading, say, "ff" as "v," a problem with some OCR software. We are able to fix up some of these biases by recoding some common OCR mistakes, for example first names that start with "AV" are almost certainly meant to start with "W." However, it is conceivable that some systematic errors remain. There are also possible problems stemming from our parser. There are numerous variations in how each patent is reported within a year. This makes it possible that the regular expressions we used to identify the names and locations of patentees are failing to account for all possible variations in how these are recorded.

To check that both of these problems are not driving persistent differences, we compare our parsed dataset to a comprehensive dataset constructed by Dr. Jim Shaw of Hutchinson, KS. Dr. Shaw transcribed by hand all of the patents in the Subject-Matter Index of Patents for Inventions Issued by the United States Patent Office from 1790 to 1873 (Leggett 1874a). We refer to this data, currently maintained by the Patent and Trademark Resource Center Association, as the "Jim Shaw data."[3] Because this dataset was assembled by hand, it avoids biases inherent in OCR software. Unfortunately, the Jim Shaw data usually only records inventors' first initial, making it mostly unusable for census matching purposes. In addition, the Jim Shaw data only includes patents through 1873. Still for four years (1870-1873), our data overlap with Jim Shaw's, allowing us to compare our data to his.

Figures 3.1-3.6 compares the characteristics of patentees including the first letter of first name, first letter of last name, and number of characters in last name for our parsed data and the Jim Shaw data for the years 1870 and 1873. Results for 1871 and 1872 are nearly identical. The dark blue dots, labeled on the left axis, show the ratio of the occurrences of each characteristic in our data to the Jim Shaw data. A horizontal line is drawn at 1. For most values, the ratio is very close to one, indicating that characteristics appear in our data at almost the same rate as in the Jim Shaw

[3] Personal correspondences with Dr. Jim Miller, the College Park, MD representative the Patent and Trademark Resource Center Association, provided additional details about the construction of this dataset (Miller 2016a; Miller 2016b). The data is available at http://www.ptrca.org/history.

data. We find that deviations between our sample and Jim Shaw's only occur, when they do, for characteristics that are quite rare. For example, in Figure 3.3 and 3.4, there are deviations in the relative frequency of length of last name, but these are for very long last names that are exceedingly rare. In Figures 3.5 and 3.6, deviations occur for last names that begin with uncommon letters such as "Q," "V", and "Y." The yellow bars, labeled on the right axis, show the distribution of characteristics in the Jim Shaw data. This gives us some confidence that our sample of patentees does not have systematically different names from the complete population of patentees. Still, we note that these results do not imply that the correspondence between our data and Jim Shaw's for *any particular* patentee is good; only that, in the aggregate, possible differences at the patentee level average out.

3.2.2 Matching Patentees to the Census

To perform the matching, we use Stata's reclink command, which is a modified bigram string comparator that returns a "distance" (match score) between two strings.[4] We matched on first name, last name, and town while requiring an exact match on state. The information we are matching on is rather limited relative to other work in the literature which also uses information on age or location of birth (Ferrie 1996). To aid the matching procedure, for both the list of patentees and census data, we also "regularized" town names from "St." to "Saint", removed "District," "Borough," and "Ward" from town names as well as removed the "special" characters

[4]The same algorithm is also used to match slave traders to shipping manifests in Steckel and Ziebarth 2013.

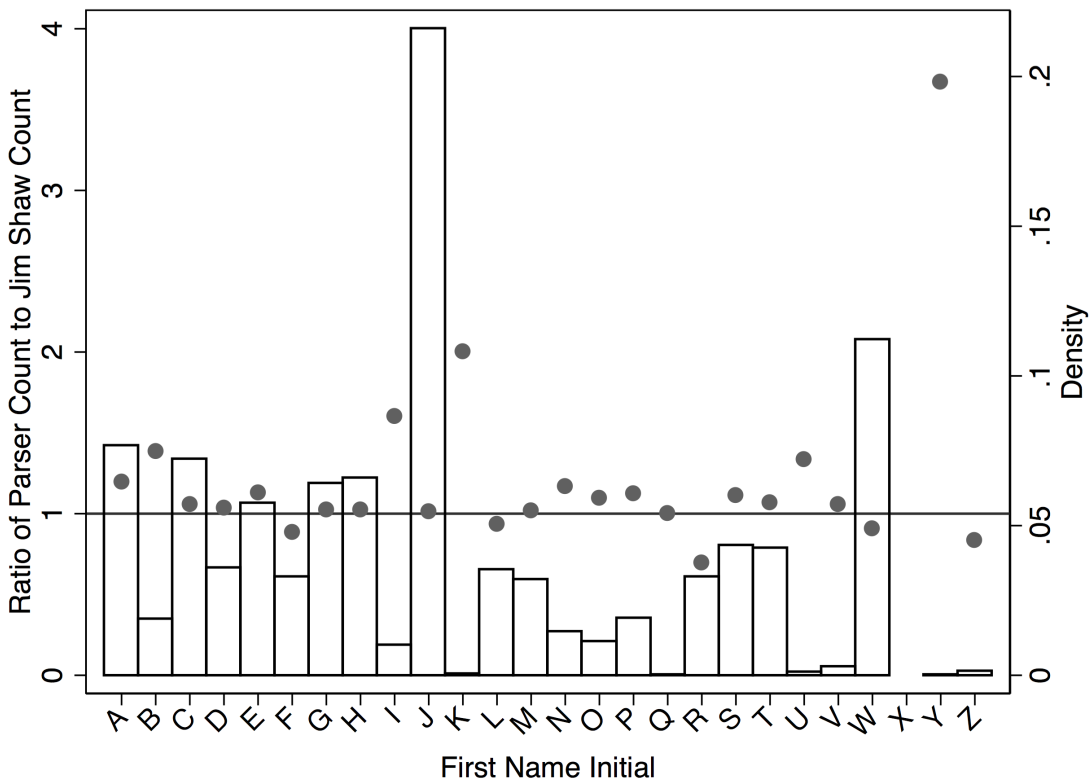


Figure 3.1: Comparison of the first letter of the first names of our parsed sample of patentees relative to Jim Shaw sample for 1870. The left hand axis plotted in blue dots shows the relative frequency in our dataset to that in Jim Shaw's. The right hand axis plotted with yellow bars shows the distribution of Jim Shaw's data for these various characteristics.

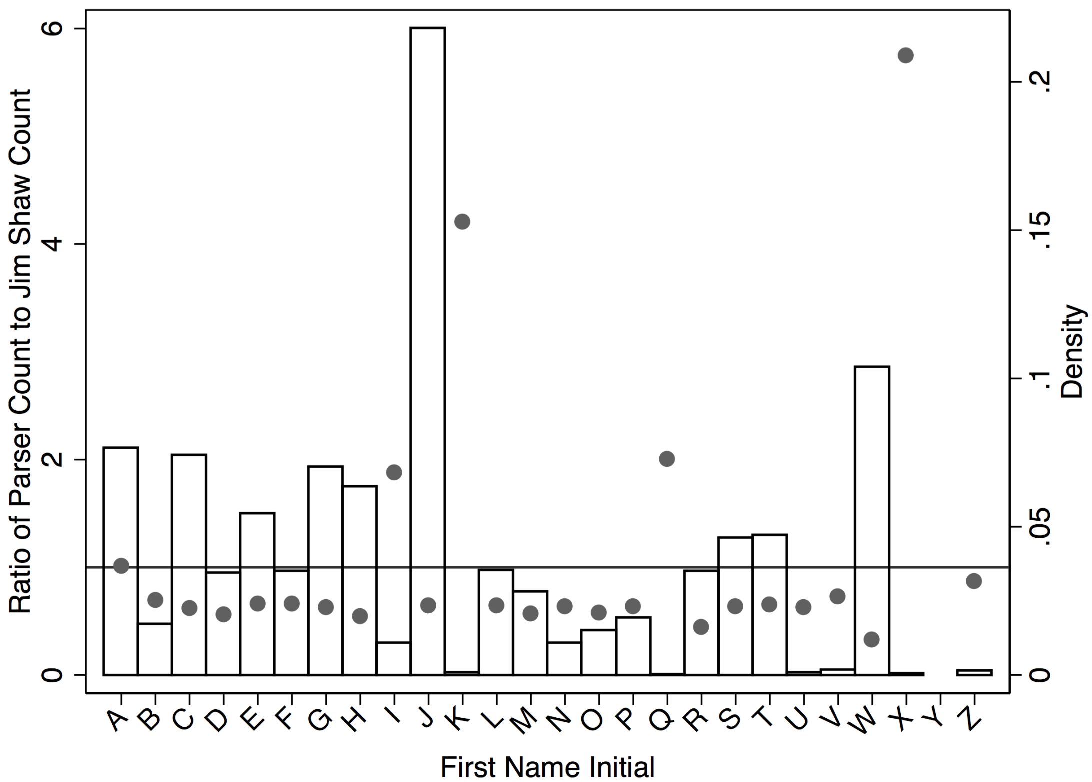


Figure 3.2: Comparison of the first letter of the first names of our parsed sample of patentees relative to Jim Shaw sample for 1873. The left hand axis plotted in blue dots shows the relative frequency in our dataset to that in Jim Shaw's. The right hand axis plotted with yellow bars shows the distribution of Jim Shaw's data for these various characteristics.

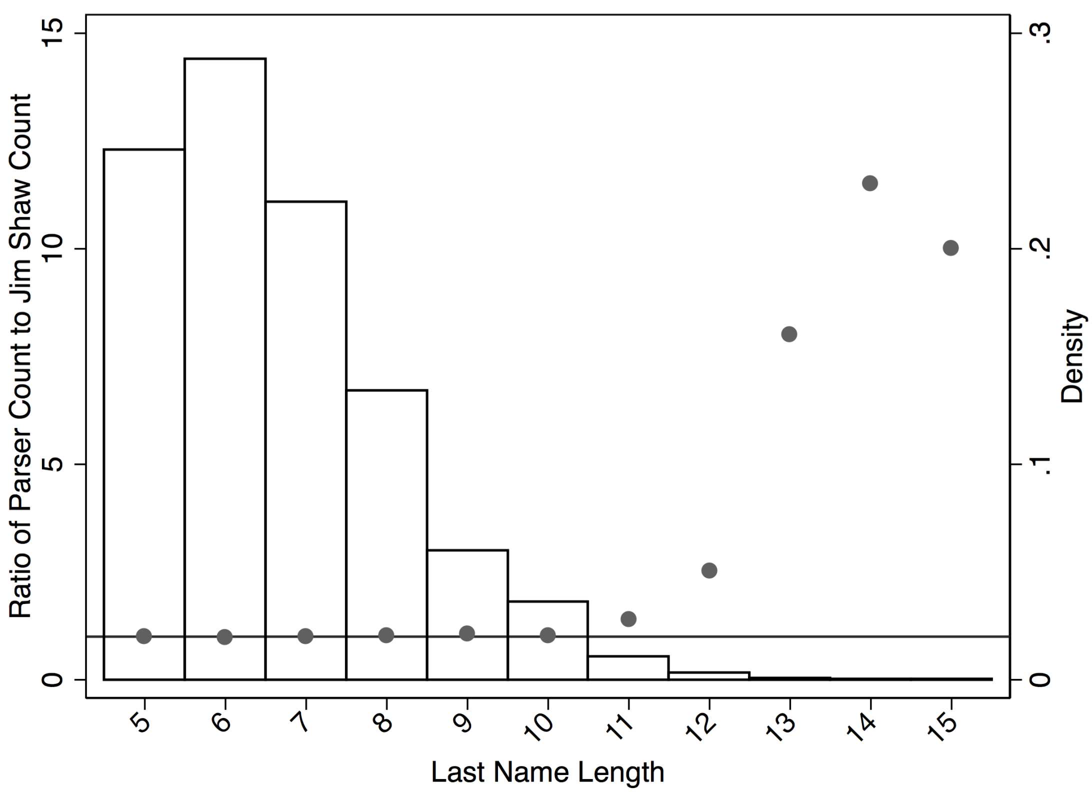


Figure 3.3: Comparison of the length of the last names of our parsed sample of patentees relative to Jim Shaw sample for 1870. The left hand axis plotted in blue dots shows the relative frequency in our dataset to that in Jim Shaw's. The right hand axis plotted with yellow bars shows the distribution of Jim Shaw's data for these various characteristics. Last name lengths are restricted to be between 5 and 15 characters.

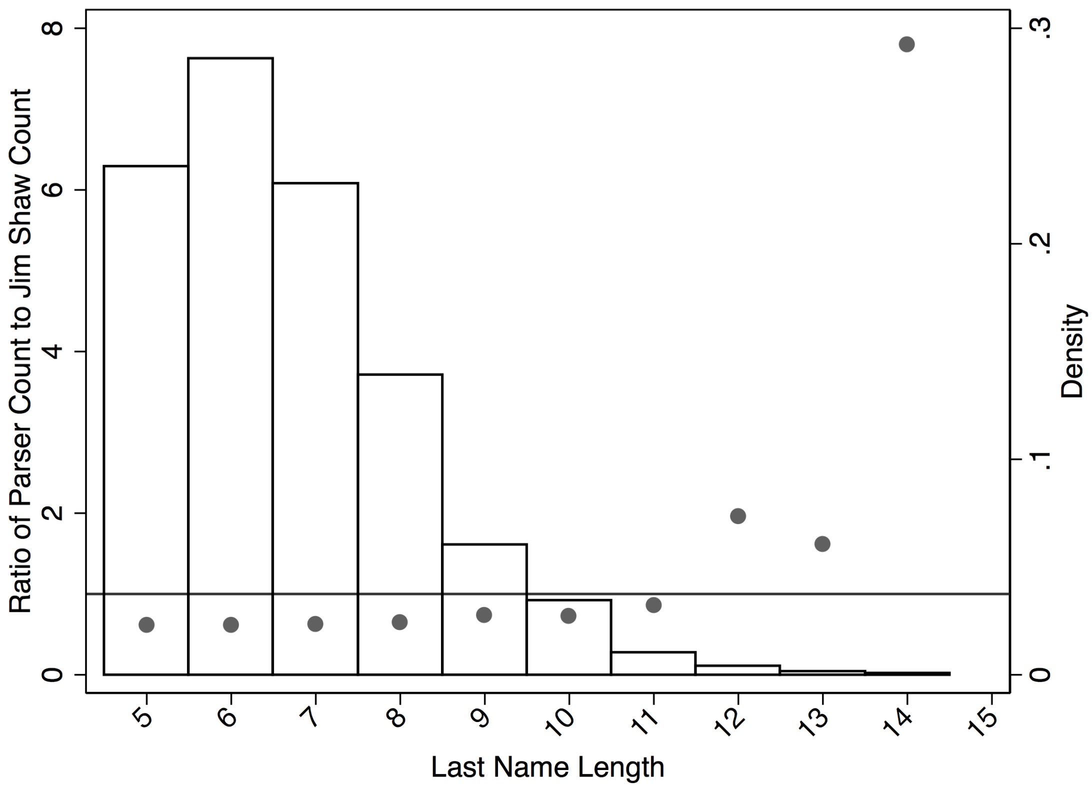


Figure 3.4: Comparison of the length of the last names of our parsed sample of patentees relative to Jim Shaw sample for 1870. The left hand axis plotted in blue dots shows the relative frequency in our dataset to that in Jim Shaw's. The right hand axis plotted with yellow bars shows the distribution of Jim Shaw's data for these various characteristics. Last name lengths are restricted to be between 5 and 15 characters.

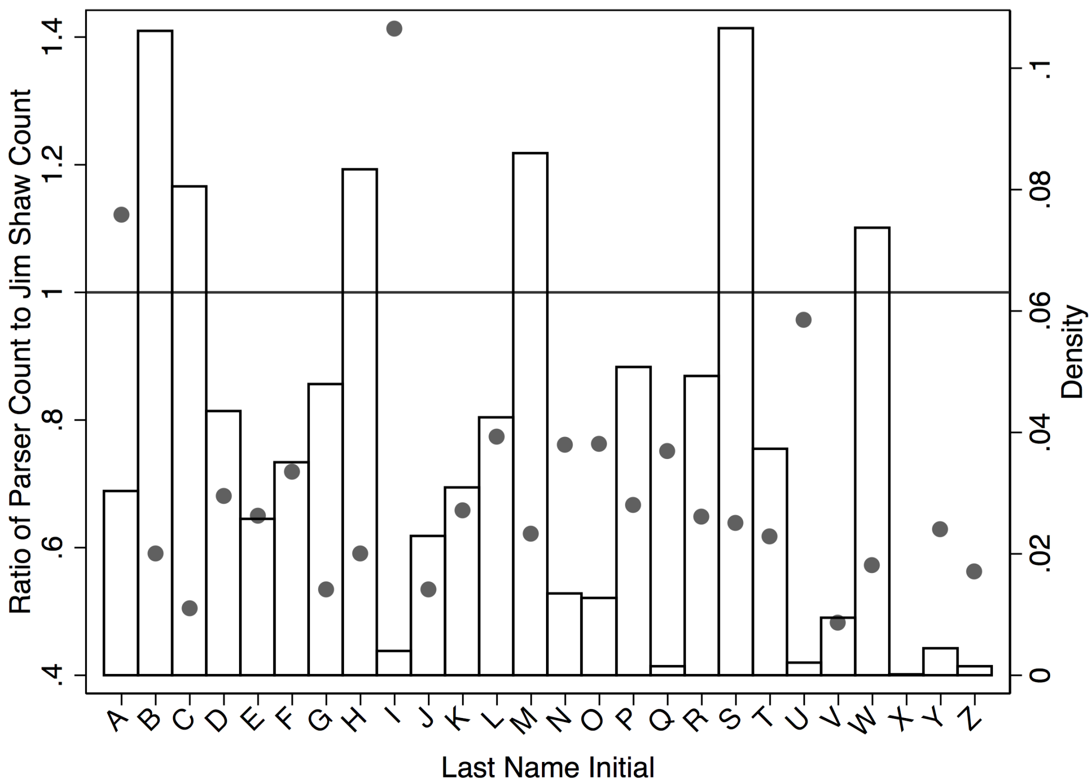


Figure 3.5: Comparison of the first letter of the last names of our parsed sample of patentees relative to Jim Shaw sample for 1870. The left hand axis plotted in blue dots shows the relative frequency in our dataset to that in Jim Shaw's. The right hand axis plotted with yellow bars shows the distribution of Jim Shaw's data for these various characteristics.

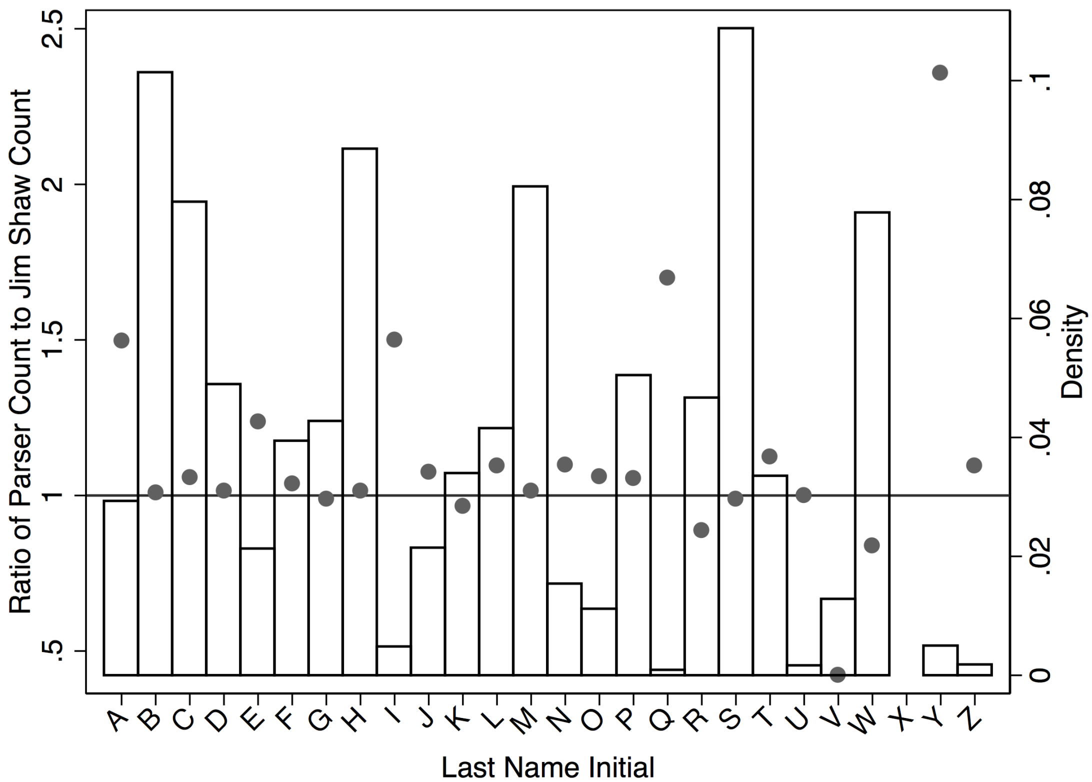


Figure 3.6: Comparison of the first letter of the last names of our parsed sample of patentees relative to Jim Shaw sample for 1873. The left hand axis plotted in blue dots shows the relative frequency in our dataset to that in Jim Shaw's. The right hand axis plotted with yellow bars shows the distribution of Jim Shaw's data for these various characteristics.

such as ();,"' from both datasets. We also used a set of common abbreviations of first names to ensure the consistency of how first names were recorded e.g. "Wm." became "William." We removed from the census dataset all individuals less than 15 or more than 80 years old under the assumption that very few of these individuals obtain a patent in any given year.

In determining what is a possible match, it is also necessary to specify weights on the match quality of the various matching characteristics as well as a minimum overall match score. To specify these parameters, we compared the matches identified by the algorithm for numerous combinations of matching weights in 1900 Vermont to the set of matches identified by "hand."[5] Vermont is, of course, not the most representative state since it tends to have relatively small towns making it easier to identify patent grantees based solely on name, but it has few enough patentees that it is feasible to check all of them by hand and a large enough number that we can be reasonably confident that matching results are not driven entirely by chance. The best parameters in specifying what is a match are able to match 76.4% (39 of 51) of Vermont patentees. Of the 12 unmatched patentees, we were unable to locate 4 through a manual search of the whole state, 2 returned possible matches at the state level although with wrong town name, and 4 (2 unique individuals, one of whom had 3 patents) more returned possible matches at the county level although again with wrong town name. The remaining two unmatched individuals were found as possible

---

[5]This procedure is essentially an informal support vector machine, a technique from the machine learning literature. See Feigenbaum 2015 for some work on this algorithmic matching topic.

matches in the correct county. There were also 5 “false positive” matches, all of which had intermediate match scores.

A perennial concern in the matching literature is the less than perfect match rate. Of course, some of this failure to match people over time is due to deaths or immigration out of the country, but rates still tend to be too low. In our case where in principle we know that someone is living in a particular town, the explanation, at least in part, must be that people move between the time when the patent application is filed and when it is granted. In this case, the location recorded in the patent report that of the location when the application is filed would be incorrect and it would be impossible to locate the patentee in the census records.

Our matching procedure returns any person in the census who is a potential match and does not enforce that matching be “injective.” There are several ways to handle the resulting cases of multiple potential matches, and we experiment with several below. First, we select the “best” match, which is the match with the highest match score; when multiple individuals produce the same match score, we randomly pick one as the best match. Second, we construct best-case and worst-case bounds on statistics of interest using the data on all potential matches. In particular, we calculate, say, the bounds on the average age by taking the average of the maximum and minimum ages of possible matches patentee by patentee. Finally, we average over all possible matches as suggested by Poirier and Ziebarth 2016. This treats all of the possible matches as exchangeable and it hinges on the fact that with probability one, the true match is in the set of possible matches. This provides a reason for having a fairly loose matching criteria (though Poirier and Ziebarth 2016 show the costs in efficiency associated with many possible matches).

The next step is to use the above-described matching procedure to link patentee names to the 100% sample of the decennial Census of Population provided by the Minnesota Population Center. The Census data offer basic demographic information such as race, age, gender, as well as information on birthplace for the individual and the individual's parents consistently across all the years.[6] We compare the demographics of the patentees to the underlying demographics of the county-level population from which they are drawn. We complement the population census data with information from the NHGIS, which has created county-level datasets drawn from the the manufacturing and agricultural censuses. These latter economic variables serve as explanatory variables in the regressions that we estimate.

Matching statistics for each year are also reported in Table 3.1. For each year from 1870 to 1920, we find a match for 52-65.5% of the parsed patents. In terms of the total number of granted patents, including those that could not be parsed, we match 20-50% for 1870 to 1920.[7] Our match rates are higher than those reported in Long and Ferrie 2013 and Abramitzky, Boustan, and Eriksson 2012 of around 30%.

[6]These are of course not all of the questions asked by the Census in any given year. Unfortunately, not all the variables have been transcribed though some specific ones such as literacy have been for particular years. That said, the 1940 file has much more detailed information on educational outcomes and income.

[7]The current issue with 1930 and 1940 is that our match rates are much lower at around 10% of the parsed patents and 5-7% of the full population of granted patents. These low match rates appear to be due to poor scanned image quality in the original *Annual Reports* which produces impossible-to-match town names.

Saying whether this rate is "too" high or low relative to the literature is challenging given the differences in variables we use for matching as well as the differences in the quality of the records attempting to be linked.

At the same time, the fact that we search for people in very narrow geographic regions mitigates the problem of multiple matches. Recall that each patentee may receive multiple possible matches from the census data, and, in fact, the same person in the census may match to multiple patentees; the match need not be "injective." Still for 1870, 1880, and 1910, about 85% of the patentees were uniquely matched. Not surprisingly, the fraction of uniquely matched patents decreases in 1920, 1930, and 1940 as population grows. The number of potential matches per patent increases from an average of 2.79 possible matches in 1870 to almost 30 possible matches in 1940. We also report the number of "perfect" matches, which are matches in which all of the characters in the last name, first name, and town of an individual in the census match exactly with an inventor in the patent report.

A crucial question is to what extent the matched sample is representative of the whole sample. This is of course impossible to demonstrate for unobservables (by definition), but we can show that along a number of observable dimensions, the matched sample looks similar to the non-matched sample. Figures 3.7-3.12 displays this comparison for 3 different characteristics for the census years of 1880 and 1920: first letter of first name, first letter of last name, and number of characters in name. Results for the other census years are very similar. There are any number of reasons the matched sample could differ from the non-matched sample. For example, given how the matching algorithm compares strings, the length of the string may make it easier (or more difficult) to declare a match. However, as is evidenced in Figures 3.11 and 3.12, there is no meaningful difference here. There is likewise negligible difference in first letters of first and last names. This gives us some confidence that our matching procedure is not biasing the sample towards particular types of patentees.

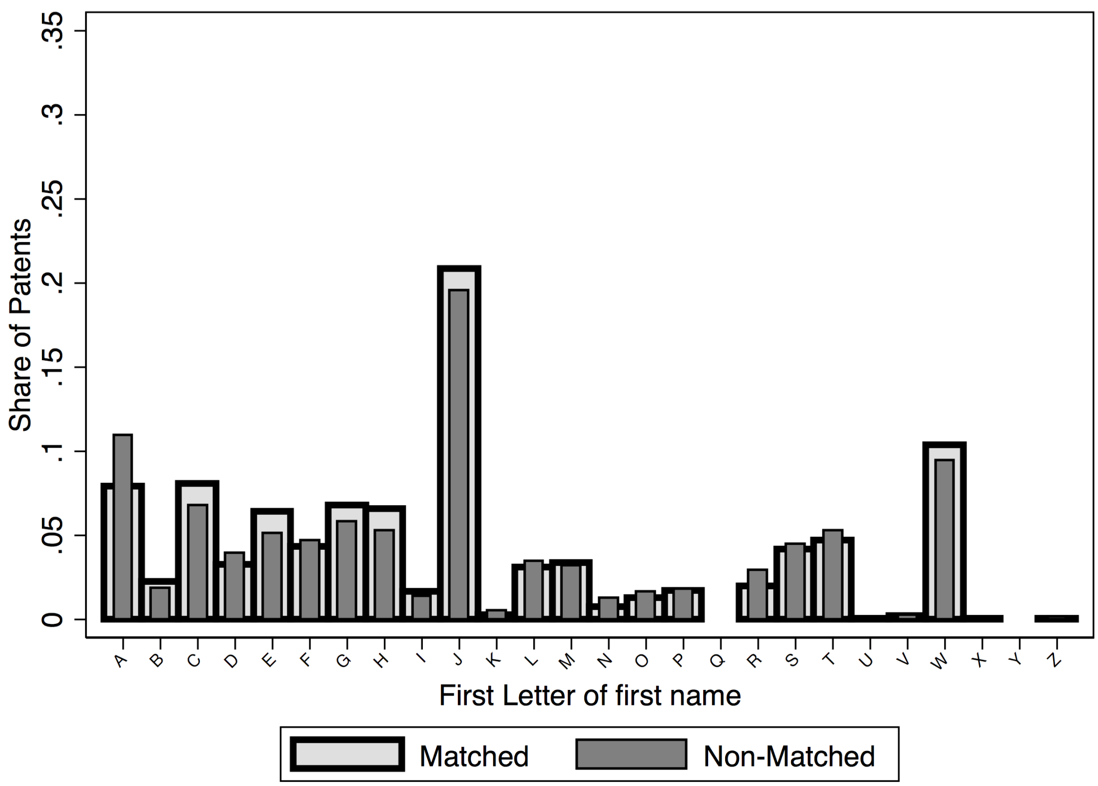


Figure 3.7: Comparing the first letter of first names of matched to non-matched patentees in 1880.

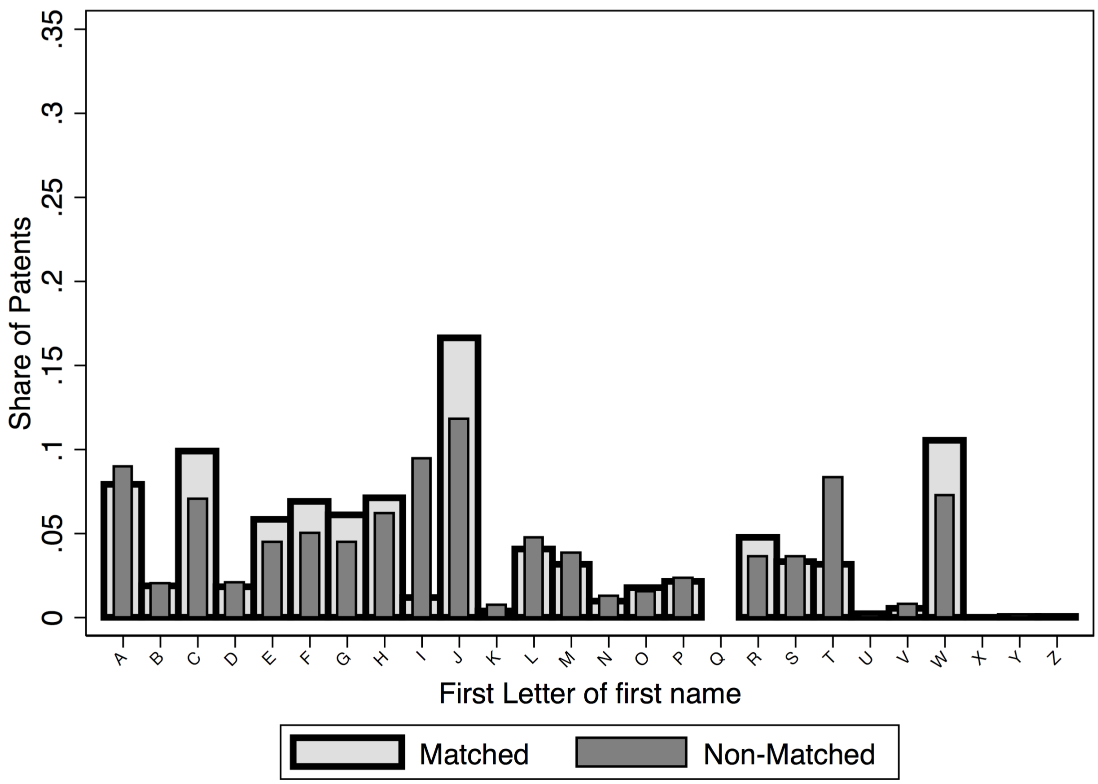


Figure 3.8: Comparing the first letter of first names of matched to non-matched patentees in 1920.

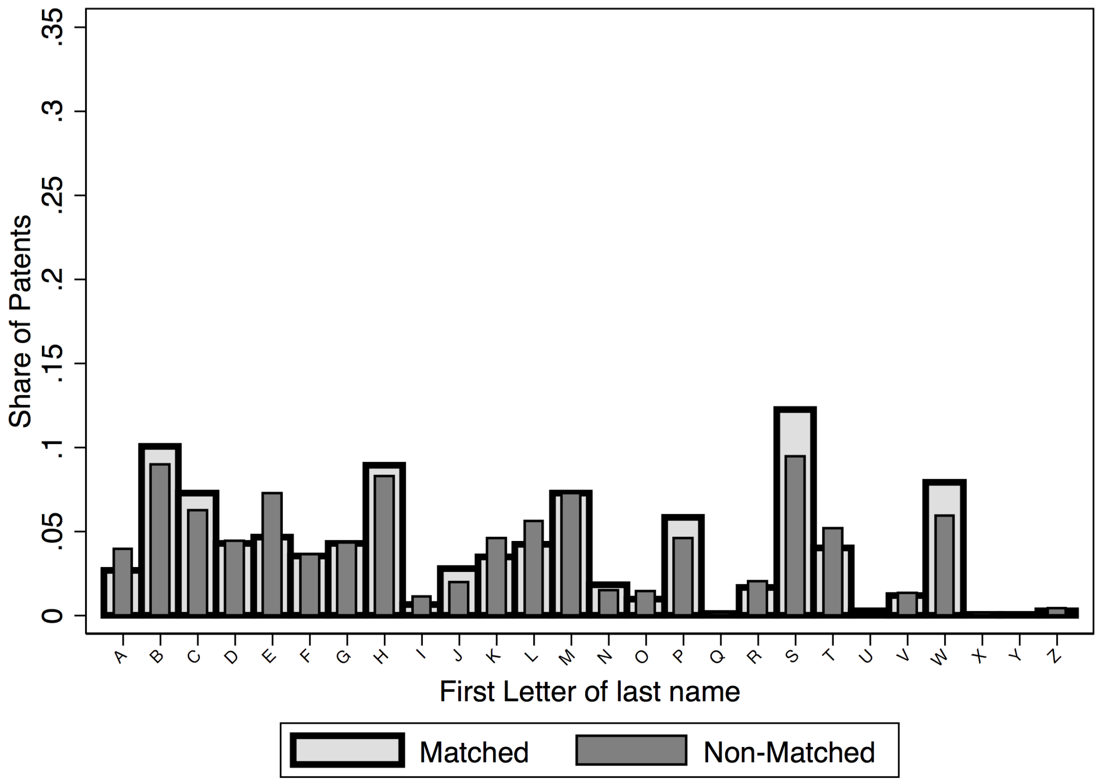


Figure 3.9: Comparing the first letter of last names of matched to non-matched patentees in 1880.

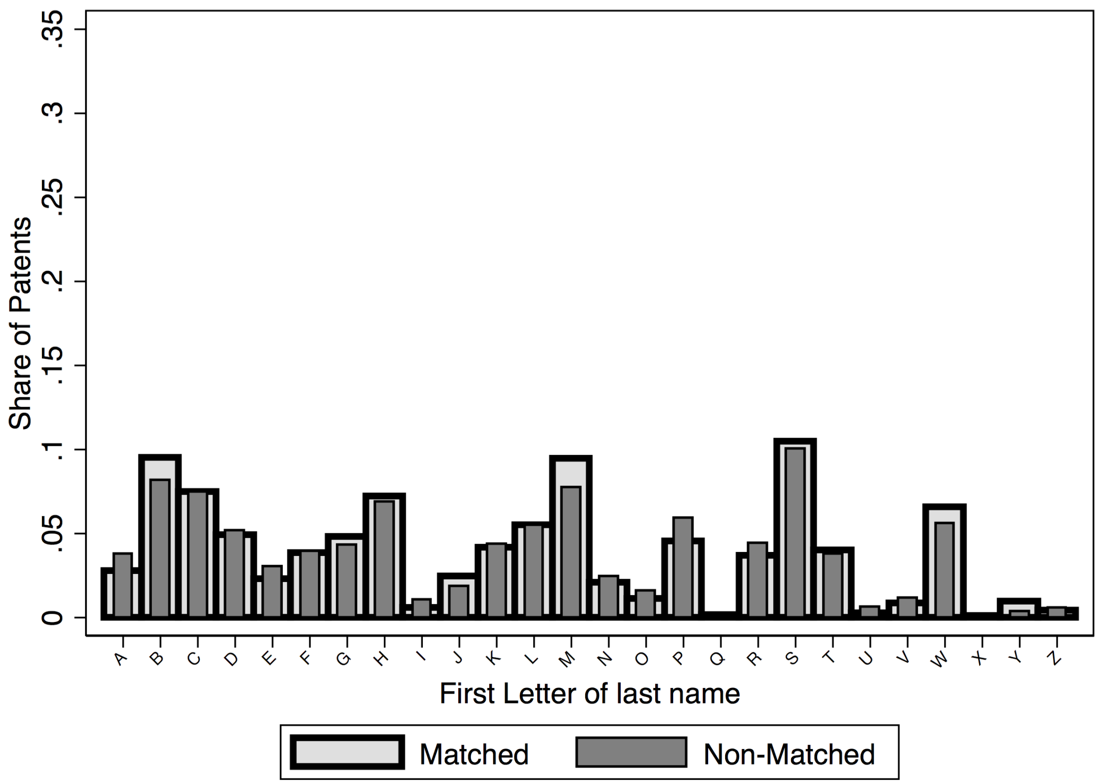


Figure 3.10: Comparing the first letter of last names of matched to non-matched patentees in 1920.

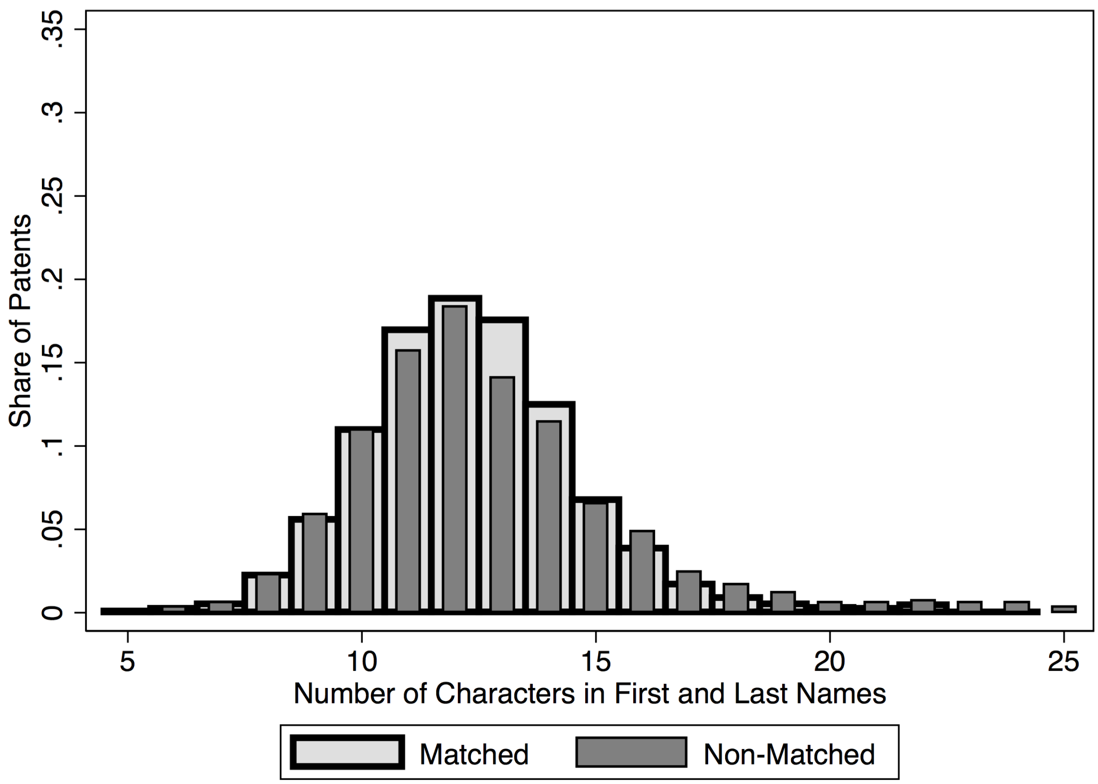


Figure 3.11: Comparing the length of last names of matched to non-matched patentees in 1880.

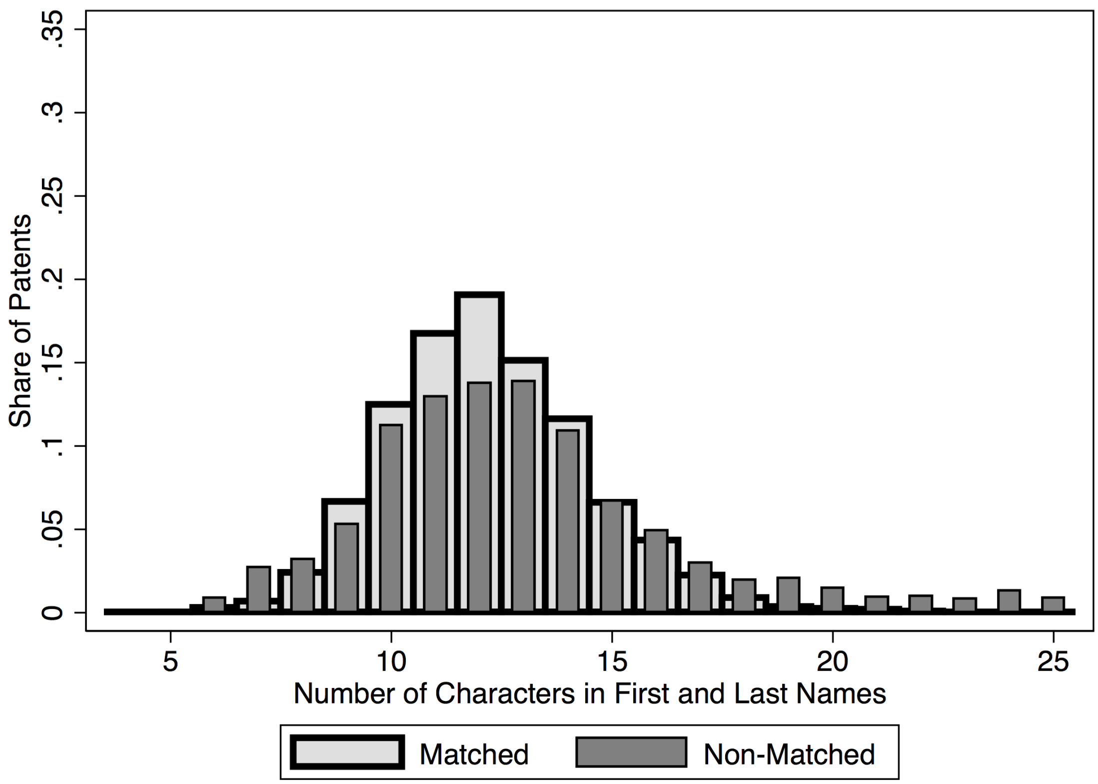


Figure 3.12: Comparing the length of last names of matched to non-matched patentees in 1920.

3.3 Results

3.3.1 Trends in the Demographics of Patentees

Over the whole 70 year time frame, patentees are on average 40 years old as compared to the population average of 37 conditional on individuals being at least 10 years old. Across our sample, 82% of patentees are male as compared to 50% in the general population. 96% of patentees are white and 66% are cross state immigrants. Though still much lower than their proportions in the population, the rate of female patenting ranges between 10 and 24% while the rate of black patenting runs between 3 and 10%. At least for blacks, there is some reason to believe that these numbers are an underestimate as suggested by Cook 2014. She argues that blacks tended not to file under their own names because of worries about how their patent would be viewed.[8]

Next, in Figure 3.13-3.16, we document some simple time series patterns of the demographics of patentees relative to the general US population. We plot the following lines. Let X be some demographic variable (age, sex, race, migration status) and let $i = 1....N$ index patents, then we calculate

1. $X^U = \frac{1}{N}\sum_i \max_j X_{ij}$
2. $X^L = \frac{1}{N}\sum_i \min_j X_{ij}$
3. $X^M = \frac{1}{N}\sum_i \frac{1}{m_i}\sum_{j=1}^{m_i} X_{ij}$

where $j = 1...m_i$ indexes possible matches for patentee i. The first two can be thought

[8] At the same time, there are questions about what legal recourse blacks would have in this case if the white person filing the patent decided to use the patent in some way contrary to the black inventor's intentions.

of as "worst case" bounds in that the "true" average must lie between them. The third measure simply averages across patentees and their potential matches. We then plot these statistics normalized by the average value of the demographic variable in the county of the patentee's residence. So a value of 1 means that the demographics of inventors in a particular county are representative of the county population as a whole.

In Figure 3.13 we show that consistently over this time period the average age of patentees was about 15% higher than the population as a whole. Recall that this is after eliminating everyone under 15 years of age. This pattern fits more recent studies as well such as that of Jung and Ejermo 2014, but contradicts that of Jones 2009, who seems to suggest that the age of inventors should be increasing faster than that of the reference population. Note that the worst case bounds, while showing different levels of average age (the lower bound suggests patentees are *younger*), does not show drastically different trends over time. We take the relative stability as the most salient and striking feature particularly in light of the changing composition of industry and areas of greatest inventive progress.

Figure 3.14 shows that relative to their representation in the population, whites are overrepresented among patentees between 1870 and 1920. However, between 1930 and 1940, this pattern is reversed where non-white patentees become the more heavily represented group. We find the last two observations rather anomalous.[9] So we

[9] As noted above, match rates are very low for 1930 and 1940 due to the poor quality of the raw data.

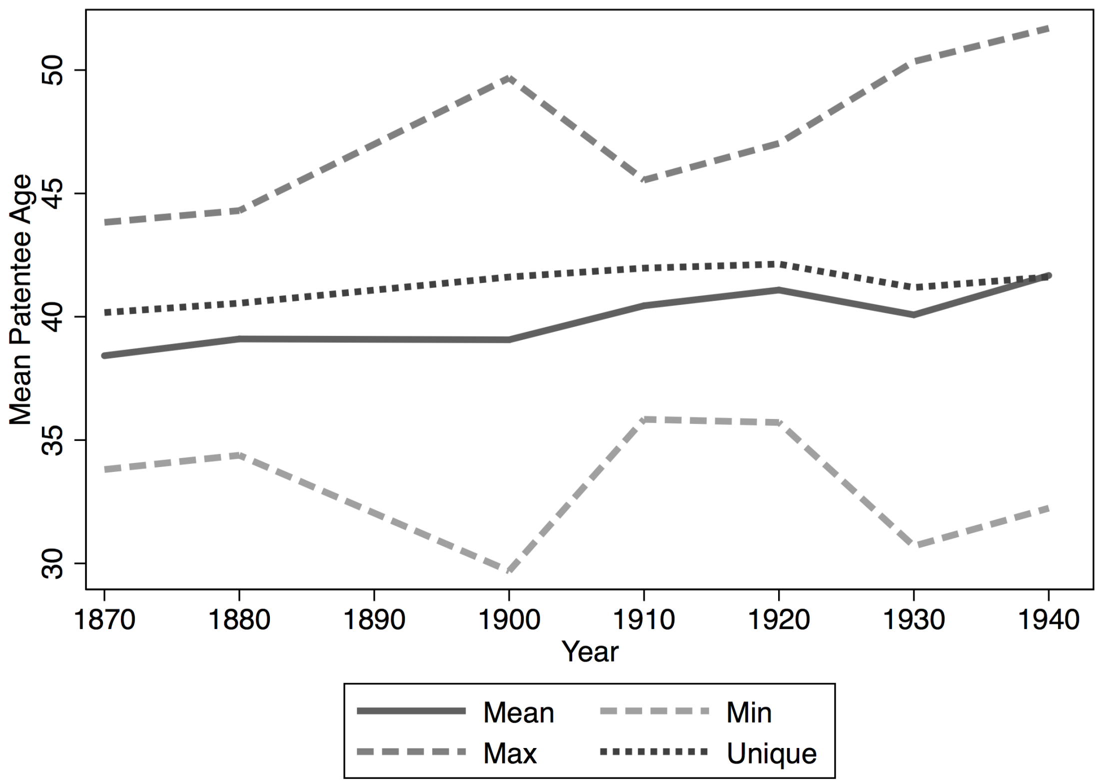


Figure 3.13: Age of patentees relative to county of residence. The mean is the average characteristic across all possible matches for a given patentee, then averaged across all patentees. The max (resp. min) is the "maximum" (resp. "minimum") value of a particular characteristic across all possible matches, then averaged across all inventors. We also report the values for the set of patentees where we have a unique match. We then report the ratio of these statistics to the average characteristics of the population in the county.

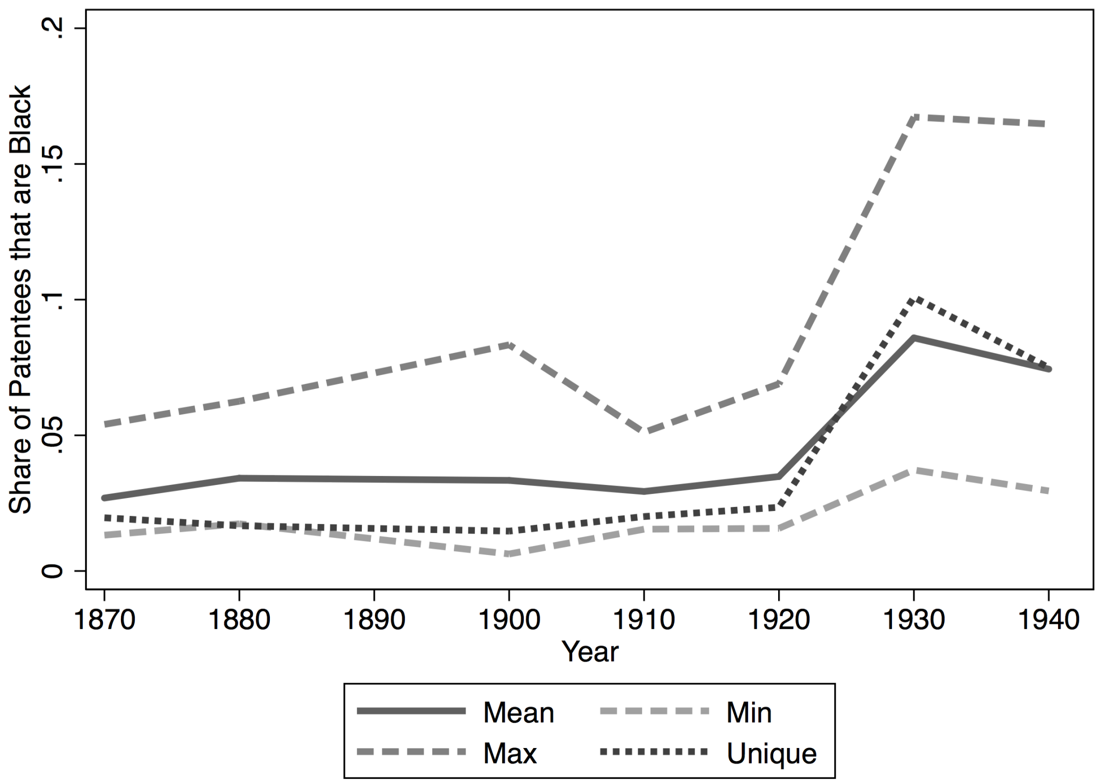


Figure 3.14: Fraction of patentees by blacks relative to county of residence. The mean is the average characteristic across all possible matches for a given patentee, then averaged across all patentees. The max (resp. min) is the "maximum" (resp. "minimum") value of a particular characteristic across all possible matches, then averaged across all inventors. We also report the values for the set of patentees where we have a unique match. We then report the ratio of these statistics to the average characteristics of the population in the county.

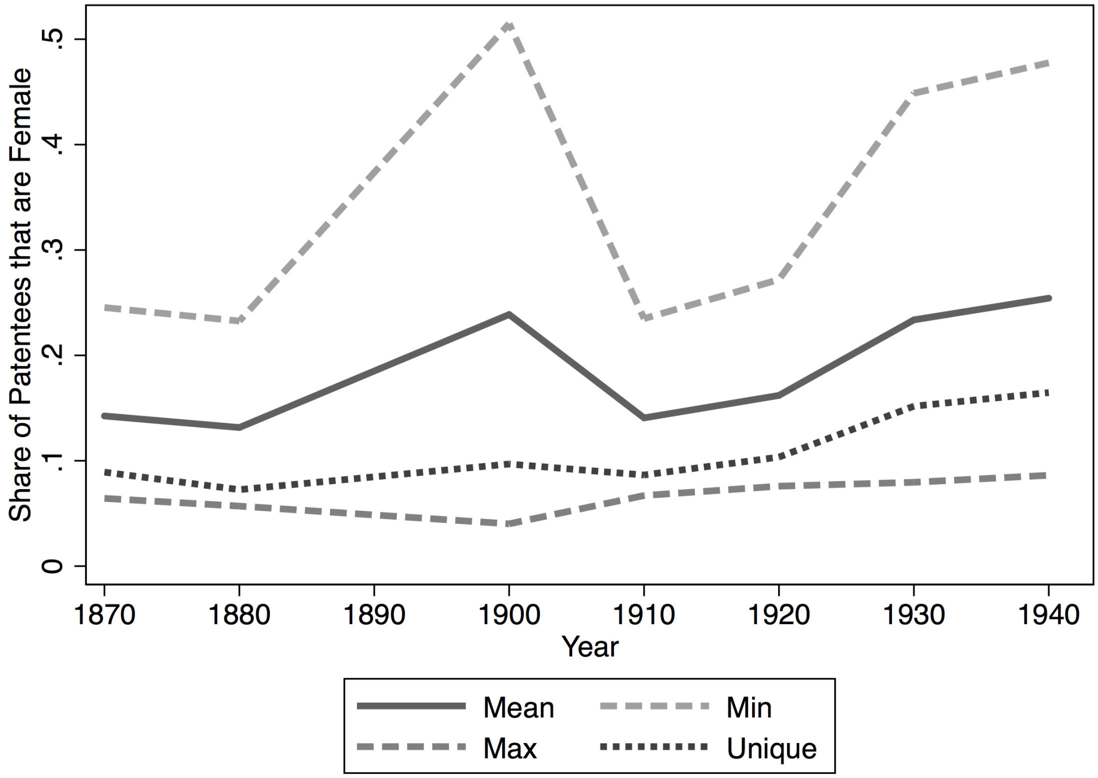


Figure 3.15: Fraction of patentees by females relative to county of residence. The mean is the average characteristic across all possible matches for a given patentee, then averaged across all patentees. The max (resp. min) is the "maximum" (resp. "minimum") value of a particular characteristic across all possible matches, then averaged across all inventors. We also report the values for the set of patentees where we have a unique match. We then report the ratio of these statistics to the average characteristics of the population in the county.

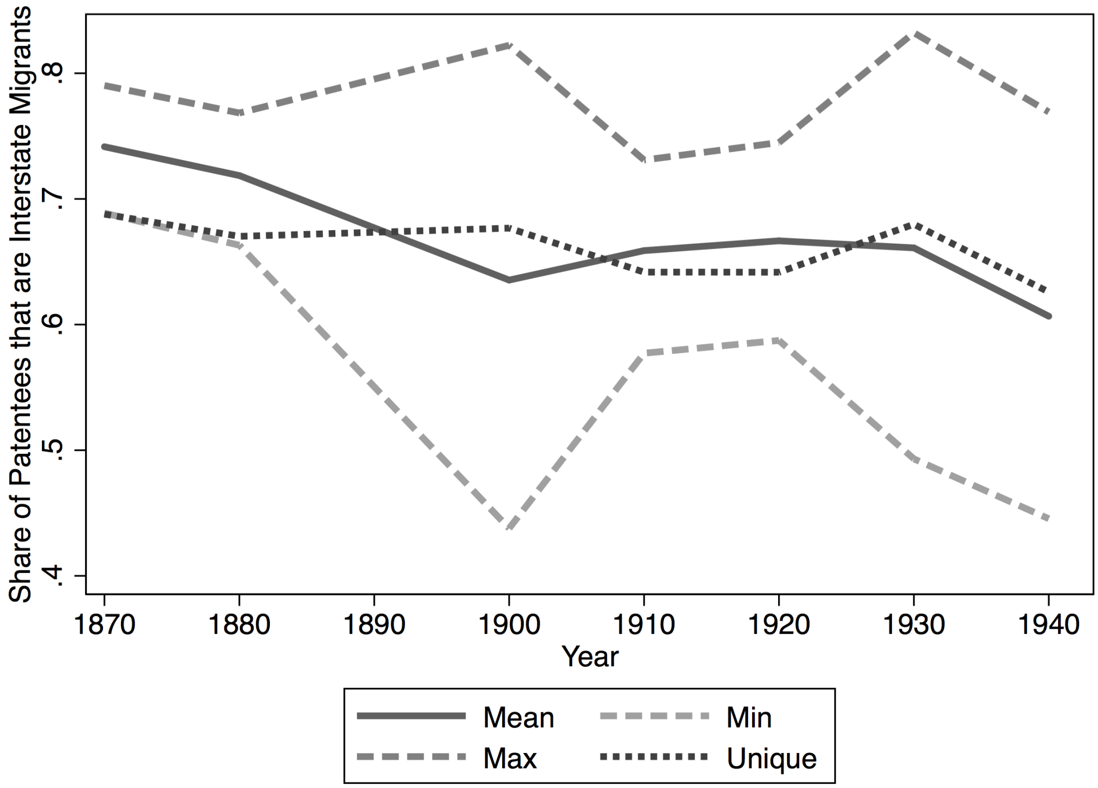


Figure 3.16: Fraction of patentees by interstate migrants relative to county of residence. The mean is the average characteristic across all possible matches for a given patentee, then averaged across all patentees. The max (resp. min) is the "maximum" (resp. "minimum") value of a particular characteristic across all possible matches, then averaged across all inventors. We also report the values for the set of patentees where we have a unique match. We then report the ratio of these statistics to the average characteristics of the population in the county.

focus on the first 50 years and again what strikes us is the relative stability of black patenting rates. This is in the face of the imposition of Jim Crow laws after the end of Reconstruction in 1877. These laws severely restricted the political rights of black in many southern states and set up a separate (and underfunded) school system for blacks. One issue that we will consider in more detail below is to what extent these rates are biased due to undercounting of African Americans by the Census (Coale and Rives 1973).

Figure 3.15 shows that female patentees are severely underrepresented throughout our timeframe, representing between 2 and 15% of patentees while comprising about 50% of the population. This disproportionate underrepresentation monotonically declines between 1870 and 1910, and then at a (slightly) faster rate from 1920 onward - coinciding with the women's rights movement. While this brings the gender composition of patentees slightly closer to that in the population, the divergence remains large. The worst case bounds show broadly similar patterns here though the drop in in the lower bound is exaggerated. Whether the relationship between increases in formal political and economic rights and patenting representation of women is more than spurious demands closer scrutiny. Note however that all of this increase precedes the large increases in female workforce participation dating to after the second World War. It is interesting to set that casual correlation against the limited change in the representation of blacks in patenting as the Jim Crow system of disenfranchisement and segregation intensifies across the county over this period Logan and Parman 2017.

Our final broad time series pattern in Figure 3.16 shows that patentees are more likely than the overall population to reside in a state other than their birth state. While there are some fluctuations in the overrepresentation of migrants amongst patentees, the overall pattern is relatively stable across time. Perhaps this can be explained by the differences in demographics presented in the other three panels (or simply state of birth). Still, we find the fact that patentees tend to be living outside their states of birth to be suggestive of inventors moving to opportunities. Understanding what drives this location decision is a key question for future research. We would note here that the worst case bounds suggest different patterns with the representation of migrants increasing over time for the upper bound and decreasing over time for the lower bound.

3.3.2 Trends in the Demographics of Patentees Inferred from First Names

As a check on the quality of the matching and as a way to get a more complete time series picture, we offer a second method for inferring the gender and race of patentees for all years not just Census years. In particular, we use the observed probability a person is black or female as a function of the first name of the person. This of course could be extended to other observable characteristics such as state of residence or last name. For example, Cook, Logan, and Parman 2013 have done this historically for black names and identified a set of “distinctively black names.” It has been used in a number of papers on patenting as well such as Jung and Ejermo 2014 to infer gender, Jones 2009 to infer age, and Celik 2015 to infer income. One upshot of this approach is that we can use the first name probabilities based on the Census to calculate the average fraction of black and female inventors for any year of the *Annual Report*. We do not have to restrict attention to only Census years in calculating this probability. Concretely, using the 100% Census dataset, for each first name η, we calculate $p_\eta = Pr(Black|\eta)$, similarly for women. Then, for patentee i with name η_i in a given patentee list, we impute the probability being black using p_{η_i}. Then our estimate of the fraction of black inventors is given by

$$\frac{1}{N}\sum_{\eta} \#_\eta p_\eta$$

where $\#_\eta$ is the number of patentees with name η. This procedure is basically a split-sample IV procedure (Angrist and Krueger 1992).[10]

Figures 3.17 and 3.18 shows the results based on this procedure for gender and race. We find broadly similar patterns to those from our "exact" matching routine. In particular, there is a remarkable amount of stability in the prevalence of these groups in patenting particular in Figure 3.17 for blacks. At the same time, there are differences. For one, the change in black patenting rates is much smaller than using the "exact" matching produced to non-existent with this procedure. Second, it is also quite clear that the overall increase in female patenting in Figure 3.18 takes place after 1900 in a more or less secular fashion (though this only constitutes a few percentage point increase).[11]

---

[10] In principle, we could apply a similar procedure to inferring ages as well.

[11] Note that we are still not able to code all names in the *Annual Report* since they are not in the Census. This is due to mistakes in the names and was part of the motivation for moving to the fuzzy matching procedure we employ.

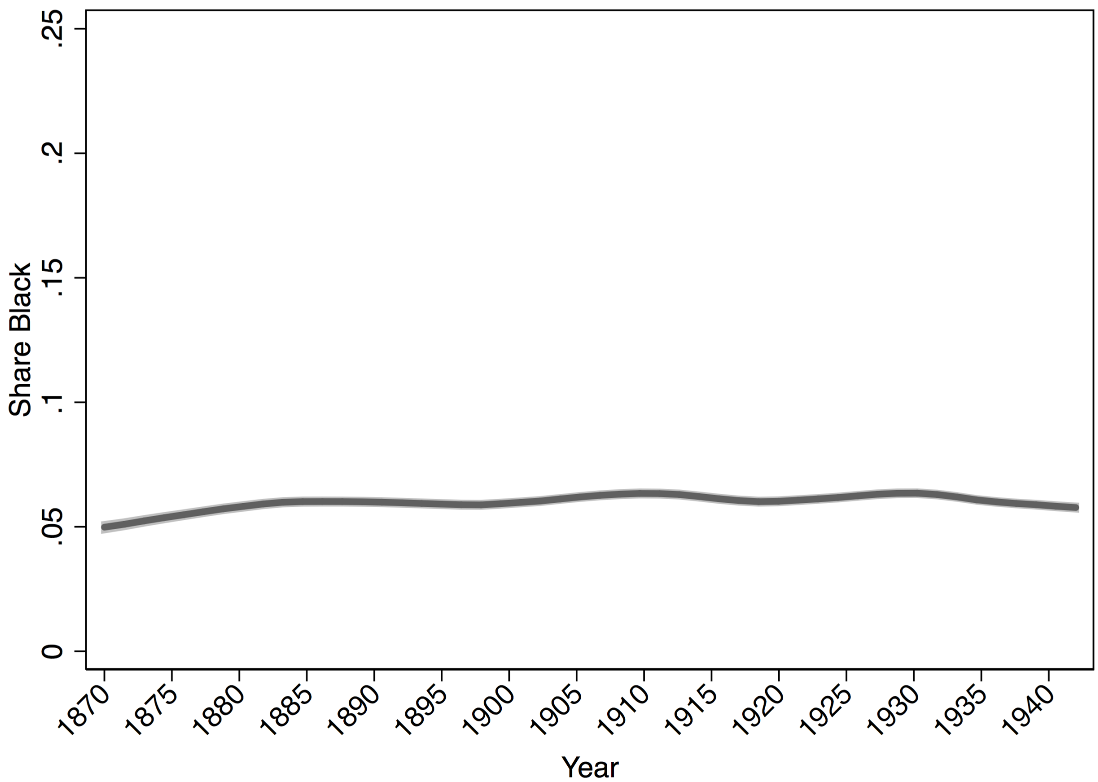


Figure 3.17: Fraction of patents by blacks based on first names of patentees. This uses a "2-sample IV" procedure to impute a probability that a particular inventor is female (resp. black) based on the probability that a person with that first name is female (resp. black) in the nearest population census. We then smooth these values over time.

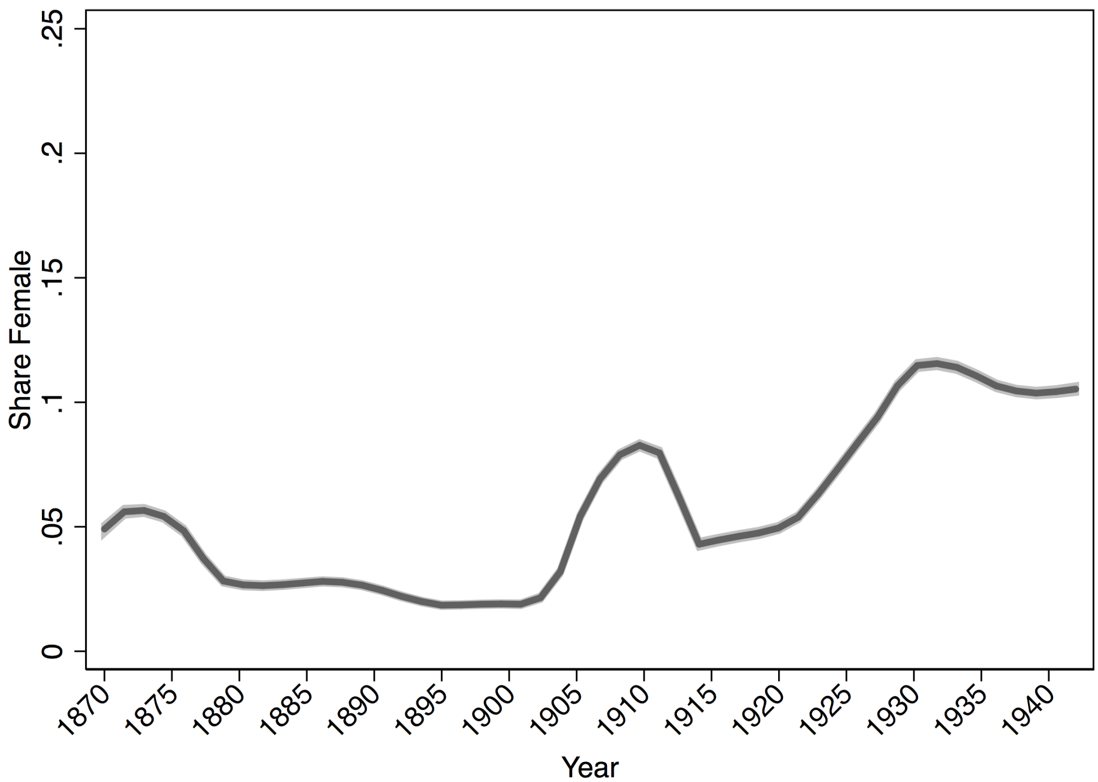


Figure 3.18: Fraction of patents by females based on first names of patentees. This uses a “2-sample IV” procedure to impute a probability that a particular inventor is female (resp. black) based on the probability that a person with that first name is female (resp. black) in the nearest population census. We then smooth these values over time.

A key question in considering these results, particularly for African Americans, is the extent of underenumeration by the Census. A number of authors have documented undercounting of African Americans going back to 1880. Coale and Rives 1973 provide some estimates of the magnitude of this problem and find that for African American males, the Census numbers are about 10% too small. While this does vary some from census to census between 1880 to 1980, there is no clear trend and the variation is all within a range of 9% and 14.4%. Besides enumerator error, there is also intended so-called "passing" on the part of African-Americans to portray themselves as white, which would affect measurement of the size of the "true" African American population.

The most obvious way that this bias could matter is biasing the denominator in calculating a rate. Assuming for a second that we correctly estimate the number of patents by black inventors but underestimate the size of the black population, then this will mechanically lead us to overestimate the *rate* of black patenting. The additional difficulty for us is that we estimate the first name probabilities based on the contaminated Census data and use these as the basis of our estimate of the number of black inventions, which forms the numerator of the black patenting rate. For now, we focus on biases that might affect this numerator.

Assuming that that this undercounting applies uniformly across space and inventors relative to non-inventors, then we can bound the magnitude of the bias. In one extreme, where there is no overlap between the names of white and blacks i.e. $p_\eta = 0, 1$, then this undercounting would have no effect since these probabilities

	η_B	η_W
B	N_{BB}	N_{BW}
W	N_{WB}	N_{WW}

Table 3.2: Two way table of populations as a function of race B, W and name η_B, η_W.

would not change. This would not be the case if "undercounting" came in the form of passing where some blacks are classified as white. Then this would clearly lead us to underestimate the number of black patents as some fraction of a black patent would be attributed to a white.

The second assumption that this undercounting applies uniformly across inventors and non-inventors, while not totally obvious, is more defensible than the assumption that it applies uniformly across space. Both Hobbs 2014; Nix and Qian 2015 find clear differences across space in the rate of passing. Jaspin 2007 argues that passing in many cases was a response to racially motivated violence. Other work by Cook 2014 has shown these hate crimes also reduce patenting by blacks. In this case, it is not obvious whether this would lead to under or over estimates as it would affect the denominator and numerator in the same direction.

We can formalize these considerations in the following manner. For simplicity, assume we have two races: B, W and two names η_B, η_W and N is a population size. Table 3.2 displays the "true" unobserved two-way table of population sizes. Besides this population information, we also observe P_B patents for people named η_B and P_W

for people named η_W. Then the true black patenting rate is

$$= \frac{P_B Pr(B|\eta_B) + P_W Pr(B|\eta_W)}{N_{BB} + N_{BW}}$$

where $Pr(B|\eta_B) = N_{BB}/(N_{BB} + N_{WB}), Pr(B|\eta_W) = N_{BW}/(N_{BW} + N_{WW})$. Subbing in for the probabilities, we have

$$\frac{\frac{P_B N_{BB}}{N_{BB}+N_{WB}} + \frac{P_W N_{BW}}{N_{BW}+N_{WW}}}{N_{BB} + N_{BW}}$$

In the case of passing, denote the number of black people named η_B that pass for white as $\Delta_B > 0$, similarly for η_W, $\Delta_W > 0$. Then the measured rate in this case is

$$\frac{\frac{P_B(N_{BB}-\Delta_B)}{N_{BB}+N_{WB}} + \frac{P_W(N_{BW}-\Delta_W)}{N_{BW}+N_{WW}}}{N_{BB} + N_{BW} - \Delta_B - \Delta_W}$$

This type of error distorts both the probabilities of being black condition on a given name as well as the total number of blacks in the denominator in the same direction.

For the underenumeration, denote the percentage of blacks of name η_B that are not counted as $q_B > 0$, similarly for those named η_W, $q_W > 0$. Then the measured rate in this case is

$$\frac{\frac{P_B q_B N_{BB}}{q_B N_{BB}+N_{WB}} + \frac{P_W q_W N_{BW}}{q_W N_{BW}+N_{WW}}}{q_B N_{BB} + q_W N_{BW}}$$

If $q_W = q_B = q$, this simplifies to

$$\frac{\frac{P_B N_{BB}}{q N_{BB}+N_{WB}} + \frac{P_W N_{BW}}{q N_{BW}+N_{WW}}}{N_{BB} + N_{BW}}$$

So in this case, it is clear that increased rates of underenumeration in the form of lower values of q would lead to underestimates of the rates.

3.4 County-level Economic and Demographic Correlates

We now offer some exploratory regressions to predict the characteristics of inventors based on characteristics of the county in which they live. We estimate simple linear specifications where we predict female patenting, black patenting, inventor age, and patenting by inter-state migrants. Note that these first three dependent variables are binary so we are estimating linear probability models. For all tables presented below, we cluster the standard errors at the county-level, include year fixed effects, and estimate using OLS. We consider multiple specifications: (1) incrementally including various controls and (2) including state fixed effects. We can also estimate these regressions using different ways of defining the dependent variable based on the outcome of the matching procedure. These include: (1) using unique matches, (2) averaging across the best matches, and (3) averaging across all "good enough" matches. We will focus on the unique matches results here though results are fairly similar across these three different dependent variables. We draw on data from the various population and non-population Censuses for our explanatory variables as assembled by NHGIS. Different variables are available in different years and this is why in the regressions, the number of observations changes across specifications.

Note that the first five rows of each table of regression results report controls for the demographics of the county that we know already are related to the demographics of inventors. Table 3.3 shows the results for female patent representation. We find unsurprisingly counties with higher fractions of women tend to have higher representation of female patentees, albeit these coefficients do not yield statistical significance.[12] What is perhaps more interesting is that this elasticity is less than one, whereas an elasticity of one would be consistent with a model wherein differences in the demographics of patentees are simply reflective of local demographic differences. Turning to the other characteristics of the county, we find that county population does not relate systematically, while being in an "older" county renders women to be less likely to patent. Being in a county with more blacks and one that is more urban also increases female patenting. Unsurprisingly, higher female employment in manufacturing relates positively to female patenting (again, not statistically significant however). Finally, we find that being in the South, increases the odds of female patenting. Taken together, these findings that counties that are more diverse in some senses - ones that are urban and with larger minority and female populations are also the ones to foster female patenting.

Similarly, table 3.4 shows that blacks are more represented in patenting in counties with a greater representation of marginalized populations. Counties that have a higher fraction of blacks and women and a lower fraction of cross-state migrants and urban populations are also the ones to have higher representation of black patenting. In contrast to female patenting which benefits from urban environments this does not appear to translate to blacks. This suggests that the conditions wherein marginalized populations thrive are not necessarily always the same ones.

Table 3.5 shows that patentees in counties with older populations and a higher

[12] The lack of statistical significance is likely due to the lack of variation in the fraction of females across counties. For the most part, this hovers around fifty percent.

	Unique match: Female				
	(1)	(2)	(3)	(4)	(5)
Log Population	0.002	0.001	-0.008***	-0.003	0.010
	(0.003)	(0.004)	(0.003)	(0.004)	(0.007)
Cty. Female	0.099	0.152	0.156	0.200	0.399
	(0.088)	(0.110)	(0.134)	(0.158)	(0.245)
Cty. Age		-0.002	-0.002	-0.008**	-0.006
		(0.002)	(0.003)	(0.003)	(0.006)
Cty. Black		0.126***	0.023	0.015	0.180**
		(0.030)	(0.045)	(0.055)	(0.075)
Cty. State Migrant		0.049***	0.061***	-0.051	-0.025
		(0.013)	(0.013)	(0.032)	(0.057)
Frac. Urban			0.008	0.010	0.020*
			(0.008)	(0.009)	(0.010)
South			0.036**		
			(0.018)		
Frac. Manuf. Female					0.142
					(0.121)
FEs	None	None	None	State	State
Observations	57339	56640	29589	29589	10133
Adjusted R^2	0.014	0.017	0.011	0.014	0.009

Table 3.3: County-level correlates of gender of patentees. The dependent variable is the average value of the demographic across the set of all possible matches for a particular patentee.

	Unique match: Black				
	(1)	(2)	(3)	(4)	(5)
Log Population	0.008***	0.008**	0.001	0.003*	0.000
	(0.003)	(0.004)	(0.001)	(0.002)	(0.003)
Cty. Black	0.429***	0.411***	0.284***	0.280***	0.279***
	(0.028)	(0.030)	(0.040)	(0.047)	(0.079)
Cty. Age		-0.001	-0.002*	-0.001	-0.003
		(0.001)	(0.001)	(0.001)	(0.002)
Cty. Female		-0.082	0.068	0.027	0.004
		(0.089)	(0.043)	(0.059)	(0.115)
Cty. State Migrant		-0.019**	-0.014***	-0.018	-0.035
		(0.009)	(0.005)	(0.017)	(0.030)
Frac. Urban			-0.002**	-0.002**	-0.003
			(0.001)	(0.001)	(0.005)
South			0.013		
			(0.016)		
Frac. Manuf. Female					-0.019
					(0.039)
FEs	None	None	None	State	State
Observations	48522	47917	25179	25179	7103
Adjusted R^2	0.062	0.062	0.049	0.054	0.084

Table 3.4: County-level correlates of race of patentees. The dependent variable is the average value of the demographic across the set of all possible matches for a particular patentee.

fraction of whites and females, are also older. Here the relationship between the county-level average age and that of inventors is only slightly smaller than 1. In sum, counties that are more urban, with more blacks and with greater female employment in manufacturing is associated with a higher prevalence of young inventors.

	Unique match: Age				
	(1)	(2)	(3)	(4)	(5)
Log Population	-0.273***	-0.374***	-0.259**	-0.112	0.113
	(0.073)	(0.077)	(0.121)	(0.154)	(0.266)
Cty. Age	0.977***	0.831***	0.762***	0.752***	0.614***
	(0.067)	(0.071)	(0.107)	(0.145)	(0.232)
Cty. Black		-3.005***	-2.880*	-1.478	-9.481***
		(0.951)	(1.734)	(1.826)	(2.804)
Cty. Female		7.057**	13.009***	11.018*	29.747***
		(3.529)	(4.740)	(6.059)	(10.457)
Cty. State Migrant		0.254	0.330	-2.598**	-0.751
		(0.389)	(0.500)	(1.232)	(2.328)
Frac. Urban			-0.123	-0.113	-0.782**
			(0.318)	(0.290)	(0.396)
South			0.224		
			(0.638)		
Frac. Manuf. Female					-5.644
					(4.186)
FEs	None	None	None	State	State
Observations	48522	47917	25179	25179	7103
Adjusted R^2	0.015	0.016	0.012	0.015	0.019

Table 3.5: County-level correlates of age of patentees. The dependent variable is the average value of the demographic across the set of all possible matches for a particular patentee.

Finally, table 3.6 shows that areas with more inter-state migrants also have more patentees of the same type. Similar to age, the elasticity here is also fairly close to one across specifications. Interestingly, population is negatively correlated until state fixed effects are added and then the correlation disappears. Broadly, few of the demographic characteristics do a good job explaining differences across counties in migrant patenting beyond the representation of that group in the whole population.

	Unique match: Migrant				
	(1)	(2)	(3)	(4)	(5)
Log Population	-0.012***	-0.011***	-0.011***	0.000	0.011
	(0.003)	(0.003)	(0.003)	(0.004)	(0.008)
Cty. State Migrant	0.883***	0.887***	0.913***	0.904***	0.988***
	(0.010)	(0.010)	(0.009)	(0.041)	(0.075)
Cty. Age		-0.005*	-0.000	0.002	-0.000
		(0.003)	(0.003)	(0.004)	(0.007)
Cty. Black		0.144***	0.072	-0.020	-0.088
		(0.034)	(0.056)	(0.062)	(0.105)
Cty. Female		-0.132	-0.037	0.175	0.102
		(0.109)	(0.109)	(0.182)	(0.266)
Frac. Urban			0.008***	0.008***	-0.012
			(0.003)	(0.003)	(0.012)
South			0.041*		
			(0.022)		
Frac. Manuf. Female					0.137
					(0.124)
FEs	None	None	None	State	State
Observations	47917	47917	25179	25179	7103
Adjusted R^2	0.229	0.231	0.225	0.229	0.271

Table 3.6: County-level correlates of migration status of patentees, i.e. whether they are born in the state they patent. The dependent variable is the average value of the demographic across the set of all possible matches for a particular patentee.

3.5 Effects of Local Institutions on Marginalized Populations

3.5.1 HBCUs

In the late 19th and early 20th century, there were numerous barriers preventing blacks from engaging in inventive activity. We focus here on one such barrier: access to higher education and an institution aimed exactly to alleviate it. While as we discuss below there are many ways in which HBCUs at this time were different than the modern research university, we think these estimates provide an interesting point of comparison to the classic paper by Jaffe 1989 and work by Andrews 2017b that studies the founding of colleges more generally during this period of history.

HBCUs were colleges and universities setup with the intention of educating blacks. Some of the earliest ones were connected to northern religious groups, but after the Second Morrill Act of 1890, a number of HBCUs were founded as public land grant institutions. Congress required that states setup separate institutions for blacks if they were excluded from the state colleges created by the original Morrill Act. The oldest one is Cheyney University of Pennsylvania founded in 1837 and these schools continued to be founded through *Brown v. Board of Education* in 1954, which outlawed racial segregation of public education facilities. These schools trained a distinguished list of graduates including Booker T. Washington, Thurgood Marshall, Ralph Ellision, Toni Morrison, and Martin Luther King among many others.

There are a number of caveats that are important to keep in mind when interpreting the results. First of all, many HBCUs were opposed to patenting and instead aimed to disseminate research broadly. Consider George Washington Carver, who was instrumental in creating a strong research environment at the Tuskegee Institute. He developed hundreds of products that made use of peanuts and sweet potatoes including more than 73 dyes alone. Yet he only patented less than a handful of inventions. He illustrates quite clearly the great number of inventions, even though useful, that are never patented. Given the opposition to intellectual property by many HBCUs, we would argue that any positive effect we identify is an underestimate of the true effect on innovation.

Second, not all of these schools were technically oriented. In fact, there was a major debate over the nature of education between people like Booker T. Washington of the Tuskegee Institute and John Hope of Morehouse College. Washington advocated for a more practical education that was relevant for work in agriculture and the trades. Hope as the first African-American president of Morehouse envisioned that college as the antithesis of the Tuskegee Institute with a much more liberal arts focus. In addition, other schools were setup as normal schools that were aimed at training teachers. We have not attempted to distinguish between these different types of schools and the fact that these differences in curriculum may affect patenting. In this respect, our estimates will reflect an average effect across all the different types of schools.

Third, there is certainly selection in terms of which African-Americans enrolled at HBCUs versus predominantly white universities. Many of the major African-American inventors of this period including George Washington Carver, Percy Julian, Elijah McCoy, and Garrett Morgan did not attend a HBCU. One interpretation of this is that social capital is crucial for inventors hoping to bring their inventions to market and that the social capital most important at this time would come from interactions with whites. Besides selection on the part of particular types of African Americans to attempt to enroll at white-dominated schools, there is the outright discrimination on the part of these white-dominated schools that would drive additional selection into who enrolls where. Taken together, these caveats provide a number of reasons why we might expect a null effect of a HBCU.

We study whether the presence of such a school had an effect on the racial composition of patenting in a county. In particular, we regress an indicator for whether a patent grantee was black on the set of county-level explanatory variables from earlier as well as an indicator for whether an HBCU was founded before 1900. The specification is

$$Black_{icjt} = Time_t + County_j + \beta * HBCU_{jt} + \epsilon_{ijt}$$

where $Black_{icjt}$ is an indicator for whether inventor i at time t in county c of state j is black, $Time_t$ represents a full set of time effects, $County_j$ is a full set of county fixed effects, and $HBCU_{ct}$ is equal to 1 if a county has an HBCU or otherwise otherwise. Then the coefficient β measures the effect of an HBCU on black representation in patenting. This is just a composition not a rate effect. A positive effect does not imply that blacks increased their patenting rates in an absolute sense but only relative to whites. Finally, as a placebo we use female representation as a dependent variable. To be sure, in many cases, the HBCUs did not forbid women from attending but they surely attended in fewer number particularly before the *Brown* decisions. Even if women did not attend school, in theory, women could also be affected by the founding of an HBCU if there are agglomeration externalities. Still as a theoretical matter, even if there were externalities, one would expect them to affect both groups and, hence, the effect for blacks should still be larger since it includes both the direct and indirect effects.

Table 3.7 shows that counties with an HBCU had higher representation of blacks amongst inventors in a statistically (at least at the 10% level) and economically significant sense. Column 3 shows that the emergence of an HBCU increases black patenting rates, but column 4 suggests that this is likely due to an increase in the local black population, rather than just the HBCU per se. This suggests that perhaps some of the link between colleges and local patenting rates documented by Jaffe 1989 is driven by endogenous changes in the composition of the local population. To be sure, these results do not rule out some other variable driving both the founding of the HBCU and changes in black patenting rates. For example, Morehouse College in 1879 was moved from Augusta, Georgia, where it was originally founded, to Atlanta. At least part of the reason for this move was the fact that the KKK was quite active in Augusta while Atlanta had a much more politically active black population. These sorts of unobserved trends could drive the correlation between the founding of the HBCU and black invention.

As a placebo check, we can also examine the changes in patenting for women reported in columns 1 and 2. In most cases, women were now allowed to attend these

	Female		Black	
	(1)	(2)	(3)	(4)
Cty. has HBCU?	0.013	0.012	0.056*	0.009
	(0.018)	(0.018)	(0.031)	(0.038)
Cty. Female		0.207		
		(0.141)		
Cty. Black				0.397***
				(0.056)
Observations	57955	57339	49020	48522
Adjusted R^2	0.032	0.033	0.096	0.107

Table 3.7: Relationship between HBCUs and representation of blacks and women amongst patentees. HBCU is coded as 1 in all years after the formation of an HBCU in a given county.

schools so we would expect there to be no effect.[13] We find no effect on female patenting representation in areas with HBCUs which suggests that any effect is operating through education of blacks and changes in the composition of the local population. We would be cautious in interpreting this result even in the case of significant effects since, by its nature, a difference-in-difference effect can only identify a partial equilibrium effect. It might be that this increased representation in counties with HBCUs is simply being offset by lower representation in counties without. So whereas the partial equilibrium effect might be positive, the general equilibrium effect could still be zero.

[13] Or at least limited. If there are spillovers through social interactions, then there might still be a correlation here.

3.5.2 Women's Suffrage

We now consider a legal reform that differentially affected women in the form of state-level extensions of the franchise in the late 19th and early 20th centuries before the 19th amendment federalizing women's right to vote. They began in the west with Colorado, Idaho, Utah, and Wyoming passing laws before the 20th century began. There was then a pause for almost 20 years before another wave of reforms again clustered in the west around 1912. Just before the ratification of the 19th amendment in 1920, a number of midwest states passed some form of enfranchisement leaving much of the confederacy as the only set of states that did not pass any reforms before the federal amendment.

For our purposes, it is clearly a central question to understand the forces that drove these state-level reforms. The historical literature is split on this question with many pointing to particular economic conditions as key predictors King, Cornwall, and Dahlin 2005 while others argue that many of the reforms were simply idiosyncratic political events Larson 1971; Beeton 1986. Much of the literature that points to economic conditions explicitly points to the fact that western states were the leaders. Historians such as Brown 1958 and Grimes 1967 argue that because of the demands of frontier life and imbalanced gender ratios, women were able to assert political power and have it codified through enfranchisement.

We estimate a difference-in-differences specification that controls for state and year fixed effects with a dummy for whether a state has passed a suffrage law. To start, we pool all the states to estimate an overall effect of suffrage laws. The specification is

$$Female_{ijt} = Time_t + State_j + \beta * PostSuffrage_{jt} + \epsilon_{ijt}$$

where $Female_{ijt}$ is an indicator for whether inventor i at time t in state j is a female, $Time_t$ represents a full set of time effects, $State_j$ is a full set of state fixed effects, and $PostSuffrage_{jt}$ is equal to 0 if the time is before a state passes a suffrage law and 1 otherwise. Then the coefficient β measures the effect of suffrage on female representation in patenting. Note that again this is just a composition not a rate effect. We restrict the years to before 1920 to avoid using the passage of the federal amendment for identification. The other specification we report interacts $PostSuffrage$ with a set of indicators for the timing of when a state passed a suffrage law. Note that because these indicators are state specific they will be absorbed in the state fixed effects. Finally, as a placebo we use black representation as a dependent variable. Data on the timing of suffrage is based on Lott and Kenny 1999.

Table 3.8 shows that there are limited effects of female representation from the passage of suffrage laws. The point estimates are quite small and in fact, the effect for black representation, the placebo, is actually larger and marginally statistically significant. Turning to the interaction with whether the state was a leader in extending the franchise, we observe that the effect of extending the suffrage increases though this is still not statistically significant.

	Female (Imputed)		Black (Imputed)	
	(1)	(2)	(3)	(4)
Post State Suffrage?	0.004	0.003	0.007*	0.007
	(0.006)	(0.007)	(0.004)	(0.004)
Leader?*Post State Suffrage?		0.009		0.003
		(0.011)		(0.005)
Observations	39651	39651	39651	39651
Adjusted R^2	0.079	0.079	0.744	0.744

Table 3.8: Relationship between state-level suffrage and representation of women and blacks amongst patentees. Post-Suffrage is coded as 1 in all periods after which a state adopts suffrage. "Leader" is an indicator if a state adopted suffrage before 1900.

3.6 Conclusion

This paper presents two main findings. First, we document an incredible degree of persistence in the demographics of patentees in the US over a seventy year period. Comparing our findings to the literature for blacks and females using more current data suggests that historical patterns are continuous with what is observed today. For ages, it seems that the recent decline since 2000 in the average of inventors is a return towards the pattern that prevailed for the last half of the 19th century and first half of the 20th with the 20 years between 1980 and 2000 as the outlier. Second, we find that it is very difficult to explain the demographics of patentees at the county-level using observable economic and demographic characteristics beyond the most obvious explanatory variable: the fraction of a particular demographic group in the overall county population.

We then discuss the impact of local institutions on inventive activity of marginalized groups. We find some evidence that the founding of an HBCU in a town led to an increase in the representation of blacks in the pool of inventors. On the other hand, we find limited evidence that state level female enfranchisement affected the representation of women. Both of these examples point towards future work, which will focus on other institutions that affect entry into inventive activity. One such barrier is the fee to filing a patent.[14] Besides fees, there are other complementary factors needed such as financing and legal representation. We hope to exploit the rich heterogeneity in the availability of, in particular, lawyers across US states stemming from variation in bar standards and accredited law schools to study how barriers differentially affect demographic groups.

[14]Nicholas 2011 studies just such a change stemming from the 1883 Patents Act in Britain and finds that it did increase patenting.

CHAPTER 4
COMPARING HISTORICAL PATENT DATASETS

4.1 Introduction

Since at least Solow 1956, economists have recognized the central role of technological change in propelling long run economic growth. This has in turn led researchers to attempt to assemble data that documents technological progress. Schmookler 1966 and Sokoloff 1988 pioneered the use of patents as a useful, if imperfect, measure of new technical knowledge. The use of historical patents to gain insight into inventive activity in the historical United States has exploded since then, as evidenced by the proliferation of historical patent datasets in recent years. In this paper, I compare several of these recent datasets and discuss the strengths and weaknesses of each.

This paper has three main objectives. First, this paper informs researchers of the variety of data sources available to study the history of invention in the United States. Far from being a barren wasteland where data is hard to come by, several research groups have compiled usable datasets that attempt to cover the universe of historical patents. The completeness of these datasets, while far from perfect, is comparable to that of datasets covering more recent patenting activity. Furthermore, several resources are available that study particular aspects of historical invention in more detail. A comprehensive understanding of what can be accomplished with each existing dataset prevents researchers from "reinventing the wheel" and building historical datasets from scratch, duplicating the efforts of previous researchers.

Second, this paper discusses the strengths and weaknesses of each of these datasets. While the creators of these datasets have striven to record the universe of historical U.S. patents, each is constructed from a different source of raw patent data and thus may be of varying quality. Moreover, different authors use different techniques to clean and process the raw patent data, introducing further irregularities across datasets. Finally, the different datasets contain different information about each patent. Understanding how the datasets differ is useful to help researchers decide which is best for a particular application. For example, some datasets contain detailed information on patent classifications, but no information on who the inventors of a particular patent are or where they lived. Understanding what information each dataset contains and how they can be used to complement one another provides researchers with the ability to answer far more questions than would be possible using each dataset in isolation. Just as importantly, even when information may be nominally available, it may be of varying quality across datasets. Learning for which years and patent information a particular dataset should be avoided is also a valuable contribution.

Third and finally, this paper ultimately seeks to convey an optimistic message: while the datasets have some differences, overall they paint a remarkably consistent picture of invention in the historical United States. This paper focuses on the ways in which the datasets deviate from one another, but this should not take away from the fact that, when looking at the broad outline of American invention, our conclusions do not depend on the particulars of the dataset that is used. This should provide confidence in the results from earlier papers making use of the diverse data available.

The four datasets that I discuss in detail here are:

1. **HistPat:** See Petralia, Balland, and Rigby 2016b. Described in Petralia, Balland, and Rigby 2016a, this dataset contains issued U.S. patents filed from 1836-1978. The data is collected from Google Patents, discussed below.

2. **Sarada-Andrews-Ziebarth (SAZ):** Described in Sarada, Andrews, and Ziebarth 2017, this dataset contains U.S. patents issued from 1870-1942. The data is collected from the Annual Reports of the Commissioner of Patents and annual Indices of Patents for the corresponding years.

3. **Jim Shaw:** This dataset contains U.S. patents issued from 1836-1873 and was compiled from the Subject-Matter Index of Patents for Inventions Issued by the United States Patent Office from 1790 to 1873 (Leggett 1874b, Leggett 1874c, and Leggett 1874d). The data from the Subject-Matter Index were transcribed by hand by Dr. Jim Shaw of Hutchinson, KS. For more information on the creation of this dataset, see Miller 2016a and Miller 2016b.[1]

4. **USPTO Historical Patent Data File (HPDF):** See Marco et al. 2015. Contains all known utility patents from 1790 to 2014, along with patent classifications for each. The dataset lacks inventor and geographic data available in the other datasets. This dataset was constructed from USPTO internal patent

[1]Jim Miller is a member of the Patent and Trademark Resource Center (PTRC) and the resident expert on the Jim Shaw patent data. To date, I have been unable to get in contact with Dr. Jim Shaw directly.

records.

I am aware of two other comprehensive historical patent datasets that are not included in this analysis: a dataset constructed by Tom Nicholas (see, for example, Akcigit, Grigsby, and Nicholas 2017), and one constructed by Mikko Packalen and Jay Bhattacharya (see Packalen and Bhattacharya 2015b and Packalen and Bhattacharya 2015a). Unfortunately, I have at present been unable to examine the underlying data or aggregate summary statistics from these datasets, and so I do not include them in the analysis below.

As is often the case in social science research, comparing these historical patent datasets faces a fundamental identification problem: it is difficult to disentangle differences across datasets that are due to differences in the underlying raw patent data sources and differences in the methods that the different researchers have used to create their datasets. It is also important to note that the datasets as compared here represent the data at a particular point in time; future researchers will hopefully have even higher quality data to work with. Nevertheless, the fact that all the datasets tell broadly the same story about the history of US patenting suggests that future improvements to the historical patent datasets will encounter some degree of diminishing returns. It is my belief, however, that much more work remains to be done before the costs of improving the historical patent datasets exceed the benefits; the continuing efforts of a large number of researchers suggests that many hold this view. By pointing out discrepancies across the datasets, this paper suggests a number of paths forward for researchers looking to improve the quality of the historical patent data.

Even when using patent data that covers the universe of patents, it is always necessary to address the question of whether patents provide a useful proxy for what researchers wish to measure. To some extent, this question is irrelevant to the analysis in this paper: as long as economists continue to use patents as proxies for innovation, it is important to ensure that the patent data is of the highest possible quality. In fact, better quality patent data should be able to shed greater light on the relationship between patenting and innovation. For instance, Moser 2005 shows that the correlation between patents and innovations is fairly low at two famous world fairs; that is, most important innovations were not covered by patents. And a cursory perusal of a random selection of patents reveals the converse to be true as well: many patents are granted to things that are not important innovations. Research using modern data suggests that the relationship between patents and inventions is fairly high, and certainly better than a random guess (see, for instance, Griliches 1990, Nagaoka, Motohashi, and Goto 2010, and Igami and Subrahmanyam 2015). More detailed work linking a broad swath of historical patents to individuals, firms, or industries could help to answer this question more definitively for historical patents.

This paper is organized as follows. Section 4.2 describes the three historical patent datasets in detail. Section 4.3 compares basic results across the datasets. Section 4.4 attempts to determine if each dataset contains the *same* patents; this is important to ensure that the different datasets tell the same story not only in the aggregate but also when looking at different geographic or industry features.

Section 4.5 briefly concludes.

4.2 The Historical Patent Datasets

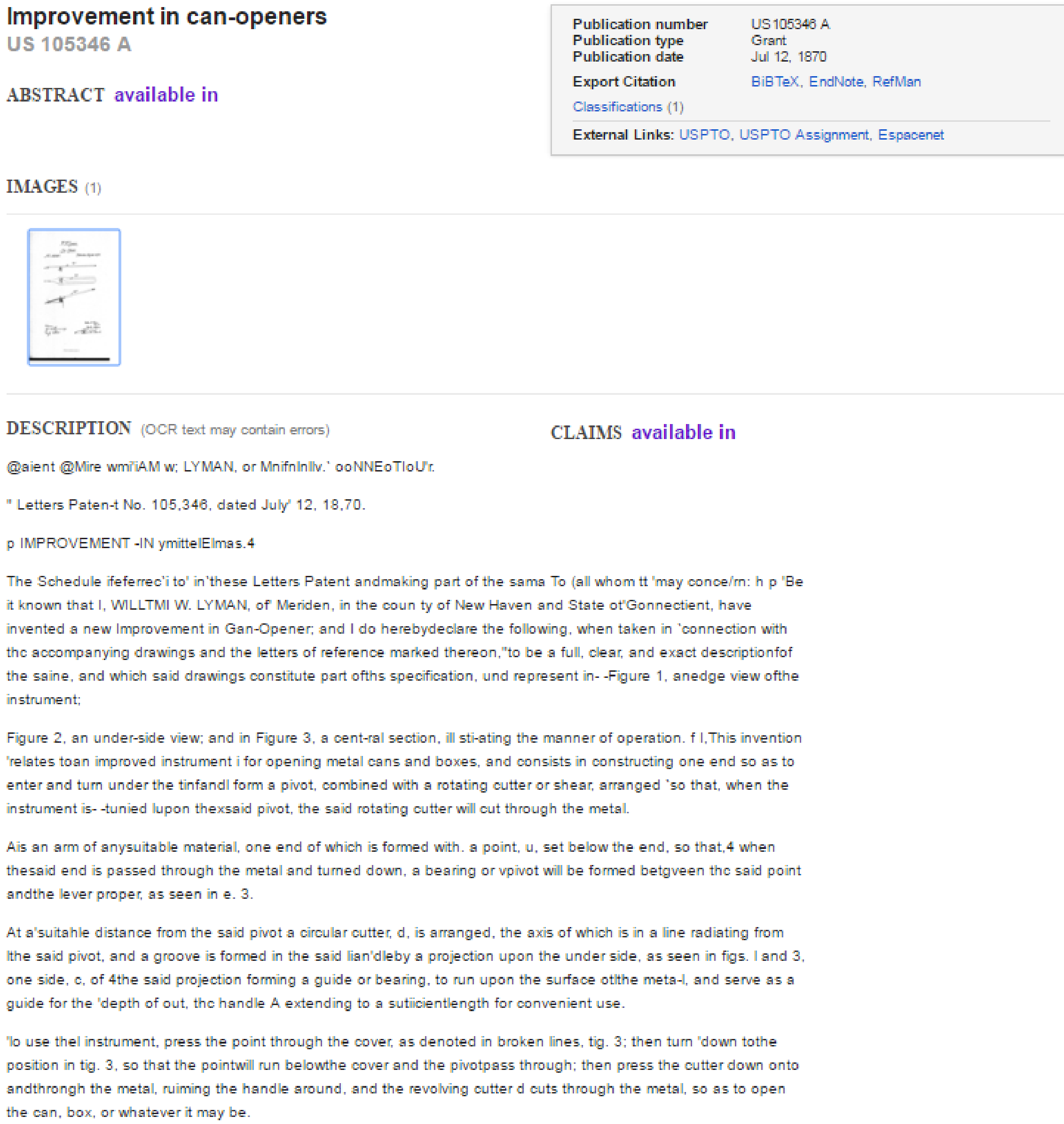
The Google Patents data form the basis for the HistPat dataset. The basis for the Google patents data are image files originally created by the United States Patent and Trademark Office (USPTO) in the 1980s using optical character recognition (OCR) software.[2] Not surprisingly given the time period in which the data were originally constructed, the quality of the image capture is quite low. This first attempt at OCR is affectionately known as "the Dirty File" within the USPTO Raider 2016.[3] Since then, Google has re-run newer versions of OCR software on the USPTO image files and merged in bibliographic information from the European Patent Office Worldwide Bibliographic Database (EPO DOCDB).[4] An example of a historical Google Patent is presented in Figure 4.1. The header of the document displays useful information including the inventors' names, the invention name, the patent number, and the patent grant date.

While newer OCR has improved the accuracy of the Google Patents dataset relative to the Dirty File, poor image quality of the original patent documents still

[2]These image files, and the USPTO's first attempts at OCR of these images are available at https://bulkdata.uspto.gov/data3/patent/grant/multipagetiff/1790_1999/.

[3]Ran Raider a former president of the PTRC and currently works at the PTRC in Dayton.

[4]Information on the process by which Google Patents digitized the USPTO patent images is obtained from Google Patents Team 2016. EPO DOCDB can be obtained at http://www.epo.org/searching-for-patents/technical/docdb.html#tab1. Reed Tech also assisted in digitizing bulk USPTO data, including patent images.



Improvement in can-openers
US 105346 A

ABSTRACT available in

Publication number	US 105346 A
Publication type	Grant
Publication date	Jul 12, 1870
Export Citation	BiBTeX, EndNote, RefMan
Classifications (1)	
External Links: USPTO, USPTO Assignment, Espacenet	

IMAGES (1)

DESCRIPTION (OCR text may contain errors)

@aient @Mire wmi'iAM w; LYMAN, or MnifnInllv.' ooNNEoTIoU'r.

" Letters Paten-t No. 105,346, dated July' 12, 18,70.

p IMPROVEMENT -IN ymittelElmas.4

The Schedule ifeferrec'i to' in'these Letters Patent andmaking part of the sama To (all whom tt 'may conce/rn: h p 'Be it known that I, WILLTMI W. LYMAN, of' Meriden, in the coun ty of New Haven and State ot'Gonnectient, have invented a new Improvement in Gan-Opener; and I do herebydeclare the following, when taken in 'connection with thc accompanying drawings and the letters of reference marked thereon,"to be a full, clear, and exact descriptionfof the saine, and which said drawings constitute part ofths specification, und represent in- -Figure 1, anedge view ofthe instrument;

Figure 2, an under-side view; and in Figure 3, a cent-ral section, ill sti-ating the manner of operation. f I,This invention 'relates toan improved instrument i for opening metal cans and boxes, and consists in constructing one end so as to enter and turn under the tinfandl form a pivot, combined with a rotating cutter or shear, arranged 'so that, when the instrument is- -tunied lupon thexsaid pivot, the said rotating cutter will cut through the metal.

Ais an arm of anysuitable material, one end of which is formed with. a point, u, set below the end, so that,4 when thesaid end is passed through the metal and turned down, a bearing or vpivot will be formed betgveen thc said point andthe lever proper, as seen in e. 3.

At a'suitahle distance from the said pivot a circular cutter, d, is arranged, the axis of which is in a line radiating from lthe said pivot, and a groove is formed in the said lian'dleby a projection upon the under side, as seen in figs. I and 3, one side, c, of 4the said projection forming a guide or bearing, to run upon the surface otlthe meta-l, and serve as a guide for the 'depth of out, thc handle A extending to a sutiicientlength for convenient use.

'lo use thel instrument, press the point through the cover, as denoted in broken lines, tig. 3; then turn 'down tothe position in tig. 3, so that the pointwill run belowthe cover and the pivotpass through; then press the cutter down onto andthrongh the metal, ruiming the handle around, and the revolving cutter d cuts through the metal, so as to open the can, box, or whatever it may be.

CLAIMS available in

Figure 4.1: An example of a historical Google Patent. The patent is for the first rotating wheel can opener, invented in 1870 by William Lyman.

results in a large number of errors in the Google Patents. Figure 4.1 makes clear that the OCR quality frequently makes the included data fields illegible. In addition to being included in the header of each patent, the inventors' full names, as well as their town and state (and frequently county, as well), are usually listed within the body of the patent text. The HistPat dataset therefore goes beyond the Google Patents header and parses the main body of the patent for the most likely inventor name and location. This process is described in much more detail in Petralia, Balland, and Rigby 2016a. The focus of this procedure is to assign each patent to a location. For this reason, the HistPat data currently available Petralia, Balland, and Rigby 2016b only includes patent number, patent grant date, and inventor county and state. Importantly, it does not contain inventor names.[5]

One benefit of using the Google Patents is that the full text of the patent is available. This opens the door for more advanced textual analysis, as in Perlman 2015, Packalen and Bhattacharya 2015b, and Packalen and Bhattacharya 2015a.[6]

In contrast, the Annual Reports of the Commissioner of Patents and Annual Indices of Patents (The Commissioner on Patents Various Years) do not contain the

---

[5]The authors are graciously share their inventor name raw data upon request. They are still in the process of cleaning the name data. The raw inventor names from the Google Patents are of particularly low quality. This makes it difficult at present to match, for instance, the SAZ data to HistPat using inventor names.

[6]The HistPat dataset does not contain the full patent text, but rather only reports patent number, county, state, year, and some information on the how each patent was parsed. None of these cited papers use the HistPat data. Instead, Perlman 2015 uses a Google Patent data collected by Tom Nicholas. The papers by Mikko Packalen and Jay Bhattacharya use a dataset constructed by those authors. At present I do not have any aggregate statistics for these datasets or any detailed information regarding how they were constructed, so I do not include them in this chapter.

full text of each patent.[7] Instead, these annual documents list only the inventors' names, inventors' towns, inventors' state, the invention title, and assignee name and location if present. An example of a page from the Annual Report of the Commissioner of Patents from 1888 is shown in Figure 4.2.[8] Sarada, Andrews, and Ziebarth 2017 use OCR to convert these images to text files to create the SAZ dataset. Each page of the annual report is easier to parse than the Google Patents, since there are no extraneous words in each entry that could be confused for crucial patent information. Because the Annual Reports do not contain the full patent text, textual analysis using this data is impossible. In addition, the SAZ data does not include patent numbers, which are necessary to link the data to other datasets such as the USPTO Historical Patent Data File, described in more detail below.

The Subject-Matter Index of Patents for Inventions Issued by the United States Patent Office from 1790 to 1873 (Leggett 1874b, Leggett 1874c, and Leggett 1874d) lists every known USPTO patent granted between 1790 and 1973, listed alphabetically by invention name. The Subject-Matter Index was transcribed by hand by Dr. Jim Shaw of Hutchinson, KS to create the Jim Shaw dataset (*Utility Patents 1-65000*, *Utility Patents 65000-100000*, and *Utility Patents 100001-146119*).[9] These

[7] The Annual Reports were downloaded from https://catalog.hathitrust.org/Record/002138126.

[8] As this figure shows, each page also contains the patent number, patent grant date, and information on how to find the patent in the USPTO monthly publications for each patent. Unfortunately, these fields are recorded in columns separated by thick printed vertical lines. These lines confuse the OCR software, making it impossible to link, for instance patent number with the inventor name and location. We have experimented with several different types of OCR software, and this problem is endemic to all.

[9] The Jim Shaw data was downloaded from http://www.ptrca.org/history. This website

Alphabetical list of patentees for the year 1870—Continued.

No.	Name, residence, and invention or discovery.	Date.
108,274	Luppen, Luppe, Pekin, Ill. Shovel-plow	Oct. 11, 1870
108,275	Same ... same	Oct. 11, 1870
108,276	Same ... same	Oct. 11, 1870
110,054	Lupton, George, Indianapolis, Ind. Purifying benzine	Dec. 13, 1870
110,055	Same ... Lamp-burner. (Antedated Nov. 26, 1870)	Dec. 13, 1870
105,958	Lusher, John, La Porte, Ind. Vegetable-cutter	Aug. 2, 1870
	Lusk, Andrew P., *et al.* (*See* Reinshagen, Peter W., assignor.)	
	Same ... (*See* Wiehl, Daniel, assignor.)	
	Lusk, Salmon B. (*See* Mallory, Orson E., assignor.)	
104,609	Luther, Henry C., Providence, R. I., and Celius E. Richards, North Attleborough, Mass. Picture-knob	June 21, 1870
	Luther, Jonathan. (*See* Burns, W. H., assignor) ... (Three cases.)	
	Same ... (*See* Long, Charles B., assignor.)	
104,970	Luther, Justus P., and Solon K. Buck, Berlin, Wis. Clamp for making whips	July 5, 1870
99,780	Luther, L. T., Oak Grove, Pa. Match-machine	Feb. 15, 1870
102,413	Luther, Ormel R., Waterbury, Conn. Adjustable foot for clock-cases	April 26, 1870
100,049	Lutz, Georg, John Schultheis, and Michel Florentin, Newark, N. J. Vegetable-cutter	Feb. 22, 1870
102,563	Lutz, George, Danforth H. Royce, Michael Trenor, and Robert Chadwick, Columbus, Ohio. Policeman's nippers	May 3, 1870
108,918	Lutz, John A., Waynesborough, Va. Cotton-chopper	Nov. 1, 1870
	Lutz, Joseph F. C., and John W. Pearman. (*See* Pearman & Lutz.)	
102,952	Lutz, Stimmel, Philadelphia, Pa. Fruit-can	May 10, 1870
101,478	Luxton, Charles, Hudson City, N. J. Peat-machine	April 5, 1870
	Lyman, Azel S., New York, N. Y. Method of cooling and ventilating rooms, &c. ... (Extension)	Mar. 24, 1870
103,478	Lyman, Chester C., Edinborough, Pa. Platform-scale	May 24, 1870
3,799	Lyman, John N., New York, N. Y. Stay-log for cutting veneers ... (Reissue)	Jan. 18, 1870
100,164	Same ... Clamp for stay-logs	Feb. 22, 1870
100,774	Lyman, Myron W., Chicago, Ill. Animal-trap	Mar. 15, 1870
102,951	Lyman, William W., Meriden, Conn. Apparatus for preserving fruit	May 10, 1870
105,346	Same ... Can-opener	July 12, 1870
105,583	Same ... West Meriden, Conn. Can-opener	July 19, 1870
108,802	Lynch, Charles S., Boston, Mass. "Fix" for puddling-furnaces	Nov. 1, 1870
108,277	Lynch, George F., Milwaukee, Wis. Railway-car axle-box	Oct. 11, 1870
	Lynch, J. Augustus. (*See* Huntoon, Reuben K., assignor.)	
105,101	Lynch, John H., New York, N. Y. Ice-chamber for refrigerators	July 5, 1870
99,578	Lynch, Matthew, New York, N. Y. Hoisting-machine	Feb. 8, 1870
101,634	Lynch, Nathaniel K., New York, N. Y. Variable cut-off valve-gear	April 5, 1870

Figure 4.2: An image from a page of the 1886 Annual Report of the Commissioner of Patents. This page contains the William Lyman can opener patent.

Subject-Matter Indices shares many of the strengths and weaknesses of the Annual Reports data. An example from the Subject-Matter Index is presented in Figure 4.3. Dr. Jim Shaw transcribed this dataset by hand to construct the Jim Shaw dataset, so it does not suffer from the OCR issues that affect both the HistPat and SAZ datasets. The Subject-Matter Index, and therefore the Jim Shaw dataset, does have one key drawback: only the first letter of each inventor's first and middle name is provided, which renders the data unusable when name-matching is required, for instance to match patentees to the U.S. census as in Sarada, Andrews, and Ziebarth 2017.

One important caveat about both the Annual Reports and the Subject-Matter Index is that they are not complete. Jim Miller Miller 2016a identifies "at least one entry" of a patent in the Subject Matter Index that does not appear in its corresponding Annual Report; it is unknown how widespread this problem is. Section 4.4 below also documents several errors in the Subject-Matter Index. It is also unclear whether the Google Patents contain every patent granted over the relevant timeframe. I am aware of no systematic study that examines which patents make it into the Google Patents data, the Annual Reports, the Subject-Matter Index, or any combination of the three. I shed some light on the extent of this problem in Section 4.4 below, but this is an obvious avenue for future work.

The final historical patent dataset is the USPTO Historical Patent Data File (HPDF). For most purposes that require using either inventor locations or inventor

---

contains a number of other interesting facts about the history of patenting in the US, and the members of the association have been very helpful in providing details about the construction of various data sources.

194 INDEX OF PATENTS ISSUED FROM

Index of patents issued from the United States Patent Office from 1790 *to* 1873, *inclusive*—Continued.

Invention.	Inventor.	Residence.	Date.	No.
Can—Continued.				
See Packing and atomizing can.				
Paint-can.				
Preserving-can.				
Rectangular can.				
Roofing-can.				
Roving-can.				
Safety-can.				
Sealed can.				
Sealing-can.				
Seamless can.				
Sheet-metal can.				
Shipping-can.				
Sirup-can.				
Spice-can.				
Sprinkling-can.				
Tea-can.				
Tin can.				
White-lead can.				
Wood-incased can.				
Wooden-cased can.				
Can	A. D. Armstrong	Pittsburgh, Pa	Sept. 24, 1867	69, 154
Can	C. A. Murdock	Milwaukee, Wis	May 20, 1873	139, 181
Can and bottle, Sealing	J. D. Willoughby	Carlisle, Pa	Jan. 4, 1859	22, 535
Can and jar, Sealing	J. Bellerjeau	Philadelphia, Pa	Mar. 31, 1868	76, 149
Can-cap, Uncut	J. I. Livingston	Pittsburgh, Pa	Mar. 2, 1869	87, 415
Can-cover lock	H. W. Shepard	New York, N. Y	Apr. 9, 1872	125, 622
Can-cover lock	H. W. Shepard	New York, N. Y	Apr. 9, 1872	125, 623
Can-filler	R. Newton	Millville, N. J	May 6, 1873	138, 574
Can filling and soldering apparatus	L. C. Straub	Pittsburgh, Pa	June 20, 1871	116, 114
Can-handle	L. A. Sunderland	Madison, Ohio	Nov. 30, 1869	97, 326
Can-hook	G. Webber	Portland, Me	Sept. 11, 1849	6, 702
Can-making die	J. L. Gray	Baltimore, Md	Apr. 2, 1867	63, 503
Can-manufacture	J. T. Ackley and J. K. Trux	Philadelphia, Pa	Apr. 10, 1866	53, 765
Can-opener	H. C. Alexander	New York, N. Y	Nov. 16, 1869	96, 761
Can-opener	H. C. Alexander	New York, N. Y	Jan. 25, 1870	99, 046
Can-opener	R. H. Atwell	Baltimore, Md	Feb. 9, 1869	86, 626
Can-opener	A. Barker	Wyoming, Pa	May 17, 1870	103, 125
Can-opener	F. G. Beach	Hartford, Conn	Apr. 6, 1869	88, 536
Can-opener	W. M. Bleakley	Verplank, N. Y	June 29, 1869	91, 902
Can-opener	W. M. Bleakley	Verplank, N. Y	Oct. 19, 1869	95, 873
Can-opener	S. O. Church	West Meriden, Conn	Jan. 15, 1867	61, 161
Can-opener	M. C. Davis	Folsom, Cal	July 13, 1869	92, 520
Can-opener	E. F. Dewey	San Francisco, Cal	Sept. 28, 1869	95, 205
Can-opener	E. M. Dewey	San Francisco, Cal	Aug. 29, 1871	118, 593
Can-opener	W. L. Hubbell	Brooklyn, N. Y	Oct. 22, 1867	69, 996
Can-opener	G. C. Humphreys	Washington, D. C	Nov. 17, 1868	84, 122
Can-opener	G. G. Joyce	Baltimore, Md	Aug. 10, 1869	93, 541
Can-opener	J. Kaufman	New York, N. Y	Sept. 6, 1870	107, 061
Can-opener	O. J. Livermore	Worcester, Mass	June 26, 1866	55, 878
Can-opener	W. W. Lyman	Meriden, Conn	July 12, 1870	105, 346
Can-opener	W. W. Lyman	West Meriden, Conn	July 19, 1870	105, 583
Can-opener	T. A. McFarland	Meadville, Pa	May 21, 1867	64, 891
Can-opener	C. J. C. Petersen	Port Chester, N. Y	June 17, 1873	140, 072
Can-opener	A. C. Platt	Sandusky, Ohio	Aug. 23, 1870	106, 723
Can-opener	J. J. Reed	Lyons, Iowa	Mar. 25, 1873	137, 149
Can-opener	C. F. Ritchel	Chicago, Ill	May 12, 1868	77, 916
Can-opener	L. B. Smith	West Meriden, Conn	June 17, 1873	140, 088
Can-opener	N. F. Stone	Chicago, Ill	Apr. 14, 1868	76, 669
Can-opener	W. Thomas	Geneseo, Ill	Nov. 26, 1872	133, 500
Can-opener	S. E. Totten	Brooklyn, N. Y	Jan. 22, 1867	61, 484
Can-opener	E. J. Warner	Waterbury, Conn	Jan. 5, 1858	19, 063
Can-opener	J. A. Wells	Holly Springs, Miss	Aug. 10, 1869	93, 505
Can-opener	J. Wood	New York, N. Y	July 8, 1873	140, 604
Can-opener	F. S. Wyman	Chicago, Ill	July 28, 1868	80, 326
Can-opener and knife or fork, Combined	T. Kenderdine	Lisbon, Iowa	Aug. 26, 1873	142, 109
Can-opener and pipe-cutter	D. A. Barnes	Chicago, Ill	Oct. 28, 1873	144, 051
Can-opening machine	W. H. Forker	Meadville, Pa	Oct. 29, 1867	70, 168
Can-opening tool	G. A. Dickson	Woodcock Township, Pa	Dec. 24, 1867	72, 464
Can-opening tool	M. T. McCormick	Meadville, Pa	Apr. 7, 1868	76, 450
Can-opening tool	E. T. Orne	Chicago, Ill	Nov. 6, 1866	59, 513
Can or bottle stopper	J. Drenton	Philadelphia, Pa	Dec. 23, 1862	37, 231
Can or canister top	A. Bliss	Newark, N. J	Oct. 21, 1851	8, 440
Can or flask	J. Dunton	Philadelphia, Pa	Mar. 3, 1863	37, 843
Can screw-tap	L. R. Boyd	New York, N. Y	June 13, 1871	115, 927

Figure 4.3: An image from a page of the Subject-Matter Index of Patents for Inventions Issued by the United States Patent Office from 1790 to 1873, volume 2. The page contains the William Lyman can opener patent.

names, the USPTO HPDF is not particularly useful, as it does not contain any of this information. Instead, the USPTO HPDF was constructed to allow researchers to index historical patents by the type of invention that the patent contains. The USPTO HPDF lists the US Patent Classification (USPC) class for each utility patent going back to 1836.[10] The USPTO patent classification scheme is designed for administrative purposes and is not particularly informative for most economic researchers. For this reason, Hall, Jaffe, and Trajtenberg 2001 developed the NBER patent classes, which is the patent classification most often used by researchers studying contemporary patenting. The USPTO HPDF applies these classifications to historical patents as well. Marco et al. 2015 describe the features of the USPTO HPDF in more detail. Because the USPTO HDF does not contains novel information on patent classes not available elsewhere but does not contain inventor or geographic data, it is best used in conjunction with the other datasets described above. Patents can be matched from the USPTO HPDF to HistPat or the Jim Shaw data using the patent number. The USPTO HPDF is also notable for being the only of the historical patent datasets published by the US Patent and Trademark Office.

Some care must be taken in interpreting the "patent date" of a given invention. A patent date could refer to the date on which a patent was issued to an inventor

[10]More precisely, the USPTO has backdated the patent classifications for all known patents dating back to 1790. In this paper, I do not consider patents before 1836. 1836 marked a major change in the U.S. patent system, essentially changing from a registration system to an examination system. More importantly, in 1836, a major fire at the U.S. Patent Office destroyed most of the patents from the early United States. While efforts have been made to rebuild a record of early patenting from other sources (these are enticingly known as the "X-patents"), it is unknown how complete these data are or whether they represent a random sample of all pre-1836 patents.

(that is, the date the patent was granted or the disposal date) or the date on which a patent application was filed with the Patent Office (the filing date, application date, or priority date). Each patent dataset studied here contains the year in which a patent is granted to an inventor. This is useful because it means that dates in different datasets can be compared without worrying about whether the date in one dataset refers to a grant date while the other refers to a filing date. Nevertheless, for many economic analyses, the patent filing date may be a more appropriate time to use as it more accurately reflects the date at which invention occurred. While both the grant date and the filing date appear in the Google Patent text, the filing date has not been parsed and included in the HistPat data yet. While the USPTO HPDF contains a field for the application date, this information is only available for patents granted in 1967 or later, and is therefore not useful for applications that use older patents. Unfortunately, no information on patent applications that were ultimately denied a patent grant (that is, rejected patents) is available for any historical patent data; the USPTO began publishing applications only in 2000.

Table 4.1 summarizes the above discussion. For each dataset, it presents the years that the data cover and each field of information contained.

4.3 Comparing Aggregate Patent Statistics Across the Datasets

Figure 4.4 shows the number of successfully parsed patents for each dataset in each year. Because most economic applications require linking a patent to a particular location, I consider a patent to be "successfully parsed" if it can be linked to a U.S.

	HistPat	SAZ	Jim Shaw	USPTO HPDF
Years Covered	1836-1976	1870-1942	1836-1873	1836-2014
Inventor First Name	N	Y	N	N
Inventor Last Name	N	Y	Y	N
Inventor Town	N	Y	Y	N
Inventor County	Y	N	N	N
Inventor State	Y	Y	Y	N
Invention Name	N	Y	N	N
Patent Number	Y	N	Y	Y
Application Date	N	N	N	Y
Grant Date	Y	Y	Y	Y
Names of Multiple Inventors	Y	N	Y	N
Names of Assignees	N	Y	N	N
Town & State of Assignees	N	Y	N	N
Patent Class	N	N	N	Y

Table 4.1: Data available in each of the historical patent datasets.

county. Linking the HistPat patents to a county is trivial, since most of the Google Patents contain a county name within the body of the patent text.[11] The SAZ and Jim Shaw datasets, on the other hand, only include town and state, and there are many possible ways to link a town-state pair to a particular county. For each of these datasets, I use a "fuzzy matching" algorithm to match town names in the patent data to town names in the U.S. decennial census data, which includes the county to which each town belongs.[12] The Jim Shaw and HistPat datasets successfully parse virtually the same number of patents from 1836 to 1873. The SAZ dataset has roughly 60% of the number of patents parsed by these other datasets for most years.

[11]Petralia, Balland, and Rigby 2016a discuss how they assign patents to a county in the cases for which a county name could not be identified in the body of the patent text.

[12]Fuzzy matching allows small errors between town-state combinations in the patents and censuses, for instance to allow for OCR errors or spelling variations. In Appendix C.1, I compare the results that using the fuzzy matching algorithm to results that include only exact string matches between town names in the patents and the census.

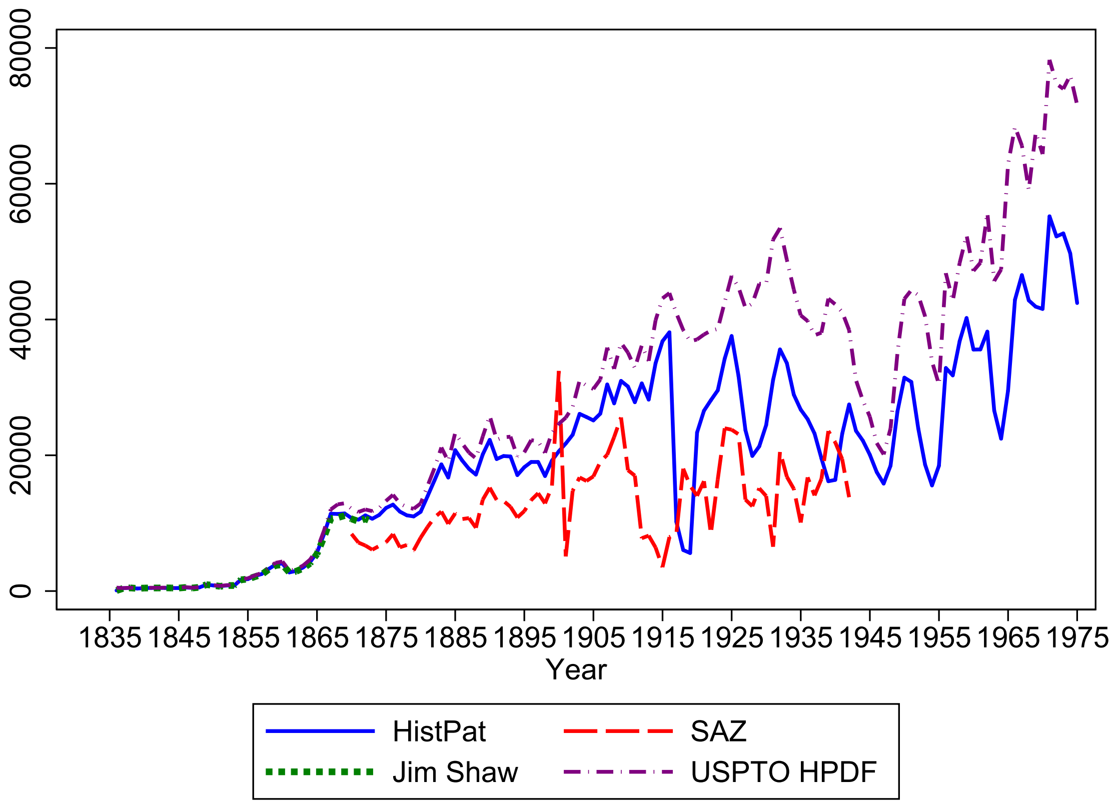


Figure 4.4: The number of patents that were successfully linked to a U.S. county each year using each patent dataset. See text for a description of each dataset.

Every year, the USPTO publishes the aggregate number of patents granted. This aggregate number is further broken down by patentees living within the U.S. and patents granted to foreigners. In Figure 4.5, I repeat Figure 4.4 but divide the number of patents by the yearly aggregate number of patents granted to people living in the U.S.[13] This graph reveals the extent of Dr. Jim Shaw's achievement: close to 100% of patents are successfully parsed using the Jim Shaw dataset. The fraction of successfully parsed patents is almost as high for the HistPat data from 1836 until 1915, when the fraction of parsed patents both decreases on average and fluctuates significantly. The SAZ dataset successfully parses between 45 and 70% of the aggregate number for most years between 1870 and 1910.[14] Both the SAZ and HistPat datasets perform poorly overall between 1915 and 1940. HistPat performs particularly bad for the years 1915-1917; at present it is unclear what is causing this large deviation. For the years 1915-1930, the image quality of the Annual Reports is particularly bad, as is the image quality of the few Google Patents I have spot-checked, which may be responsible for some of the observed deviations. The HistPat data recovers to successfully parse roughly one hundred percent of the recorded USPTO aggregate US patents by 1975.

For most years, the USPTO HPDF contains more than 100% of the USPTO aggregate US patents. This is because the USPTO HPDF contains *all* USPTO patents,

[13]Obviously, foreign inventors cannot be matched to a U.S. county and would therefore artificially lower the successful parse rate.

[14]There are, of course, yearly deviations in these results. Most notable is the year 1900, in which the SAZ dataset successfully parses more than 100% of the patents counted by the USPTO; I am in the process of investigating this anomaly.

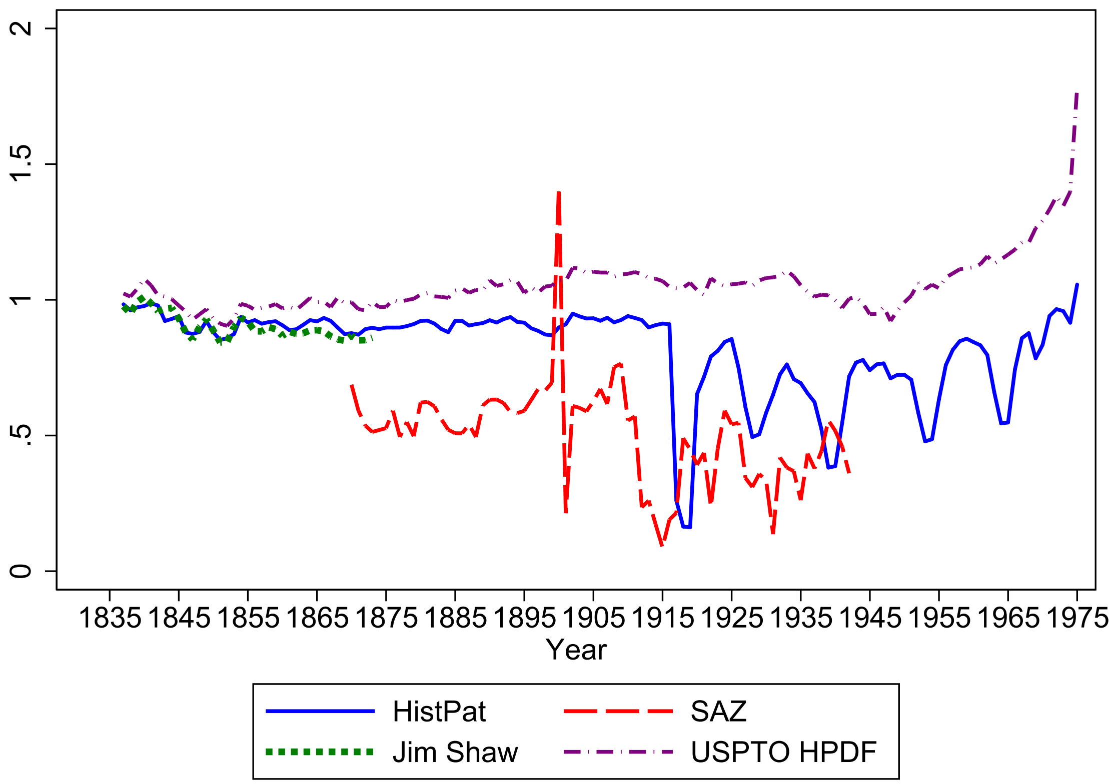


Figure 4.5: The fraction of the total USPTO aggregate patents that were successfully linked to a U.S. county each year using each patent dataset. See text for a description of each dataset.

whereas the aggregate numbers are restricted to include only patents granted to individuals living in the United States. Because the USPTO HPDF does not contain any information on the geographic location of its inventors, it is impossible to remove the international inventors from the USPTO HPDF. There are some years, however, in which the USPTO HPDF contains *fewer* patents than are recorded in the USPTO aggregate statistics. This is due to either the USPTO aggregate data overstating the number of US patents granted in a given year or, more likely, missing patents from the USPTO HPDF. While missing patents in the HPDF is discouraging because this is the most complete counting of individual patents available, the differences between the number of patents in the USPTO aggregate statistics and in the HPDF are modest in years in which the HPDF has fewer patents.[15]

Figure 4.6 presents the number of counties in which at least one patent is found in each year using each of the patent datasets. For this figure, the USPTO HPDF is excluded because, as mentioned above, there is no way to link the HPDF patents to a particular county. With the exception of a few years, mostly 1915-1920 as discussed above, all three datasets find patents from nearly the same number of counties in each year. For every year from 1836 to 1870, the Jim Shaw data finds more counties with at least one patent than does the HistPat data, although the difference is very small, on the order of 5-20 counties per year. The differences between the HistPat and SAZ data are larger, but which dataset finds more counties varies depending on

[15]Although, because the HPDF contain patents granted to individuals living outside of the US, this difference is a lower bound on the number of missing patents in the HPDF.

the year and there is no clear pattern. Overall across all three datasets, the number of counties with at least one patent increases rapidly between 1836 and 1905, from about 80 to 2000 counties. Such an increase in the number of counties with at least one patent is consistent with the annexation of new U.S. states over this period and the concurrent westward expansion of the U.S. population.

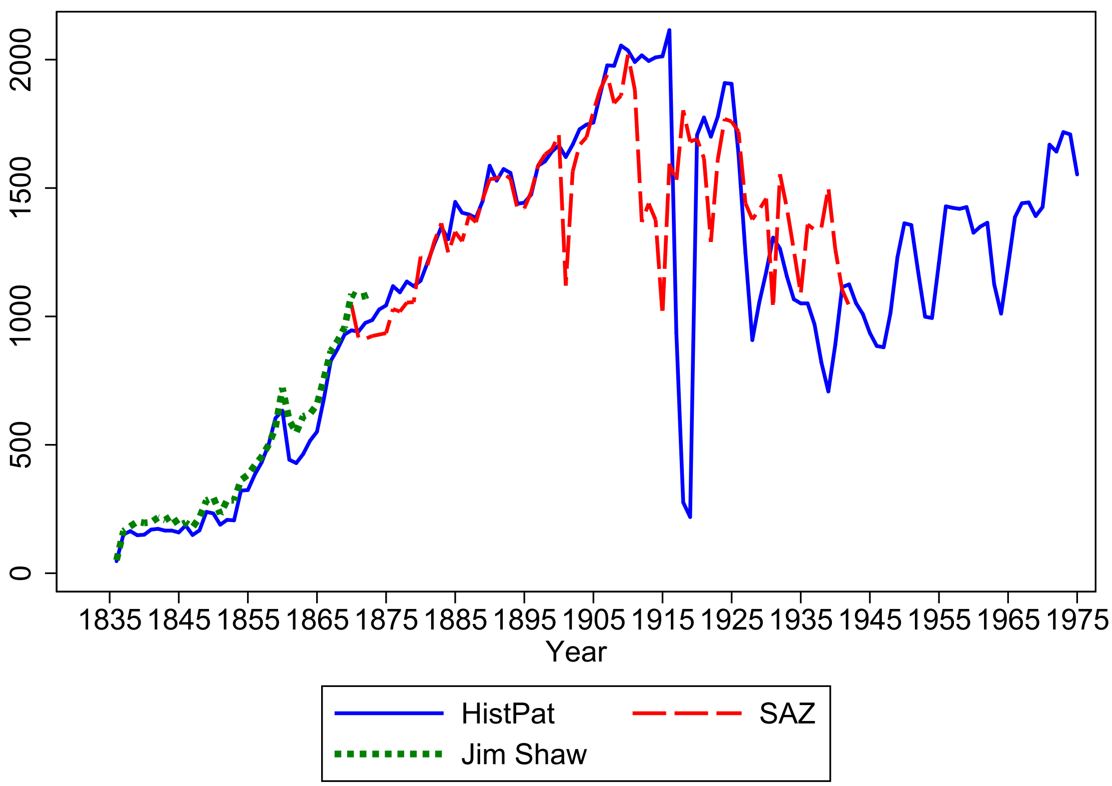


Figure 4.6: The number of U.S. counties that have at least one patent each year using each patent dataset. See text for a description of each dataset.

In Figures 4.7-4.9, I shift the focus from counting the number of patents to counting the number of inventors. The number of inventors plotted in Figure 4.7 count the number of inventors listed on each granted patent in each year.[16] Notably, this number is not a count of the number of unique inventors. If the same inventor obtains two patents within the same year, that individual will be counted twice for that year.[17] In these figures, it no longer makes sense to compare the number of inventors in each dataset to a USPTO aggregate, since the USPTO only reports the aggregate number of patents granted and not the number inventors to whom they are issued. Likewise, the USPTO HPDF only records patent numbers and so contains no information on the number of inventors that are listed in granted patents.

Figure 4.7 tell a story similar to that in Figure 4.4, with the Jim Shaw and HistPat datasets having nearly the same number of inventors in all years. The scale of the figure can mask the differences between the two datasets, however. Figure 4.8 puts the number of inventors into perspective by dividing the number of inventors on successfully parsed patents by the number of patents. For most years, Jim Shaw finds between 1.08 and 1.16 inventors per patent. Strikingly, the HistPat data finds exactly one inventor per patent for all years until 1896.[18] After 1920, the number of inventors

[16]Although the annual reports list all of the inventors on a patent, the current version of the SAZ data does not count multiple inventors.

[17]Even with contemporary patent data, determining the number of unique inventors is difficult. The USPTO does not assign a unique patent identification number to patentees, and it is not uncommon for individuals with multiple patents to record their name in different ways (for instance, by using nicknames or including or excluding middle names or initials) in different patent filings. Even if an individual records his or her name in the same way across all of their patents, geographic mobility makes it difficult to ascertain if patents issued to the same name in different locations belong to the same person.

[18]Cleaning up the inventor names in the HistPat data is still a work in progress, which

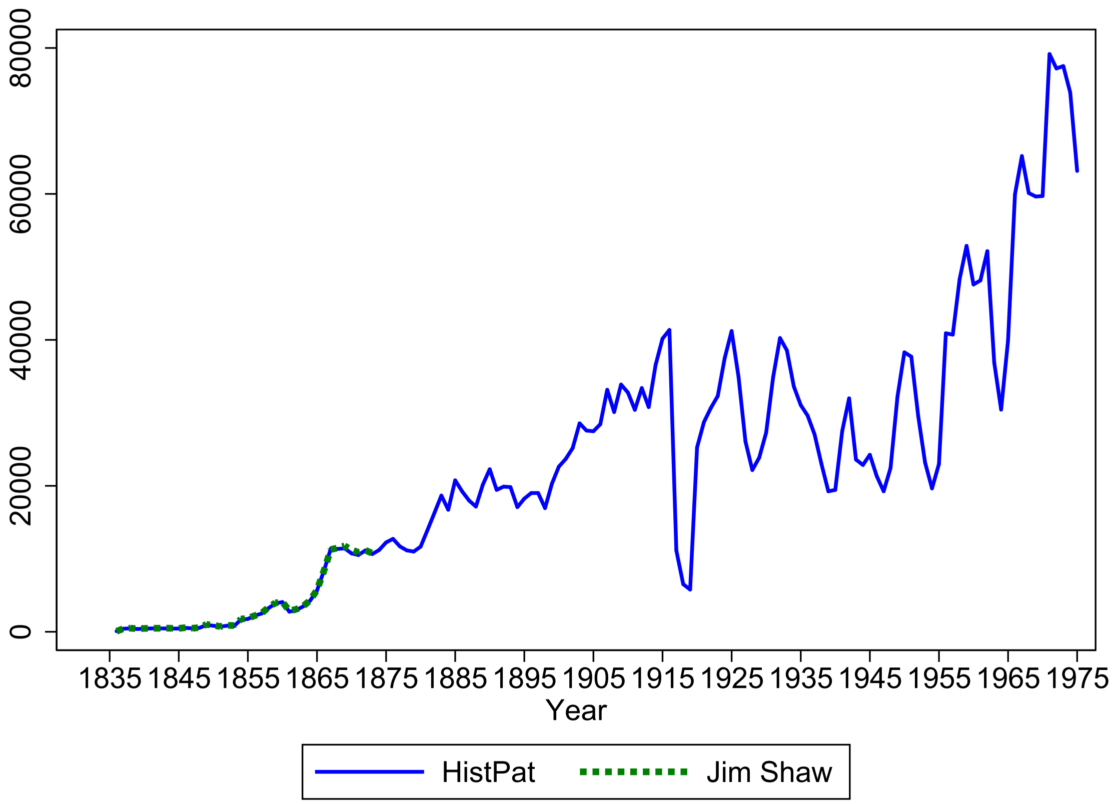


Figure 4.7: The number of inventors listed on U.S. patents that were successfully linked to a U.S. county each year using each patent dataset. See text for a description of each dataset.

per patent begins increasing. Combined with the time series on the number of patents in Figure 4.4, this shows that not only is there a secular increase in the number of inventions, but the rate of co-inventing increases over time as well, consistent with a decline in the role of independent inventors and an increase in professionalization of inventive activities.[19] Figure 4.9 plots the fraction of patents for each dataset in each year which contain multiple inventors. It is conceivable that this figure could tell a different story than the previous two graphs if, for instance, a particular dataset does a good job of flagging any patents with two inventors, but is much less successful at identifying the third, fourth, etc. inventors. This figure shows an increase of less than 10% of patents having more than one inventor in 1920 increasing to more than 35% by 1975.

4.4 Do the Datasets Contain the Same Patents?

While it is reassuring that the different patent datasets present roughly the same pattern over time (although with notable exceptions, as discussed above), an important concern is whether each dataset is comprised of the same types of patents. Similar aggregate trends can mask a great deal of heterogeneity in terms of who and where the patents come from.

Even if the datasets contain different absolute numbers of patents, ideally each is still a representative sample of the universe of US patents. Since each dataset relies on different techniques to parse out a patent's location, it is possible that some

---

likely accounts for the absence of multiple inventors from 1836 to 1895.

[19]See Chandler 1990, Mowery 1990, Nicholas 2009, and Nicholas 2010.

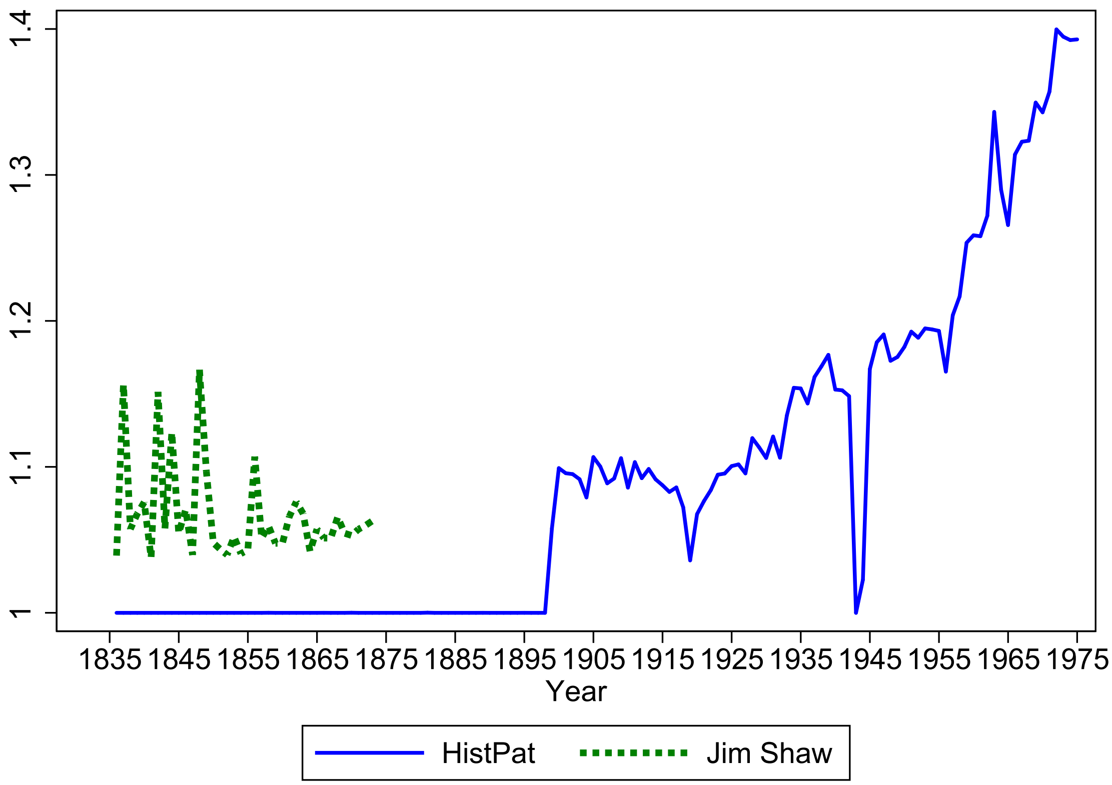


Figure 4.8: The number of inventors divided by the number of patents for each year using each patent dataset. See text for a description of each dataset.

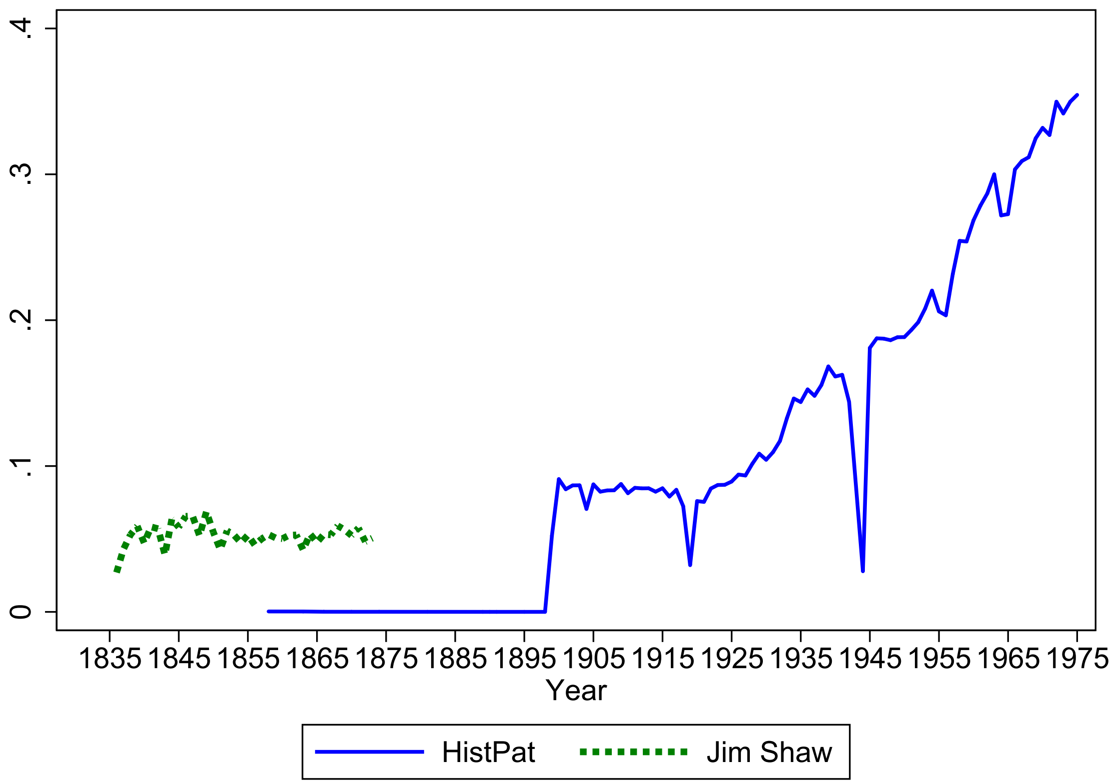


Figure 4.9: The fraction of U.S. patents successfully linked to a U.S. county each year that contain more than one listed inventor for each patent dataset. See text for a description of each dataset.

datasets are better at finding patents from large cities that are relatively easy to identify. This would lead to an over-representation of high population areas and an under-representation of low population areas. In Figure 4.10, I plot the share of patents in each dataset that come from counties with less than 5,000 people.[20] The pattern for the fraction of patents from counties with less than 5,000 people is remarkably consistent across the HistPat, SAZ, and Jim Shaw datasets.[21] Overall a tiny share of patents (about 0.5-2.5% of patents) comes from counties with fewer than 5,000 patents, so it is important not to over-interpret any small differences in these results. Figure 4.11 repeats this exercise but uses a population of 50,000 as the cutoff. Instead of displaying the share of patents coming from very small counties, this figure effectively plots that share of patents that *do not* come from counties with a very large population. In the 1830-1840s, roughly 40-60% of patents come from counties with less than 50,000 people. By 1940, the fraction had fallen to 10-20%. In this figure, the Jim Shaw and SAZ data have a higher share of patents coming from counties with smaller populations. This is suggestive evidence that the HistPat data over-represents patenting in high population areas. While the datasets all tell qualitatively the same story, the modest quantitative differences may nevertheless prove important. For instance, using the HistPat data instead of one of the other datasets could make technology clusters to appear more important than they actually

[20] 5,000 people is the census's official designation of a rural area.I use county population from the previous U.S. census; results using county population interpreted either linearly or with a cubic spline are similar.

[21] Again, the USPTO HPDF is excluded as there is no way to link patents to counties.

were in the history of US invention.

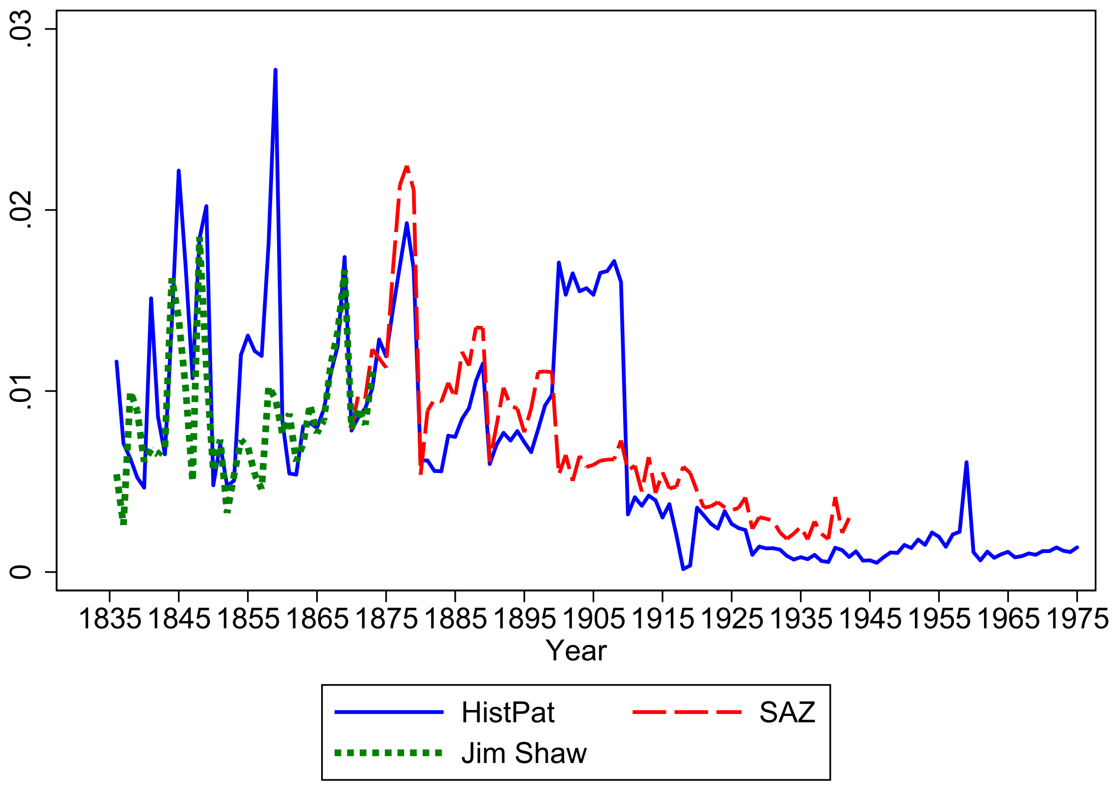


Figure 4.10: The share of patents coming from counties with less than 5,000 people living in the county according to the previous decennial census. See text for a description of each dataset.

In Figures 4.12, 4.13, and 4.14, I plot the ratio of the share of patents in each state in the SAZ dataset to the share of patents in each state in the HistPat dataset for the years 1870, 1900, and 1920, respectively. The distributions for other years are similar. A value of 1 (indicated by a dashed blue line) indicates that a particular

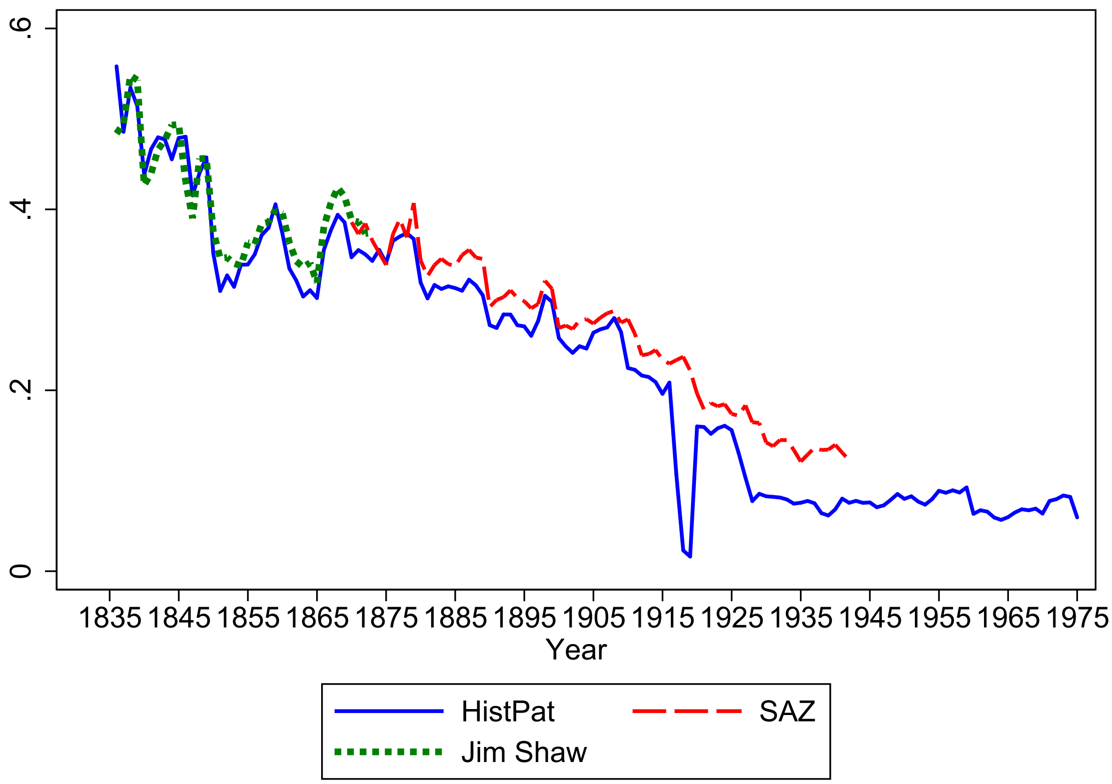


Figure 4.11: The share of patents coming from counties with less than 50,000 people living in the county according to the previous decennial census. See text for a description of each dataset.

state has the same share of patents in both the HistPat and SAZ datasets. The solid black line plots the share of patents belonging to each state in the corresponding year of the HistPat data. What these graphs show is that, for the most part, states have the same share of patents in both the HistPat and SAZ datasets; states with a large fraction of the patents in HistPat have a large share of patents in SAZ, and likewise for states with a small fraction of patents. In addition, the graphs show that, when large deviations in the share of patents belonging to a particular state occur, they tend to take place in states with a very small share of the HistPat patents.[22] For instance, some of the largest deviations in each year take place in Georgia, a state that had only 63 patents in 1870, 145 in 1900, and 77 in 1930 according to the HistPat data (the SAZ data has 66, 682, and 134 patents in Georgia in these years, respectively). Because such a small share of patents are found in Georgia in the HistPat data, small changes in the share of patents in Georgia in the SAZ data can lead to large changes in the ratio of shares. The fact that the SAZ data tends to find a larger share of patents in states with few patents than the HistPat data, and the fact that states with few patents also tend to be more rural, is consistent with the above results that suggest that the SAZ data finds more patents from less populous counties. In contrast, in the states with the largest shares in the HistPat data, namely Illinois, Massachusetts,

[22]A notable exception is Washington, D.C., which is not parsed in the current version of the SAZ data. While the HistPat data attributes only about 2.5% of annual patents to Washington, D.C. in most years, D.C. tended to have the highest rate of patenting per capita, as noted in nearly every Annual Report of the Commissioner of Patents. It is therefore an important geographic location to consider. Future versions of the SAZ data will include Washington, D.C. Also, note that excluding Washington, D.C. slightly artificially inflates the ratio of shares of patents in SAZ to HistPat; since no SAZ patents are recorded in D.C., the share in each other state must be higher than if D.C. had some patents.

New York, Ohio, and Pennsylvania (and in later years California and Michigan), the ratios tend to be very close to 1 for all years. One important exception is New York in 1930; in this year the SAZ data locates 17.5% of its patents in New York, whereas the HistPat data locates a much larger 26.2%.

For the datasets that contain patent numbers, it is possible to verify directly whether the datasets contain the same patents. Both the Jim Shaw and HistPat datasets contain patent numbers, and so each individual patent can be compared across these datasets. As Figure 4.4 shows, when the patents are matched to counties, the Jim Shaw and HistPat datasets contain virtually the same number of patents in all years. For this exercise, I consider a more liberal definition of a "successfully parsed patent," namely, I consider a patent to be successfully parsed if it can be linked to a US state. This rules out patents granted to individuals living outside the US, which are included in the raw Jim Shaw data but not in the HistPat data. In a further testament to the completeness of Jim Shaw's work, there is only *1* patent number in the HistPat data that does not appear in the Jim Shaw dataset. This lone patent is #US355,830, which must be a mistake in the HistPat records because in the HistPat data the patents from 1867 end with #US72,958 and the patents for 1868 begin with #US72959; chronologically, patent #US355,830 should not appear until 1887. It is likely that the Google Patents mis-recorded the patent data of 1887 as 1867.[23]

To check whether patent years were often mis-recorded in either the Jim Shaw

[23]Indeed, patent #US355,830 appears in the USPTO HPDF, granted on January 11, 1887 for an invention relating to "Joints and Connections."

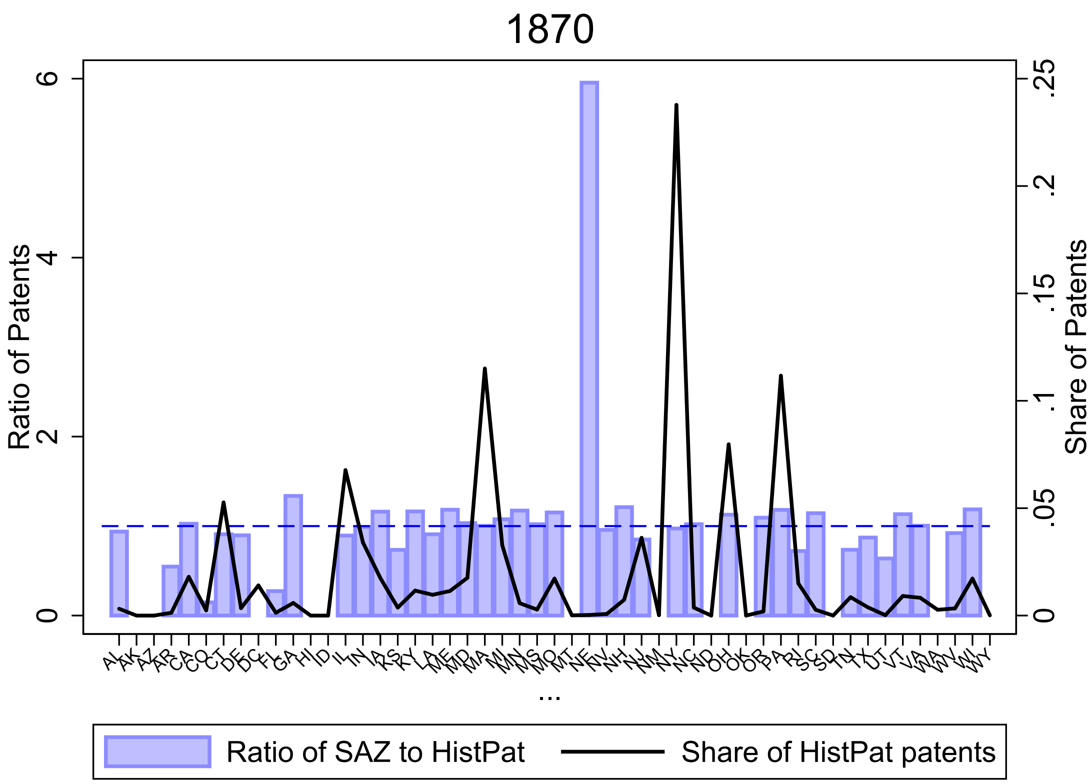


Figure 4.12: Comparison of patenting by state in the SAZ and HistPat data for 1870. The light blue bars (left axis) show, for each state, the ratio of the share of successfully parsed SAZ patents to the share of successfully parsed HistPat patents. A value of 1, indicated by a dashed blue line, indicates that a particular state has the same share of patents in both the SAZ and HistPat datasets. The black line (right axis) shows the share of successfully parsed HistPat patents belonging to each state.

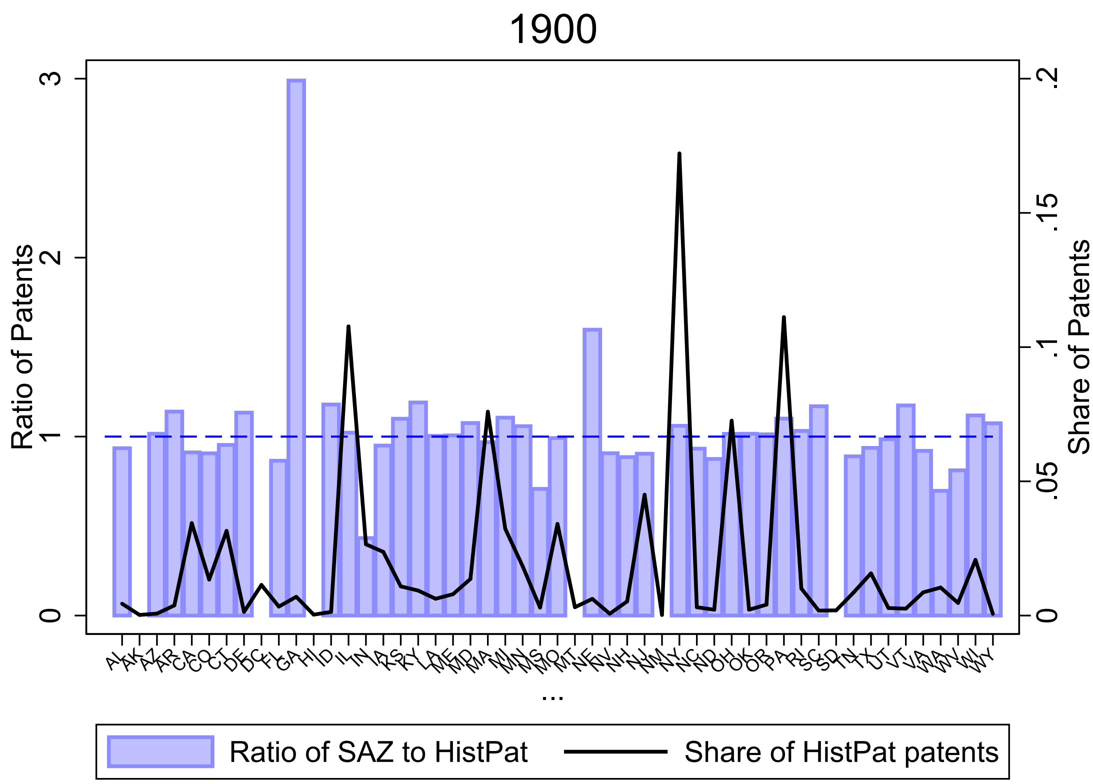


Figure 4.13: Comparison of patenting by state in the SAZ and HistPat data for 1900. The light blue bars (left axis) show, for each state, the ratio of the share of successfully parsed SAZ patents to the share of successfully parsed HistPat patents. A value of 1, indicated by a dashed blue line, indicates that a particular state has the same share of patents in both the SAZ and HistPat datasets. The black line (right axis) shows the share of successfully parsed HistPat patents belonging to each state.

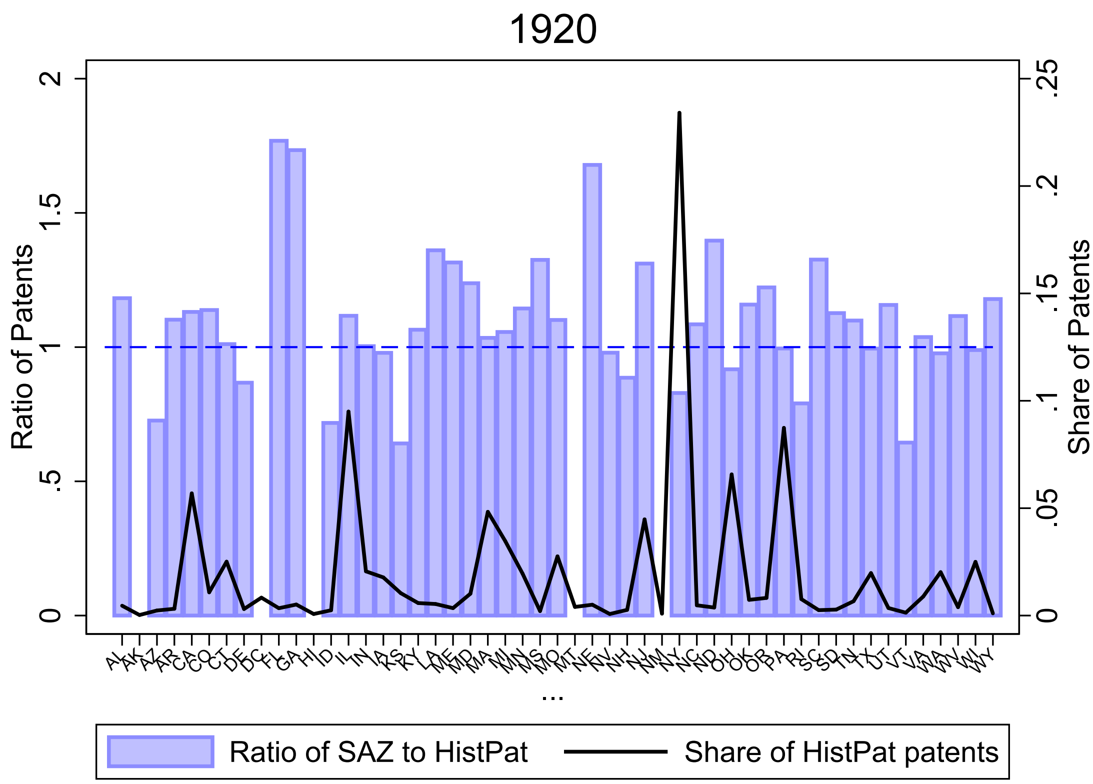


Figure 4.14: Comparison of patenting by state in the SAZ and HistPat data for 1920. The light blue bars (left axis) show, for each state, the ratio of the share of successfully parsed SAZ patents to the share of successfully parsed HistPat patents. A value of 1, indicated by a dashed blue line, indicates that a particular state has the same share of patents in both the SAZ and HistPat datasets. The black line (right axis) shows the share of successfully parsed HistPat patents belonging to each state.

or HistPat data, I list all patent numbers that appear in both the Jim Shaw and HistPat datasets but have different patent years recorded for each. I then search for the corresponding patent number in the USPTO HPDF. I use the patent grant date from USPTO HPDF to reconcile discrepancies across these two datasets. Surprisingly, out of the 133,801 patent numbers that occur in both the Jim Shaw and HistPat data, only 33 have different patent years recorded. Appendix C.2 lists each of these patents, the recorded patent year from both Jim Shaw and HistPat, and the "true" patent year from the USPTO HPDF. Of the 32 patents for which a patent number could be located in the USPTO HPDF data, in three cases the number was recorded correctly in the Jim Shaw data, while in the other 29 cases the number was recorded correctly in the HistPat data. All of the mis-recorded years in the Jim Shaw data appear to be due to mis-recorded years in the underlying Subject-Matter Index on which the Jim Shaw data is based.[24] If patent numbers were frequently recorded with the wrong years, this would give researchers reason to question even broad time series results. But, far from throwing the credibility of the HistPat data into question, this analysis reveals that errors in recording patent dates are extremely rare, in spite of the poor underlying quality of the OCRed Google Patents text.

In contrast to the lonely mis-recorded patent that occurs in HistPat but not Jim Shaw, there are a number of patent numbers that appear in the Jim Shaw data

[24] A similar procedure could be used to check if there are many discrepancies in patent location for the same patent numbers occurring in both the Jim Shaw and HistPat datasets. In this case, however, there is no USPTO HPDF geographic data to provide insight into which dataset has the "true" geographic location.

but do not appear in the HistPat dataset. Figure 4.15 plots the number of patent numbers that appear in the Jim Shaw data each year that do not appear in the HistPat data for every year that the two datasets overlap. Of the 8,515 patent numbers over all years that appear in the Jim Shaw data but not in the HistPat data, 8,450 of them can be located in the USPTO HPDF, suggesting that the vast majority of these are not simply "non-existent" patents that happened to be recorded in the Jim Shaw data. Even the 65 patents that cannot be matched to the USPTO HPDF all have plausible inventor and town names, suggesting that these were actual patents known in the 1874 Subject-Matter Index but subsequently lost within the USPTO. There are no clear patterns regarding the type of invention, town or state, or name of inventor for the Jim Shaw patents that were not matched to the HistPat data; they appear to be a random sample of lost patents.

4.5 Conclusion

While this paper has focused on the differences across the various historical patent datasets, visual inspection of Figures 4.4-4.14 reveal that the datasets share much in common. They all tell the same broad story of the history of American invention: in the 1830s, patenting was very rare and concentrated in a few large innovative hubs, but then patenting increased in frequency and spread across a broader geographic area, although a disproportionate share of inventions still come from large innovative cities such as New York and Boston.

Upon closer inspection, however, there are differences across the datasets. In

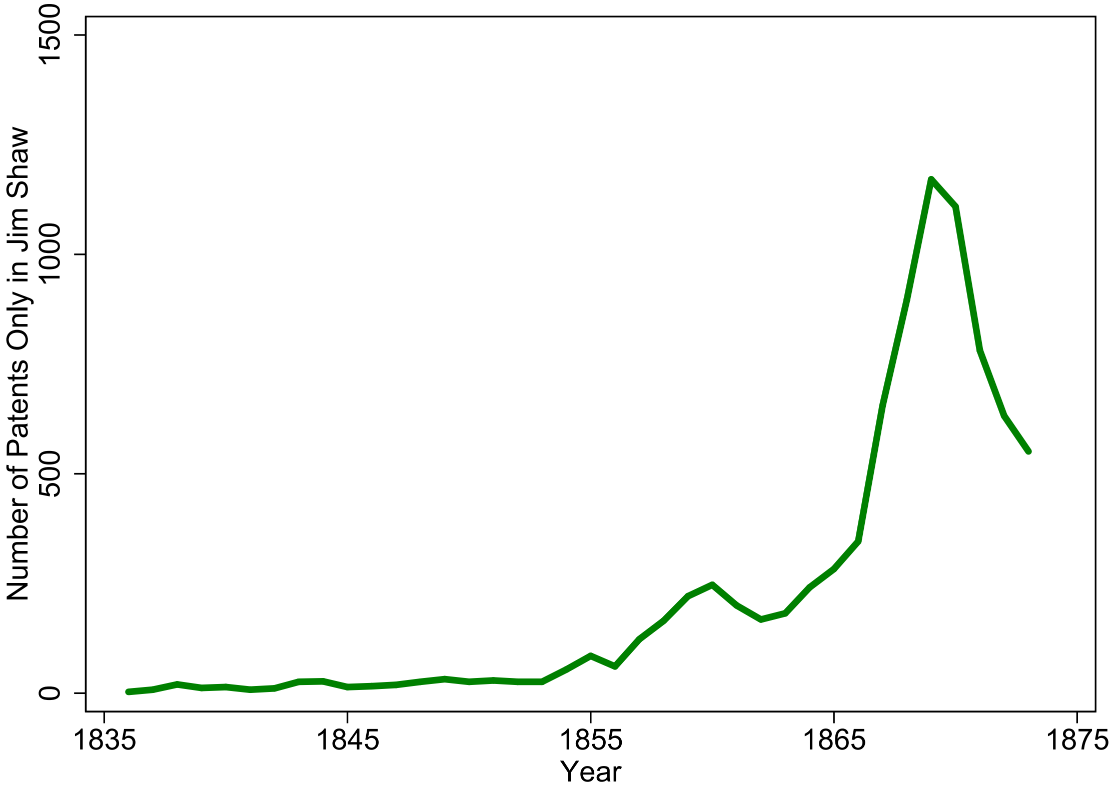


Figure 4.15: The number of patent numbers that are found in the Jim Shaw data that are not found in the HistPat data.

particular, while the overall shape of the time series is similar, the Jim Shaw and SAZ datasets tend to have a smaller fraction of patents coming from large cities than do the HistPat data. I also document a number of patent-level discrepancies between the Jim Shaw and HistPat datasets. An open question is to what extent these discrepancies across datasets are due to differences in the underlying raw patent data from which these datasets are constructed. I show that errors in the recorded patent years in the Jim Shaw dataset are due to errors in the Subject-Matter Index of Patents published by the USPTO in 1874. It is unclear whether errors in published USPTO documents also explain differences in the location of patents found in the SAZ and HistPat datasets. Better understanding of the differences between these datasets is an important next step to understanding which dataset is most useful for a given application.

APPENDIX A
APPENDIX TO CHAPTER 1: TECHNICAL APPENDIX

A.1 Additional Balance Checks and Placebo Tests

Table A.1 includes several other categories along which treatment and control counties can be measured. As in Table A.1, I show that the treatment and control counties are much more similar than the treatment and non-experimental counties in the same state. The first column lists the mean and standard deviation of treatment counties. The second column lists the mean and standard deviation of the control counties. The third column lists the difference in the mean between the treatment and control counties, as well as the standard error of the difference. The fourth column lists the mean and standard deviation of the non-experimental counties. The fifth column list the difference in the mean between the treatment and the non-experimental counties, as well as the standard error of the difference.

I next conduct a placebo test to determine whether patenting changes differentially in treatment and control counties in the years leading up to the college site selection experiment. I drop all data for the years after and including the year in which the college was established; all the remaining data is for the pre-trend. I then artificially designate the halfway point between the first year of observations and the last pre-experiment year as the "experiment year" and re-run the baseline regressions. Results are presented in Table A.2. If the treatment counties are up-and-coming places, then they should be growing faster then the control counties in the years before the original college site selection experiment and the estimated coefficient (Treatment * "PostTreatment") should be significantly positive. Instead, none of the coefficients are statistically different from zero and, while slightly positive, the coefficients of interest are much smaller in magnitude than their counterparts in Table 1.3. I take this as further evidence that the college site selection experiment is valid. Results are very similar if I instead designate random pre-treatment years as the placebo "treatment" year.

Finally, one may be concerned that the subjective nature by which an experiment is classified as high quality or low quality may lead to "cherry-picking" of experiments to achieve desired estimate. This is unlikely for two reasons. First, including all of the low quality experiments actually increases the estimated magnitude. Second, the relatively large number of college site selection experiments and the distribution of estimated experiment coefficients presented in Figure 1.3 make it unlikely that reclassifying a small number of experiments as either high or low quality will materially affect the results. Indeed, I verify this by excluding each high quality experiment, one at a time, and re-estimating the baseline regression. I also reclassify each low quality experiment as high quality, one at a time, and re-estimate the baseline regression. In all cases, the estimated coefficient is very similar to the baseline result and statistical significance is unchanged. These results are available upon request.

	Treatment	Controls	Treat. - Cont.	Non-Experiment	Treat. - Non-Exp.
Total Pop.	31,849.28	24,773.03	7,076.2497	22,435.87	9,413.4085
	(54,724.02)	(40,259.65)	(7,219.1101)	(109,806.06)	(14,200.8323)
Frac. Rural	0.84	0.84	-0.0078	0.93	-0.0910***
	(0.21)	(0.21)	(0.0361)	(0.17)	(0.0230)
Segregation	0.34	0.34	0.0056	0.36	-0.0167
	(0.23)	(0.24)	(0.0583)	(0.21)	(0.0429)
Pop. per Sq. Mile	80.26	47.10	33.1579	49.45	30.8019
	(248.73)	(92.78)	(38.1282)	(634.17)	(117.8889)
Frac. Attending School	0.14	0.12	0.0183	0.15	-0.0153
	(0.08)	(0.08)	(0.0234)	(0.08)	(0.0186)
Manuf. Establishments	128.00	118.52	9.4839	114.16	13.8434
	(138.01)	(170.22)	(48.2134)	(584.29)	(141.8459)
Manuf. Employment	823.33	1,418.92	-595.5950	1,174.31	-350.9879
	(1,935.58)	(7,423.64)	(1,197.0870)	(11,152.15)	(1,764.0384)
Value Manuf. Output	1,432,135.91	3,262,587.35	-1,830,451.4479	4,391,171.67	-2,959,035.7603
	(3,772,832.04)	(22,766,052.45)	(3,154,735.5862)	(57,226,282.76)	(7,862,090.4114)
Manuf. Wages	416,109.72	992,501.92	-576,392.1950	993,785.23	-577,675.5067
	(1,094,275.31)	(6,529,775.53)	(1,042,206.1112)	(11,356,701.19)	(1,796,113.3422)
Value Farm Product	1,095,524.47	1,154,241.75	-58,717.2757	1,678,618.65	-583,094.1767
	(1,351,876.43)	(2,479,984.59)	(379,132.9680)	(3,978,590.63)	(568,990.1071)
Farm Wages	132,687.60	108,372.69	24,314.9077	76,953.60	55,734.0035*
	(105,706.01)	(100,856.57)	(33,274.1962)	(116,367.11)	(30,208.6285)
Value Farms	5,094,621.34	4,069,069.71	1,025,551.6293	4,883,984.25	210,637.0932
	(8,284,190.81)	(5,100,590.43)	(1,062,864.8802)	(8,333,384.34)	(1,153,409.5965)

Table A.1: T-tests comparing the means of the treatment counties, control counties, and non-experimental counties.

	log(Patents + 1)	log(Patents + 1)
Treat.County * HighQual. * PostTreatment: (% Change)	0.0637	-0.0611
	(0.0955)	(0.0895)
(# Change)	0.2291	-0.2197
	(0.3432)	(0.3216)
PostTreatment: (% Change)	-0.0685	-0.0396
	(0.0475)	(0.0441)
(# Change)	-0.2464	-0.1424
	(0.1706)	(0.1586)
Treat.County * Trend * PostTreatment: (% Change)		0.0091
		(0.0090)
(# Change)		0.0328
		(0.0325)
Trend * PostTreatment: (% Change)		0.0003
		(0.0055)
(# Change)		0.0010
		(0.0199)
Trend: (% Change)		0.0150***
		(0.0048)
(# Change)		0.0539***
		(0.0173)
County Fixed Effects	Yes	Yes
Year Effects	Yes	Yes
Cnty-Year Obs.	8,887	8,887
# Counties	197	197
# Experiments	64	64
Adj. R-Sqr.	0.2848	0.2883

Table A.2: Placebo tests. The baseline regression results are reproduced with all post-experiment data dropped. The experiment year is set to halfway between the initial year of patent data and the year prior to the original college site selection experiment.

A.2 College Rankings

In certain instances, it is possible to rank the quality of each finalist county. In particular, I can rank the finalists when I either observe the bids that different counties offered or the number of votes that each received from site selection committees or state legislators. The finalist site ranked number one offers the highest bid; the lowest ranked county offers the lowest bid. For this exercise, I use data on all 136 college site selection experiments for which I am able to identify finalist locations; I do not restrict attention to only the high quality experiments. This allows me to verify that the "quality" of the counterfactual, in the sense of how close two given sites are in the rankings, is important when comparing winning to losing counties. There are 29 experiments for which I have data on either bids offered or votes received.

Figures A.1-A.4 plot differences in a number of outcome variables across finalists of different ranks. In particular, I examine the probably that a county with a given rank wins the college. The highest ranked county has the highest probability of winning the college, but the probability is far from one, suggesting that in many cases other factors such as politics also play an important role in determining which county ultimately receives a college. To give a sense of how close the competitions were, I also compare the fraction of the highest bid by colleges of each rank. Finally, I compare colleges by the amount of patenting or county population in the last census year before the college site selection experiment. The first and second ranked counties appear very similar, with each additional ranking appearing less similar to the others.

In Table A.3 re-estimates the baseline specification but including different numbers of finalist sites. In Column 1, I include all 29 experiments for which I can rank the finalists. Due to the relatively small number of such experiments, these results are much noisier than the estimates using the full sample of colleges. In Column 2, I include only the first, second, third, and fourth ranked finalists. In Column 3, I include the first, second, and third ranked finalists. Finally, column 4 includes only the first and second ranked finalists. As one reads the table from left to right, the coefficients shrink in magnitude, with the exception of Column 4, confirming the intuition discussed in Section 1.3.1 that including lower quality controls inflates the estimate of the effect of establishing a new college.

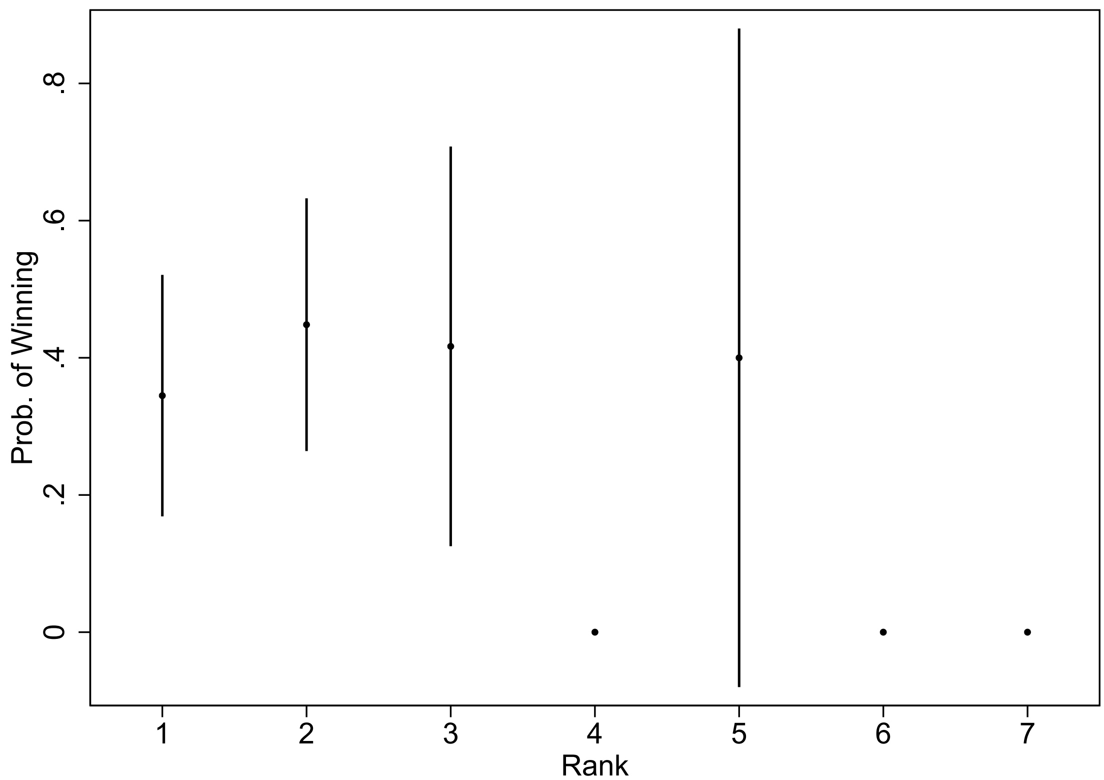


Figure A.1: The probability of "winning" and receiving the college for finalists of various ranks. Colleges are ranked based on the size of bids submitted or votes received.

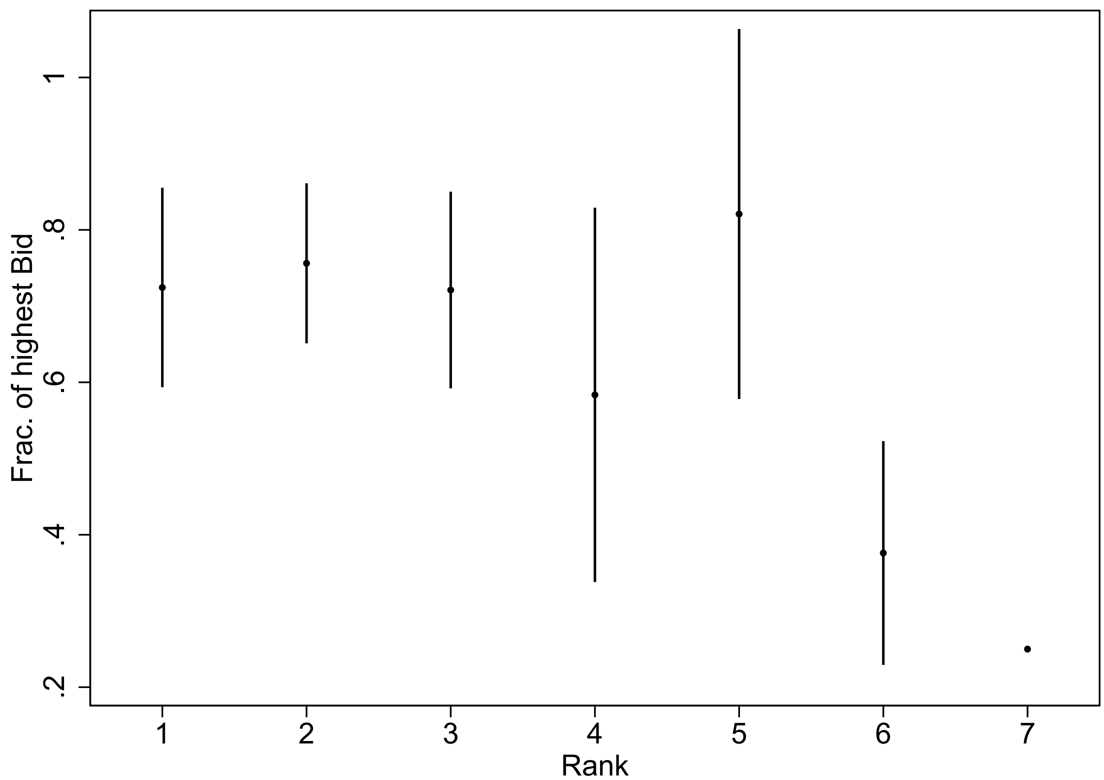


Figure A.2: The vote share for finalists of various ranks. Colleges are ranked based on the size of bids submitted or votes received.

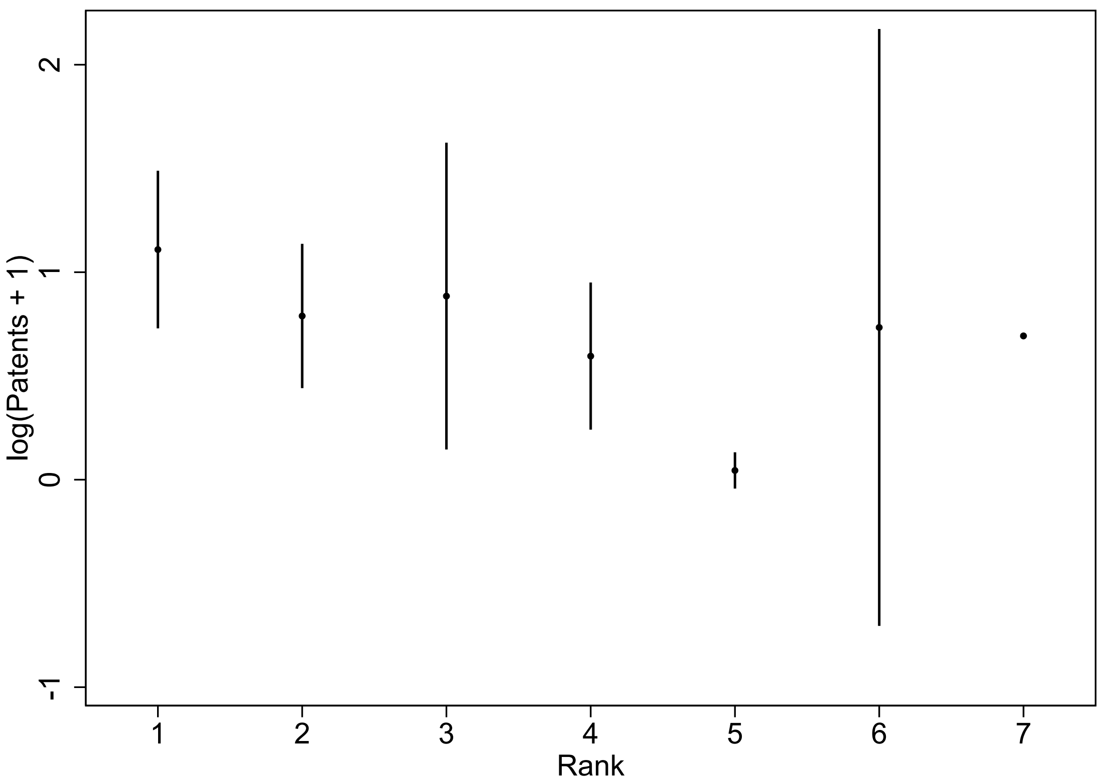


Figure A.3: The $log(Num.Patents+1)$ for finalists of various ranks. Colleges are ranked based on the size of bids submitted or votes received.

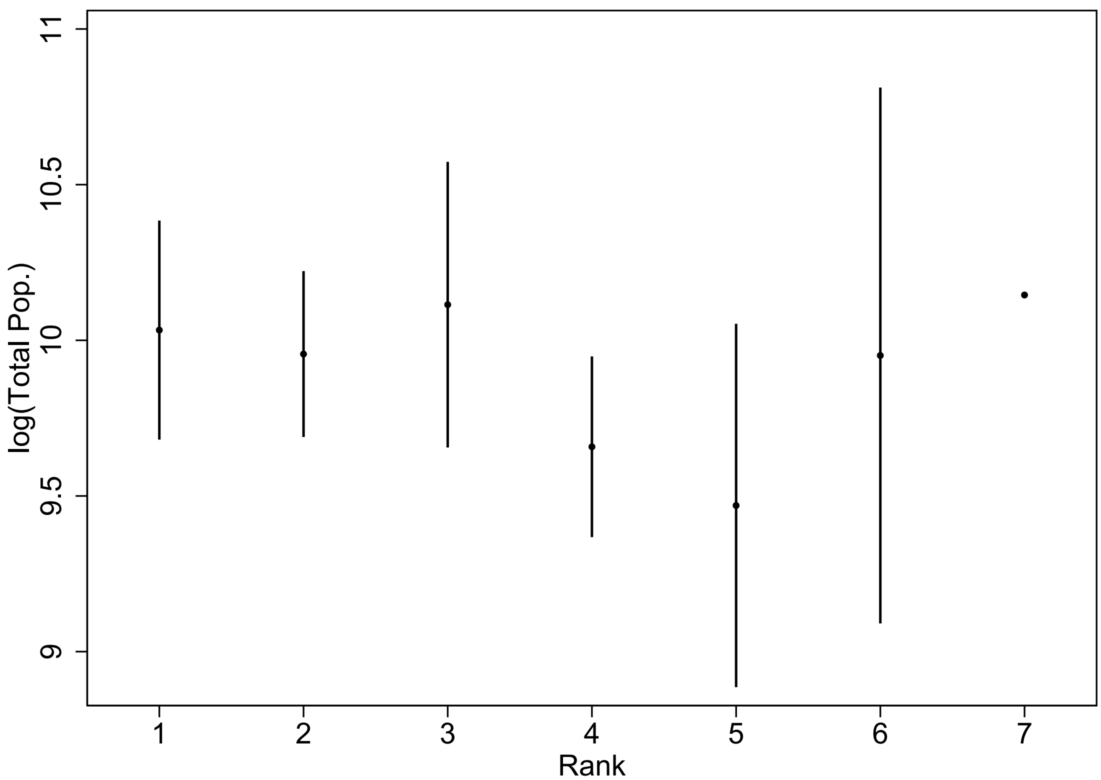


Figure A.4: The $log(TotalPop.)$ for finalists of various ranks. Colleges are ranked based on the size of bids submitted or votes received.

	All Ranked Counties	Top 4 Counties	Top 3 Counties	Top 2 Counties
Treat.County * Exp.County * PostTreatment: (% Change)	0.1826	0.1456	0.1314	0.1817
	(0.1733)	(0.1708)	(0.1726)	(0.1873)
(# Change)	0.6564	0.5235	0.4724	0.6530
	(0.6229)	(0.6138)	(0.6206)	(0.6734)
PostTreatment: (% Change)	0.0127	0.0202	0.0109	-0.0127
	(0.1170)	(0.1204)	(0.1196)	(0.1229)
(# Change)	0.0457	0.0727	0.0391	-0.0455
	(0.4207)	(0.4328)	(0.4299)	(0.4417)
County Fixed Effects	Yes	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes	Yes
Cnty-Year Obs.	15,575	13,825	12,600	10,500
# Counties	89	89	89	89
# Experiments	30	30	30	30
Adj. R-Sqr.	0.3623	0.3649	0.3616	0.3636

Table A.3: Results using finalist counties that can be ordinally ranked. Counties are ranked if the value of a bid or the number of votes received are recorded.

A.3 Results by Experiment Type

A related concern is that different types of college experiments may be systematically different from one another. I argue in Section 1.2.1 that the college site selection experiments are as good as random assignment. While each experiment is unique, they tend to fall into groups in which the colleges were assigned with different general methods. It would be suspicious if one method of "random" assignment gave systematically different results from other such methods. In this subsection, I test this concern by grouping experiments by the method in which the college was assigned and then checking that the estimated coefficients are similar across different groups.

I use four broad groups: auctions, politics, infrastructure, and other. "Auctions" refer to all cases in which a board of trustees, state legislature, or other site selection body solicited bids from localities; identification comes from comparing very similar bids across different locations. "Politics" refers to cases where political maneuvering, involving things like quid pro quos, strategic timing of votes, or even outright bribery, secured the college for one location over another; identification rests on the assumption that these political schemes are uncorrelated with any other local factors that would affect the college location decisions.[1] "Infrastructure" refers to cases in which the college had specific infrastructure needs that could only be satisfied by a

[1] For this reason, I do not consider an experiment to be of high quality if the work of a governor or legislative leader was instrumental in deciding where to locate the college and represented the winning county as this may reflect longstanding political influence rather than a quasi-random event.

limited number of candidate locations. As an example, the Morrill Land Grant Colleges Act forbade the use of land grant funds to construct buildings, so many land grant colleges had to be located where there was an existing and available building large enough to be used for a college. In other cases, colleges had to be located near the center of a state, near viable drinking water or on navigable waterways, or close to railway lines. All of the control counties in the were deemed to meet these infrastructure requirements by the site selection committee. Finally, "other" refers to all experiments that do not fit into one of the above descriptions. This can include pure random assignment (as in the case of the University of North Dakota), cases where weather played a pivotal role (as in the University of Arizona), or other bizarre circumstances (such as Cornell University). In several cases, an experiment could plausibly fit into several groups. For instance, in many cases bids were solicited only from localities that met certain infrastructure needs. I attempt to put each experiment into the most appropriate group; the results are not sensitive to reclassifying marginal experiments.

Table A.4 shows the results. The coefficients for the interaction term are qualitatively the same over all experiment types. The coefficients for auctions, politics, and other are in line with the baseline regression results. The coefficients are much larger for cases in which states selected sites on the basis of existing infrastructure, although admittedly few of these cases occur in the data; removing these cases and re-estimating the baseline equation does not change in the results in any meaningful way, nor does estimating the results without any of the other experiment types, as

Columns 2-5 show.

	log(Patents + 1)	No Auctions	No Politics	No Infrastructure	No Other
Auctions: (% Change)	0.2821				
	(0.2070)				
(# Change)	1.0139				
	(0.7439)				
Politics: (% Change)	0.3003**				
	(0.1478)				
(# Change)	1.0795**				
	(0.5313)				
Infrastructure: (% Change)	0.9136***				
	(0.3403)				
(# Change)	3.2838***				
	(1.2230)				
Other: (% Change)	0.3443				
	(0.4100)				
(# Change)	1.2375				
	(1.4735)				
Treat.County * HighQual. * PostTreatment: (% Change)		0.3665**	0.3563*	0.3022**	0.3158**
		(0.1429)	(0.1797)	(0.1260)	(0.1277)
(# Change)		1.3172**	1.2806*	1.0861**	1.1351**
		(0.5137)	(0.6461)	(0.4529)	(0.4592)
PostTreatment: (% Change)		-0.0531	0.0674	0.0594	0.0211
		(0.0890)	(0.0965)	(0.0726)	(0.0670)
(# Change)		-0.1909	0.2421	0.2133	0.0760
		(0.3199)	(0.3469)	(0.2610)	(0.2407)
County Fixed Effects	Yes	Yes	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes	Yes	Yes
Cnty-Year Obs.	34,194	18,235	20,369	32,619	31,359
# Counties	197	105	118	188	180
# Experiments	64	64	56	64	64
Adj. R-Sqr.	0.3466	0.3431	0.3577	0.3392	0.3403

Table A.4: Regression results by experiment type.

A.4 Results Using Other Patent Data

As noted in Section 1.2.2, the Annual Report and Jim Shaw patent data list each inventor's town and state of residence. The analysis above is conducted at the county level, so it is necessary to assign each patent to a county. In the analysis above, a town-state pair is placed into a county when the exact town-state pair is found in the U.S. census, which lists both the towns and counties of all residents. There are alternative ways to match town-state pairs to counties, however. Column 1 of Table A.5 recreates these results. I also experiment with the baseline estimate when a fuzzy matching algorithm is used to match town-state pairs in the patent data to town-state pairs in the census data.[2] These results are presented in Column 2. The coefficients are very similar to, and in fact slightly larger than, those presented in Table 1.3.

The same analysis could also be performed using alternative patent data altogether. While the data used above draws on annual reports compiled by the U.S. Patent Office, others have collected data on each patent individually. I also repeat the baseline estimates using HistPat data (Petralia, Balland, and Rigby 2016b).[3] The HistPat data is collected from Google Patents, which were digitized in the 1980s and thus tend to be lower quality images. See Andrews 2017a for an in-depth discussion

---

[2]More precisely, Stata's reclink command is used, which performs a bigram string comparator that returns a "distance" between the town-state strings in each dataset. Using various different weights for the town and state strings in the distance function returned qualitatively similar results. See Andrews 2017a for more information on the differences between the exact and fuzzy matching between towns and counties.

[3]Petralia, Balland, and Rigby 2016a describe the construction of the HistPat dataset in detail.

of the strengths and weaknesses of different historical patent datasets. The results using the HistPat data, presented in Column 3, are very similar to those using the Annual Report and Jim Shaw data. These results provide confidence that the results presented above are not an artifact of the particular patent dataset used or the choices made to geo-locate patents.

	Exact-Matched	Fuzzy-Matched	HistPat
Treat.County * HighQual. * PostTreatment: (% Change)	0.3274***	0.3848**	0.2789**
	(0.1231)	(0.1670)	(0.1173)
(# Change)	1.1767***	1.3829**	1.0023**
	(0.4425)	(0.6001)	(0.4215)
PostTreatment: (% Change)	0.0277	-0.0171	0.0860
	(0.0693)	(0.0778)	(0.0803)
(# Change)	0.0996	-0.0616	0.3092
	(0.2490)	(0.2797)	(0.2888)
County Fixed Effects	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes
Cnty-Year Obs.	34,194	34,194	34,160
# Counties	197	197	196
# Experiments	64	64	64
Adj. R-Sqr.	0.3428	0.2805	0.4174

Table A.5: Regression results using different experiment dates.

A.5 Town-Level Patenting

It may be the case that the county is the wrong geographical unit at which to measure the effects of a new college. Section 1.3.3 shows that the effects of colleges may spill over into neighboring counties. In Table A.6, I examine the effect at an even smaller geographical unit: the town. When filing a patent application, inventors list their town of residence. There are numerous reasons to be skeptical of town-level patenting data. First, inventors may list neighborhoods instead of the larger city (for instance, listing the town of invention as Manhattan, or even the Upper East Side, rather than New York City; this can be checked for in larger cities where neighborhood names are well known, but this is infeasible for every city in the country). Second, there is greater ambiguity about town borders than county borders. Third, town borders or names are much more likely to change over time. Fifth, many areas are not within any incorporated town boundary; it is unclear how inventors in these areas record their town of residence. Sixth, many states have multiple towns of the same name; Section 1.2.2 discusses how this is handled at the county level, but at the town level this leads to an over-count in the number of patents. Seventh, for some experiments, it is possible to identify counterfactual counties but not towns; the Historical Appendix lists the treatment and control towns and counties when they are known.

Despite all these objections, the results in Table A.6 are qualitatively similar to the county-level results presented in column 1 of Table 1.3, although smaller in magnitude. When using patents matched to towns, I find that establishing a new college increasing patenting by about 13% in the treatment towns relative to the control towns.

		log(Patents + 1)	log(Patents + 1)
Treat.Town * PostTreatment:	(% Change)	0.1218**	0.1129
		(0.0547)	(0.1198)
	(# Change)	0.4377**	0.4060
		(0.1966)	(0.4305)
PostTreatment Dummy:	(% Change)	0.0638	0.0714
		(0.0604)	(0.0718)
	(# Change)	0.2291	0.2566
		(0.2172)	(0.2582)
Treat.Town * Trend * PostTreatment:	(% Change)		0.0001
			(0.0011)
	(# Change)		0.0003
			(0.0041)
Trend * PostTreatment:	(% Change)		0.0009
			(0.0016)
	(# Change)		0.0031
			(0.0056)
Trend:	(% Change)		-0.0013
			(0.0013)
	(# Change)		-0.0046
			(0.0046)
County Fixed Effects		Yes	Yes
Year Effects		Yes	Yes
Cnty-Year Obs.		27,171	27,171
# Counties		192	192
# Experiments		64	64
Adj. R-Sqr.		0.2488	0.2490

Table A.6: Regression results at the town level.

A.6 Additional Results by Type of College

In this section, I further break down the results of different types of colleges on patenting. Table A.7 shows the increase in patenting in treatment relative to control counties after college establishment with separate interactions for each type of college. Row 1 presents estimates land grant colleges, which make up most of the colleges in the sample. Row 2 presents results for technical colleges, row 3 for normal schools, row 4 for HBCUs, row 5 for military academies, row 6 for other public colleges, and row 7 for other private colleges.

These results must be interpreted with extreme caution. As there are often only a few colleges of a particular type (for instance, HBCUs and other private colleges have an especially small number of colleges the sample), there is insufficient power to draw strong conclusions. Nevertheless, the results are suggestive, so I discuss them below.

The results for land grant colleges, technical colleges, and normal schools seem to conform to the intuition that college type influences the amount of patenting. Normal schools increase patenting very little, only 2% more than the control counties. Technical colleges, on the other hand, have a remarkable 97% more patents per year than their control counties. Land grant colleges are in the middle, with 22% more patents per year than their control counties. Surprisingly, however, other public universities had 33% more patents per year than their control counties, a larger estimated coefficient than land grant colleges which purportedly had a more technical focus.

HBCUs, shown in row 4, are an interesting case. The curriculum at HBCUs varies greatly across colleges, with some resembling normal schools and others providing a practical education in agriculture and machinery. The comparison to other college types is even more difficult because HBCUs tended to be established in areas with large African American populations, which tended to be poor and have a very low level of baseline patenting. HBCU counties have about 13% more patents per year than their control counties.

Military academies, shown in row 5, also form an interesting comparison group. Military academies focus on technical skills such as engineering and seamanship, but graduates from the academies are commissioned and dispersed to other locations; they cannot remain in the college county, eliminating one channel by which colleges can affect local invention. Moreover, because these colleges are focused on producing soldiers, sailors, and airmen, the technical skills taught may be less directed towards commercial applications and therefore less likely to obtain a patent. Nevertheless, counties with military academies produce far more additional patents per year than do land grant colleges. Military academy counties have 125% more patents per year than their control counties.

The one large outlier in these different college types are other private colleges, which remarkably saw 11% fewer patents per year than their control counties. As Table 1.1 shows, however, there are very few "Other Private" college experiment in the sample, so this result may reflect an idiosyncrasy associated with that particular experiment.

While there are certainly differences between the coefficients between different types of colleges, the limited number of each type of college makes drawing inferences from these estimates difficult. In particular, the coefficient for the effect of normal schools on patenting is statistically indistinguishable from the coefficient on land grant colleges, technical schools, and other public colleges. Even military academies, with clearly the largest coefficient, are statistically indistinguishable from technical schools and other public colleges. The only college type that is typically statistically different from all the rest is the private colleges (although even this is statistically identical to normal schools at conventional levels).

In all, these results make it difficult to paint a general picture about the effects of college type on patenting. Technical schools, which are expected to teach practical skills that easily translate into more invention, do indeed show a dramatic increase in patenting relative to control counties. But public universities that have a more classical focus ended up leading to more invention than did technically-focused land grant colleges. As expected, normal schools and private colleges saw the smallest increase in patents relative to their control counties. But while the results for normal schools and private colleges are consistent with the idea that the skills developed in college matter for patenting, it is unclear whether this is due to the fact that these schools do not teach skills conducive to patenting or whether these schools are simply very small.[4] I explore the effects of new colleges in driving county population directly

[4]A different way to think about this issue is to draw an analogy to the experimental literature. Because large state universities, land grant colleges, and state-sponsored technical schools tend to be larger colleges, the variance between the "treatment" administered to the college counties and the "lack of treatment" given to the controls is larger than when the treatment involves a smaller college. See, for example, List, Sadoff, and Wagner 2011.

in Section 1.4.4.

Land Grant Interaction:	(% Change)	0.2026
		(0.1326)
	(# Change)	0.7283
		(0.4766)
Technical School Interaction:	(% Change)	0.5875
		(0.4346)
	(# Change)	2.1118
		(1.5621)
Normal School Interaction:	(% Change)	0.0384
		(0.2580)
	(# Change)	0.1382
		(0.9272)
HBCU Interaction:	(% Change)	0.1272
		(0.3265)
	(# Change)	0.4571
		(1.1735)
Military Academy Interaction:	(% Change)	1.3104
		(1.8718)
	(# Change)	4.7101
		(6.7280)
Public Other Interaction:	(% Change)	0.3367*
		(0.1898)
	(# Change)	1.2101*
		(0.6823)
Private Other Interaction:	(% Change)	-0.1092
		(0.0766)
	(# Change)	-0.3926
		(0.2755)
	County Fixed Effects	Yes
	Year Effects	Yes
	Cnty-Year Obs.	34,194
	# Counties	197
	# Experiments	64
	Adj. R-Sqr.	0.3552

Table A.7: Regression results by college type.

APPENDIX B
APPENDIX TO CHAPTER 1: HISTORICAL APPENDIX

In this appendix, I include descriptions of the site selection process for each college in my sample. The sample consists of 219 U.S. colleges. I break these up into "high quality," "low quality," and "no quality" experiments. High quality experiments are experiments in which I can identify losing finalist locations and the college is plausibly randomly assigned across the finalists. Low quality experiments are experiments in which I can identify losing finalist locations but the assignment of the college was not random and the winning and losing finalists are likely very different from one another. The "no" quality experiments are cases in which I could not identify losing finalist locations.

To construct the sample, I investigated the institutional histories of the included colleges. I investigated every land grant college; the first public university founded in each state (with a few exceptions that were founded before the start of the patent data); the flagship university of a each state's public university system if this is different from either the land grant or first public university; every state technical school and mining college; and every federal military academy. When data was available, I also investigated historically black colleges and universities (HBCUs) and private colleges, with a focus on the private colleges that have been historically noteworthy or are currently considered prestigious; a number of private colleges, particularly religious colleges, remain to be explored. For a handful of states, I also investigated each normal school established in that state. Over time, normal schools typically evolved to become "directional" state universities (for example, the Michigan State Normal College became Eastern Michigan University).

For the high and low quality experiments, I describe the site selection process in detail. For the no quality experiments, since no information about alternative sites are available, I simply list each college in a table. The colleges are listed by experiment quality: high, low, and "no." Within each quality group, I list colleges alphabetically first by state and then by college name. I list colleges under their current name, which frequently is not the name of the original college.[1] I also include references for institutional histories for every college in the sample.

B.1 High Quality Experiments

In this section, I describe each of the 73 high quality experiments. I attempt to include sufficient detail to explain how the finalist sites were selected, where the losing finalist locations were, how closely contested the site selection process was, and why I consider this to be a high quality experiment. As noted in the body of the paper, experiments are considered to be of high quality for four main reasons. First, states held auctions, soliciting bids from towns and counties; I consider cases with close bids to be high quality experiments. Second, site selection committees or legislatures voted on the location of the site; I consider cases with close votes to be high quality experiments. Third, a new college had very specific infrastructure re-

[1]This is not always possible, for instance in cases where colleges merged or split. So, for example, I list Case Institute of Technology and the Western Reserve University as separate entries since they were formed at different times, even though today they have merged and are known as Case Western Reserve University.

quirements and only a few locations had the existing infrastructure in place to meet those requirements. Fourth is all other cases in which plausibly random assignment played a role. Often, the site selection process falls into multiple of these categories, for instance a state would hold an auction but also had specific infrastructure requirements. Because bids submitted by localities and votes taken are useful in determining if an experiment is high quality, I record these whenever available. Unfortunately, in many cases numbers are not available, or, more likely, the bid from or votes for the winning county are recorded, but not for each of the losing finalists. In these cases, I am forced to rely on assertions from contemporaries or historians that bids or votes were particularly close. Even when bids are recorded, the raw values should be interpreted with caution. It is often unclear whether recorded bids refer to one-time payments, the lifetime value an endowment, or annual payments from a perpetual endowment, as well as whether they include land, buildings, utilities, or other amenities. Furthermore, real estate and other assets were often assessed strategically to make a given locality's bid appear more appealing, for instance by finding a sympathetic assessor. In spite of these concerns, I contend that there is a relatively clear distinction between high and low quality experiments which should be apparent from the descriptions below. In addition, as I show in the body of the paper, empirical results are not sensitive to reclassifying marginally high quality experiments.

Auburn University: Devastated by the Civil War, Alabama did not act on its land-grant until 1871, when it set about to select the site of its agricultural and mechanical college. Since land-grant funds could not be used for building construction, the state sought a location at which existing buildings were available for use. There were three serious candidate locations: Tuscaloosa in Tuscaloosa County, Florence in Lauderdale County, and Auburn in Lee County. Talladega was also briefly considered but was not a top candidate due to its lack of existing buildings and equipment. Tuscaloosa housed the existing University of Alabama and was centrally located. Florence housed the struggling Florence Wesleyan University, valued at roughly $50,000, which was offered to the state in exchange for receiving the land-grant college. Auburn also had a struggling university, the Methodist-run East Alabama Male College, as well as a central location. A state commission to select the site, chaired by William Murrah of Pickens County, had a very difficult time selecting the best location and gave a tentative recommendation for Auburn. This recommendation was not changed when the Murrah Commission and a smaller subsequent committee submitted their reports. A bill placing the land-grant university in Auburn passed was signed into law in 1862. This account is drawn from Rogers 1960, p. 8-14.

University of Alabama: On April 20, 1818, the U.S. Congress passed a law laying out the management of the sale of public lands in the newly formed Alabama Territory. Part of that law stipulated that a township be set aside for the creation of an institution of higher education. While its future seemed secure, ground was not broken on the university as Alabama achieved statehood and set about established other state institutions. This lack of progress had many causes, but chief among it them were severe disagreements about how to manage Congress-approved land grant scrip and where to locate the university. Finally, frustrated by the lack of progress, in December of 1827 the trustees of the university-to-be recommended that the new college be located as close as possible to the middle of the state to minimize sectional jealousies. (In reality, all of the proposed sites were in the northern half of the state.) Now spurred to action, the Alabama legislature held a joint evening session on December 29, 1827, to decide among 14 candidate sites from the center of the state. The sites were Gage's in Perry County, Greensborough in Greene County, Lagrange in Franklin County, Athens in Limestone County, Montevallo in Shelby County, Honeycomb Springs and Bellfont in Jackson County, Somerville in Morgan County, Moulton in Lawrence County, Davis in Autauga County, Greenville in Butler County, Tascaloosa in Tuscaloosa County, Elyton in Jefferson County, and Village Springs in Blount County. It took nineteen ballots before one location had a majority of the votes. One the nineteenth and final ballot, five contenders remained: Tuscaloosa, Montevallo, Lagrange, Athens, and Bellfont. On this final ballot, Tuscaloosa won 47 out of 81 possible votes. I consider the four other sites that remained until this final ballot to be high quality controls, while the rest are considered to be low quality controls. The university finally opened to students in April 1831, almost 13 years to the day after the university was established by an act of Congress. This account draws from Sellers 1953, p. 7-36.

University of Arizona & Arizona State University: In 1885, Arizona's in-famous "Thieving Thirteenth" legislature met in Prescott, in Yavapai County, to allocate a number of state institutions. Martin 1960, p. 21 sets the scene:

> It did not take a very bright man to see that when the Apache were subdued the army would leave and the paydays that had meant so much would disappear. It was quite obvious that new sources of revenue must be tapped, and so there was a new war on when the Thirteenth Legislature convened under Governor F. A. Tritle in 1885. This was a war for commercial gain, and it was just as bitter as the war with the Apache had ever been. The battleground was the legislative chambers of the "Thieving Thirteenth," which got its name from its reckless, unnecessary, and illegal expenditures, for the Legislature had the power to hand out spoils in the form of Territorial buildings and institutions.

Naturally, every town wanted one of these institutions for itself. The biggest prizes were the territorial insane asylum, which came with a grant of $100,000, and the territorial capital. Lesser prizes were the territorial university, with a grant of $25,000, and the territorial normal school, with a grant of $5,000. The territory did not yet have any high schools, so these colleges were viewed by many as a waste of money. The delegation from Tucson, in Pima County, set out with its heart set on the insane asylum. But flooding on the Salt River delayed the delegation (Wagoner 1970, p. 210-211, Cline 1983, p. 3). By the time they arrived in Prescott, many institutions had already been spoken for. Phoenix in Maricopa County received the insane asylum. Prescott retained the capital. The territorial prison remained in

Yuma in Yuma County, which also received a levee on the west bank of the Gila River. Florence in Pinal County received a $12,000 appropriation for a new bridge across the Gila River, although the bridge was washed away not long after being built. The normal school, which would go on to become Arizona State University, went to Tempe, also in Maricopa County, after skillful political maneuvering by the Tempe delegates (Wagoner 1970, p. 209-210). The Tucson delegation was stuck with the university. The Tucson delegation was so upset by this that they booed and threw rotten eggs at their representatives when they returned to Tucson to share the news. Tucson even sent a second delegation to Prescott to outright bribe the other legislators to get the capital moved to Tucson, although this was unsuccessful. Even after all this, the bill formally granting the university to Tucson nearly failed in the territorial House until Representative Selim Franklin gave a moving speech:

> Gentlemen, the Thirteenth Legislative Assembly is generally conceded to have been the most energetic, the most conscientious and the most corrupt Arizona has ever had. We have been called the Fighting Thirteenth, the Bloody Thirteenth and the Thieving Thirteenth. We have deserved these names and we know it...
>
> But gentlemen, here is an opportunity to wash away our sins. Let us establish an institution of learning, where for all time to come the youth of the land may learn to become better citizens than we are, and all our shortcomings will be forgotten in a misty past and we will be remembered for this one great achievement. (Martin 1960, p. 23-24)

Even after the bill passed, Tucson still had to provide 40 acres of land for the university before the end of 1886. No citizens in Tucson were willing to donate anything for a university that they viewed as a waste of resources and a squandered opportunity. Finally, with the deadline fast approaching, a saloon owner and two gamblers donated land in the desert outside of town. The first classes began in 1891. Because Prescott and Yuma retained institutions that they already owned, I consider these to be low quality experiments. This account is drawn from Martin 1960, p. 21-25, Wagoner 1970, p. 194-222, and Cline 1983, p. 2-4.

Arkansas Tech University: In the first decade of the twentieth century, rural citizens in Arkansas began lobbying for better agricultural education. In February 1909, Act 100 was signed into law, establishing four new agricultural high schools located across the state. A five-member Board of Trustees for the Second District school announced that it would only consider locations that had raised at least $40,000 and provided a site of at least 200 acres. When the board met in February 1910, four locations met this criteria. Fort Smith in Sebastian County and Ozark in Franklin County promised $40,000 and 200 acres of land. Morrilton in Conway County promised $46,000 and 200 acres of land. Russellville in Pope County promised $40,000 and 220 acres of land. Fearing that it would lose out to either Morrilton or Ozark, the Russellville delegation increased its bid to also provide free light and water for three years. The town of Atkins in Pope County was reported to have pledged $30,000 and 320 acres of land, but it was not included in the final bidding, so I therefore include it as a low quality control. Three trustees voted for Russellville, while one trustee voted for Ozark and another for Morrilton. Classes began in October of 1910. While it was founded as a farmer's high school, a movement was shortly underway to transform it into an agricultural and mechanical college. This movement finally succeeded in 1925, when the school became a polytechnic college. This account draws from Walker 1992, p. 1-22.

University of Arkansas: Starting in 1868, the state of Arkansas began the process of soliciting bids from individuals, towns, or counties to receive the state land-grant university. In order to submit a valid bid, each location had to submit a petition and a promise to hold a local election regarding the terms of the bid in July, 1871. Two counties submitted bids that complied with all of the legal requirements: Washington County, which bid $100,000 in bonds plus real estate; and Independence County, which bid $50,000 in bonds plus real estate. Two towns within Washington County each wanted the university and bid bonds in addition to the amount bid by Washington County. Fayetteville bid an additional $25-30,000, while Prairie Grove bid an additional $23,265. After inspecting all three possible sites, the state gave the land-grant university to Washington County and let the county determine which town would receive the school. Washington County settled on the town with the higher bid, Fayetteville. This account is drawn from Reynolds and Thomas 1910, p. 43-62.

Southern Arkansas University: The Third District Agricultural School would be allocated to a community in southern Arkansas. As in the case of the other agricultural schools, the Board of Trustees required bids to include at least $40,000 and 200 acres of land. For the Third District school, however, no community promised such an amount, so the trustees decided to simply accept the highest bid. When the trustees met in Little Rock in March 1910, they had received bids from five locations: Camden and Stephens in Ouachita County, Hope in Hempstead County, Mena in Polk County, and Magnolia in Columbia County. Late bids from Bingen in Hempstead County and Prescott in Nevada County submitted late bids and were therefore excluded from consideration; I include them as low quality controls. The Magnolia delegates were confident that they had secured the highest bid, worth $26,000 and 300 acres of land. When they arrived in Little Rock, however, they learned that the citizens of Mena had managed to pledge $40,000 and 200 acres. The delegates from Magnolia therefore increased their pledge to $35,000 to at least become competitive. Surprisingly, Magnolia received few votes from the trustees; instead, Hope became Magnolia's fiercest competition. In seven rounds of balloting, no site received a majority. Finally, on the eighth ballot, Magnolia received three votes to Hope's two. Classes began in winter 1911. The school officially became a college in 1925. This account draws from Willis 2009, p. 21-43.

University of California Berkeley: In 1856 a committee was formed to explore opening the College of California. The committee commissioned Horace Bushnell to survey sites and submit a report. Bushnell delivered his report in January 1857. He concluded that the college should be located close to a major city, either San Francisco or Sacramento, but far enough away that the students would not be distracted by urban amenities. The board of trustees decided to move as quickly as possible to select the location of the school while popular opinion was favorable and public assistance was likely. While Bushnell had recommended a location in Napa, the trustees' first choice was to purchase land in the Clinton neighborhood of Oakland in Alameda County. However while inspecting the site, the trustees found that the water yield was much lower than previous years, making the trustees believe obtaining water would be too difficult. The second choice site was Bushnell's first choice in Napa, in Napa County. However, between the time of Bushnell's survey and the trustee's move to purchase the land, it had been sold to a new owner who refused to sell. The third choice was a site in San Pablo, in Contra Costa County. The owner originally seemed enthusiastic about donating the site, but "found several reasons in the early months of 1857 for not being so generous" (Ferrier 1930, p. 178). Bushnell's original report had concluded that San Pablo was too windy to make a good site anyway, so the climate there was not ideal. The secretary of the board of trustees vacationed in the summer at the San Jose Mission, in Santa Clara County, and recommended a site there that could be obtained at no cost and had running water, but the rest of the trustees did not act on this recommendation. Instead, they turned their attention to a site at Berkeley, about eight miles from the original site in Oakland. By November 1857, the trustees had decided to locate the new college in Berkeley. Thus it appears that local private landowners' unwillingness to part with their property, no doubt tied to conditions in the San Francisco area real estate market, played a key role in locating the college. While the site was selected in 1857, trouble obtaining funding and issues with construction delayed the opening of the College of California until 1866; it provisionally opened in Oakland before moving to its current site in Berkeley in 1873. The school was renamed the University of California in 1868. This account is drawn from Ferrier 1930, p. 157-214.

University of Colorado: The citizens of Boulder had long wanted to obtain the state university, but every time a measure gained momentum in the territorial legislature, enthusiasm was soon lost and the measure was tabled. Finally, in January 1874, a petition was submitted asking for a $30,000 appropriation to locate the university in Boulder. Opponents of the proposal instead insisted that the state would appropriate $15,000 if and only if the citizens of Boulder could raise a matching amount; as this was a large sum of money, the opponents likely thought that this would kill the proposal. David Nichols was the representative for Boulder in the territorial legislature, as well as serving as speaker of the house. As soon as the legislature adjourned after deciding that Boulder must raise $15,000, Nichols left the session in Denver and road on horseback through a rainstorm to Boulder, where he proceeded to wake several prominent townspeople around midnight to secure their donations. He then "stopped only long enough to change his tired horse for another, then began the weary ride back to Denver" (Davis 1965, p. 11). When the legislative session began the next morning, Nichols was present and reported that he had secured the necessary funds.

Representatives from Canon City had also been lobbying hard for the university and had planned to raise money on their own. But because Nichols had secured the funds so quickly, "[t]he Canon City delegates had only promises to offer the legislative body" (Davis 1965, p. 11). This act greatly impressed the legislature, which voted to approve locating the university in Boulder. The bill was signed by the territorial governor on February 6, 1864. The university became Colorado's land grant college in 1876 and the first classes were held in 1877. This account is drawn from Davis 1965, p. 6-21. Davis 1965 reports that "[o]ther towns and communities in the state, however, were as eager as Boulder to be selected as the home of the University," although he does not list these towns. From earlier bills to select a location for the university dating back to 1861, however, there is suggestive evidence that Georgia Gulch in Clear Creek County, Golden and Bradford in Jefferson County, Denver consolidated city and county, Mill City near present-day Fort Collins in Larimer County, McNulty in Eagle County, Pueblo in Pueblo County, and Conejos in Conejos County were all interested.

Florida Agricultural and Mechanical University: In April 1887, the state introduced a bill to create normal schools for white and black students in Florida. Initially, the location of the black normal school was not specified. A member of the Committee of Education, T.V.R. Gibbs, proposed to locate the black normal school in his hometown of Jacksonville in Duval County. This proposal made it out of the Committee of Education, but the full legislature decided against the Jacksonville site, arguing that a seaport city was more susceptible to infectious diseases and that a state normal school should be located closer to the geographic center of the state. Gainesville was first recommended as the most suitable site, although it was already the location of the white normal school. The legislature spent considerable time considering Ocala in Marion County, but it finally selected Tallahassee, in Leon County, as the final site. The school opened its doors in October 1887. This account is drawn from Neyland and Riley 1963, p. 7-10.

Florida Southern College: The college that was to become Florida Southern College began in Orlando in 1883, founded by Florida Methodists. By 1902, the college was located in Sutherland in Pinellas County, following 16-year stint in Leesburg. Unfortunately, the campus was destroyed by a fire in 1921. The college moved to an emergency location at the Clearwater Beach hotel, also in Pinellas County. While the Clearwater Beach site was adequate, the trustees assembled in February 1921 in Jacksonville to select a permanent location. As the previous sites in Southerland and Clearwater Beach were perfectly acceptable to the college prior to the destruction of college buildings in each, I consider them to be low quality controls. The trustees received offers from Lakeland in Polk County, Tampa in Hillsborough County, St. Petersburg in Pinellas County, and Jacksonville in Duval County. Haggard 1985, p. 38 writes that "all...were excellent proposals" that would have made suitable locations for the college. I therefore include them as high quality controls. The trustees preferred the bid from Lakeland, however, which came with the equivalent of a $200,000 endowment. The Lakeland site opened in early October 1922. This account is drawn from Haggard 1985, p. 21-39.

University of Florida: The Florida Agricultural College was established in 1872 in accordance with the Morrill Act. The Republican-dominated administration appointed an eight member Board of Trustees solicited proposals for sites. They finally settled on the small town of Eau Gallie in Brevard County. Multiple buildings were constructed, but before the college was opened, the 1876 election swept Democrats into power who "wanted nothing to do with decisions made earlier" (Proctor and Langley 1986, p. 20). The college plan was scuttled, and in 1883 new offers were accepted, with trustees deciding to locate the agricultural college in Lake City in Columbia County. Offers were also received from Gainesville in Alachua County, Live Oak in Suwannee County, Tallahassee in Leon County, Ocala in Marion County, and Madison in Madison County. Unfortunately, it is unclear how strongly any of these other offers were considered. Additionally, there is the possibility that the Democratic party leaders' complaints about Eau Galle were valid: it was very small and not centrally located compared to these other proposed locations. For this reason, I consider this to be a low quality experiment. The college opened in 1884. However, it would not remain in Lake City for long.

By 1905, Florida had eight public institutions of higher education located in Gainesville, Lake City, DeFuniak Springs in Walton County, Bartow in Polk County, St. Petersburg in Pinellas County, a site in Osceola County, and two in Tallahassee. But there was a great deal of duplication between the different institutions, and demand for a given academic program at each was low. The Florida legislature therefore decided to pass the Buckman Act, which closed all existing institutions of higher education; reorganize the normal school for African Americans and the Institute for the blind, deaf, and dumb; and create the University of Florida and the Florida Female College. A ten member Board of Control was appointed to select the location of the new University of Florida, and the act explicitly stated that the sites of the abolished schools should receive strong consideration. In addition to these sites, the Board toured locations in Fernandina in Nassau County, Live Oak, Ocala, and Jacksonville in Duval County, but it is unclear how strongly each of these was considered. Throughout the process, Gainesville and Lake City were the strongest contenders. In fact, an early version of the Buckman Bill had proposed two branches of the state university, with one each in Gainesville and Lake City (Proctor and Langley 1986, p. 24). When the bids were presented to the state legislature, Gainesville's amounted to $70,000 cash plus land; Lake City's amounted to $60,000 in cash and bonds plus land. After an intense debate, the Board chose Gainesville by a vote of six to four. People in Lake City were "infuriated." No locals were willing to help pack supplies from the now-defunct seminary for the move to Gainesville; workers had to be hired from other towns. And when all of the equipment finally left Lake City, it did so under armed guard (Proctor and Langley 1986, p. 26). After a year of constructing a new Gainesville campus, the University of Florida opened in September 1906. This account is drawn from Proctor and Langley 1986, p. 18-26.

Georgia School of Technology: In October 1885, Georgia passed a law establishing the state technical school and creating a five-person committee to solicit bids from prospective sites and select the school's location. The committee was filled with members from the cities expected to compete most vigorously for the new school, with one member each from Macon, Athens, and Atlanta, and two members from Penfield. When it came time to select the site, Macon had bid $10,000 cash and a $3,000 endowment for 22 years, for a total of $76,000. Athens offered land and buildings on the site of the existing University of Georgia, valued at $163,500 in total. Atlanta bid $50,000 from the city, $20,000 from private citizens, one of three possible sites valued at $10,000, and an endowment of $2,000 for twenty years, for a total value of $120,000. Penfield offered land and buildings formerly used by Mercer University, with an estimated value around $75,000. Millidgeville, which also submitted a bid, offered $10,000 in cash and a number of old state buildings. While the commission took the value of these bids into account, politics among the commission members played a very large role. In October 1886, the commission voted on the site of the school, with three votes being required to win the school. On the first 23 ballots, no site won the requisite three votes. Finally, on the 24th ballot, the representatives from Atlanta and Penfield combined to win the Georgia School of Technology for Atlanta. This account is drawn from McMath Jr. et al. 1985, p. 24-32.

Georgia Southern University: In 1906, Georgia Governor Joseph Terrell used a US Department of Agriculture commission to study the soil quality of each congressional district as justification for proposing legislation establishing a state agricultural and mechanical college in each of the state's 11 congressional districts. On December 1, 1906, the governor and a board of trustees met in Savannah to receive bids from counties to receive the A&M college for Georgia's 1st Congressional District. Representatives from Stillmore in Emanuel County, Statesboro in Bulloch County, and Tattnall County (representing the area between the towns of Claxton and Hagan), presented their bids to the trustees in turn. Expected competition from Burke County never materialized, and so I include it as a low quality control. The bid from Stillmore and Emanuel County was tabulated to be $67,300, including a finished building located at the tallest point in the district. The bid from Statesboro and Bulloch County was valued at $95,500, while the bid from Tattnall County was valued between $95,500 and $100,000. Panicking that their bid was not the highest, the representatives from Bulloch County argued that the Tattnall bid placed too high of a value on water and sewage amenities and that, in light of this, each delegation should have the opportunity to recalculate the value of their bids before final submission. The trustees relented. The representatives from Bulloch County took this opportunity to raise an additional $30,000 from the Bulloch County Commissioners, Satesboro city council, and county board of education, all of whom had accompanied the Bulloch County delegation to Savannah. Tattnall County increased its bid by only $2,500, while the representatives from Emanuel County, confident in the quality of the land and buildings they had promised, re-submitted their original bids. Thus, the final bids came out to $67,300 for Emanuel County, $125,500 for Bulloch County, and $102,500 for Tattnall County. The trustees then adjourned to consider the bids, emphasizing that the value of the bid alone was not enough to secure the college; the trustees would also take into account location and other amenities. When the trustees' deliberations drug out much longer than anticipated, members of each delegation became apprehensive. Finally, after 90 minutes, the board announced that Bulloch County had won the college. To win, a county needed a majority of votes of the 12-member board, but it had been deadlocked with six votes for Bulloch, four votes for Tattnall, and two votes for Emanuel. Governor Terrell was forced to cast the tiebreaking vote for Bulloch County. Classes began in February, 1908. This account draws from Presley 2006, p. 2-24.

University of Idaho: The political situation during Idaho's early years was very contentious. Believing that the northern counties were going to secede from the state and join Washington, in 1887 the Idaho legislature voted to locate the university at Eagle Rock (now known as Idaho Falls) in southern Idaho. The bill to locate the university there passed both houses of Congress, but Governor Edward Stevenson vetoed the bill because it was "carelessly worded" (Petersen 1987, p. 19) and did not provide sufficient details regarding how the university would be funded. When the legislature next met to reconsider the bill in 1888, the political situation in Idaho had changed dramatically. North Idaho was no longer threatening secession from the state, and so northern Idaho was proposed as the site of the university as a political compromise to ensure buy-in from those in the north. While debating the state university in the legislature, the influential state newspaper the *Idaho Daily Statesman* argued for locating the new school in Lewiston "because the scenery there is better" (Gibbs 1962, p. 16), although there is no evidence that this proposal was taken very seriously by the legislature. This account draws from both Petersen 1987, p. 16-20 and Gibbs 1962, p. 11-17.

Eastern Illinois University: 1895 was an eventful year for higher education in Illinois. That year saw the creation of two of the state's regional normal colleges, one in the north and one in the east. The two projects were intimately intertwined: "They played tag through the legislature, with the Northern bill breaking the ice for the Eastern bill. The pattern seemed to be that the Northern bill had to have the support of Eastern people; the Eastern bill was the reward for those who supported the Northern one" (Hayter 1974, p. 23). The representative from Mattoon, in Coles County, had introduced the eastern normal school bill, and the people of his town believed that this effort would be sufficient to ensure that they received the location of the college. But as the eastern normal school bill passed and the legislature turned its attention to selecting a site, it became apparent that this was not the case. While in the process of swapping votes with counties that wanted the northern normal school, other towns in the east had been securing votes for their own location. Charleston, also in Coles County, posed the strongest competition. After a contentious decision, Mattoon narrowly lost to Charleston. Classes began in 1899. This account draws from Hayter 1974, p. 23-30.

Northern Illinois University: In January 1895, a bill to establish a normal school in northern Illinois (along with a sister bill establishing a normal school in the eastern part of the state) was introduced into the Illinois state legislature. Rockford in Winnebago County, Freeport in Stephenson County, Polo and Oregon in Ogle County, Dixon in Lee County, Fulton in Whiteside County, and DeKalb in DeKalb County quickly emerged as the leading contenders. Early on, the representatives of Rockford and Dixon sought to stipulate that the college must be located on either the Fox, Pecatonica, Mississippi, or Rock Rivers, effectively ruling out DeKalb and some of the other contenders. This move was defeated, and the bill was passed in May 1895, stipulating that the governor appoint a five member board to select the site of the college. Three of the members came from towns that were not in the running to receive the normal school. The fourth member was business and "barbed wire millionaire" Isaac Ellwood from DeKalb. The governor wanted the fifth member to be from either Freeport or Rockford, but the two towns could not agree on one candidate, and the governor, offended by their obstinate unwillingness to cooperate, appointed the final member a town not in the running. This failure to compromise gave DeKalb a surprise advantage on the board. After inspecting all of the sites, the commissioners met in Chicago to select the site. They were split between Rockford and DeKalb, with two commissioners favoring each and the last (the final commissioner member appointed) undecided. After much debate, the committee emerged with a unanimous vote for DeKalb. I consider Rockford to be a high quality control and the others to be low quality controls. Classes began in October 1899. This account draws from Hayter 1974, p. 17-46.

Southern Illinois University: In March 1869, the Illinois General Assembly created Southern Illinois Normal University, specifying that it be located in the southern third of the state. A board of five trustees, appointed by the governor, was in charge of selecting the site and overseeing construction of buildings. Eleven communities in southern Illinois submitted bids to receive the new college. Of these, three were taken particularly seriously: the bids from Centralia, located at the borders of Clinton, Jefferson, Marion, and Washington Counties; DuQuoin in Perry County; and Carbondale in Jackson County. The trustees accepted the bid from Carbondale, citing the "good supply of water which the city affords" (quoted in Mitchell 1993, p. 10. There is one problem with this justification, namely that Carbondale did not at the time have sufficient supply of fresh water to support the families that already lived there, much less a sufficient supply for the construction and subsequent operation of a new college. After improvements to the local wells proved inadequate, the lack of water was resolved during construction of the college by damming a local ravine to form an artificial lake. Given these difficulties, it is unclear exactly why the trustees selected Carbondale over the other locations, although Carbondale's bid was slightly higher than its rivals. Even this is suspicious, however; Carbondale's promise of $100,000 factored in the value of donated buildings, but the trustees instead decided to build the college buildings from scratch on a new site. The contract for building construction was then awarded without being subject to competitive bidding. These issues make it difficult to accept the trustees' decision to locate at Carbondale at face value, and suggest that there may have been other, less publicly defensible, reasons for the decision. For this reason, I consider this to be a high quality experiment. The campus was constructed and classes began in July 1874, several years behind schedule and greatly over budget. This account draws from Mitchell 1993, p. 9-10.

University of Illinois: The state of Illinois solicited bids to locate the state agricultural university. By early 1867, the state had received four bids, and it dispatched a special legislative committee to visit each site and ascertain the real cash value of each proposal. The committee appraised the offer from Jacksonville, in Morgan County, as the most valuable at $491,000. Coming in second was the bid from Bloomington in McLean County, valued at $470,000. In third place was the bid from Lincoln in Logan County, valued at $385,000. In a distant fourth was Urbana-Champaign in Champaign County, with a bid valued at only $285,000. While several sources list Chicago as a bidder (see, for example, University of Illinois 1950, p. 8), it never submitted a formal bid, although in earlier years it had lobbied hard for the establishment of an industrial college using land grant money. While it was originally intended to locate the land grant university at the site with the highest bid, the legislative committee made no formal recommendation and instead left the choice to the general assembly. Urbana's representative in the Illinois house, Clark Grigg, began a feverish campaign to convince his colleagues to vote for his town, going so far as to elicit charges of bribery (Solberg 1968, p. 79). Grigg also launched a media campaign claiming that the true value of Urbana's bid was $450,000 rather than $285,000. Grigg's efforts were successful, as the legislature voted to locate the university in Urbana-Champaign in February, 1867. This account draws extensively from Solberg 1968, p. 59-80. See also Turner 1932, p. 63-90.

Western Illinois University: By 1895, Illinois had established normal schools in all parts of the state except for the west. A bill establishing a normal school in the western part of the state was carefully drafted by influential Macomb politician Lawrence Y. Sherman, with the intention of securing the prize for his town. The citizens of Macomb, in McDonough County, pledged $70,000 for the school, confident that they would receive it. They were thus shocked when they observed that rival towns had submitted bids and that they were competitive: Rushville, in Schuyler County, pledged $120,000; Monmouth, in Warren County, pledged $54,000; Quincy, in Adams County, pledged $30,000; and LaHarpe, in Hancock County, pledged $10,000. Although I can find no record of the amount pledged, Aledo in Mercer County was also considered a strong contender. Making matters worse for the people of Macomb, the Board of Trustees was composed of one member from each of the towns that had submitted a bid. When the board began voting on September 1, 1899, each trustee voted for his own town. This continued, through September and October and into November. On November 7, the board voted 112 times without reaching a decision. During the Christmas holiday of 1899, one of the trustees decided to change his vote to one of Aledo, Monmouth, or Rushville when the board met again following its recess. If allowed to proceed, this vote would ensure that Macomb would not receive the normal school. At this point, at least ostensibly unaware that the impasse was almost over and citing the board's inability to reach a decision, the governor abolished the board of trustees and formed a new one. It is unclear what influence Sherman exerted over the governor in reaching this decision. What is clear is that Sherman was very influential in choosing the new members of the board of trustees. He was able to secure the selection of individuals favorable to Macomb. On August 14, 1900, Macomb won on the first ballot. The first students began attending in 1902. In 1957, the college was renamed Western Illinois University. This account draws from Hicken 1970, p. 3-13 and Hancks and Carey 2009, p. 7.

Indiana University: Upon admission to statehood in 1816, the Indiana legislature adopted a constitution that required the state to "provide for a general system of education" (Woodburn 1891, p. 75), which included establishing a state university. After four years, public lands were made available for sale to support this system of education, and the legislature took up establishing a state university. Governor Jennings proposed a bill that would locate the college near Bloomington in Monroe County. Upon getting to the Senate floor, however, amendments were proposed, including one that would relocate the college to Gibson County. So strong was support for Gibson County, and opposition to Monroe, that the vote for the bill was tied in the Senate. Lieutenant Governor Ross cast the tiebreaking vote for Monroe County.

The college opened in 1825. This account draws from Woodburn 1891, p. 74-76 and Banta 1889, p. 3-25.

Purdue University: The Indiana legislature held five sessions over the course of six years to determine where to locate the state land grant college without managing to resolve the issue. The competition was especially fierce between three finalists: the site of Battle Ground College in Lafayette in Tippecanoe County; as an extension to the existing Indiana University, and using the facilities of Northwestern Christian University, in Bloomington in Marion County; and at the state capitol in Indianapolis in Monroe County. In 1867, the town of Greenfield in Hancock County also became a major contender to receive the college. Each of these towns could form a coalition to block one of its rivals from securing enough votes to receive the university. Moreover, the offers of land and money from each county were roughly comparable, making a decision even more difficult. Near the end of the 1869 regular legislative session, Lafayette industrialist John Purdue was convinced to donate to the school "out of his own purse" (Topping 1988, p. 28). Purdue's donation made Lafayette's offer much more appealing, and the legislature voted to locate the land grant college there during a special legislative session in April 1869. The school opened in 1874. This account draws from Topping 1988, p. 21-32.

Iowa State University: In March, 1858, the legislature passed a measure officially founding the Iowa Farmers' College and establishing a board to select the site.

After sending out a prospectus asking for bids for the sale of land, the board received offers from Hardin County, Jefferson County, Marshall County, Polk County, Story County, and Tama County. All were located near the geographic center of the state, although Jefferson County lies farther to the southeast than the others. Because the proposed site in Story County was close to the border with Boone County, citizens from both counties raised funds. I therefore include Boone County as a treatment county in the dataset, although of low quality. Together, the citizens of these two counties raised over $21,355 for the college. In June, 1859, "after considerable balloting, the Story County site was selected" (Ross 1942, p. 26). Unfortunately, no information on the other bids is provided. When debating the acceptance of Morrill Act funds in the early 1860s, several legislators argued that the money should be split between the Farmers' College in Ames and the state university, located in Iowa City in Johnson County. In spite of the support of popular former Governor Kirkland, it is not clear how much of a threat the state college actually posed to the funding status of the Farmers' College, and so I consider it only a low quality control. This account is drawn from Ross 1942, p. 14-44. For an alternative account that describes Boone County's contribution to the Ames site in more detail, see Ross 1958, p. 21-38.

University of Kansas & Kansas State University: Kansas was in a state of turmoil during the 1860s. Or, as Carey 1977, p. 12 put it:

> It has been said, without much exaggeration that of the first two United States senators from Kansas, one, Samuel C. Pomeroy, was a crook and

> the other, James H. Lane, was crazy. The people of the entire region had suffered a confused, bloody period of border warfare and were now caught in the middle of the Civil War. It was no wonder that they would begin to reap a portion of that bitter harvest from the grapes of wrath, the seeds of which had been germinated primarily in the eastern states.

In this environment, the citizens of many Kansas towns vied to win numerous state institutions. In 1861, Topeka, in Shawnee County, and Lawrence, in Douglas County, were in a fierce competition for the state capital. The residents of Manhattan, in Riley County, thought that their town was in ideal position to receive the state university due to the presence of Bluemont Central College, which was financially struggling but had the requisite infrastructure. Carey 1977, p. 12 writes that "Manhattan moved into an excellent position ahead of Emporia and Tecumseh in the race for a university." Other sources suggest that the contest was much closer than Carey 1977 indicated. Howes 1963, p. 12 writes that "the contest for the university between Lawrence and Emporia was very lively and for a time it was doubtful which would win." I therefore include both Emporia, in Lyon County, and Tecumseh in Shawnee County, as high quality controls. Leavenworth, in Leavenworth County, was also in the running for a state institution but seemed willing to accept the state penitentiary from the start and so is also listed as a low quality control. Because of its strong position, residents of Manhattan did not expend many resources on lobbying at the state convention; the proposal to locate the state university in Manhattan passed both houses of the legislature. But the residents of Manhattan were shocked when their proposal was vetoed. The governor, Charles Robinson, was from Lawrence, and he decided that it would be better to postpone the university site selection decision until after the capital had been allocated, to better ensure that Lawrence would receive at least one of the two prizes. The citizens of Manhattan vowed to redouble their efforts. By the time a bill locating the state university in Manhattan was again introduced into the legislature, however, Topeka had already been voted the state capital. After "furious infighting" (Carey 1977, p. 13), and a renewed effort by Emporia as well, the Lawrence delegation gifted $15,000 to the state legislature. The Manhattan measure lost by one vote in the Senate, and the state university was located in Lawrence in 1863. Still reeling from its defeat to obtain the state university, the citizens of Manhattan succeeded in receiving land grant status under the recently passed Morrill Act, making Kansas State University the first institution founded under the conditions of the Morrill Act. This account is drawn from Carey 1977, p. 11-15, Howes 1963, p. 12, and Griffin 1974, p. 10-26.

Kentucky State University: A petition by 14 black teachers for the establishment of a state-supported black normal school passed the Kentucky legislature in May 1886 and was signed into law later that same month. A board of trustees was appointed to select the site, although notably none of the trustees was from Frankfort in Franklin County, the town eventually selected to receive the school. In addition to Frankfort, the trustees were considering sites in Owensboro and Knottsville in Daviess County, Bowling Green in Warren County, Danville in Boyle County, and

Lexington in Fayette County. 1886 turned out to be the year of Franklin's centennial celebration, and the townspeople were extra motivated to acquire some sort of lasting institution in that year. The mayor even donated $1,500 to acquire scenic land that would be used for the university. This excitement and the local donations carried the day, and Franklin was selected as the site later in 1886. This account is drawn from Hardin 1987, p. 1-3 and Kentucky State University 2016.

Louisiana State University: The Seminary of Learning of the State of Louisiana was originally located in Rapides, near Pineville in Rapides Parish. This site burned down in 1869. The seminary moved to Baton Rouge because an existing building, the home of the deaf and dumb asylum, was available; the state made clear that this was a temporary arrangement. In 1870, the seminary renamed Louisiana State University and $20,000 were appropriated to help with the move and renovating the Baton Rouge location. Unfortunately, upon arriving in Baton Rouge, the deaf and dumb asylum refused to give up its building, and the university was not able to construct any new rooms; thus the university's existence in Baton Rouge was extremely tenuous. Many in the legislature wanted to see the school rebuilt in Rapides, however funds were never raised for rebuilding the burned down site. Contingents also argued for Mt. Lebanon in Bienville Parish and Jackson in East Feliciana Parish. As no decision on where to relocate could be made, the university remained in Baton Rouge, gradually acquiring more rooms whenever possible. Louisiana State University merged with the state's agricultural and mechanical college, originally located in New Orleans, in 1877 to become Louisiana's land-grant institution. This account is drawn from Fleming 1936, p. 184-195.

Maine Maritime Academy: As World War II neared, it became apparent that the existing Coast Guard and maritime academies were insufficient to meet the demand for trained seamen. Sensing an opportunity, Ralph A. Leavitt, coming from a long maritime family, sought to establish a new academy at Portland in Cumberland County. Leavitt ran for and won a seat in the Maine legislature and set to work convincing his colleagues of the utility of such a school, and in the summer of 1940 submitted a bill to locate the academy in Portland. He was convinced by former legislator Ray Graves to remove the wording stipulating the academy be located in Portland from the bill; Graves was hoping to instead locate the school at the site of the struggling Eastern Maine Normal School in Castine in Hancock County. With Portland removed from the bill, others took interest in getting the academy for themselves. Bath Iron Works promised $10,000 to the academy if it were to locate in Bath, in Sagadahoc County. The bill passed the Maine legislature on March 21, 1941, and was followed by another bill leasing the building in Castine. The first class began attending in 1941. This account is drawn from Aldrich 1991, p. 13-23, which includes an extended quote from a planned book by Leavitt. The Leavitt quote goes into a great deal of detail regarding the serendipitous encounters and political compromises that went into locating the academy, any one of which, had it not occurred, would have resulted in the academy going to a different location.

University of Maine: Debate to establish a land grant college in Maine had stalled by 1864. Interest was renewed, however, when several farms were offered to the state to be used for the agricultural college. In February 1865, a bill passed the state legislature that resolved that Maine would create a de novo state agricultural college and established a sixteen member board of trustees to select the site, with one member from each county in the state. The trustees were especially concerned about the financial security of the college, and for this reason only strongly considered sites that could deliver a fund of $50,000. Throughout 1866, the trustees visited numerous farms. In September, they met to vote on a location. A farm in Orrington, in Penobscot County, was discarded because only half of the $50,000 had been raised. The farm in Topsham, in Sagadahoc County, was only very narrowly voted down 5-to-6. The trustees met again in November to consider another slate of sites, in particular farms in Orono, Bangor, and Old Town, all in Penobscot County. The proposal from Orono was narrowly accepted by a vote of 8-to-7. The proposal passed with the condition that Orono could produce $14,000 of the fund and a land title within sixty days, a condition that the Orono farm met. The university opened in 1868. This account is drawn from Smith 1979, p. 1-11.

Eastern Michigan University: Just as it was a leader in the establishment of public higher education, Michigan was also one of the earliest states to establish a public normal college for the training of teachers. Initially, the state intended to train its teachers at branches of the University of Michigan. But it quickly became clear that these branches were producing very few individuals who intended to teach in the state's young high schools; moreover, the branches themselves were on shaky footing, with most closing within a few years. In March, 1849, the state legislature passed a bill establishing a single state normal school, at a location to be decided by a State Board of Education, to be appointed by the governor. In early 1950, the Board of Education solicited bids from localities to house the college. Bids were received from Ypsilanti in Washtenaw County, Jackson in Jackson County, Marshall in Calhoun County, Gull Prairie in Kalamazoo County, and Niles in Berrien and Cass Counties. Niles offered land and $5,000. Gull Prairie submitted "[t]he most elaborate paper" (Putnam 1899, p. 13) as well land and $7,364. Marshall offered land valued at $4,000. Jackson promised land, free use of rooms until the school buildings were constructed, and $10,335. Ypsilanti's bid, consisting of land, use of rooms until the school buildings were constructed, $13,500, and a promise to pay the salary of the principal of a model training school for five years, was accepted by the board. While the vote by the board was unanimous, I consider Jackson to be a high quality control as the promised money was very similar in value and the principal's salary was not very large. The college opened its doors in March, 1853. This account draws from Smith and Heaton 1999, p. 13-14, Isbell 1971, p. 1-11, and Putnam 1899, p. 13-15.

Mississippi State University: In 1878, the influence of the state Grange was felt as the Mississippi legislature passed a bill creating two agricultural colleges, one for blacks and one for whites. The black school became Alcorn State University in Lorman. At the time the bill was passed, however, no one had any idea where the white school would be located. Governor John Stone appointed a nine-member board of trustees to review bids from localities across the state and select the best site. The trustees received a large number of bids from all across the state, ranging from the Gulf Coast in the south to Corinth in the north. The trustees decided to locate the college in east-central Mississippi, which contained the state's "Black Belt" of extremely fertile soil, which would be a great boon to the experimental farm. Ballard 2008, p. 6 reports that when the trustees met on December 13, 1878 to decide on the college's location, they had narrowed it down to a small number of Black Belt towns: "Meridian [in Lauderdale County] and Starkville [in Oktibbeha County], with West Point [in Clay County] still having some hope." I therefore include West Point as a low quality control. Unfortunately, I do not have information on the bid amounts of these towns. Ballard 2008, p. 8 writes that, "Reasons for the board's ultimate choice of Starkville remain somewhat vague and elusive, though there is little doubt that Colonel Montgomery played a key role in influencing other board members to bring the school to his hometown. Criticism from other parts of the state was to be expected, and indeed it came, though not in sufficient strength to change the decision." The college opened its doors in 1880. This account draws from Ballard 2008, p. 1-8.

Southern Mississippi University: Following an intense state-wide lobbying campaign, the Mississippi legislature enacted a law allowing for the construction of a state normal school in the spring of 1910. Later that year, two other bills were passed that allowed counties and municipalities to offer inducements to receive the new school. The governor appointed a board of trustees, who decided to solicit bids from localities to receive the school but decided to only accept donations greater than $100,000 plus a building site. Only three towns made offers meeting these minimum requirements: Jackson in Hinds County offered $200,000, Laurel in Jones County offered $230,000, and Hattiesburg in Forrest County offered $250,000. All three also offered land for the site. Two other towns, Meridian in Lauderdale County and Artesia in Lowndes County, were also reported to be interested but did not submit formal bids; I include them as low quality controls. After narrowing down their choice to either Laurel or Hattiesburg and visiting each, the board voted on September 10, 1910. Hattiesburg won with six votes, while Laurel received two and Jackson received one. The first classes arrived in September, 1912. This account draws from Morgan 2010, p. 11-19.

University of Mississippi: The sale of land gave the state of Mississippi a large seminary fund with which to establish a state university, but statesmen doubted whether such a university would be practical given the level of education in Mississippi. Following the crisis of 1837, when the seminary fund was nearly lost in a bank failure, the legislators realized that they needed to place the fund in the hands of university trustees before they lost it completely, igniting a sense of urgency to establish the school. In February, 1840, the legislature submitted nominations for sites from the counties; each county could submit at most one site. A first round of voting eliminated all but seven sites. The eliminated sites, Redbone in Warren County, Bare-foot, Brandywine in Clairborne County, Sweet Water in Lincoln County, Good Springs, and Holly Springs in Marshall, are included in the data as low-quality experiments. The seven finalist sites were Louisville in Winston County, Kosciusko in Attala County, Mississippi City in Harrison County, Brandon in Rankin County, Oxford in Lafayette County, Middleton in Montgomery County, and Monroe Missionary Station in Monroe, Mississippi. A three person committee was then established to investigate each site. The committee reported back to the legislature during an 1841 special session and reported that all seven finalists were acceptable for a university, except for Middleton. Six of the seven finalists were then eliminated through successive rounds of voting. By the sixth ballot, only Oxford and Mississippi City remained. Oxford won by a vote of 58 to 57. The university was officially chartered in 1844, and its first class was held in 1848. A common story, quite possibly apocryphal, is that when Oxford was founded in 1836, resident Thomas Isom suggested the name Oxford with the knowledge that the state would soon be selected the site of its university and the hopes that the name would evoke the center of learning in England. It is, of course, unclear how much this choice of name helped the town in obtaining the university. This account is drawn from Sansing 1999, p. 1-24.

Missouri University of Science and Technology: While the Missouri state legislature eventually decided to locate the state agricultural college with the existing university in Columbia, they resolved to locate a college for mining and metallurgy in the mineral-rich southeastern part of the state. The January 1870 bill that establishing the mining college also established a Board of Curators to solicit bids from towns in the state's mineral district; the college would be located in the town that submitted the highest bid. Subsequent measures to consider locations throughout the state of Missouri were defeated in the legislature. Only two bids were of a "sufficient character" (Roberts 1946, p. 16) to warrant serious consideration from the curators. Iron County submitted a bid of $112,545. Phelps County submitted a bid of $130,545. The curators therefore decided to locate the school at Rolla, in Phelps County, in December 1870. The school, called the Missouri School of Mines and Metallurgy, was opened in November 1871. The account is drawn from Roberts 1946, p. 9-20.

University of Missouri: The Geyer Act of 1839 authorized the establishment of a state university in Missouri, but did not establish its location. Later that same year, a legislator named James Sidney Rollins marshaled a bill through the legislature established a competition between six central Missouri counties, all located along the Missouri River, to receive the university. Commissioners would visit in turn Cole, Cooper, Saline, Howard, Boone, and Callaway Counties. Rollins himself was from Boone County and had a strong personal preference to see the school located in Columbia. While all counties were considered legitimate candidates to receive the college, competition was especially fierce between Boone and Howard Counties. After initial canvassing meetings, citizens of Boone County had pledged roughly $50,000 for the college (Burnes 2014, p. 11). However, on a trip to Fayette in Howard County, Rollins learned that prominent citizens in Howard County had purchased large tracts of land at the market rate of $30 per acre but then had valued it at $80 per acre, artificially inflating the value of Howard County's bid. (I have not found any details regarding how the land was assessed.) Rollins realized that he would have to similarly inflate the value of land in Boone County if his chosen location were to have a higher bid. Rollins thus had to race from Fayette to Columbia on horseback to ensure he got back to Boone County before the site selection commissioners arrived to receive the county's bid. In the end, Howard County's bid was valued at roughly $94,000 while Boone County's was valued at $117,921. The commissioners thus selected Boone County as the site of the university. The first students attended the university in 1842. This account is drawn from Burnes 2014, p. 4-16 and Rees and Walsworth 1989, p. 10-11.

Decades later, when the state of Missouri accepted federal land grant funds in 1870, the state had to decide where to locate the agricultural college. Naturally, the citizens of Columbia wanted to locate the agricultural college within the existing state university. But many other locations also wanted the agricultural college, most prominently citizens in Jackson County and Springfield in Greene County. Both of those locations submitted bids valued at $200,000 to receive the agricultural college. The bid from Columbia was valued at only $90,000. "Much of the credit for the college ultimately being built in Columbia went to Rollins," who had been a U.S. Congressman throughout the 1960s (and in fact had voted for the Morrill Act) and returned to Missouri in time to be elected a state senator for the 1868 and 1870 sessions (Burnes

2014, p. 41). Rollins was able to build a winning coalition for the agricultural college to go to the existing university in Columbia through, among other means, agreeing to divert one fourth of the land grant funds to support a mining college in Rolla. This account is drawn from Burnes 2014, p. 40-42.

University of Nebraska at Kearney: The Nebraska state legislture met in 1903 to establish a normal school in the western part of the state. Numerous towns competed to be selected, including Alliance in Box Butte County, Ainsworth and Long Pine in Brown County, Fairfield in Clay County, Central City in Merrick County, Lexington and Gothenburg in Dawson County, Ord in Valley County, Broken Bow in Custer County, Saint Paul in Hastings County, Holdrege in Phelps County, Aurora in Hamilton County, North Platte in Lincoln County, and Kearney in Buffalo County. In September, the state Board of Education voted for the site of the normal school. "After 111 ballots the board awarded the new school to Kearney, citing its central location, railway accessibility, density of population, and offer of Green Terrace apartments for use as a dormitory. Kearney received four votes, Broken Bow two, and Ord one" (Bloomfield, Schuessler, and Reed 2005, p. 6). From this description, it is unclear whether it took 111 rounds of voting to establish Kearney as the winner or whether 111 total votes were cast and these three towns received the most votes (although it is unclear how Ord with one vote could have more than any other towns). In either case, it appears that the decision was quite contentious, so I include Broken Bow and Ord as high quality controls. Kearney's bid was valued at

$90,000 and consisted of 23 acres of land, a source of water, and buildings. After the vote, many in the losing sites argued that Kearney did not submit the strongest bid, suggesting that politics may have played a role as well. The college opened in the summer of 1905. This account is drawn from Bloomfield, Schuessler, and Reed 2005, p. 5-8.

University of Nevada: The original university was located in Elko, in Elko County. However there was widespread dissatisfaction with this site, as it was too remote from the vast majority of the state's population. In 1885, a bill was proposed in the state legislature to move the university from Elko to the state's capital in Carson City. The bill failed by one vote. On the last day of the legislature, the bill was raised again, but the site was changed to Reno, in Washoe County, and more details were included regarding compensating Elko. This bill passed, and the University of Nevada moved to its current location in Reno. This account draws from Doten 1924, p. 36.

University of New Hampshire: New Hampshire's land-grant university was originally part of Dartmouth University in Hanover, in Grafton County. However many people were dissatisfied with the arrangement, arguing that the agricultural program was not getting enough attention. In 1887, a committee was formed to explore options for moving the land-grant university to a new location. At that time, Charles Tilton offered his farm and $40,000 if the state located the school in Tilton. While the committee concluded in 1889 that the land-grant university should stay in Hanover, many individuals, including the state master of the Grange, William Stinson, advocated for the state to accept the Tilton gift. While still debating whether or not to move to Tilton, Benjamin Thompson of Durham, NH died and left his estate to the state on the condition that it be used for the state agricultural college. The full estate was valued at almost $400,000, of which $19,500 was available in the first year to cover moving expenses. Thompson's will was challenged by his heirs, but the case was dropped before it reached the state Supreme Court. In 1891, the state accepted Thompson's will, locating the University of New Hampshire in Durham and discarding the Tilton proposal. Because there was considerable debate about whether or not the land grant college should remain with Dartmouth in Hanover, I also include Grafton County as a low quality control. This information is drawn from University of New Hampshire 1941, p. 76-96. Johnson 1956, p. 8-14 provides more details on the debate about whether to sever ties with Dartmouth College.

Rutgers University: Queens College was founded as a theological seminary by New Jersey's early Dutch settlers. The charter for the college was issued in 1766 (although this charter has since been lost, and a nearly identical charter was granted in 1770) by the Amsterdam Classis. The location for the seminary, however, had yet to be decided. Two locations were the clear front-runners: Hackensack in Bergen County and New Brunswick in Middelsex County. Hoping to acquire the church-chartered college, each town established an academy. After much fruitless deliberating, the church decided to place the seminary at the town making the largest financial contribution. New Brunswick's bid was the highest, and Queens College opened in that town in 1771. While the amounts of the bids are not known, both towns had already invested sufficient funds to establish academies to try to attract the college, so I therefore consider this to be a high quality experiment. The college changed its name to Rutgers University in 1824 and became New Jersey's land grant college in 1864. This account draws from Burr 1942, p. 19-22.

The College of New Jersey: In the mid 1850s, civic leaders in the state of New Jersey agitated for a public normal school in their state. A bill establishing such a school was passed in January 1855, with the opening date of the school set to October 15 of the same year. The board of trustees put out newspaper advertisements soliciting bids. New Brunswick, in Middlesex County, offered land valued at $2,000, $8,000 in cash for the construction of buildings, and lecturers from Rutgers College. Orange, in Essex County, offered to construct buildings at no charge to the state and also provide lecturers from nearby Princeton or Pennington. Beverly, in Burlington County, offered a brand new building to hold classes as well as a building to be used as the home of the president. Trenton, in Mercer County, offered land and $14,000 for constructing buildings. Other localities also submitted bids, but these four were most closely considered. In a meeting on July 17 in Princeton, the board of trustees decided to locate the school in Trenton. The school was originally called the State Normal School of New Jersey, eventually changing its name to Trenton State College in 1958 and finally to the College of New Jersey in 1996. This account draws from

Jarrold and Fromm 1955, p. 9-10.

New Mexico State University, University of New Mexico, & New Mexico Tech: When it became apparent that New Mexico would achieve statehood in the late 1880s, citizens in many areas were excited to receive state higher educational institutions, especially since it was known that the state could take advantage of land grant funds. It was widely believed that the state educational institutions would be located in the southern part of the state, since the northern part of the state had already acquired the state penitentiary. On the first day of the legislative session in 1888, Albuquerque in Bernalillo County, Socorro in Socorro County, and Las Vegas in San Miguel County all submitted bills to receive the state agricultural college. Las Cruces in Dona Ana County, which was the site of the new Las Cruces College, submitted its own proposal soon after. What followed was "more than a month of logrolling" (Kropp 1972, p. 12). When the dust settled, the Rodney Act of 1889 established the outline of New Mexico's higher education: Las Cruces received the land grant college; Albuquerque received the state university; Socorro received the mining college, now commonly known as New Mexico Tech; and Las Vegas received the state insane asylum. This account is drawn from Kropp 1972, p. 6-12.

Cornell University: In 1864, New York decided to designate People's College, located in Havana (present-day Montour Falls) in Schuyler County, as the state's land grant college following a campaign by state senator and People's College sponsor Charles Cook. Shortly after, however, Cook had a stroke and was unable to receive the state land grant funds, forcing the legislature to select a new location. State senator Ezra Cornell had long lobbied for Ovid Agricultural College, in Ovid in Seneca County, to receive some of the land grant funds. Fellow state senator Andrew White disliked the Ovid site. The two men were willing to contribute their own private fortunes towards a new university if it would secure state land grant status. The two senators agreed to find a compromise location. White lobbied for Syracuse in Onondaga County, where he had built a successful banking business. But "Cornell did not have fond memories of that city, where as a young man he had been robbed not once but twice" (Kammen 2003, p. 13), and he refused to locate the school there. The two thus settled on Cornell's home town of Ithaca in Tompkins County. Before the pair could present their proposal, the New York legislature decided to give People's College additional time to make arrangements to secure the land grant. At this same time, in 1865, a well-known advocate of compassionate care for the insane, Dr. Sylvester Willard, came to Albany to give a speech. Fortunately, for Ithaca, but unfortunately for Dr. Willard, he died mid-speech. White and Cornell argued that an insane asylum should be established in Seneca County as a memorial to Willard. Satisfied with the asylum, the representatives from Seneca County agreed to support Cornell and White's proposal to locate the land grant university in Ithaca. Finally, in April 1865, the legislature voted to establish Cornell University as the state land grant college. The first classes were held in 1868. Syracuse, meanwhile, would have to wait until 1870 to receive its own university. This account draws from Kammen

2003, p. 3-19 and Bishop 1962, p. 50-68.

East Carolina University: For more than a decade, citizens of eastern North Carolina had been agitating for a normal school, but they were constantly rebuffed by opponents in the north and west of the state. Finally, in 1907, a compromise was reached in which legislators from the east would support establishment of new high schools in the west in exchange for chartering the East Carolina Teachers Training School (the school was so-called so that its proponents could argue that it served a slightly different function from the North Carolina State Normal School, although this difference was purely semantic). Prominent citizens in a large number of eastern communities sprang into action to ensure that their county received the new school, most notably the people of Greenville in Pitt County. In order to most impress the board by Greenville's seriousness and resources, former North Carolina governor and Greenville resident Thomas Jarvis was adamant that the city and county hold a bond issue to raise $100,000 before the board met to determine the site of the college. So desperate were the school's supporters that one local businessman literally ate the ballots of those voting against the bond issue (Bratton 1986, p. 52). When the Board of Education met in Raleigh on June 5, 1907, Greenville and Pitt County had offered $100,000, less the cost of land for the school site. The only other delegation that had already conducted a bond issue was Kinston in Lenoir County, which had raised $25,000; Kinston also promised free electricity for ten years, land, and a building. Washington in Beaufort County promised $75,000 and land. Elizabeth City in Pasquotank County promised $62,500 and land. Tarboro in Edgecombe County pledged $30,000 and free utilities for ten years, and both New Bern in Craven County and Rocky Mount in Edgecombe and Nash Counties offered $25,000 and land. Because of the generosity of so many of the offers, the board decided to visit prospective sites in person before deciding. After this trip, the board further delayed a decision while allowing the communities to increase their submitted bids. The competition was seen to be between Greenville, Kinston, and Washington, with each county libeling the amenities of its rivals in local newspapers. Washington took this opportunity to increase its bid to $95,000. Finally, on July 10, 1907, after a final round of arguments, the board voted on the school location. Greenville received one vote, while Rocky Mount surprisingly received two votes and Kinston the remaining three votes. Because no site had received a majority, a second round of voting commenced; in this round, each site received two votes. Finally, on the third round, the two delegates voting for Rocky Mount switched their votes to Greenville. I consider Kinston, Washington, and Rocky Mount to be high quality controls. Construction began in 1908 and the school opened in October 1909. This account draws from Bratton 1986, p. 11-89.

North Carolina Agricultural and Technical College: While there had been several unsuccessful attempts to establish a college for blacks in North Carolina, such a college was not established until 1890. North Carolina's education was biracial, and to receive land grant funds under the 1890 Morrill Act, a public college for blacks had to be established. Not waiting for the legislature to act, North Carolina's land grant college, North Carolina A&M (present day NC State), began an annex for black students associated with the land grant college in Raleigh. It was quickly apparent that this would not be a permanent situation, and in 1891 the North Carolina legislature passed a law establishing an independent black college and establishing a board of trustees to select the college site. The trustees began soliciting bids for the college location in June 1891 and met to compare bids and select the site in Match 1892. The trustees received bids from Greensboro in Guilford County, Durham in Durham County, Mebane in Alamance County, Wilmington in New Haven County, Winston in Forsyth County, and the current site of Raleigh in Wake County. Notably, most of these sites had existing colleges that could provide resources for the black land grant college. The trustees decided that Greensboro's bid of $11,000 was the best. The monetary values and other considerations of other bids are not recorded. This account draws from Gibbs 1966, p. 1-7.

North Carolina State University: In the decades after the Civil War, several prominent North Carolina citizens wanted the state to create an industrial college. Administrators of the University of North Carolina were strongly opposed, however, fearing (correctly, as it turns out) that a new industrial college would usurp the established university's status as primary recipient of the state's land grant fund. Realizing that no proposal for a new college was likely to pass in the legislature, comprised largely of farmers, unless the college also taught agriculture, the progressive Watauga

Club introduced a measure to establish an industrial and agricultural college. In 1885, the bill passed in the legislature and a newly established Commission of Agriculture accepted bids for new sites. Almost immediately, Charlotte in Mecklenburg County submitted a bid for $5,000, Kinston in Kinston County submitted a bid of $10,000, and Raleigh in Wake County submitted a bid of $8,000. All three bids were rejected, and the prevailing opinion is that this is because the University of North Carolina dominated the Commission. The Watauga Club then exerted "considerable pressure" (Reagan 1987, p. 15) on the Commission, which finally accepted Raleigh's bid in July 1886. Throughout 1886 and early 1887, other farmers movements in the state become increasingly discontented with the teaching of agriculture at the University of North Carolina. In January 1887, the legislature voted that the state's land scrip should fund the new industrial and agricultural college, making North Carolina College of Agriculture and Mechanic Arts the state's land grant institution. In 1918, its name was changed to the North Carolina State College of Agriculture and Engineering, and in 1965 it was finally changed to North Carolina State University at Raleigh. This account is drawn from Reagan 1987, p. 13-20.

University of North Dakota & North Dakota State University: The Dakota Territory had voted to locate the state university in Vermillion, located in what is today South Dakota, during its first session in 1862. In fact, all of the state institutions had gone to sites in the south, a fact that angered many citizens living in the northern half of the territory. In 1882, Territorial Governor Nehemiah G. Ordway spearheaded a movement to relocate the territorial capital to the north and he was "determined to distribute the other institutions in whatever way was necessary to achieve that end" (Geiger 1958, p. 15). In order to secure the support of all the northern towns, which was necessary in order to ensure that the capital relocation vote would win in spite of strong opposition from the south, Ordway promised state institutions to many prominent northern towns, including Grand Forks in Grand Forks County, Jamestown in Stutsman County, Fargo in Cass County, and Bismarck in Burleigh County. Some northern representatives were unhappy with their promised institutions, however, and collaborated with the southern towns, introducing legislation that would appropriate money for institutions in the south. In order to preserve the northern coalition and ensure that all northern towns felt they were being treated fairly, Grand Forks representative George Walsh gathered the representatives from the four largest northern towns and had them draw lots for each institution. The state university went to Grand Forks, the agricultural college to Fargo, the insane asylum to Jamestown, and the penitentiary (and later the capital) to Bismarck. Still nervous that the south might overturn this decision, Walsh filled the legislative hopper with blank sheets of paper with the words "A bill for an Act Locating the University of North Dakota at Grand Forks, N. D., and Providing for the Government thereto" (Geiger 1958, p. 19), ensuring that such legislation would be considered by the legislature before the end of the legislative session. In an act of questionable legality (Geiger 1958, p. 21 calls it a "peculiar political method"), Walsh then wrote up the contents of the bill after it had already been added to the legislative schedule. The bill made it out of committee without further modification, and quickly passed both chambers and was signed into law in February 1883. Measures to fund the other state institutions, including the North Dakota agricultural college and the state university and agricultural college in South Dakota, passed around the same time. The first classes began in 1884. This account draws from Geiger 1958, p. 13-27.

Kent State University: By 1909, the state of Ohio had three normal school departments, but all were located at larger existing universities (Miami University, Ohio University, and Ohio State University), and all were located in the southern half of the state. Following a report by the new state commissioner of education that documented a shortage of 58,000 teachers, with most in the northern part of the state, the legislature approved a normal school bill, and it was signed into law on May 19, 1910. This law established two normal schools, one in the northeast and one in the northwest of the state. The new normal school could not be located in a county that already had a college. Beyond that, the winning town must meet a number of requirements, including a sufficient number of nearby children to support a model training school. A large number of communities qualified, and roughly twenty locations applied to receive the northeastern school: Ashtabula and Geneva in Ashtabula County; Canton and Massillon in Stark County; Chagrin Falls in Cayuhoga County; Columbiana and Salem in Columbiana and Mahoning Counties; East Liverpool in Columbiana County; Hudson in Summit County; Lorain in Lorain County; Medina, Seville, and Wadsworth in Medina County; Ulrichsville in Tuscarawas County; Warren and Hubbard in Trumbull County; Youngstown and Poland in Mahoning County; and Kent and Ravenna in Portage County. A five member commission quickly began touring the sites, with an ambitious visitation schedule. Wadsworth, Kent, and Ravenna were all scheduled to be visited in the same day, September 27, 1910. The visit in Kent got off to an inauspicious start: the citizens of Kent expected the commissioners to arrive by car, and so no one was at the rail station to greet the commissioners when they arrived. To make matters worse, a dense fog lay over the town on that day, completely obscuring the proposed college site's scenic view of the Cayuhoga River. It appeared that the commissioners were anxious to leave Kent and get on to Ravenna, and Kent's chances of receiving the college appeared to be all but zero. At that moment, the commissioners were convinced to stop by the home of Frank Merrill for a "quick" meal. Fried bluegill were served. By all accounts the fish was delicious, and while it can never be known what role the bluegills played in swaying the commission's eventual decision, the citizens of both Kent and Ravenna blamed the fish. Or, as Hildebrand 2009, p. 9 put it, "the fastest way to a normal school is not a straight line but a fish fry." In early November, 1910, the commission made surprise second visits to four sites: Wadworth, Kent, Ravenna, and Warren. Although the commission kept all of its deliberations completely confidential, there can be little doubt that these were the four finalist sites. I therefore consider them to be high quality controls; the other non-finalist sites are included as low quality controls. Following a final round of hearings, the commission announced that the normal school would be located in Kent on November 25, 1910. The college opened its doors in fall 1912. This account draws from Shriver 1960, p. 3-24 and Hildebrand 2009, p. 5-11.

Miami University of Ohio: The initial proposal for Miami University occurred only a month after the adoption of the Northwest Ordinance in 1787. John Cleves Symmes proposed to purchase lands between the Big and Little Miami Rivers and bordering on the Ohio River, with the intent of constructing a college. But as time wore on, "Symmes's business affairs became hopelessly confused" (Knight and Commons 1891, p. 30) and the contract could not be executed as originally specified. When the university was chartered by the state legislature in 1809, it was therefore located just outside of, but contiguous to, Symmes's original purchase. The original purchase constitutes Hamilton County, while the university was actually located in the town of Oxford in Butler County. Because the move to Butler County was caused by unanticipated difficulties executing Symmes's purchase, I consider this a high quality experiment. The college opened in 1824. This account draws from Knight and Commons 1891, p. 30-31.

Oregon State University: The Oregon legislature took up the task of establishing its land grant college in 1868, just before the initial conditions of the Morrill Act were set to expire. The initial bill located the college in Salem in Marion County at the site of the existing Willamette University. The bill was delayed in the state senate due to concerns about how the college land grant decision would affect land grants to the state's two major railroads. During this delay, a representative of Corvallis in Benton County substituted the words "Corvallis College" for "Willamette University" in the text of the proposed bill. The modified bill passed eventually in October 1868, making Corvallis College the state's land grant college. Moore, McCornack, and McCready 1949, p. 133 report that several decisions regarding the location of other state institutions were also made that same year. Salem had previously been designated the state capital, but the capital had already moved several times in Oregon's history, so it is unclear if the legislative session in 1868 solidified Salem's position. In addition, the state penitentiary was allocated to Portland in Multnomah County. As there are no details regarding how the prison location decision, I record Portland as a low quality control. In 1870, after formalizing the land grant, the legislature voted to make permanent their decision to locate the state agricultural college in Corvallis. Since the college was built on the site of the existing Corvallis College, classes could begin immediately, with the first class graduating in 1872. This account draws from Landis 2015, p. 23-25.

University of Oregon: In 1850, the Donation Land Act granted the state of Oregon land to be sold for the purpose of establishing a state university. "[T]he whole matter promptly became a political football...then nothing happened until 1857 when it once more became a very live issue before the people of Oregon" (Moore, McCornack, and McCready 1949, p. 132-133). When it became apparent that the Oregon legislature would take up the issue of locating the state university, Monmouth in Polk County, home of Christian College, quickly became the leading contender. In fact, all of the towns jockeying to receive the state university were the home to an existing denominational college. The exception was Eugene in Lane County. Eugene was the home of its own denominational college, Columbia College, until it was destroyed by fire in 1859 and never rebuilt. Fearing that their bid would not be taken seriously without an existing college, the citizens of Eugene created the Union University Association and selected sites for future college buildings. When the Eugene delegation submitted its bid to the state legislature in September 1872, they promised the state the land and buildings of Union University, which were valued at $50,000 and promised to be open by January 1, 1874. As an additional incentive to the state, this proposed new university was nondenominational. When the legislature met to consider bids, the leading contenders were Union University at Lane, Christian College at Monmouth, Albany College at Albany in Linn County, and Pacific University at Forest Grove in Washington County. Willamette University at Salem in Marion County also submitted a bid, but it "was not formidable" (Sheldon 1940, p. 20). The bids of of Eugene and Albany were nearly identical. The representatives of Eugene were able to form a winning coalition, however. The college opened its doors in 1876. This account draws from Sheldon 1940, p. 24-44 and Moore, McCornack, and McCready 1949, p. 132-196.

Pennsylvania State University: The institution that would eventually become Penn State University was chartered as the Farmers' High School of Pennsylvania in February, 1855. A thirteen member Board of Trustees was appointed and in June set to work selecting a site for the school. They received offers of 200 acres each from

Centre County, Erie County, and Blair County, as well as offers for 2000 acres in Perry County and 600 acres in Allegheny County. After touring the sites, the board decided in July to postpone any site selection decision to ensure they did not "neglect to advertise it sufficiently hitherto" (Dunaway 1946, p. 12). This provided time for advocates from all of the sites that had previously submitted bids to sweeten their offers, as well as allowing new sites to enter into contention, namely a promise of \$10,000 for a site in Dauphin County. When the board reassembled in September, they considered four proposals: the 200 acres promised in Franklin County, 200 acres in Huntingdon County (with an optional additional 200 acres), \$10,000 and 400 acres in Blair County, and \$10,000 and the 200 acres in Centre County. It is unclear why the other previously-received proposals were not considered at this meeting. The board voted on each in turn, but ultimately selected the Centre County proposal. As the monetary contribution and acreage is very similar, I consider the Blair County site to be a high quality control; I include all the other proposals as low quality controls. While there were several supporters of the Centre County location, the decision seemed puzzling to many. As Dunaway 1946, p. 14-15 writes:

> The selection of Centre County for the location of The Farmers' high School was due to the enterprise and influence of its prominent citizens...to its central position; to the liberal offers of land and money; perhaps even to the natural beauty of the landscape. nevertheless, the location, by reason of its inaccessibility and of the lack of water on the farm on which its buildings were to be erected, was long the occasion of criticism by the

> foes of the institution, and even of doubts on the part of its friends. It was distant from any city, and there was no railroad in the vicinity; yet, according to Judge Watts, it possessed "the most essential advantages of soil, surface, exposure, healthfulness, and centrality." Although located in almost the exact geographical center of the State, it was, as President Sparks is credited with saying, "equally inaccessible from all parts of it." But its very isolation was thought by some to be desirable as removing the students from the distractions and temptations incident to city life. After all, in the minds of its founders, it was to be a school designed chiefly for farmers' sons; hence the logical place for it was well out in the country "far from the maddening crowd."

At any rate, it is clear that the Centre County location was not a clear favorite relative to the other sites that promised nearly equal amounts of land and funding. The school opened in February, 1859. This account draws from Dunaway 1946, p. 1-25.

After the passage of the Morrill Act in 1862, the Farmer's High School changed its name to the Agricultural College of Pennsylvania to better reflect its mission of higher education. The school's proponents thought it was the only school in the state suitable to satisfy the conditions of the Morrill Act, and the Pennsylvania Land Grant Act was introduced into the legislature designating it as the sole recipient of state land grant funds. But the Land Grant Act failed in the state legislature, primarily because many legislators wanted to see the land grant funds distributed among many state institutions. Throughout the following two sessions of Congress, the legislature received petitions from several individual colleges to receive all or part of the state's land grant funding. Finally, in 1865, two bills were introduced into the House of Representatives. The first bill would have split the state land grant among six existing colleges: the University of Lewisburg, now Bucknell University, in Lewisburg, Union County; Allegheny College in Meadville, Crawford County; Pennsylvania College, now Gettysburg College, in Gettysburg, Adams County; Western University, now the University of Pittsburgh, in Pittsburgh, Allegheny County; Polytechnic of the State of Pennsylvania in Philadelphia, Philadelphia County; and the Agricultural College of Pennsylvania in Happy Valley. These six schools thus appear to be the best succinct list of finalist sites. However, this first bill was never seriously considered by the legislature, and so I list these finalists as low quality counties. The second bill allowed the state to sell the land grant scrip, give one third of the proceeds to the Agricultural College, and deposit the rest into the state treasury until further notice. The bill served its intended purpose of pacifying both supporters of the Agricultural College as well as other institutions, and it was passed into law in 1865. However, now that the Agricultural College's share was officially codified in law, opposition from other colleges died out over time and the Agricultural College received the full land grant. The Agricultural College changed its name to Pennsylvania State University in 1874. This account draws from Moran and Williams 2013, p. 105-118.

Brown University: In the 1760s, Baptist leaders in American wanted to establish a college of their own. While a congregation met in Philadelphia in 1762 to initially propose an idea for a college, they ultimately decided to locate the school in Rhode Island, where Baptists made up a sizable portion of the state legislature. James Manning was sent to Rhode Island in 1763 to gauge support for the college. A charter was drafted, splitting authority between the Baptists and other Protestant denominations. At the last minute, the Baptists decided they wanted to retain more control over the governance of the college, delaying the passage of the college charter until 1764. There remained the problem of where to locate the college. James Manning was the unanimous choice to become president of the new college, but Manning needed to secure a position as a Baptist minister to pay his salary, and there were no ministerial openings in Newport in Newport County or Providence in Providence County, so Manning went to Warren in Bristol County. This became the first site of the college. The first student attended in 1765.

By 1769, the college had outgrown Warren. Movements quickly sprang up across Rhode Island to relocate the college and also obtain a royal charter. In 1769, it was decided that the college should instead go to the county that raised the largest subscription. Four of Rhode Island's five counties jumped into the contest. While East Greenwhich in Kent County, Newport in Newport County, and Providence in Providence County were all under serious consideration, in November 1769 the trustees met and decided to locate the college at Bristol in Bristol County. However, the trustees also decided that no additional funds should be raised for the college until the next year, giving the other counties time to increase their bids; it appears that the trustees were hoping to locate the college in one of the state's two largest cities, either Newport and Providence. An astronomical event would help to decide between the two The second half of the 18th century was a fertile time for the new science of astronomy. Before his death in 1742, Edmund Halley had predicted that Venus would cross the face of the sun in 1769. Amateur astronomers across the world, including those in both Newport and Providence, broke out their telescopes to witness this event, test the accuracy of Halley's prediction, and use the measurements to calculate the size of the sun. Each city hoped that successfully viewing Venus would be proof of its intellectual prowess in the eyes of the college's trustees. The team from Providence, supported by the Brown family of industrialists, succeeded in witnessing the transit of Venus; the Newport effort "suffered a few miscalculations" Widmer 2015, p. 51 and failed. This success gave Providence a great deal of credibility in the eyes of the trustees, in spite of the fact that Newport was the larger city in terms of population and commercial development (although, in as much as measurement was possible in the 18th century, Providence was growing quickly in the years before the contest). The trustees and delegations from the various sites met in Wareen in February, 1770 to decide on the site of the college. Widmer 2015, p. 52 writes that: "The amounts raised by Newport and Providence were similar - but also hard to measure, for each side was indulging in creative math, counting pledges and hints of pledges to come." Finally, the trustees voted, and Providence won by a vote of 21-14. The leaders of Newport then attempted to charter a college of their own, a measure that was "favorably received in the house, but indefinitely postponed by the Senate" (Tolman

1894, p. 100), likely blocked by the Baptist members of the legislature. I consider Newport to be a high quality control and the other counties to be low quality controls. Although the new college buildings were not yet built, classes began in Providence in the spring of 1770. This account draws from Tolman 1894, p. 93-100 and Widmer 2015, p. 35-54.

Clemson University: The Clemson estate at Fort Hill in Pickens County, South Carolina, had been home to the famous statesman John C. Calhoun before passing to Thomas Green Clemson through marriage to Calhoun's daughter. In his will, last updated in 1886, Clemson donated his estate to South Carolina on the condition that it become the state's land grant college; if the will were not accepted within seven years after Clemson's death, a board of trustees was to establish a private college instead. Clemson passed away in April 1888, and the contents of the will were the focus of public debate. Many in the state wanted the land grant college to go to one of the existing public universities in the state, especially the University of South Carolina at Columbia in Richland County. Prominent politician, future governor, and Clemson supporter Benjamin Ryan Tillman argued strongly that the University of South Carolina had historically catered to elite families, and a new institution was needed to train common men in agricultural. In the 1888 election, a large number of Tillman supporters, known as "Tillmanites," won election in the state House, but Tillman's influence was much smaller in the state Senate. In December 1888, the state legislature took up voting on whether to accept Clemson's will. The House voted to adopt the will on the third reading by a vote of 67 to 48 and following several attempts to kill the bill or delay passage. The Senate likewise voted to adopt the will on the third reading, but by the narrow margin of 17 to 15. This followed a movement to delay consideration of the will, which was tied 16-16, with the tie being broken by the lieutenant governor. The bill was not signed into law by the governor until November 1889. Because of the closeness of this vote, particularly in the Senate, I consider this to be a high quality experiment. The college first opened in July 1893. This account draws from Reel 2011, p. 33-64.

University of South Dakota: The first legislative session in Dakota Territory met in March 1862 in Yankton. One item of business was to allocate territorial institutions. Three communities were in contention to become the state capital: Yankton in Yankton County, Bon Homme in Bon Homme County, and Vermillion in Clay County, with Yankton and Vermillion being the two frontrunners. As Schell 1975, p. 95, "[b]ecause of the smallness of the legislative body, it readily lent itself to manipulation, and Yankton was not slow in arranging a deal to assure itself of the prize." But a personal disagreement between the speaker of the legislature George M. Pinney, from Bon Homme, and the Yankton delegates scuttled the arrangement. Pinney attempted to have Bon Homme substituted for Yankton in the proposed capital bill and, when that failed, succeeded in securing the capital for Vermillion over Yankton by a vote of seven to six in the house, although the measure failed in the upper chamber. The relationship between Pinney and the Yankton representatives became so heated that Governor Jayne sent a detachment of troops to the legislature to maintain order, which only succeeded in further stirring up feelings of resentment. The house adjourned, with Pinney resigning the next day (Schell 1975, p. 95). The break allowed the legislators to cool off, and more bargaining took place behind the scenes. Eventually, the legislators agreed to locate the capital at Yankton, the territorial prison in Bon Homme, and the state university in Vermillion. While the university was officially established in 1862, buildings were not constructed and classes did not begin until 1882, a full twenty years later. This account draws from Hoagland 1989, p. 3 and Schell 1975, p. 94-97. The discussion of the early years of the University of South Dakota following its official founding is found in Knutson 1989, p. 13-15.

Middle Tennessee State University: In 1909, the Tennessee legislature passed the General Education Bill which, among other things, provided for establishing a normal school in the western, middle, and eastern parts of the state. Three members of the state Board of Education were tapped to form a site selection committee. The committee solicited bids from all across the state and then proceeded to visit sites. The decision of where to locate the Middle Tennessee Normal School was particularly contentious, with the largest number of bids and the longest deliberations. In all, the committee visited sites in Columbia in Maury County, Cookeville in Putnam County, Clarksville in Montgomery County, Fayetteville in Lincoln County, Monterey in Putnam County, Murfreesboro in Rutherford County, Shelbyville in Bedford County, Tullahoma in Coffee and Franklin Counties, and Winchester in Franklin Counties.

While the committee made its last site visit on October 14, it put off meeting to decide a location until November 29. Throughout that time, the Nashville American newspaper frequently reported that Clarksville had submitted the most appealing bid and was all but certain to win the normal school. Reports from the meetings suggested that the board had a very hard time deciding between the Clarksville and Murfreesboro bids. The sites for the eastern and western normal schools were decided on within a day; deciding between Clarksville and Murfreesboro delayed the formal announcement until December 1. The board took the very unusual decision of announcing that, while it had decided to locate the normal school in Murfreesboro, "[t]his bid by Murfreesboro and Rutherford County is about equal to that of Clarksville and Montgomery County and is greater than that of any other County or municipality bidding for the Normal in Middle Tennessee" (Leone and Lodl 2011, p. 14). In fact, the Clarksville bid been slightly higher: Murfreesboro had offered $180,000 and a free site, while Clarksville had bid $185,000 and a free site. For this reason, I consider Clarksville to be a high quality control. The other counties that submitted bids are considered low quality controls. The normal school opened in September 1911; in 1925 it became a four-year teachers' college and in 1965 it became Middle Tennessee State University. This account is drawn from Leone and Lodl 2011, p. 7-17.

University of Tennessee: In 1806, the U.S. Congress agreed to relinquish the title to all land in the territory of Tennessee. In exchange, the territorial government had to accept a number of stipulations, including setting aside land to fund two public colleges, one in East and one in Middle Tennessee. The college in Middle Tennessee was located in Nashville with little drama. Deciding on a site for the East Tennessee College was more involved. The trustees of Blount College in Knoxville in Knox County, Greeneville College in Somerville in Fayette County, and Washington College in Limestone in Washington County all submitted bids. The citizens of Blount and Hawkins Counties also submitted bids. In October 1807, the legislature voted to locate East Tennessee College in Knoxville. This is likely due to the fact that Knoxville was located close to the middle of East Tennessee and was at the time the capital of the state, and because the governor sat on the board of Blount College and was a persuasive supporter of the institution. For this reason, I consider this to be a low quality experiment. This account is drawn from Montgomery, Folmsbee, and Greene 1984, p. 15-18.

In 1867, the Morrill Land Grant Act was extended to allow southern states to take advantage. This extension was particularly aimed at the state of Tennessee, which had been quick to ratify the fourteenth amendment. About a year later, the state legislature voted to take advantage of the land grant funds and establish a state agricultural college. It was a near-certainty that the land grant college would be located in the eastern part of the state, as this part of the state was home to the Radical Republicans that controlled the state legislature and executive. It was unclear which East Tennessee town would receive the land grant, however. The leading contender was Union University at Murfreesboro in Rutherford County, which promised 120 acres of land as well as use of the university buildings. (Union University was so called not because the Radical Republicans in that part of the state supported the Union during the Civil War, but rather because the college had been founded as a union between the Tennessee and Alabama Baptist denominations (Pittard 1973, p. 29-30).) Representatives of Knoxville introduced resolutions making it clear that the East Tennessee University (the name was changed from East Tennessee College in 1840) would be willing to establish an agricultural college and accept a fraction of the land grant. The offer to divide the grant among multiple institutions was enough to postpone a vote giving the college to Murfreesboro. When the legislature reconvened in 1869, influential Knoxville businessman Edward J. Sanford had been appointed the university's agent; he would prove to be just persuasive enough among the state legislators. A bill locating the land grant college in Knoxville narrowly passed the House by a vote of 35 to 33. Because of the closeness of the vote and the seriousness of the Murfreesboro proposal, I consider this a high quality experiment. East Tennessee University's charter was modified on January 19, 1869, making it the state's land grant college. Ten years later, the school's name was changed to the University of Tennessee. This account is drawn from Montgomery, Folmsbee, and Greene 1984, p. 73-76.

Southern Methodist University & Texas Christian University: By the early 1900s, the Southern Methodist conference was growing increasingly dissatisfied with its existing Southwestern University at Georgetown in Williamson County, Texas. Georgetown was simply too small to support the type of flagship regional university that the Methodist conference desired. Hoping to spur potential suitors to action, Southwestern President Robert S. Hyer submitted a proposal to build a new $225,000 building on the Georgetown campus. Methodists in Dallas and Fort Worth took note and realized that, if the building were completed, Southwestern would never be moved from Georgetown, and thus if they wanted to get the Methodist university for themselves, they must act quickly to convince the trustees to relocate the college. Fort Worth in Tarrant County, under the leadership of prominent Methodist and president of the small Fort Worth Polytechnic Hiram Boaz, pledged $250,000 as well as land and existing polytechnic buildings valued at $275,000 for Southwestern to relocate there. Methodist and commercial leaders of Dallas, in Dallas County, were preparing their own similar bid, additionally making the argument that the saloons in Fort Worth exerted too strong of an influence and would be corrupting to the college. In 1910, before Dallas could submit a bid to Southwestern, however, a large fire burned down the Restorationist (now Disciples of Christ) Texas Christian University (TCU), then located at Waco in McLennan County. The Dallas Chamber of Commerce quickly sent a delegation, including many members involved in preparing a bid to Southwestern University, to Waco to convince TCU to relocate to Dallas. The TCU students voted “almost unanimously” (Payne 2016, p. 14) to move to Dallas, and TCU trustees made multiple trips to Dallas to scout potential sites. The people of Fort Worth then presented the TCU trustees a plan to locate to one of two locations in Fort Worth, along with a cash incentive of $250,000. The TCU trustees voted to move to Fort Worth. (Previous to locating in Waco, TCU had previously been located in Fort Worth from 1869-1873, then in Thorp Springs from 1873-1895, and finally moved to Waco in 1895.) The representatives in Dallas panicked, worried that Fort Worth would succeed in capturing multiple large denominational schools, while Dallas would be left with nothing. The city of Dallas presented the Southwestern trustees with two plans: one with $325,000 in cash and a 125 acres of land, and one with $400,000 in cash and 50 acres of land. Surprisingly, the Southwestern trustees turned down the offers from both Dallas and Fort Worth and decided to remain in Georgetown. By this time, however, the Methodist conference had become set on establishing a denominational university in a city large enough to support it. So, while Southwestern would not relocate, a new university would be built; the only question was whether it would go to Dallas or Fort Worth. In February 1911, the Methodist education commission hosted a meeting in Dallas to review proposals from both cities; they then proceeded to tour the potential sites. After the tours, the commissioners established a 10 p.m. deadline to receive final offers, with a vote scheduled the next day. Dallas offered one of three sites with either 300, 100, or 50 acres, as well as $300,000 in cash. Fort Worth also offered three packages: 100 acres and half interest in 1,100 acres plus $300,000 cash; 100 acres and one-third interest in 1,500 acres plus $400,000 cash; or 100 acres and half interest in 1,500 acres plus $500,000 cash. Realizing that the Fort Worth offer was better, the Dallas delegation overnight contacted some of their citizens and were able to secure an additional half interest of 725 acres. The delegates from Fort Worth strenuously objected since this extra promise of land had come after the 10 p.m. deadline. The commissioners agreed to give both delegations an extra day to finalize their offers, but "the Fort Worth contingent indignantly refused" and "departed in anger" (Payne 2016, p. 20). The commission then proceeded to vote 14-4 to locate the new Southern Methodist University in Dallas. The losing commissioners proposed to make the final vote officially unanimous so that the university could be started on more secure footing. Southern Methodist University opened to students in the fall of 1915. In addition to Dallas and Fort Worth, I also include the previous locations of the Southwestern Methodist University and TCU in Georgetown and Waco, respectively, as low quality controls. This account draws from Payne 2016, p. 1-45 and Thomas 1974, p. 28-34. Hall 1947 provided useful background on TCU.

Texas Agricultural & Mechanical University: On April 17, 1871, the Texas legislature accepted the terms of the Morrill Act and established the Texas Agricultural and Mechanical University. Unfortunately, the state had to formally begin operation of its state university by July 23, 1871, an impossible task given that a site had not been selected and no construction of buildings had yet begun. Texas Republican Governor Davis promptly appointed three Republican state legislators to be commissioners for the location committee. Davis would subsequently veto a bill providing state appropriations for the commissioners, arguing that the commissioners were to act without any compensation. This, however, made bribes much more appealing to the commissioners and tainting the selection process. In addition, given the tight time constraint, the commissioners surely could not have performed the due diligence evident in other site selection processes; other factors than a reasoned consideration of each site's merits must have played a role. Richardson 2013, p. 138-139 documents that the commissioners visited San Antonio in Bexar County, Austin in Travis County, Waco in McLennan County, San Marcos in Hays County, and Tehuacana Hills in Limestone County. Dethloff 1975, p. 15 reports that four sites in particular received special consideration. These were Kellum Springs and Piedmont Springs in Grimes County, Bryan in Brazos County, and Bellville in Austin County. (Ousley 1935, p. 39 also records that the two locations in Grimes County were strongly considered; an architect was hired to begin examining these sites before the commission made its final site selection decision.) The competition was especially fierce between Bryan and Bellville, each of which had a resident on the selection committee. A letter from Brazos County representative Charles Gardiner to Governor Davis recommends removing the Bellville commissioner and replacing him with Gardiner, as selecting Bryan as the site of the college would solidify Republican Party prospects in Brazos County, supporting the notion that politics and possibly corruption determined the location of the college. When Bryan's representatives met with the commissioners in Houston on June 20 to formally present their proposal, accounts suggest that the commissioners agreed to locate the college in Bryan after a private meeting with a single Bryan representative and before listening to the other proposal, further raising the possibility of a corrupt decision. There are even accounts that Bryan's representative won the college in a poker game, although unfortunately there is not any evidence to either support or refute this story (Dethloff 1975, p. 18). Contemporary charges of corruption were widespread, and did not end after the site selection decision had been made. Richardson 2013, p. 139 and Dethloff 1975, p. 21-28 report that the commissioners had to spend the several months after the selection of the site defending themselves from accusations that they had swindled funds. Frustrated, Davis replaced the initial commissioners, but even after that progress on constructing the university was slow while costs were high. In a January 1873 address to the legislature, Davis acknowledged that many were unhappy with Bryan as the site of the college, but given the (slow but steady) progress that had been made in construction, it would be impractical to move the university at that stage. The university finally accepted its first students in October 1876. Even then, the start of the university was particularly inauspicious: the area was overrun with wolves, with one boy even being attacked in broad daylight within sight of the main administration building! This account draws from Dethloff 1975, p. 3-29 and Richardson 2013, p. 131-142.

Texas Technological College: While eastern Texas had developed quickly following statehood in 1844, West Texas remained mostly undeveloped frontier through most of the second half of the nineteenth century. However, by the late 1800s, many in West Texas were frustrated with the current state of affairs in which they would pay taxes to the rest of the state without receiving state institutions or services in return, and several began agitating for a state university. Reflecting the East's view of West Texas, in 1894 the Fort Worth Gazette remarked that the only college needed in West Texas was a college for coyotes (Rushing and Nall 1975). Unsatisfied with receiving a normal school in 1909, state representatives and senators from West Texas lobbied for an agricultural and mechanical college from 1910 to February 1917, when a bill establishing a branch of the state agricultural college west of the 98th meridian passed the state legislature. A five member location committee was established that received applications from 23 towns across West Texas, all of which were visited within a few weeks after passage of the establishing act. A confidential vote gave the new college to Abilene, in Taylor and Jones Counties. Two of the five members were known to favor Abilene. However, in ensuing sworn testimony, none of the other three members would confess to casting the critical third vote. The ballots had not been reviewed before the outcome had been read by a governor-appointed secretary. At the time, the governor was being investigated for corruption and misusing state funds, casting the entire process of selecting a university site under a cloud of suspicion. By September 1917, the governor had been removed from office and the act establishing the West Texas agricultural college was repealed. Organizers in West Texas would have to wait almost five and a half years, until January 1923, for an act establishing a university in West Texas was passed and signed into law. By then the name of the school had morphed into Texas Technological College. This time, 37 towns submitted briefs to the locating board, and all were visited over the course of July and September, 1923. The towns were: Lubbock in Lubbock County, Floydada in Floyd

County, Plainview in Hale County, Big Spring in Howard County, Sweetwater in Nolan County, Boerne in Kendall County, Lampasas in Lampasas County, Brady in McCulloch County, Menard in Menard County, Brownwood in Brown County, Coleman in Coleman County, Ballinger in Runnels County, Paint Rock in Conco County, Miles in Runnels County, San Angelo in Tom Green County, Midland in Midland County, Standon in Martin County, Colorado City in Mitchell County, Abilene in Taylor and Jones Counties, Buffalo Gap in Taylor County, Clyde in Callahan County, Cisco in Eastland County, Seymore in Baylor County, Munday in Knox County, Haskell in Haskell County, Stamford in Haskell and Jones Counties, Snyder in Scurry County, Post in Garza County, Wilson in Lynn County, Crosbyton in Crosby County, Spur in Dickens County, Tulia in Swisher County, Amarillo in Potter County, Claude in Armstrong County, Memphis in Hall County, Quanah in Hardeman County, and last but probably not least, Vernon in Wilbarger County. Many of these towns surely were not serious contenders, so most are recorded as low quality control towns. The board met on the morning of April 23, 1923 in the Texas Hotel in Fort Worth to select the final site. After a morning of comparing briefs, the board announced that no decision would be arrived at until the afternoon, and then broke for lunch. This prompted rumors that the board had narrowed down its options to Snyder, Sweetwater, and Lubbock, so these are considered high quality controls. Those taking bets considered Snyder to be the favorite. Lubbock was ultimately selected, and classes began in October 1925. This account is drawn from Rushing and Nall 1975, p. 1-25. Details of the final selection process are from Gibbs 1939, p. 40-45.

United States Air Force Academy: The United States Air Force became an independent branch of the armed forces with the passage of the National Security Act of 1947. On April 1, 1954, President Eisenhower signed into law the Air Force Academy Act. Five days later, Secretary of the Air Force Harold Talbot established the Air Force Academy Site Selection Commission. The commission consisted of Air Force Generals Spaatz and Harmon, State University of Iowa President Dr. Virgil Hancher, Vice President of the Hearst Corporation Merrill Meigs, and famed aviator and Reserve Brigadier General Charles Lindbergh. The commission decided to accept proposals for sites until April 21, after which they would tour sites and make a decision. They further decided that, if the commission could not reach a unanimous decision, they would submit three finalist sites to Secretary Talbot to make the final decision. The commission received 582 proposed locations in 45 different states (Fagan 2006, p. 33). The commission visited 34 sites in 21 states in person and viewed another 33 sites in 17 states from the air (Nauman 2004, p. 11), covering 18,852 miles over 18 days (Fagan 2006, p. 33). The commission also took extraordinary steps to ensure they were not pressured by local constituents. Thus the commissions recommendations should reflect, as closely as possible, the commission's appraisal of the relative merits of each site. In the end, the commission was unable to reach a consensus and submitted their three finalists to Secretary Talbot. The finalists were Colorado Springs in El Paso County, CO; Alton in Madison County, IL; and Lake Geneva in Walworth County, WI. Once the finalists were announced, local chambers of commerce and other local and state officials at all three finalists worked to try and convince Secretary Talbot and President Eisenhower that their location was the best. At the same time, many local groups were strongly opposed to the disruption that a military academy would cause, and were especially concerned that the federal government would appropriate local land without fair compensation (Fagan 2006, p. 38-39). There is speculation that Eisenhower may have also lobbied for the Colorado Springs site; Eisenhower's wife was from Colorado, and the president frequently vacationed and golfed there (Nauman 2004, p. 12). Secretary Talbot announced the selection of Colorado Springs on June 24, 1954. The first class was sworn in the following year. Several exemplary studies of the site selection process for the Air Force Academy exist. This account draws from Fagan 2006, p. 29-42 and Nauman 2004, p. 10-14.

United States Merchant Marine Academy: The Merchant Marine Act of 1936 established the U.S. Merchant Marine Corps, but initially most instruction occurred during internships aboard merchant ships at sea. Over the next several years, various plans to incorporate merchant marine training at the Coast Guard Academy or to establish a separate merchant marine academy in New York City fell through. The start of World War II in Europe provided more urgency, and resources, for the establishment of a Merchant Marine Academy. In September 1941, the Maritime Commission, led by Richard McNulty, discovered an estate, owned by Hetty Green and located near the port of New Bedford in Bristol County, MA, that was for sale at a reasonable price and would serve the academy's needs. During negotiations, however, the Green family raised their asking price from $200,000 to $600,000. The team next scouted out locations at Groton and Mystic, both in New London County, CT. Because it is unclear how seriously these sites were considered, I include them as low quality controls. In early December, the estate of the late automaker Walter Chrysler came on the market in Kings Point in Nassau County, NY. As the U.S. entered the war, the family, likely moved by patriotism, was willing to lower their asking price from $175,000 to $100,000. The Maritime Commission recommended purchase of the estate on December 8, 1941; within days, the deal was finalized. The new academy was dedicated in September 1943, and cadets entered on abbreviated 18 month curricula to meet the need of merchant marines for the war effort. This account is drawn from Cruikshank and Kline 2008, p. 51-78.

Utah State University: In 1888, companion bills were proposed to the Utah State legislature, one establishing the state agricultural college and the other the state reform school. As Cache and Weber Counties were the two largest counties that had yet to receive a state institution, it was thought that one of these institutions would go to each county. The two counties fiercely lobbied to be the one to receive the state university. During the same legislative session, the representative from Utah County submitted a bill to locate the state university in his own county. Now at risk of losing both state institutions, the representatives of Weber County banded together with those of Cache County to deprive Utah County of the school. In exchange Weber County agreed to accept the reform school. Notably, Utah County had previously received the state insane asylum. This account draws from Ricks 1938, p. 17-20.

Virginia Agricultural & Mechanical College: In 1870, the Virginia legislature took up the problem of deciding how to handle federal land grant funds. Almost every existing university in the state of Virginia sought to gain the land grant status. From the beginning, the three front runners were the Virginia Military Institute (VMI) in the independent city (and county seat of Rockbridge County) Lexington, the University of Virginia (UVA) in the independent city (and county of Albemarle County) Charlottesville, and the recently re-named Washington and Lee University also in Lexington. While these schools had strong support, the Republican members of the state legislature were strongly opposed to giving the land grant to an existing public university. In 1871, the Prestin and Olin Institute, in Blacksburg in Montgomery County, entered the fray. It was undergoing severe financial difficulties, and its trustees decided that the school could completely turn itself over to the state in exchange for the land grant status and funds. Throughout the fall 1871 legislative session, representatives from Montgomery County agreed to provide $20,000 to relaunch the school. Finally, as the end of the 1872 legislative session approached and no decision had been made, the state Senate acted. They decided to allocate one third of the land grant fund to the Hampton Institute for black students, with the remainder of the fund split among other existing or new university for whites. After each ballot, the combination of white schools with the lowest vote share would be eliminated from the ballot. Voting would continue until one combination of sites won a majority. In addition to VMI, UVA, and the Prestin and Olin Institute, the ballot included Richmond College in the independent city of Richmond, Roanoke College in the independent city (and county seat of Roanoke County) Salem, Emory and Henry College in Emory in Washington County, Randolph-Macon College in Ashland in Hanover County, the Hampden-Sydney College in Hampden Sydney in Prince Edward County, the New Market Polytechnic Institute in New Market in Shenandoah County, and a school in the independent city of Fredericksburg. On the third ballot, the Prestin Olin Institute won a majority, with a combination that paired VMI and UVA coming in second. The Virginia House separately took up the question of deciding which school should receive the land grant status, but quickly defaulted to the decisions already made by the Senate. I therefore include Rockbridge and Albemarle Counties as high quality controls, while the other counties are included as low quality controls. This account is drawn from Wallenstein 1997, p. 37-44 and Kinnear 1972, p. 19-41.

Washington State University: After attaining statehood in November 1889, the citizens in southeast Washington turned their attention towards establishing their state's land grant college. As Frykman 1990, p. 1 puts it, "It is entirely possible that Pullman's leaders initially may have sought publicity and were not entirely serious in their effort to obtain the site of the new college." But, in spite of themselves, the people of Pullman soon found themselves deeply invested in attaining the college. A three person site selection commission ruled out all towns in the western part of the state as well as any town that had already obtained another state institution. The remaining towns were all very similar in terms of population, access to railroads, and demographic and economic outlook. Among these towns, Pullman, in Whitman County, and Yakima, in Yakima County, emerged as the two leading contenders. This commission failed to select a site in 1890. In the spring of 1891, a second commission met and also struggled to decide a winner. Finally, on April 25, 1891, the commission selected Pullman over Yakima, ending a debate that had lasted more than a year. The second commission also failed to select a winner on its first ballot. The first classes began in January, 1892. This account draws from Frykman 1990, p. 1-7.

West Virginia University: West Virginia became a state in 1863, the year after President Lincoln signed the Morrill Act. Because of this, the state legislature was careful to clarify with the U.S. Congress that it could still take advantage of land grant funds. In 1866, smaller agrarian communities applied to receive the state land grant college; larger towns such as Wheeling, in Ohio and Marshall Counties, did not apply out of fear that receiving the land grant college would decrease their chances of receiving the state capital. Bethany in Brooke County, Frankford in Greenbrier County, Greenwood in Doddridge County, Harrisville in Ritchie County, Morgantown in Monongalia County, Philippi in Barbour County, Point Pleasant in Mason County, Ravenswood in Jackson County, and Spencer in Roane County initially submitted applications. But it appeared that there would not be much of a competition after State Senator William Price introduced a bill donating the property of the Monongalia Academy and Woodburn Seminary to locate the college in Morgantown. For this reason, all of the above sites are recorded as low-quality finalists (with the exception of Frankford, described below). While the bill passed in the Senate, the House amended it to also consider Charleston in Kanawha County, West Liberty in Ohio County, Point Pleasant in Mason County, and Flemington in Taylor County. Northern legislators favored Morgantown, arguing that it wouldn't be proper to locate the land grant college in areas that had a large number of Confederate sympathizers. Southern legislators favored Charleston, arguing that locating the college in the north would benefit Ohio and Pennsylvania more than West Virginia. In 1867, Charleston removed itself from consideration to receive the land grant college in exchange for receiving the state capital. South legislators then turned to favoring a site in Frankford, which offered 1000 acres of land in an application that rivaled that of Morgantown. The final "frail decision" (Doherty, Jr. and Summers 1982, p. 6) came out in favor of Morgantown. This account draws from Doherty, Jr. and Summers 1982, p. 3-8.

University of Wisconsin: Wisconsin's state constitution not only mandated the establishment of a state university, but also that it be situated "at or near the seat of state government" (quoted in Curti and Carstensen 1949, p. 6). The "experiment" in this case involved deciding where to locate the state capital. The initial proposal in 1836 located the capital at Fond du Lac in Fond du Lac County. Thanks to the work of Judge James Duane Doty, however, the site was changed to Madison in Dane County. While the fight for the capital was still ongoing, a second bill quickly went through the legislature establishing a territorial university at Belmont in Lafayette County. "Since [no one] at the time thought to petition Congress for a grant of land for the support of the institution, and since no representative from Belmont manifested interest in a university, the act gives every evidence of having been little more than a gesture to propitiate Belmont supporters with the gift of a university on paper" (Curti and Carstensen 1949, p. 39). In 1838, a second bill was introduced to establish a territorial university at Four Lakes on the northwest side of Lake Mendota, also in Dane County. This was changed in the territorial council to locate the university at or near Madison, on the south side of Lake Mendota. This was followed by laws establishing a permanent endowment as well as a cash grant to support the university. As details of all of these deliberations are few, I consider these to be low quality controls. The university did not open, however, until 1851, several years after Wisconsin achieved statehood. This account draws from Curti and Carstensen 1949, p. 37-51.

A decade and a half after the university first opened, the state legislature took up the task of allocating Wisconsin's land grant funds. The chairman of the Committee of Education Hammer Robbins, a longtime supporter of the university, introduced a bill giving the land grant to the university on the condition that Dane County provide $40,000 to purchase an experimental farm. The bill lost by a vote of 38 to 36. Representatives from Fond du Lac County attempted to introduce a new bill substituting their own Ripon College for the university in Madison, but a movement by a Dade County representative adjourned the session before a vote could be taken. When the legislature reconvened the next day, both sides had regrouped and lobbied potential swing votes. A motion to reconsider the initial bill passed 45 to 28, but the passage was again blocked. After two more days of debate, the bill was approved by a vote of 49 to 21. Meanwhile, the Senate had passed a bill awarding the land grant to Ripon College. It appears that this reflected indifference on the part of the Senators rather than a strong preference for the Ripon site; the next day the Senate voted to adopt the House's version, giving the land grant to Madison, by a vote of 22 to 4. The bill was signed into law on April 12, 1866 with the caveat that the act would be null and void if Dane County failed to deliver the $40,000 in bonds to the Board of Regents. Because of the fraught nature of the vote, with multiple rounds of voting required before Madison acquired the land grant, I consider this to be a high quality experiment. This account draws from Curti and Carstensen 1949, p. 296-300.

B.2 Low Quality Experiments

In this section, I describe each of the 63 low quality experiments. For each description, I include the locations of the losing finalist sites. If additional information regarding the site selection process is available, I describe this too, as well as a justification for why I consider the experiment to be low rather than high quality. In some cases, I indicate that, while it appears that a high quality experiment likely occurred, there is not enough information available to determine how close the contest was or which of the finalists were especially close to winning.

La Grange Military Academy: Alabama's premier military academy began as a classical college in La Grange, in Franklin (present day Colbert) County. "With varying fortune it continued until 1855, when an effort was made to transfer the institution to Florence, in Lauderdale County" (Wyeth 1907, p. 9). In 1857, the college became a military academy. I am unable to find any additional information regarding the attempted move to Florence, nor any information about the initial establishment of the La Grange college, and so I regard this as a low quality experiment. The military academy was short lived, however, closing in 1862 as the Union Army approached the campus and almost all of the students and faculty had joined the war effort. This account is drawn from Wyeth 1907, p. 9-11.

Talladega College: In the late 1860s, the Freedman's Bureau of Alabama undertook establishing a college for African Americans in Alabama. In 1866, the high school in Talladega, in Talladega County, was for sale. Local African American community leaders notified the Freedman's Bureau, and then in turn contacted the American Missionary Association (AMA), which ran a number of primary schools in the state but was interested in expanding and opening a college. Jones and Richardson 1990, p. 2 explain why Talladega was preferred over other locations: "Talladega was a good choice for a black institution because a college could be maintained more cheaply in such a grain-growing region than in the cotton belt; the region was healthier than Selma, Montgomery, and Mobile, where the AMA had primary schools; and the property was offered at an unusually good price." I therefore consider Selma in Dallas County, Montgomery in Montgomery County, and Mobile in Mobile County as controls. Because there is no information on how closely the AMA considered those other sites, I consider this a low quality experiment. Talladega College opened in the fall of 1867. This account draws from Jones and Richardson 1990, p. 2-3.

Alaska Agricultural College & School of Mines: Unlike most other agricultural colleges, in Alaska agricultural experiment stations were established before the land grant college. Upon learning that the state of Alaska could acquire a significant endowment by setting up an agricultural college, Alaskan representative James Wickersham went about lobbying for the creation of such a college. The college was to be placed close to the existing agricultural experiment station in Fairbanks in Fairbanks North Star Borough. Other Alaskan agricultural experiment stations that existed at the time include the station in Kenai in the Kenai Peninsula Borough, Kodiak in the

Kodiak Island Borough, Sitka in Sitka Borough, Cooper Center in Valdez-Cordova Borough, and Rampart in Yukon-Koyukuk Borough. There is no evidence, however, that any of these locations was ever considered. Indeed, successful agricultural endeavors in almost all parts of the state were extremely difficult. For instance, one congressman remarked that "a college anywhere else in Alaska *but* Fairbanks would be a 'joke,' though he added that only time would tell if a college in Fairbanks would or would not be a laughing matter as well" (Cole 1994, p. 5). Wickersham may have had ulterior motives to locating the college in Fairbanks as well: he owned property nearby that "was worth, he hoped, $10 million. The presence of a nearby college was not going to detract from the value of Wickersham's holdings" (Davis 1992, p. 32). Because Alaska was still a territory, to get approval to establish a land grant college, Wickersham first had to get a bill through the U.S. Congress. Here Wickersham faced some opposition from congressmen who owned property near Seward in Kenai Peninsula Borough and wanted to get the college located there (Davis 1992, p. 32). But due to some political maneuvering that involved having the bill come up for vote at 3 a.m. immediately before Congress adjourned, Wickersham and his allies were able to get the bill approved. The college was formally established on May 3, 1917, and classes began in September 1922. This account is drawn from Cole 1994, p. 3-17 and Davis 1992, p. 31-52.

University of California San Diego: The chairman of the University of California Berkeley's department of zoology William Ritter had a deep interest in marine biology and had fallen in love with exploring the waters off the coast of southern California. He frequently petitioned University of California President Wheeler for an experiment station close to the water where he could conduct research. Finally, Wheeler relented, selecting San Pedro in Los Angeles County as the site. San Diego physician Fred Baker, who also collected shells, was upset by this decision as he had wanted the small institute located near San Diego in San Diego County instead. Ritter finally placated Baker:

> In 1903, Ritter told Baker that if a lab could be found and equipped and $500 could be raised, he would bring his research program to San Diego. Baker was a canny as well as energetic fund raiser. To San Diegans intent on making a fortune in a hoped-for real estate boom, he pitched what he called Ritter's "Aquaria" as "an advertisement" that would "rival anything on the coast." He also contacted the man he described to Ritter as a "wealthy rancher," E.W. Scripps, who he said "might put your whole project on its feet." (Anderson 1993, p. 16)

This was enough for Ritter, and by 1905 the institute was located in La Jolla, just north of San Diego, and was on secure financial footing. I consider San Pedro to be a low quality control. Scripps continued donating to marine biology research in the area, and in 1912 the Scripps-funded Marine Biological Association became part of the University of California system. After serving as a key site of naval research during World War II, and a key receiver of Naval research funds in the early Cold War era, San Diego and the University of California-affiliated institute there was a natural candidate to become the newest branch of the University of California system in 1956. Originally still just a research institute, the university began accepting graduate students in 1960 and undergraduates in 1964. This account draws from Anderson 1993, p. 15-65.

San Jose State University: The Minn's Evening Normal School was constructed in San Francisco in 1857 and was taken over by the state in 1862 and renamed the California State Normal School. It moved to San Jose, in Santa Clara County, in 1870. The school building was destroyed by fire in 1880. Several communities throughout California lobbied to have the new building constructed in their towns, including Redding in Shasta County, Fresno in Fresno County, Santa Rosa in Sonoma County, and Los Angeles in Los Angeles County. The school was rebuilt in San Jose, however. Because I have no information on the intensity of these lobbying efforts, I consider this to be a low quality experiment. This account draws from Anderson 2015, p. 5.

Stanford University: Leland Stanford made a fortune as a principal investor in the Central Pacific Railroad, among many other pursuits. Upon the death of his only son in 1884, Stanford decided to build a university in his adopted home state of California as a monument. Stanford frequently declared that, "The children of California shall be my children" (Elliott 1937, p. 13). From his early plans to found a university, Stanford appears to have had his Palo Alto farm, in Santa Clara County, in mind; the farm is mentioned often in correspondences. But in at least one case, the Argonaut newspaper recorded that "Mr. Stanford has plans for the establishment of a school for boys and girls at Menlo, where practical education will be afforded in order to fit pupils for the scramble for life" (Elliott 1937, p. 17-18). Menlo, now known as Menlo Park, is located in neighboring San Mateo County. It is unclear how seriously, if at all, Stanford ever considered a Menlo site. I therefore record Menlo as a low quality control. I also include several of Stanford's other Californian land holdings large enough to serve as the site of a university as low quality controls. This account draws from Elliott 1937, p. 10-38. An account of Stanford's other properties that were eventually used for charitable purposes is taken from Bartholomew, Brinegar, and Nilan 2001.

Colorado State University: As the citizens of Colorado became increasingly interested in pursuing statehood, individuals in various communities began thinking about how they could best secure particular state institutions for themselves. In 1870, Mathew S. Taylor, a Fort Collins attorney and representative of the territorial legislature, was able to secure passage of an act establishing a state agricultural college at Fort Collins in Larimer County. But the college existed on paper only, as no funding was forthcoming. Because of this, members of several other communities also thought they had a chance to gain the future state land grant college. The people of Greeley in Weld County were especially "energetic" in pushing for the future state agricultural college. In 1874, however, the legislature passed a law funding three institutions of higher education in Colorado: the state university in Bolder, the mining college in Golden, and the agricultural college at Fort Collins. The agricultural college received a grant of only $1,000 (the state university and mining college received $15,000 and $5,000, respectively), but the funding and official seal of approval was enough to effectively kill attempts by any other communities to receive the state land grant college. When Colorado became a state in 1876, the agricultural college at Fort Collins was explicitly recognized in the state constitution. The college began operating in September 1879. This account draws from Hansen 1977, p. 21-39.

University of Connecticut: In the 1860s, Yale University, located in New Haven in New Haven County, was a regional leader in agricultural research. Writes Stemmons 1931, p. 21, "It was no accident that Yale was made the beneficiary of the Land Grant Act in 1863. Prior to passage of the act it is doubtful if any American institution had made a contribution to agricultural science comparable to that of Yale." Yale was not to keep the land grant endowment, however. In December 1880, Augustus and Charles Storrs offered the state 170 acres of land and buildings and $5,000 in cash for the establishment of a state college of agriculture to be located at the family estate in Storrs in Tolland County. The state voted to accept this gift on April 21, 1881. By the late 1880s, the presence of two agricultural colleges in the state had become a problem: the legislature planned to allocate the $25,000 a year from the 1890 Morrill Act entirely to the Storrs Agricultural College, while Yale would continue to receive the $6,750 per year endowment from the 1862 Morrill Act. Yale was, understandably, unhappy with this arrangement. A legal fight ensued that would become known as "the Yale-Storrs Controversy," with the key issue beign whether Yale had a vested right to receive land grant funds for perpetuity. Finally, in 1896, the issue was resolved with the Storrs Agricultural College receiving the full land grant status and endowment, and Yale receiving compensation for damages equal to $154,604. This account draws from Stemmons 1931, p. 21-77.

University of Delaware: Newark, in New Castle County, was the home to a Presbyterian academy since about 1750. During its long history, defenders of the academy had to respond to numerous attempts to relocate the school, most notably to Wilmington and New Castle, both in New Castle County, or Dover in Kent County. Perhaps surprisingly, then, given the prestige and resources of other colleges in the state, that a bill to establish the Newark school as the official state college passed in 1820 with few amendments. The bill not only gave the college official status, but also secured a source of annual funding: the state of Delaware would run a state lottery and tax commerce between New York and Philadelphia to the north and Baltimore and Washington, D.C. in the south and put the proceeds into a fund for the college. The imposition of the new taxes caused a public backlash, championed largely by jealous citizens in Wilmington and New Castle. This resulted in the repeal of most of the new tax, but the college survived and was allowed to keep the proceeds from the state lottery. After the passage of the Morrill Act, there was little opposition to establishing the college in Newark as the state's land grant college in 1870. I therefore include Wilmington, New Castle, and Dover as low quality controls. This account draws from Munroe 1986, p. 9-49, 121-124.

Florida State University: In 1851, the Florida legislature established two public seminaries, with one on each side of the Suwannee River. While the East Florida Seminary quickly located in Ocala (and, after several location changes, would go on to become the University of Florida), locating the West Florida Seminary was very contentious. The towns of Tallahassee in Leon County, Marianna in Jackson County, and Quincy in Gadsden County all repeatedly submitted bids to receive the university, with the competition between Tallahassee and Marianna being particularly fierce. In 1854, the city of Tallahassee took matters into its own hands, building a county-run school for boys. In 1856, Tallahassee again submitted a bid, with the land and building of the boy's school, along with a $2,000 annual contribution, as the centerpiece. I have found no evidence of Marianna taking similar steps to try and attract a school over this time period. The legislature approved the bid to locate the West Florida Seminary in Tallahassee, and it was signed into law on January 1, 1857. The school began operating that same year. The West Florida Seminary was a coeducational institution since its second year of operation in 1858, but in 1905 it would be reorganized as the Florida Female College. It was not until 1947, after the passage of the G.I. Bill, that the school again became coeducational and was renamed Florida State University. This account is drawn from Wills and Morris 1987, p. 38. For background on the decision to transform the school into the Florida Female College, see Proctor and Langley 1986, p. 23-26.

University of Central Florida: In the early 1960s, the invention of air conditioning and NASA's decision to launch its manned spaceflight missions from Cape Canaveral made central Florida an appealing location for development. On June 10, 1963, the Florida legislature passed a bill establishing a university in the central region of Florida. Finally, a site in Orlando in Orange County was chosen over finalist sites at South Orange Blossom Trail, now also inside Orlando in Orange County, and in Seminole County. Unfortunately, I have been unable to find any information regarding how contentious the decision was. But Orlando did sit at the intersection of recently constructed east-west and north-south highways, making it an appealing site. Whatever features attracted the site selection committee to Orlando likely also attracted Walt Disney, who chose Orlando as the site of Disney World in the same year. For this reason, I consider this to be a low quality experiment. The college, originally called Florida Technological University and focusing on training engineers for the booming aerospace industry, held its first classes in 1967. This account draws from Holic and the UCF Alumni Association 2009, p. 7-10.

Georgia State Industrial College for Colored Youth: After the Civil War, racially integrated higher education was available for blacks in Georgia, particularly at Atlanta University, which opened its doors in 1865 as part of the city's reconstruction efforts following General Sherman's famous march. The whites attending Atlanta University were typically sons and daughters of the faculty or others who did not have the resources to attend the University of Georgia or one of Georgia's more selective colleges. This integrated education soon caused controversy, however, and funding for the university were withdrawn, forcing it to close its doors, in 1887. African Americans in the state thus began a search for a new location for a flagship college to teach black students. Only a few years after Atlanta University closed, in 1890, the U.S. Congress passed the Second Morrill Act which required states obtaining land grant funding to either admit African Americans on an equal basis or else establish a new institution of higher education for blacks. This gave the Georgia legislature a strong incentive to also look for a replacement to Atlanta University. The college was officially founded on November 26, 1890, although at the time no decisions had yet been made regarding where the city would be located or even whether it would be independent or a branch of an existing university. As several cities prepared bids to receive the new school, in June 1891 the black college temporarily opened as an extension of the University of Georgia in Athens, in Clarke County. As the administration of the University of Georgia did not want whites and blacks sharing the same facilities at the time, it appears that the Athens location was always meant to be temporary, so I include it as a low quality control. In the end, Augusta in Richmond County, Macon in Bibb County, Americus in Sumter County, Columbus in Muscogee County, and Savannah in Chatham County were all contenders to receive the school. Savannah's bid of $10,000 plus land was accepted by the state. Unfortunately, I can find no information on the other towns' bids or how closely contested the contest was, so I therefore record this as a low quality experiment. The college, named the

Georgia State Industrial College for Colored Youth, moved to Savannah and officially opened its doors in October 1891. The name was changed to Georgia State College in 1932 and again to Savannah State College in 1950. In 1996, it was finally renamed Savannah State University. This account draws from Hall 1991, p. 2-6 and Brooks 2014, p. 25-43.

University of West Georgia: In 1906, the state of Georgia established a state agricultural and mechanical college in each of the state's 11 congressional districts. The members of Georgia's Fourth Congressional District met in Columbus on December 8, 1906 to select the location of their college. The two highest bidders were Muscogee County and Carroll Counties, the latter of whose representatives submitted a bid of $7,000. Unfortunately, I do not know the amount of Muscogee County's bid. In addition, the representatives of Carroll County emphasized that their county was largely agricultural and so suited to the needs of the college, whereas Muscogee was seen as a largely industrial community. For this reason, I consider this to be a low quality experiment. The citizens of Carroll County selected Carrollton as the site of the college. The doors of the school opened its doors in January 1908. This account draws from Bonner, House, and Mathews 1998, p. 11-18.

University of Hawaii: In the first meeting of the Hawaii territorial legislature in 1901, Representative Kaliikoa of Hawaii County introduced a bill to create a territorial university, located at Mountain View in Hawaii County. The bill passed the

Senate on the last day of the legislative session, likely because Mountain View was the home district of the Senate president, but never reached the House before the legislature adjourned. In the next session, a nearly identical bill was introduced in the House, but the location of the college was changed to Lahainaluna in Maui County to appease the Speaker of the House. This bill passed the House but did not receive a vote in the Senate. Following the failure of these first two attempts to establish a territorial college, the legislature commissioned a report to study the feasibility of a land grant college in Hawaii. The report, drafted by local newspaper editor Wallace Rider Farrington, concluded that an agricultural college would be most effective if it was co-located with the existing federal agricultural experiment station near Punchbowl Crater in Honolulu County. A new bill establishing a college in Honolulu passed both houses of the legislature with little opposition; for this reason, I consider this to be a low quality experiment. The act was signed into law on March 25, 1907. The board of regents finally settled on a site in lower Manoa, a neighborhood in Honolulu, and doors opened to students in September 1908. This account draws from Kamins and Potter 1998, p. 3-12.

University of Notre Dame: Father Edward Sorin arrived in Indiana from France in 1841 and quickly settled in to the St. Peter's parish, between Washington and Mt. Pleasant in Daviess County. Sorin had planned to construct a Catholic elementary school in his parish, but his ambitions soon grew, and by spring of 1842 he had decided to build a college. Without consulting the regional bishop, Sorin and the brothers in the parish began collecting building materials to construct the main college building. When he found out about the plan to build the college, Bishop de la Hailandière "strenuously objected to the unauthorized project" (Schlereth 1976, p. 6) because of the proximity of another Catholic college, St. Gabriel's, only 30 miles away. Not wanting to blunt the enthusiasm of the young Father, the Bishop then relented and offered Sorin at South Bend in St. Joseph County, at the far north end of the diocese. Sorin agreed and moved north to restart his college project at a new site. The college, named Notre Dame du Lac, opened in August 1844. This account draws from Hope 1978, p. 24-33 and Schlereth 1976, p. 1-10.

Illinois State University: In 1857, the Illinois legislature took up the task of establishing a state normal school for the first time. The bill did not stipulate a location for the school; pushing this problem off into the future helped to secure the passage of the bill (Combs 1921, p. 9-10). The state Board of Education solicited bids from communities that wanted to receive the school. The board met in Peoria on May 7, 1857 to review their bids. Washington, in Tazewell County, offered cash, land, and buildings valued at $20,000. Batavia, in DuPage and Kane Counties, offered cash, land, and buildings valued at $45,000. Peoria, in Peoria County, submitted a bid valued at $80,032. Finally, Bloomington, in McLean County, offered cash and land worth $141,000. Because the Bloomington bid was so much greater than all the others, it was accepted with little objection. Classes began in the Bloomington courthouse in October, 1857, while the main campus was under construction. The normal school was built roughly two miles north of downtown Bloomington; the town would be renamed Normal in 1865. This account draws from Combs 1921, p. 9-11.

Northwestern University: In 1850, members of the Methodist Church set out to establish a regional university that would cater to young people from all across the Northwest Territory. Because Methodists were the dominant religion in Chicago at the time, the delegation decided early on to locate the university in the Chicago area. The delegates, led by John Evans, Orrington Lunt, and Grant Goodrich, originally planned to locate the school in Chicago, in Cook County, IL. The university's first president, Clark Hinman, was strongly opposed to this plan. Hinman proposed building the college along one of the roads extending out of Chicago; this would provide the college with room to grow, ensure it was still along a transportation artery to the rapidly growing city, and emphasize that it was catering to all people in the region and not simply Chicagoans. The board of trustees were impressed with this plan and set out to find a new site. In searching for a new location, "Lunt and his committee went south as far as the Indiana border and as far north as Winnetka. They had finally settled on some property near Jefferson Park when Lunt joined a friend on a drive up the North Shore" (Williamson and Wild 1976, p. 8). It was on that trip that Lund fell in love with a farm owned by Dr. John Foster. Evans was later able to secure purchase of the farm in 1853. There appears to be little deliberation between regarding selecting Foster's Farm, in present-day Evanston, versus the Jefferson Park site. Other evidence suggests that perhaps Lund and Evans were more strategic in their selection of the Evanston site. For instance, Pridmore 2012, p.   writes that

> He [Evans] certainly knew, for example, that the railroads were opening great tracts of previously remote real estate. Evans later recalled, too, that he discussed the Northwestern plan with his friend Walter S. Gurnee, president of the as-yet-unbuilt Chicago & Milwaukee Railway. Evans inquired if the new line might pass through a settlement known as Ridgeville, and Gurnee indicated that it would. Ridgeville was the outpost that became Evanston, and Evan's farsightedness turned out to be crucial for the future of Northwestern.

Whether there was little deliberation or the site was selected because of its proximity to railway lines, I consider this to be a low quality experiment. Both locations are in Cook County, and Jefferson Park is today within the borders of Chicago. The college opened its doors in November, 1855. This account draws from Williamson and Wild 1976, p. 1-11 and Pridmore 2012, p. 11-25.

University of Iowa: The University of Iowa was founded on February 25, 1847, less than sixty days after Iowa had become a state. The university was located along with the state capital in Iowa City in Johnson County, but the bill establishing the university also called for other "such branches as public convenience may require" (quoted in Gerber et al. 2005, p. 6. This clause led to a debate about whether or not the Iowa City site would be the sole location of the state's university. The problem was compounded when the university failed to open in a timely manner, due to lack of funding and trouble finding someone willing to accept the position of university president. The citizens of other localities, sensing an opportunity, lobbied to make their towns the main campus of the university. The lobbying grew so intense that the state legislature acquiesced to starting branches at Fairfield in Jefferson County, Dubuque in Dubuque County, Andrew in Jackson County, Oskaloosa in Mahaska County, and Mount Pleasant in Henry County. The state legislature did not appropriate any funds for these branches, however. Before the doors to the Iowa City university opened, the state capital had moved to Des Moines. The Iowa City campus could thus no longer claim co-location with the capital as a special feature of its location. The fact that the capital was no longer in Iowa City did, however, mean that the university could expand into the recently-abandoned government buildings, greatly reducing the costs needed to start the university. This, combined with the sentiment that Iowa City deserved the university as a consolation prize for losing the capital, resulted in a new state constitution in 1857 that Iowa City was to be the sole site for the University of Iowa. The university's first classes began in September 1855, two years before the state constitution cemented its status. Because this decision was driven largely by the availability of existing capital buildings, and because it seemed highly likely that Iowa City would have obtained at least a share of any university system, I consider this to be a low quality experiment. This account draws from Gerber et al. 2005, p. 6-10.

University of Northern Iowa: Iowa lagged behind its neighbor states in establishing a state normal school to train teachers, in spite of several attempts to establish such a college throughout the 1860s and 1870s. One such bill made it out of committee, proposing to establish a normal school in Marshalltown in Marshall County. The bill was amended multiple times, including in attempts to establish a normal school with an existing university. Sites that were considered were at the Iowa Agricultural College at Ames in Story County, at Iowa College in Grinnell in Poweshiek County, at Upper Iowa University in Fayette in Fayette County, or at Adel in Dallas County. This bill ultimately failed by a vote 15 to 24 in the state senate. In 1876, however, the Orphans Home in Cedar Rapids was to close its doors and would remain vacant unless another use could be found for it. A bill establishing the normal school in the buildings of the Orphans Home passed the Senate by a vote of 26 to 14 and then, after some dramatic maneuvering to ensure sufficient support, the House by a vote of 52 to 33. The bill was signed into law on March 17, 1876, with classes beginning in September of that year. After several intermediate names, the school finally changed its name to the University of Northern Iowa in 1967. This account draws from Hart 1951, p. 6-8.

Berea College: John A. Rogers was a Presbyterian minister who had been heavily influenced by his time at Oberlin College in Oberlin, Ohio. When he arrived in Kentucky, he set to work to learn the area and eventually establish a similar college in his new adopted state. This work quickly led Rogers to John G. Fee, a prominent reverend located at Berea in Madison County. "Mr. Fee discouraged any attempts in Madison county, but thought a favorable opening might be found in Estill county" (Rogers 1903, p. 52). Not long after that meeting, Fee had a violent encounter with segregationist individuals that caused a change of heart. Inspired to create a progressive institution that would teach individuals of all races, "Fee wrote to Mr. Rogers urging him very strongly to come with his wife to Berea and start the proposed school there" (Rogers 1903, p. 52). Although there is no evidence that Rogers made much progress in exploring Estill County, I consider it as a low quality control. The college was established and opened in 1858. This account draws from Rogers 1903, p. 39-65.

Eastern Kentucky University & Western Kentucky University: In the early 1900s, the citizens of Kentucky grew concerned that, unlike their neighboring states, they had not yet established a system of state-supported normal schools. As the process of drafting a normal school bill began, representatives from towns likely to be in the running for a school had to make the strategic decision of how many schools to establish. If there were too few schools, then it was likely that a particular town would not get chosen. If there were too many schools, on the other hand, then each school's endowment would be smaller. The citizens of Richmond, in Madison County, initially wanted their town to be the only location of a state normal. But it quickly became obvious that the bid from Bowling Green, in Warren County, would be viewed as more favorable by the state legislature and governor. The Richmond representatives thus proposed a bill calling for the establishment of two state normal schools. The bill was passed in 1906, and the process of formally deciding the locations began.

The citizens of Richmond were still nervous, as there were other potential sites that could submit bids, most notably Louisville in Jefferson County. When Louisville did not pursue a normal school, the two schools went to Richmond (Eastern Kentucky Normal School) and Bowling Green (Western Kentucky Normal School). It is unclear why the citizens of Louisville did not submit a bid for a normal, but the fact that they likely would have won had they submitted a bid suggests that it may not be a fair comparison to the other two towns; I therefore include it as a low quality control. Both the Eastern and Western Normal Schools held their first classes in 1907. This account draws from Ellis 2005, p. 21-25.

University of Kentucky: In January, 1863, the Kentucky legislature accepted the conditions of the Morrill Act and empowered the Board of Directors of the State Agricultural Society to find the location for a school. Writing about the challenges facing the creation of a new college, one writer claimed that no challenge "seems more formidable...than the simultaneous offer of so many college buildings, in so many towns and villages, when common sense at once decides that these buildings ought to be in the midst of the college far" (quoted in Hopkins 1951, p. 61). This concern, it turns out, was unfounded. For six months, the Board accepted bids from localities that wanted to host the new college. At the end of this time, only one site, at Transylvania University in Lexington, in Fayette County. Thinking that perhaps some parts of the state had not had time to learn about the opportunity of the land grant college and put together a bid, the Board extended the campaign. After this extension, Lexington remained the only bid. Worried that the deadline to accept the Morrill Act funds would pass before a spirited competition would arise between Kentucky towns, the Kentucky Senate voted to accept Lexington's offer in February, 1864, but the House blocked the measure. Transylvania University had a troubled past, which many legislatures worried would jeopardize the new institution. Originally founded as the state university, Transylvania could not support itself, closed for a time, and eventually reopened at a new location as a denominational school; its financial future was still uncertain. Another denominational university that had emerged from the ashes of the original Kentucky state college was Kentucky University, previously named Bacon College, located at Harrodsburg in Mercer County. The campus of the Kentucky University had been recently damaged in a fire. The state legislature decided to merge the Kentucky University with Transylvania University and the new land grant college, and locate them all in Lexington. The citizens of Harrodsburg opposed, not wanting to lose their institution. I can find no evidence, however, that the legislature ever seriously considered locating the land grant college in Harrodsburg instead, nor did the Harrodsburg residents ever submit a bid to receive the new college. For this reason, I consider Harrodsburg to be a low quality control. The legislature approved the merger on February 22, 1865. The new state university began in the fall of 1865. This account draws from Hopkins 1951, p. 51-72.

University of Maryland: A number of wealthy planters in the state, spearheaded by Charles Benedict Calvert, saw an agricultural college as the best way to train experienced farm overseers, as well as to learn best practices to improve their agricultural output. By 1848, these planters had formed the Maryland Agricultural Society and began lobbying for state support for such a college. In March 1856, a bill was passed establishing a state agricultural college and providing $6,000 per year in state support, if $50,000 in stock were purchased within two years. Finding buyers proved more difficulty than anticipated, and with only months remaining until the deadline, the agricultural society agreed to purchase the remaining shares themselves. The college formally founded, the shareholders met in January 1858 to elect a board of trustees to select the site. Allan Bowie Davis, one of the original members of the society, offered 100 acres in Montgomery County as an outright gift. Other farms were tendered at a discount, although unfortunately many detailed accounts of the college founding were destroyed in a fire. After visiting many sites, the committee voted to accept the northern plot of Calvert's Riverdale plantation, consisting of 420 acres at $50 per acre, along with a $10,000 indefinite interest-free loan made by Calvert. Since Calvert was the president of the board of trustees and one of the earliest and most prominent advocates for an agricultural college, this site cannot be considered random. The first students began attending in 1854, and the college achieved land grant status in 1864. The college was renamed the Maryland State College in 1916, and in 1920 it became the flagship campus of the University of Maryland system. This account is drawn from Callcott 1966, p. 131-142.

Boston University: In 1839, a congregation of Methodist ministers met in Boston establish a Methodist educational institution somewhere in New England to train future ministers. The seminary began in Newbury, in Orange County, VT, in 1839. In 1847 it was moved to Concord in Merrimack County, NH. In 1866 it moved again to co-locate with Harvard University in Cambridge, in Middlesex County, MA. Finally, the seminary moved to Boston, in Suffolk County, MA, in 1871. I use 1871 as the experiment year and use each prior location as a plausible control. However, I can find no discussions of why the seminary moved in each instance nor what alternative sites were considered. For this reason, I consider this to be a low quality experiment. This account draws from Kilgore 1991, p. 3-4.

University of Massachusetts Amherst: While agricultural associations routinely advocated for the creation of an agricultural college from as early as 1826, the college was not founded until passage of the Morrill Act in 1862. The state legislature decided to establish a state technical institute separately from an agricultural college; the natural site for the technical institute was in Boston. There was competition from four sites to receive the agricultural college. Lexington, in Middlesex County, was the only county in the eastern part of the state to submit a proposal to receive the college. The trustees in charge of selecting the site doubted whether the people of Lexington would be able to make good on their promise of $75,000, and so the site was not seriously considered. Springfield, in Hampden County, and Northampton and Amherst, both in Hampshire County, received stronger consideration, all promising to approximately $75,000 in bonds and land. The trustees voted ten to four to locate the college in Amherst. Amherst had several other benefits. In particular, it was the headquarters of the state agricultural society, which had long led the push for a university, and it was already the home of Amherst College. Thus selecting Amherst was likely not an exogenous decision. This account is drawn from Cary 1962, p. 23-37.

Worcester Polytechnic Institute: John Boynton, of Templeton in Worcester County, MA, had made his fortune as a tin manufacturer. He retired after only twenty years and became restless in his later life. As he entered his seventies in the early 1860s, he conceived of the idea of endowing a college specifically geared towards teaching industry and the mechanical arts. Boynton was undecided on where to locate his proposed technical college, although he had in mind either his hometown of Templeton; Leominster, also in Worcester County, MA, where he had lived for a number of years; or perhaps, Mason in Hillsborough County, NH, close to where he had first learned to make tinware. Boynton discussed his idea for the first time with his cousin and business partner David Whitcomb, in the fall of 1864. Whitcomb suggested that Worcester in Worcester County, MA, would serve as a better location due to its rapid industrialization. Boynton agreed. Because the new economic opportunities in Worcester were the reason for it receiving the college, I consider this to be a low quality experiment. Whitcomb discussed the idea with local clergyman and Harvard overseer Seth Sweester, who drafted the first plan for the university. Boynton, whose vision for the university appears to have been quite vague, approved of the plan without revision. Boynton did have one condition, however. The people of Worcester must demonstrate that they wanted the college by agreeing to provide land and buildings. Boynton and his associates sent a letter to 30 prominent Worcester citizens in March 1865. Most agreed wholeheartedly; the only individual who was likely disappointed was Ichabod Washburn, Worcester's leading industrialist who had been planning on building his own technical school in the city. Washburn eventually relented and agreed to support Boynton's school on the condition that he could donate and establish the school's machine shop. In early May 1865, the Massachusetts legislature voted to approve the establishment of the school in Worcester. The college received a fund of $100,000, donated by Boynton, and the land and building donated by the local people. Boynton also insisted on choosing the board of trustees himself. The college opened its doors in November, 1868. Unfortunately, neither Boynton nor Washburn survived to see the opening of the new school. This account draws from Tymeson 1965, p. 1-35.

Alcorn State University: The first land grant college designated only for African Americans was established in Lorman, in Jefferson County, MS in 1871. Named after Governor James L. Alcorn, The college was founded at the site of the now-defunct Oakland College, which had been closed by the Civil War when the vast majority of the student body joined the Confederate Army (Posey 1994, p. ix). The availability of college infrastructure sitting vacant appealed to the Mississippi legislature, which likely did not want to pay to construct new buildings for an African American college. It is also likely that the legislature saw poetic justice in establishing the African

American college at the site of a college that had closed so that its students could support the Confederate war effort. For this reason, I consider the sites of three other colleges closed during the Civil War to be counterfactuals. These were Corona College in Corinth in Alcorn County, Franklin Female College in Holly Springs in Marshall County, and Rose Gates College in Okolona in Chickasaw County. The terminal dates of Mississippi colleges are obtained from Brown 2014b, which contains a wealth of fascinating information on college histories. Also see Sansing 1999, p. 14 and the preceding pages for a description of the antebellum establishment of state-chartered colleges in Mississippi. As there is no direct evidence that the state of Mississippi considered these other defunct colleges as potential sites for Alcorn State University, they are recorded as low quality controls. This account is drawn from Posey 1994, p. ix-x, 3-4, as well as the aforementioned sources.

Michigan State University: By 1854, popular sentiment in Michigan supported establishing an agricultural college independent of the state university in Ann Arbor. When the bill was introduced into the state legislature, representatives from Eaton, Ontonagon, Montcalm, Clinton, St. Clair, and Newaygo counties attempted to amend it to secure the agricultural college for their own counties. Lansing was selected as a compromise location, being essentially centrally located between the competing interests. As Kuhn 1955, p. 10 puts it, "The Lansing location was a compromise between rival areas, rather than a reasoned decision. However wise a choice it might prove in the twentieth century, in 1855 it placed the school in an undeveloped and inaccessible part of the state." For this reason, the counties attempting to secure the school do not appear to be good controls for Lansing. With the compromise location settled, the bill establishing the agricultural college passed the legislature and was signed into law by Gov. Bingham in 1855. Construction was completed and classes began in 1857. The Morrill Act of 1862 used the Michigan university system, and Michigan's agricultural college in particular, as a model for the requirements in the act. The agricultural college changed its name to Michigan State University in 1955. This account is drawn from Kuhn 1955, p. 1-12. See also Dunbar and May 1995, p. 279-296 for a broader overview of Michigan's pioneering role in higher education.

University of Minnesota: Even before it became a state, the Minnesota House of Representatives published a report urging the incorporation of a territorial university and establishing an endowment of land that could grow in value until the university opened. An act to this effect was introduced and passed the same year, in 1851. Governor Ramsey advocated for locating the university at Fort Snelling in Hennepin County. But "[f]or some reason which does not appear, this failed to materialize" (Johnson 1910, p. 18). Instead, the university's charter stipulated that the university be located "at or near the Falls of St. Anthony" (quoted on Johnson 1910, p. 18), in present day Minneapolis and Saint Paul, in Hennepin and Ramsey Counties, respectively. As it is unclear why the Fort Snelling site was note used, I consider it a low quality control.

After the passage of the Morrill Act eleven years later, the state had to decide how to allocate its land grant funds. At that time, the university was struggling financially. At the same time, a movement started to establish a new state agricultural college at Glencoe in McLeod County. Minnesota Governor Pillsbury favored having only one state chartered college and giving the entire land grant to the university at St. Anthony. To this end, he donated a plot of land near the campus to be used as the university farm. With this donation in place and the university's debt recently paid off, the legislature voted in 1868 to give the full land grant to the university at St. Anthony. As it is unknown how strong support was for the Glencoe college, and given that the governor was a strong supporter of the university at St. Anthony, I consider this to be a low quality experiment. This account draws from Johnson 1910, p. 29-30 and Brady 2008.

University of Montana: The state legislature in Helena, MT took up the creation of a state university in 1893. Citizens of Missoula, in Missoula County, considered their town ideal due to the fact that it was the most populous city in the western part of the state and its accessibility along a transcontinental railroad line. But Missoula faced competition from Great Falls in Cascade County, the representatives of which had promised "many acres of land and a goodly sum of money" to receive the university (Merriam 1970, p. 2). But the people of Missoula were ready to do what it took to lobby the state legislatures and ensure that their town received the state university. Merriam 1970, p. 2 describes the expense paid to "entertain" the state legislators: "5 gal. whiskey $25, 1 case of beer $5, two dozen Appolinaris $9.60, 1 case wine $42, 350 cigars $34, 1 corkscrew $1." It should be noted that this is quite an expensive corkscrew, worth roughly $29 in 2016 dollars. It is unclear how large of a role the alcohol played in the decision, but the state legislature decided to put the state university in Missoula. The unviersity opened its doors in September 1895. Because little is known about how strong the competition from Great Falls was, I consider this a low quality experiment. This account draws from Merriam 1970, p. 1-3.

Dartmouth College: The Congregationalist minister Eleazer Wheelock opened a school to teach native American children at Lebanon, in New London County, CT, in 1754. Wheelock struggled to recruit students, however, and sought to relocate his school closer to the American frontier. He entertained offers to obtain land for the school in Chester, in Orange County, NY; Wyoming, in Wyoming County, NY; and Albany, in Albany County, NY. Wheelock also had several other offers along the Hudson and Connecticut Rivers, although it is unknown in which towns or counties these sites resided. Later, Wheelock was offered land in Plymouth, Romney, or Compton, all in in Grafton County, NH, in exchange for locating his school there. After touring New Hampshire, Wheelock finally settled on a town in the Cowas District of New Hampshire, which is today Hanover in Grafton County. A charter was obtained in 1769 and the college's name was changed in honor of the Earl of Dartmouth. I consider all of the alternative sites considered, as well as the original location at Lebanon, to be low quality controls. The first students graduated in 1771. This account draws from Smith 1878, p. 29-48.

Montclair State University: The movement to establish a system of normal schools across New Jersey began in 1895, with an address by the state's superintendent of schools that charged that the existing normal school at Trenton was insufficient to serve the state's needs. Progress was slow, however. After the 1900 census revealed that about one third of the state's high school graduates lived in New Jersey's eight northernmost counties, the state legislature was forced to act. Beginning in 1903, the state Board of Education visited 64 sites in Bergen, Essex, Hudson, Morris, Passaic, Sussex, Union, and Warren Counties. In 1904, the Board voted unanimously to locate the new normal school at Montclair in Essex County. Because the vote was unanimous and there is no evidence that any of the other 63 sites were ever strongly in contention, I consider this to be a low quality experiment. The college opened its doors in September, 1908. This account draws from Moore 2008, p. 2-9.

Columbia University: The mid-eighteenth century saw a small wave of new denominational colleges opening in America. New York had largely been immune to the desire for religious colleges spawned by the Great Awakening, as it was a city focused on commerce:

> The founding of Harvard in 1636 and Yale in 1701 had set no competitive juices flowing in New York's merchants. But the announcement in the summer of 1745 that New Jersey - which had only seven years before

> secured a government separate from New York's and was still considered by New Yorkers to be within their cultural catch basin - was about to have its own college demanded an immediate response. (McCaughey 2003, p. 8)

Several prominent New York Anglicans submitted proposals to establish a college: Cadwallader Colden recommended Newburgh in Orange County; James Wetmore recommended Rye in Westchester County; and Samuel Seabury proposed Hempstead, on Long Island in Nassau County. None of these proposals were acted upon, however. In 1752, the Trinity Church offered the Queen's Farm property in New York City. All ten Anglican commissioners voted to accept this site. Because the other locations were never brought to a vote, and the New York City site appears to have been accepted without much debate, I consider this to be a low quality experiment. The college, originally called King's College, opened in July 1754. This account draws from McCaughey 2003, p. 1-25.

New York State Merchant Marine Academy: By the late 1920s, the New York State Merchant Marine Academy was no longer satisfied with performing all instruction aboard ship; the academy's Board of Visitors, and in particular Superintendent James Tomb, wanted to find a permanent site to house the academy. For Schuyler was originally an Army base located at a crucial point to defend the northeast mouth of New York harbor, where the East River meets Long Island Sound. By the late 1920s, however, the Army no longer had any use for the property and were considering turning it over to New York City for use as a park. in 1928, the Board of Visitors learned that the site was available and saw it as an ideal location for the academy. Because it was currently an Army property, it could be purchased for far less than comparable privately-owned properties. Before negotiations could begin, however, the Army removed the fort from its abandoned list with plans to convert it to a military prison. The Board of Visitors consequently examined sites in Queens and at Lloyds Neck and Cold Spring Harbor on Long Island in Suffolk County, "but these did not work out" (Williams 2013, p. 126). After again failing to wrest Fort Schuyler from the Army, the board considered Clason Point in the Bronx, but it was deemed to expensive. In the meantime, the Army again abandoned its plans to use the fort, but the city expressed even greater interest in using the site as a public park. Finally, Tomb was able to convince a major property owner in the residential community adjacent to Fort Schuyler to oppose any city projects on the fort. A bill allowing the college to operate onshore was hastily drafted and passed through a special session of the state legislature in 1933. Once the bill was passed, the War Department drew up a new lease and authorized the purchase of Fort Schuyler for the New York State Merchant Marine Academy, under pressure from new president (and former New York governor and longtime Merchant Marine Academy advocate) Franklin Roosevelt. The academy opened in 1938. Because the Board of Visitors kept returning to fight for Fort Schuyler in spite of other, although clearly less desirable, options, I consider this to be a low quality experiment. In addition, all of the considered locations are either in Burroughs of New York City or located very nearby, all within the New York Metropolitan Area, so there is little cross-city variation in sites considered. This account draws from Williams 2013, p. 124-137.

Duke University: Trinity College was a small Methodist College located at Trinity, in Randolph County, North Carolina. By 1888, college president J. F. Crowell had decided that the college had outgrown its small town and, to fulfill its potential, must move to one of the larger metropolitan areas in the state. Most of the members of the board of trustees, as well as nearly all of the alumni, were strongly opposed to Crowell's plan, but seemingly through sheer force of will he was able to convince the board of the necessity of the move. The next issue was determining which city would be willing to house the city. Crowell originally thought either Greensboro in Guilford County or Winston in Forsyth County would be ideal locations, but neither city offered any financial support. In 1889, the city of Raleigh in Wake County offered $20,500 and a site for the campus if Trinity College moved there. After much deliberation, the board of trustees voted to accept Raleigh's offer contingent on a few other small conditions being accepted. At about the same time, news reached the city of Durham, in Durham County, that Raleigh was about to win Trinity College. Washington Duke, a wealthy Methodist tobacco farmer, offered $50,000, combined with $35,000 from the city, if Trinity College relocated to Durham. In March 1890, the board of trustees drafted a new resolution asking Raleigh to release Trinity from its obligation to move there and accepting the offer from Durham. Raleigh accepted this resolution without any record of putting up much of a fuss. Because the amounts of the offers between Raleigh and Durham are so different, I consider this to be a low quality experiment. The state of North Carolina officially modified Trinity College's charter to move to Durham in 1891, and the college moved to its new home in 1892. The college's name was changed to Duke University in 1924. This account draws from Chaffin 1950, p. 478-519.

University of North Carolina: Presbyterians in North Carolina had been attempting to establish a crown-chartered university since the 1750s. All attempts before the late 1780s had failed due to, among other reasons, disagreements over whether or not the university should be funded by alcohol taxation (Snider 1992, p. 6). The revolutionary war and later debates over whether to adopt the U.S. Constitution had altered the view of many in the state regarding state support for education. Only days after voting to adopt the Constitution, on December 11, 1789, the North Carolina legislature, spurred on by Revolutionary War hero William Richardson Davie, passed a bill establishing a state university, with the stipulation "that the university's site not be within five miles of the seat of government or any place holding court" (Snider 1992, p. 11). A later bill established a board of trustees with the power to raise funds and select a location of the university. The trustees considered sites close to the center of the state in an attempt to ease sectional concerns, reviewing proposals for Raleigh in Wake County (even though Raleigh had become the state capital in 1788), Williamsboro in Granville County, Hillsboro in Orange County, Pittsboro in Chatham County, Cyprett's Bridge in Chatham County, Smithfield in Johnston

County, and Goshen in Granville County. On August 2, 1792, the trustees selected Cyprett's Bridge. Unfortunately, no records exist documenting the vote, so it is impossible to know how strongly the other locations were considered. After exploring land within 15 miles of the bridge, the trustees selected a site on Chapel Hill. It is unknown why this particular plot was chosen, but the current landowners donated a sum of cash to the soon-to-be college. The university first opened its doors on February 12, 1795. This account draws from Snider 1992, p. 3-23.

Akron University: In the 1870s, the Universalist Church in Ohio was looking to establish its own institution of higher education. William S. Kent of Kent in Portage County, had always dreamed of founding a college in his community, and offered up his farm for the site of the college. While Kent offered the land, he did not provide funds for construction. While the church was attempting to raise these funds, the industrialist John R. Buchtel offered $100,000 to locate the college in Akron in Summit County. The church accepted in 1870. Because this was an amount of money far more than Kent was willing to match, and far more than the value of his farm, I consider this to be a low quality experiment. Kent would have to wait almost forty years before he could contribute to a college in his community; in 1910, Kent received the Northeast Ohio Normal School, now known as Kent State University. Buchtel College is now known as Akron University. Classes began in 1872. This account draws from Shriver 1960, p. 15.

The Ohio State University: Like several other states, the legislature in Ohio had to decide whether create a de novo college to receive its land grant funds or to give the funds to one, or possibly several more, existing colleges. In Ohio, three existing colleges were in the running to receive at least a fraction of land grant funds: Miami University at Oxford in Butler County; Ohio University at Athens in Athens County, or at a small institution in College Hill, now a part of Cincinnati, in Hamilton County. Columbus, in Franklin County, was also considered. After an act establishing the college and a board of trustees was passed, the board solicited bids from the interested locations. Following the trustees' solicitation, the board also received offers from Wooster College in Wooster in Wayne County and from the towns of Worthington in Franklin County, Urbana in Champaign County, London in Madison County, and Newark in Licking County, as well as bids from Montgomery and Clark Counties. Montgomery County bid $400,000, while Franklin County bid $300,000 and Champaign and Clark Counties bid $200,000 each (Pollard 1952, p. 10). In 1870, the board selected Columbus's bid even though it was not the largest because they wanted to keep all of the state's main institutions near the capital in Columbus. Because of this strong desire to keep the college close to the capital, it is doubtful that the other sites ever had a real chance, and so I record this as low quality experiments. The university opened it doors on September 17, 1873. This account draws from Knight and Commons 1891, p. 37-39 and Pollard 1952, p. 1-11.

Western Reserve University: Within the first few weeks of its existence, the state legislature of Ohio incorporated the Erie Literary Society, which was given the power to establish a college in the northeastern part of the state set aside for the citizens of Connecticut to compensate them for losses suffered at the hands of the British, known as the Western Reserve. The Erie Literary Society promptly chartered a college at Burton in Geauga County in 1801. While a preparatory school ran intermittently over the next 25 years, the college at Burton never materialized. Fed up by this lack of progress, the Congregationalists and Presbyterians that made up the bulk of the people living in the Western Reserve. In the early 1820s, they began exploring options to independently create a new college. Because the citizens of Burton had shown little interest in starting or supporting a college, they ruled out that city in 1823. Cleveland, in Cuyahoga County, was the next most likely site for the college, but the church leaders believed that a commercial port city was an inappropriate location for a school as there were too many distractions for young men. The church leaders finally settled on Hudson, in Summit Ohio, named after one of the early Connecticut pioneers of the Western Reserve (and a descendant of the famous Henry Hudson) and located on the main road east from Pittsburgh. Because the two other strongest candidates for the site of the college were ruled out for not wanting a college or having an improper atmosphere for a college, I consider this to be a low quality experiment. After petitioning the state legislature, the charter for the Western Reserve College passed in February, 1826. Classes began in 1827. The college would eventually move to downtown Cleveland in 1967 when it formally merged with the Case Institute of Technology, becoming Case Western Reserve University. This account draws from Cramer 1976, p. 3-14.

University of Oklahoma, Oklahoma State University, & University of Central Oklahoma: The Oklahoma legislature met in 1890 to decide how state institutions would be allocated. Representatives from Norman early planned to lobby for the state university. Not wanting to get involved in what was shaping up to be an intense debate over the location of the state capital, the Norman representatives introduced a bill to locate the state university, agricultural college, and normal school separately from other state institutions. The governor was in favor of competitive bidding among the localities to receive state institutions, so the education bills were amended to require the counties to make financial contributions in exchange for receiving the college or university. Eventually, the state university went to Norman in Cleveland County. In contrast to the people of Norman, the citizens of Stillwater, in Payne County, were all too willing to become entangled in the fight to secure the state capital. Realizing that their small town had little hope of winning the capital outright, the majority Populist Party in Payne County offered to align themselves with the Republicans from Kingfisher and Logan Counties to ensure that the state capital would be in Guthrie, in Logan County. In exchange, the Payne County delegates asked for the Republicans' votes in securing the agricultural college for their county. The Republicans, confident in their numerical superiority, turned down the offer, likely with the hopes of securing the agricultural college for one of their own Republican-dominated districts as well. Rebuffed, the delegates from Payne County approached the Democrats, representing Oklahoma County, with the same offer. The Democrats agreed, and combined with the Progressive Party's votes, won the state capital for Oklahoma City in Oklahoma County. The state normal school was also located in Oklahoma County, at the town of Edmond. The agricultural college, now Oklahoma State University, went to Payne County. While the bill to locate the capital was initially vetoed by Republican Governor Steele, the vote to locate the land grant college was not stopped by the governor. Eventually, the issue of locating the capital and normal schools was settled, and as part of the deal, Canadien County received the honors of selecting the state speaker of the house. Although the agricultural college was located in Payne County, there was still no consensus on which town would host it. Commissioners traveled across the county touring various sites, with Perkins emerging as the most likely site. But the representatives of Stillwater had been instrumental in securing the school for Payne County in the first place, and they proved no less adept at winning the agricultural college for themselves (Kamm, Hanneman, and Hiner 1990, p. 17). This account draws from Levy 2005, p. 13-18, Green 1990, p. 3-10, Kamm, Hanneman, and Hiner 1990, p. 17. The list of consolation prizes comes from Wardner 1939, p. 7-8.

University of Tulsa: Henry Kendall College was created as a Presbyterian school in Muskogee, in Muskogee County, in 1894, with the primary objective of teaching Indian children. By 1905, however, the Presbytery concluded that "H.K. College is not worthy to be ranked as a Presbyterian college" (quoted in Logsdon 1977, p. 69).

The college had little funding, and it soon became apparent that it would not survive in Muskogee. The Synod of Indian Territory met in October 1906 to discuss, among other things, the state of Presbyterian schools. The Synod recommended that control of Henry Kendall College revert to the Presbytery and that a Board of Trustees be established to select a permanent site of the college. These recommendations were accepted, and on May 14, 1907, the trustees met in Tulsa to evaluate bids from Guthrie in Logan County, Wynnewood in Garvin County, Muskogee in Muskogee County, Enid in Garfield County, Chickasha in Grady County, Shawnee in Pottawatomie County, El Reno in Canadian County, and Tulsa in Tulsa County. The board accepted the bid from Tulsa, which included $100,000 as well as land and access to public utilities including water and a streetcar line. Unfortunately, I have no information on bids from other counties, and so I consider this to be a low quality experiment. The land in Muskogee was sold and the college was relocated to Tulsa, reopening its door in September 1907. This account draws from Logsdon 1977, p. 35-91.

Drexel University: After taking over his father's banking business and becoming one of the wealthiest men in America, Anthony Drexel turned his attention to philanthropy, hoping to mimic the other great industrialists of his day by sponsoring an institution of higher education. Drexel initially wanted to establish a woman's college in Wayne, in Delaware County, and west of the city of Philadelphia. So committed was he to this idea, that Drexel even purchased the land for the college. Later, however, Drexel changed his mind, concluding that the college was too far from the city.

In addition, Drexel's passion changed from a college for women to a coeducational industrial academy. The Board of Managers for the Drexel Institute of Art, Science and Industry met in downtown Philadelphia, in Philadelphia County, in December, 1891. The formal dedication of the institute followed soon after. Courses began in February 1892. Because it is clear that Drexel considered the downtown site superior to a proposed location in the suburbs, I consider this to be a low quality experiment. This account draws from Butler and Strode 1992, p. 70-71.

University of Rhode Island: In 1887, the state of Rhode Island received $15,000 in Hatch Act funding to establish an agricultural experiment station. The general assembly appointed a committee to determine the best way to distribute these funds. Rather than give the funds to the state's current land grant college, Brown University in Providence in Providence County, the committee recommended establishing a new college. On March 23, 1888, the state legislature passed a bill establishing the Rhode Island Agricultural School in Kingston in Washington County. Classes began in September, 1890. To ensure they would get full use of federal funds from the 1890 Morrill Act, the legislature decided to amend Brown University's charter to formally give the land grant status, and the endowment that went with it, to the newly renamed Rhode Island College of Agriculture and Mechanic Arts. Brown University challenged this move, arguing that all funds from the 1890 Morrill Act should be deposited in Providence; the supreme court issued an injunction preventing any new land grant funds from being sent to Kingston. The court case made it all the way to the United States Supreme Court. Finally in 1894, before the court could decide, the state general assembly passed a compromise act: the state treasurer paid Brown $40,000, and Brown relinquished $138,000 in total land grant funds under its control. The court case was dropped, and the university in Kingston became Rhode Island's official land grant college. This account draws from Tolman 1894, p. 201-202.

University of South Carolina: At the start of the nineteenth century, many in South Carolina chafed at the fact that their state's youths had to go to the northeast to obtain an education. In 1801, Governor John Drayton proposed establishing a state college at the site of the state capital in Columbia in Richland County. In his address, Drayton mentioned several other existing institutions of education, located at Cambridge in Greenwood County, Winnsborough in Fairfield County, Beaufort in Beaufort County, and Alexandria College also in Beaufort County. However, the governor was quick to point out that none of these was sufficient to satisfy the needs of the state, and there is no indication that any location other than the state capital was seriously considered. I thus record this as a low quality experiment. While the bill faced opposition, primarily from people in the northern, rural part of the state that viewed a public college as an unnecessary expense, the bill was signed into law in December 1801. The college oepened its doors in January 1805. This account draws from Green 1916, p. 9-15.

South Dakota State University: The citizens of Brookings, South Dakota sent

John O'Brien Scobey to the territorial legislative session in Yankton in the winter of 1881 with the expectation that he would fight for the state penitentiary. Scobey was unable to convince the legislature to locate the penitentiary in Brookings (it ended up in Sioux Falls in Minnehaha County instead) and, after failing to convince the territorial governor to appoint his friend, George Mathews, as the superintendent of public instruction, he was able to secure Brookings as the location of the territorial agricultural university. There is no evidence that Scobey was particularly close to getting the penitentiary in Brookings, nor is there evidence that other locations were strongly considered for the agricultural university once Brookings had lost out on the penitentiary. For this reason, I consider this to be a low quality experiment. While Brookings was designated as the site in 1881, no funding was provided, and the citizens of Brookings struggled to raise funds while the buildings were constructed over the next several years. The university was designated a land grant college when South Dakota became a state in 1891. This account is drawn from Dunkle and Smith 2003, p. 1-7 and Miller 1989, p. 33-34.

South Dakota School of Mines and Technology: As South Dakota's mineral wealth became apparent after the discovery of gold in 1874, demand for a mining college grew. Rapid City, in Pennington County, grew along with the mining industry in the territory. An 1883 bill to locate the mining college in Rapid City passed the legislature but was vetoed by the governor. Many felt that the college should be located closer to the actual mines, in particular close to either Deadwood in Lawrence County or Keystone, also in Pennington County. As the other considered sites were located closer active mining sites than Rapid City, I record them as low quality controls. Moreover, the Deadwood residents were "seemingly opposed to a school of mines anywhere, especially in Rapid City" (Dirksen 1989, p. 81). A new governor more favorable to the establishment of a mining college was elected in 1884. A similar bill passed the legislature and was signed into law in January 1885, along with a $10,000 building appropriation from the state treasury. The college opened in February 1887. This account draws from Dirksen 1989, p. 81-84.

Vanderbilt University: At first blush, it indeed seems strange that Vanderbilt is located in Nashville, TN. Carey 2003, p. 48 describes the puzzle: "So why on earth did Cornelius Vanderbilt - man who was poorly educated, superstitious, not especially charitable, and who may have never stepped foot in the South in his life - give $500,000 for the establishment of a Methodist College in the South?" Vanderbilt had originally intended to bolster his legacy by establishing a university on Staten Island, in Richmond County, NY, to honor his mother. The Southern Methodist Congregation had already decided that it wanted to establish a centrally located Southern Methodist university, with Nashville, in Davidson County, as the likely site. In March 1873, Southern Methodist Bishop Holland McTyeire was visiting New York to see a surgeon about his bad back. McTyeire happened to be married to one of Cornelius Vanderbilt's cousins, and, while recovering from surgery, he paid the railroad tycoon a visit. During their talk, McTyeire asked Vanderbilt for money for the Methodist university, and Vanderbilt agreed. John Tigert, a biographer of McTyeire, argues that Vanderbilt's wife Frank, deserves the lion's share of the credit for convincing Cornelius to fund the school:

> Her love of Amelia [her cousin and McTyeire's wife], her confidence in the powers of the Bishop, and, above all, her deep devotion to the South and grief for its desperate plight, all prompted her hope of opening the Commodore's heart so that he would want to endow a university in the South...She knew too that her husband was desirous of leaving some great memorial before his death (quoted in Carey 2003, p. 49).

The funding in place, the college opened in the fall of 1875. Because it is unclear how advanced Vanderbilt's plans were to construct a university on Statin Island, and because it was unknown how torn he was between the New York and Tennessee sites, I consider this to be a low quality experiment. This account draws from Carey 2003, p. 41-62.

Baylor University: In 1845, the Texas Baptist Association obtained a federal charter for a new university. They called it Baylor University, named after Judge Robert Baylor, an early and untiring proponent of the school. The school was located in Independence, in Washington County, Texas. The Reverend Rufus Burleson took over as president of Baylor University in 1851. Following a dispute with the director of Baylor's Female College, in 1861 Burleson left to take over the recently founded Baptist college located at Waco, in McLennan County. For more than twenty years, Waco University and Baylor University competed for the resources of the state Baptist Association. By most metrics, including number of students and quality of the facilities, Waco University quickly surpassed its older rival. In 1885, Baylor University President William Crane passed away, removing one of the last remaining impediments to consolidating the two universities. That same year, the annual Texas Baptist Convention finally took up the question of whether and how to merge the two colleges. A special committee on education voted to unite Baylor and Waco universities. The campus would be moved to Waco, and to compensate the losing college, the name of the merged institution would be Baylor University. To ensure its victory, the citizens of Waco promised to provide a "substantial gift of money, land, and facilities" (Baker 1987, p. 46-47). Because the move was a long-time coming and the consensus appears to have been that Waco provided the better site, I regard this as a low quality experiment. This account draws from Baker 1987, p. 9-47.

Rice University: William Marsh Rice became one of the richest men in Texas by the last quarter of the nineteenth century, first through a prosperous import-export business and later through investments in land, railroads, hotels, and cottonseed oil. During the 1867 Houston Yellow Fever Epidemic, Rice left the city and moved to New Jersey. While he would never again reside in Houston, he visited frequently to maintain to his business interests. At some point during his career, Rice developed a passion for education. He originally planned to found an orphans institute near his farm in Dunellen, in Middlesex County, New Jersey. He was so committed to this idea that he even wrote it into his will in 1882. Around the same time, he was exposed to technical institutes in New York, and frequent business visits to Houston convinced him of the need for vocational education in the city where he had made his fortunes. In 1891, Rice signed the charter for the William Marsh Rice Institute for the Advancement of Literature, Science, and Art, establishing a $200,000 endowment for the institute to be located in Houston, in Harris County, Texas. Rice was found dead on September 23, 1900, but the institute was not to be: Rice's will had recently been changed to leave most of his fortune to his lawyer, Albert Patrick. A subsequent investigation discovered that Patrick had forged the new will and convinced Rice's valet to kill him in his sleep. Patrick was arrested, and the institute was back on track. Courses began in the fall of 1912. This account draws from Boles 2007, p. 5-9, 24-26.

United States Coast Guard Academy: While the United State Coast Guard dates back to the establishment of the United States Revenue Cutter Service in 1790, and professional instruction began in 1876, Coast Guard courses were always taught aboard a training ship until 1900. That year, when the Revenue Cutter Service instruction ship docked at Arundel Cove in Anne Arundel County, MD, students got off an began learning on shore for the first time. In 1904, this site was officially dubbed the "School of Instruction." In 1910, Historic Fort Trumbull, located at New London in New London County, CT, was transferred from the War Department to the Commerce Department and became the permanent site of the Coast Guard Academy (although the Coast Guard Academy would not move into its current building until 1932). Unfortunately, I can find no accounts of why Arundel Cove was initially selected as the site of the Academy nor why it was moved to New London, so I therefore record this as a low quality experiment. This account draws from Hughes 1944, p. 48-61.

United States Merchant Marine Training School, New Orleans Region: In addition to the main academy, the U.S. Merchant Marines planned on two regional cadet training schools during the early 1940s. These schools would serve a nearly identical role as the main academy, but would serve cadets in other parts of the country. The New Orleans District Office had been operating out of the Coast Guard Air Station at Biloxi, MI starting in the spring of 1940. The Coast Guard reclaimed its space in November, 1940, however, forcing the Merchant Marine District Office to relocate. Housing at the Algiers Navy Yard in the city of New Orleans also proved temporary. Richard McNulty and New Orleans District Port Inspector-Instructor Allen Hoffman frantically surveyed sites along the gulf looking for land to purchase. They found a piece of land at Bayou St. John, in the city of New Orleans in Orleans Parish, LA. The school was set to be completed by early January, 1942. Until then, the training school operated out of a house boat. Before the building got underway, however, a storm during a training cruise forced the merchant marines into port at Pass Christian, in Harrison County, MI. They discovered that the hotel at which they were staying was for sale, and at a good price; the owners even included a one hundred foot yacht to sweeten the deal. McNulty authorized the purchase for $145,000, and classes began in fall 1942. While the events leading to its adoption were serendipitous, the site at Pass Christian appears to have been an objectively better site than that in Bayou St. John, so I consider this to be a low quality experiment. The New Orleans region training school was closed in 1950, with the remaining cadets there transferring to the main academy in Kings Point, NY. This account is drawn from Cruikshank and Kline 2008, p. 73-74.

United States Military Academy: In the early years of the republic, many in prominent positions in the U.S. government, including Washington, Hamilton, Adams, and Secretary of War Henry Knox, believed that the country needed a permanent military academy. Numerous proposaks for academies were circulated. Most located the academy at the existing fortification at West Point, in Orange County, NY. One prominent proposal from Revolutionary War hero Louis de Tousard advocated locating a permanent academy at either Carlisle, in Cumberland County, PA, or Springfield, in Hampden County, MA. Facing opposition from a penny-pinching Congress and from Jefferson, who argued that establishing such an academy was unconstitutional, the proponents of these academies failed to make much progress until 1798. In that year, new Secretary of War Samuel Dexter realized that he could use existing funds for training artillerists and engineers to create a de facto military academy without Congressional approval. Following his election in 1800, Jefferson reversed his position on establishing a permanent academy and set to work, along withhis Secretary of War Henry Dearborn, to put Dexter's plans into action. As Crackel 2002, p. 44 writes:

> The choice of West Point was a simple one. The post was already associated with the Corps of Artillerists and Engineers, which would be the Academy's most immediate benefactor... Establishing the Academy without going to Congress first, as Dexter had conceived and as Jefferson and Dearborn planned, required placing the school at an established post. West Point was one of a few choices available. Carlisle had been abandoned, and the Springfield Arsenal, which had not been formally established until 1794, was little more than a few storehouses and offices. It was not a decision that Dearborn troubled over.

For this reason, I consider this to be a low quality experiment. The academy was officially recognized by Congress and began instruction in 1802. This account draws from Crackel 2002, p. 36-51.

United States Naval Academy: While the United States Army had an official military academy at West Point, New York since 1801, the Navy had no such academy. Upon his inauguration in 1845, President Polk instructed his Secretary of the Navy, George Bancroft, to improve the Navy in every way possible. With the president's blessing Bancroft, began maneuvering to establish a naval academy without arousing Congressional opposition. Bancroft soon learned about the Army's Fort Stevens overlooking the Severn River in Annapolis, Maryland. The Army no longer had any use of the fort so, while serving as acting Secretary of War, Bancroft signed Fort Stevens over to the Navy. His next challenge was to get the current administrators of the Naval Asylum School, the closest thing the Navy had to an academy, on board with the move to Annapolis. The Naval Asylum School was established in Philadelphia in 1839, and its instructors were initially not excited to move. But by promising an enlarged curriculum, Bancroft "had presented the problem to [the Naval Asylum School administrators] in such a way that it became a question of not whether the school should be organized but where it should be located" (Sturdy 2015, p. 8). In spite of this quote, there does not appear to have been much consideration of other sites. By promising the opportunity to perform gunnery instruction in the Chesapeake Bay, Bancroft was able to get the administrators to agree to the move. It helped that one of the instructors at the Philadelphia asylum owned land about eight miles from Annapolis and "believed that the world revolved around that place" (Sturdy 2015, p. 8). While it had been an important colonial city and even served as capital of the U.S. while Washington, D.C. was being constructed, by 1845 was a backwater, "rich in history, tradition, and little else" (Sweetman 1995, p. 23). Annapolis could therefore scarcely be more different from Philadelphia, so I consider this a low quality experiment. This account is drawn from Sturdy 2015, p. 3-9 and Sweetman 1995, p. 19-25.

University of Vermont: The University of Vermont is noteworthy for being the first public university officially chartered by a state constitution. Vermont's constitution called for a single university to be established within the state. In 1791, the same year that Vermont became a state, the issue of the university was raised in the legislature. Ira Allen, brother of Ethan Allen and an important leader of the Green Mountain Boys in his own right, had been busy even before the bill was drafted, preparing the way for the city of Burlington in Chittenden County to receive the university. Ira Allen introduced the bill and promised 4000 pounds to go towards a college, on the condition that it be located in Burlington. When the bill came up for a vote, 89 members voted in favor of locating the university in Burlington. 24 voted for Rutland in Rutland County, 5 for Manchester in Bennington County, 5 for Williamstown in Orange County, and one each for Danville in Caledonia County, Castelton in Rutland County, and Berlin in Washington County. As there was never much doubt that Burlington would receive the college, I record these as low quality controls. This account is drawn from Lindsay 1954, p. 13-30.

Senator Morrill, who introduced the eponymous land grant colleges act, was from Vermont. Yet the state was not the first to accept federal land grant funding. Instead, the state legislature spent three years arguing over how the fund should be distributed. The initial proposal, laid out in the inaugural address of Governor John Gregory Smith in 1863, called for uniting the three colleges in Vermont into one university system and splitting up and the land grant among them. The three colleges were the University of Vermont located in Burlington, Middlebury College in Middlebury in Addison County, and Norwhich College in Northfield in Washington County. After much debate, the trustees of Middlebury and Norwhich rejected this proposal. Various other proposals to unite different combinations of the three colleges subsequently failed. Finally, in August 1865, a bill proposed locating the new agricultural college at the university in Burlington. This measure was passed in November 1865, and the University of Vermont became the state's land grant college. As the Burlington site was involved in most of the proposals in one form or another, I consider this to be a low quality experiment. This account is drawn from Lindsay 1954, p. 220-223.

College of William and Mary: The first attempts to create a college in Virginia were begun by the Virginia Company around 1617. The company planned a seminary in present-day Henrico County. At the same time, colonists began planning for an East India School to be located at Charles City. An Indian attack in 1622 virtually wiped out Henrico and other settlements along the James River. The plans for these early colleges were scuttled, and the colonists focused their attention on rebuilding. In the subsequent years, the Virginia Company's charter was revoked and the colony became a province of the crown. By 1690, the colonists were again ready to create a college of their own, voting to send the Reverend James Blair to England to petition the king and queen for a royal charter for the school. Blair obtained royal approval in February, 1693. When Blair returned to Virginia in October, 1693, he, along with the Virginia general assembly, set about selecting a college site. They ultimately chose a site known as Middle Plantation, located between the York and James Rivers in what is today Williamsburg, VA. Unfortunately, I do not have any records of which other sites the general assembly considered, but the vote for Middle Plantation was "overwhelming" Godson et al. 1993, p. 24 and was at least partially motivated by a desire to move the capital of Virginia from Jamestown to Williamsburg. I use the two earlier sites, at Henrico and Charles City, as low quality controls. There is evidence that students were attending classes as early as 1697; the main building was finished in 1699. This account draws from Kale 2007, p. 17-29 and Godson et al. 1993, p. 24-25.

University of Virginia: The University of Virginia began as the Albemarle Academy, "a classical school that had existed on paper since just after the turn of the nineteenth century but never got into actual operation" (Dabney 1981, p. 2). By 1814, the trustees of this on-paper academy included President James Monroe, former President James Madison, and, most famously, Thomas Jefferson. Jefferson lobbied hard to transform the academy into a full college, going so far as to design a curriculum and buildings. In 1817, the first cornerstone of Jefferson's proposed college was laid near Jefferson's home in Mount Vernon, outside of Charlottesville, an independent city and the county seat of Albermarle County. In 1818, the Virginia legislature passed a bill establishing a state university. The bill established a commission of 24 to decide on the site; Jefferson and Madison were among the commissioners. Naturally, Jefferson wanted the state university located at the still mostly vacant site in Charlottesville. The commission also considered sites at Lexington, an independent city and county seat of Rockbridge County, and Staunton, an independent city and enclave of Augusta County. Charlottesville's prospects appeared bleak for a time: "The delegates west of the Blue Ridge were divided on whether Staunton or Lexington would be the best site, but they had united to oppose Charlottesville" (Bowman and Santos 2013, p. 27). Because construction had already started in Charlottesville, and likely due to Jefferson's prestige and influence, the commission voted to locate the university in Charlottesville. The legislature continued to debate the issue for another year, but the commission's decision was formally encoded in law on January 25, 1819. The university opened its doors in March 1825. This account draws from Dabney 1981, p. 1-6 and Bowman and Santos 2013, p. 20-32. Bowman and Santos 2013 focus on the enemies Jefferson made throughout his political career and how these enemies threatened Charlottesville's candidacy; nevertheless, for the reasons mentioned above, I view it as likely that Jefferson would have founded a university in Charlottesville, even if the state university was located elsewhere. For this reason, I consider this to be a low quality experiment.

Virginia Military Institute: Following the War of 1812, in which the Virginia militias struggled to keep their arms in serviceable condition, the Virginia legislature established three arsenals throughout the state. One was located at Lexington in Rockbridge County. Another, known as the Bellona Arsenal, was located in Chesterfield County (National Park Service, United States Department of the Interior 1969). I have been unable to determine the location of the third arsenal. The soldiers that were housed at the arsenal "caused disturbances and incidents that upset the 'gentle town' " (Wise 1978, p. p), prompting plans to transform the arsenal into a cadet school in 1834. In March 1836, an act establishing establishing the Virginia Military

Institute was passed by the legislature. The first classes began in 1839. As I can find no evidence regarding why there was a movement to transform the Lexington Arsenal into a military academy but no such movement at the Bellona Arsenal, I consider this to be a low quality experiment. This account draws from Couper 1939, p. 1-36 and Wise 1978, p. 9-14.

University of Washington: In 1855, the Washington territorial legislature passed an act establishing two branches of the state university, one in newly-established town of Seattle in King County and the other in Lewis County. Understandably, both locations wanted the entirety of the university for themselves. Representatives from King County, in particular Arthur Denny, were successful in passing legislation in 1861 getting the entire university for Seattle. In exchange, the King County representatives promised to support efforts to locate a state land office in Port Townsend in Jefferson County, the territorial capital in Vancouver in Clark County, and the state penitentiary in Walla Walla in Walla Walla County. As these other locations also had aspirations to receive state institutions at the same time, I record them as low-quality experiments. Gates 1961, p. 5 explains why the site selection decision in Washington may have been less contentious than other states: "There was some advantage in the fact that higher education in Washington was so much in its nascent stage, that the proponents of a University faced no hostile vested interests and no strong conflicting ideologies." The university officially opened in November, 1861, however it closed several times during its first several years of operation due to a shortage of students;

the first students graduated in 1876. This account draws from Johnston 2003, p. 15.

West Virginia Institute of Technology: Beginning as a preparatory school in 1895, the school in Montgomery, in Fayette County, West Virginia, began granting bachelor's degrees in 1929, officially changing its name to New River State College in 1931. The mountainous location of the college put its campus at risk of landslides, however. As soon as it became a four-year college, rumors began that College President Martin was looking to move the school to a more suitable location. Citizens of the town of Mt. Hope, also in Fayette County, were willing to donate $300,000 and 50 acres of land to attract the college away. The Charleston Civitan Club adopted a resolution in February 1930 calling for relocating the college to Charleston, in Kanawha County. Alarmed that they might lose their school, the citizens of Montgomery lobbied intensely to keep their college. Friends of the college argued before the state legislature that the threat of landslides had been exaggerated. A $50,000 state appropriation and $2,000 local contribution allowed for the purchase of additional lands in Montgomery and landslide prevention measures, ensuring that the school would not be moved. The college was renamed the West Virginia Institute of Technology in 1941. Because of its entrenched status as a Montgomery institution, I consider this to be a low quality experiment. This account draws from Alexander 1992, p. 25-39.

University of Wyoming: Lame-duck territorial governor Francis Warren was determined to cement his legacy by permanently establishing the future state's capital in Cheyenne, in Laramie County. A representative from Laramie County introduced a bill to establish the capital in Cheyenne in February 1886. Not surprisingly, the bill met stiff opposition from counties. It is likely that Warren met secretly with Albany County legislator Stephen Downey, who would become known as the father of the university, prior to the introduction of the bill. Together, there was enough population in Laramie and Albany Counties to carry the Wyoming legislature, but the arguments from other counties were still very intense. In exchange for their support, Albany County was promised the state university. Evanston in Uinta County received the state insane asylum, establishing further support for the location of the capital. In March 1884, bills to locate all three institutions passed the legislature. The university was located in Laramie in Albany County and, after a $50,000 bond issue to construct buildings, the university opened in September 1887. Numerous attempts to establish agricultural colleges, and take a portion of the land grant funds, in the northern regions of the state failed in the ensuing decades. This account is drawn from Hardy 1986, p. 1-9.

B.3 "No" Quality Experiments

Below, I list each of the 83 "no" quality experiments. These are experiments for which no losing finalist locations could be identified. Colleges in this list can be essentially placed into one of two groups. First, there are colleges for which relatively detailed information about the college establishment exists, but only one site was ever seriously considered. The University of Georgia and University of Michigan fall into this category. Second, there are colleges for which there is not enough information to know which other locations may have been considered. This list includes a large number of private universities, for which the site selection process was often opaque and decided by only a few individuals. For each college, I list the year in which it was founded, the current locations, and references to institutional histories.

College	Year Founded	County, State	Source
Tuskeegee University	1880	Macon, AL	Thrasher 1900
Northern Arizona University	1899	Coconino, AZ	Cline 1983
California Institute of Technology	1891	Los Angeles, CA	Goodstein 1991
California Military Academy	1929	Solano, CA	Jaffee 1996
California State University, Fresno	1911	Fresno, CA	Secrest and Larson 2011
San Diego State University	1897	San Diego, CA	Starr 1995
University of California Los Angeles	1881	Los Angeles, CA	Anderson 2015
University of San Diego	1949	San Diego, CA	Engstrand and White 1989
University of Southern California	1880	Los Angeles, CA	Lifton and Moore 2007
Colorado School of Mines	1873	Jefferson, CO	Eckley 2004
Delaware State University	1878	Kent, DE	Skelcher 2000
Goldey-Beacom College	1905	New Castle, DE	Kline 1993
Georgetown University	1789	Washington, DC	Daley 1957, Durkin 1964
George Washington University	1821	Washington, DC	Kayser 1970, George Washington University 1996
University of Miami	1925	Dade, FL	Tebeau 1976
Albany State University	1903	Dougherty, GA	Brown 2003
Georgia Military Institute	1851	Cobb, GA	Livingston 1997, Yates 1968, Rodgers 1890
Georgia State University	1933	Fulton, GA	Smith 2004
University of Georgia	1801	Clarke, GA	Boney 1984, Dooley 2011
University of North Georgia	1873	Lumpkin, GA	Roberts 1998
Boise State University	1932	Ada, ID	Chaffee 1970
Idaho State University	1901	Bannock, ID	Beal 1952, Olson 1999
DePaul University	1898	Cook, IL	Meister 1998, McCann 1998
University of Chicago	1890	Cook, IL	Boyer 2015
University of Louisville	1837	Jefferson, KY	Kentucky Writers' Project of the Works Project Administration 1939
Grambling State University	1901	Lincoln, LA	Gallot 1985
Louisiana Tech University	1894	Lincoln, LA	Gould 1992
Tulane University	1884	Orleans, LA	Dyer 1966
Johns Hopkins University	1876	Baltimore, MD	French 1946, Gilman 1894, Hawkins 1960
University of Maryland Eastern Shore	1886	Somerset, MD	Hytche 2002
Boston College	1863	Suffolk, MA	Donovan, Dunigan, and FitzGerald 1990
Brandeis University	1948	Middlesex, MA	Goldstein 1951, Sachar 1995
Harvard University	1636	Middlesex, MA	Quincy 1860
Massachusetts Institute of Technology	1861	Middlesex, MA	Wylie 1975
Northeastern University	1898	Suffolk, MA	Holton 1998, Fountain 1998
Central Michigan University	1892	Isabella, MI	Westbrook 2007
Michigan Technological University	1885	Houghton, MI	Halkola 1985 McLaughlin 1891
University of Michigan	1837	Washtenaw, MI	McLaughlin 1891
Wayne State University	1868	Wayne, MI	Achenbrenner 2009, Hanawait 1968
Jackson State University	1877	Adams, MS	Dansby 1953
Washington University in St. Louis	1853	St. Louis, MO	Morrow 1996
Montana Tech	1893	Silver Bow, MT	McGlynn 1984
Creighton University	1878	Douglas, NE	Doll 1990, Mihelich 2006

Continued on next page

Table B.1 – continued from previous page

University of Nebraska	1866	Lancaster, NE	Crawford 1925
University of Nevada Las Vegas	1954	Clark, NV	Moehring 2007
New Jersey Institute of Technology	1884	Essex, NJ	Thomas 2004
Princeton University	1746	Mercer, NJ	Oberdorfer 1995, Wertenbaker 1996
Seton Hall University	1856	Morris, NJ	Seton Hall University 1956
Stevens Institute of Technology	1870	Hudson, NJ	Ronde Furman 1905, Rogers 1979, Clark 2000
Fordham University	1841	Westchester, NY	Shelley 2016
New York University	1830	New York, NY	Jones 1933, Frusciano and Pettit 1997
Rensselaer Polytechnic Institute	1824	Rensselaer, NY	Ricketts 1914
Syracuse University	1870	Onondaga, NY	Galpin 1952, Greene 2000
University of Rochester	1850	Monroe, NY	Pieterse 2014
Vassar College	1861	Dutchess, NY	Lossing 1867
Yeshiva University	1886	New York, NY	Klaperman 1969
Wake Forest University	1834	Forsyth, NC	Paschal 1935
Case Institute of Technology	1882	Cuyahoga, OH	Cramer 1980
Oberlin College	1833	Lorain, OH	Fletcher 1943
University of Cincinnati	1819	Hamilton, OH	McGrane 1963, Steger 1995
Langston University	1897	Logan, OK	Patterson 1979
Oklahoma City University	1902	Oklahoma, OK	McGee and McFarland-Fenton 2004
Oklahoma State Tech	1946	Okmulgee, OK	Davis 1991
Southern Oregon University	1969	Jackson, OR	Kreisman 2002
Willamette University	1842	Marion, OR	Hines 1868
Carnegie Mellon University	1900	Allegheny, PA	Fenton 2000, Pileggi 2013
Dickinson College	1783	Cumberland, PA	Morgan 1933, Sellers 1973
Drexel University	1891	Philadelphia, PA	Dilworth and Knowles 2017
Temple University	1884	Philadelphia, PA	Hilty 2010
University of Pennsylvania	1755	Philadelphia, PA	Thomas and Brownlee 2000
University of Pittsburgh	1787	Allegheny, PA	Alberts 1986
Villanova University	1842	Philadelphia, PA	Contosta 1995
Providence College	1917	Providence, RI	McCaffrey 1992
South Carolina State University	1896	Orangeburg, SC	Martin, Berry, and Hine 2000
The Arsenal Academy	1842	Richland, SC	Buckley 2004
The Citadel Academy	1842	Charleston, SC	Bond 1936, Dry 1987, Buckley 2004
Fisk University	1865	Davidson, TN	Richardson 1980
University of Memphis	1912	Shelby, TN	Bond, Sherman, and Breland 2012
Prairie View A&M University	1876	Waller, TX	Nojeim and Jackson 2011
Texas State University	1899	Hays, TX	Brown and Nelson 1999
University of Houston	1927	Harris, TX	Nicholson 1977, Adair and Gutiérrez 2001
University of Texas El Paso	1914	El Paso, TX	Hamilton 1988, Craver and Martin 1992
Bringham Young University	1875	Utah, UT	Wilkinson 1975
University of Utah	1850	Salt Lake, UT	Chamberlin 1960
Norwhich University	1819	Washington, VT	Ellis and Dodge 1911
Hampton University	1868	Hampton, VA	Ludlow and Goodale 1885

Continued on next page

Table B.1 – continued from previous page

James Madison University	1908	Rockingham, VA	Jones 2004
Norfolk State University	1935	Norfolk, VA	Brooks 1983
Old Dominion University	1930	Norfolk, VA	Brydges et al. 2000
Gonzaga University	1887	Spokane, WA	Schmeltzer 2012, Schoenberg 1963
Marshall University	1837	Cabell, WV	Turner 1986
Beloit College	1846	Rock, WI	Eaton 1928
Marquette University	1881	Milwaukee, WI	Jablonsky 2007
University of Wisconsin, Stout	1891	Dunn, WI	Thorie 1990

Table B.1: List of colleges without counterfactual sites.

APPENDIX C
APPENDIX TO CHAPTER 4

C.1 Matching Patents to Counties

As mentioned above in Section 4.3, assigning a particular patent to a county is not trivial. The raw data used to construct the Jim Shaw and SAZ datasets do not contain the county in which an inventor lives; instead, these data only include the town and state of a patentee. It is therefore necessary to first match towns to counties. I use the 100% U.S. decennial censuses to obtain a list of every town in each county. To aid the matching procedure, state, county, and town names are regularized for both the patent and census data. For instance, I replaced "Saint" with "St"; removed the terms "District," "Borough," and "Ward" from town names; and removed the "special" characters such as ();,"' from both datasets. Because county names and boundaries change over time, I aggregate counties to their largest historical boundaries, adopting a method similar to Hornbeck 2010 and Perlman 2015. I next use a fuzzy matching algorithm to match the towns listed in the patent data to a town in the census data, after blocking on state name. More precisely, I match using Stata's reclink command, which is a modified bigram string comparator that returns a "distance" (match score) between two strings.[1] I block on state name and match on the town name. Regularizing town and county names successfully links most of the towns to counties; the fuzzy matching procedure adds relatively few additional

[1]The same algorithm is used to match inventors to the US decennial census in Sarada, Andrews, and Ziebarth 2017.

matches. Figure C.1 plots the number of successfully parsed patents using both the fuzzy matching algorithm as well as when town names are required to match exactly in order to record a successful link. I plot this comparison for both the Jim Shaw and SAZ datasets. Results looking at the fraction of patents successfully parsed each year or the number of counties with at least one successfully parsed patent are similar for both the fuzzy and exact matches.

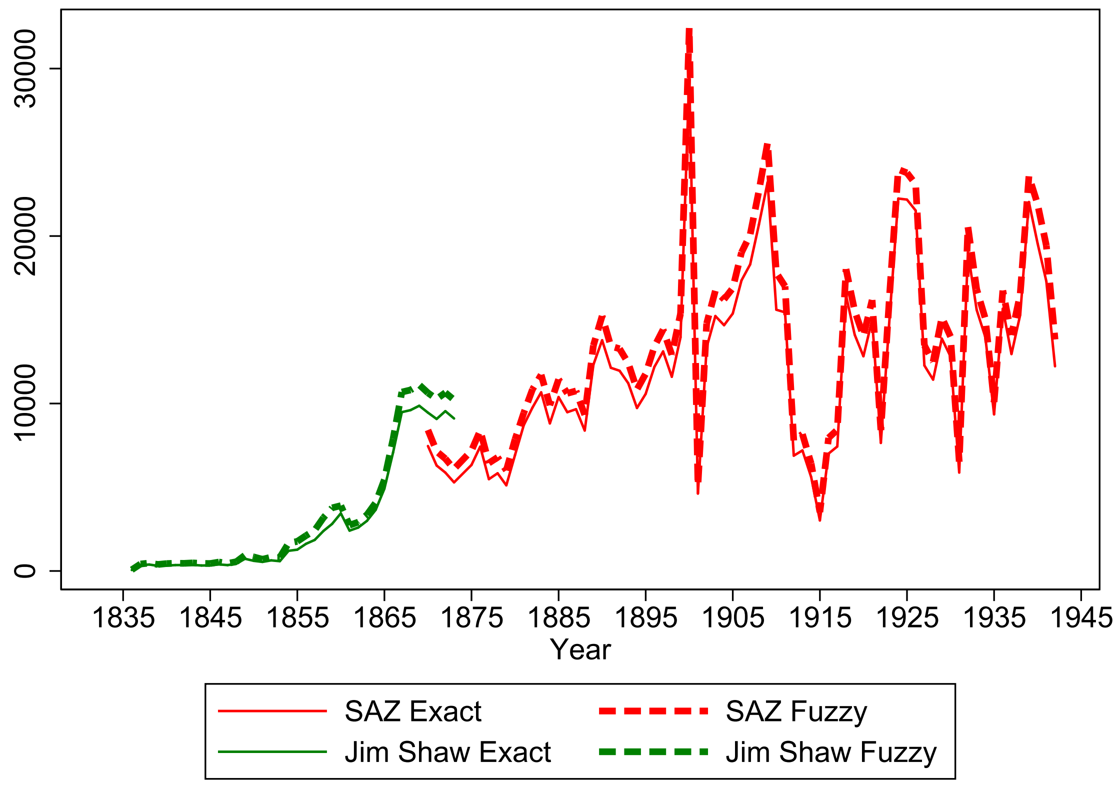


Figure C.1: The number of successfully parsed patents in the Jim Shaw and SAZ datasets when patents are matched to counties using a fuzzy matching procedure to match towns names in patents to town names in the census versus the number of successfully parsed patents when an exact match between town names is required to record a match. Dashed lines indicate fuzzy matching. Solid lines indicate exact matching.

C.2 Discrepancies in Patent Years Between the Jim Shaw and HistPat Data

Several patents appear in both the Jim Shaw and HistPat datasets, but have conflicting patent grant years in each dataset. Table C.1 lists each of these patents by patent number, as well as the recorded grant year for both datasets.

Patent #	Jim Shaw Year	HistPat Year	USPTO HPDF Year
12	1836	1839	-
102	1836	1861	1861
552	1838	1858	1858
1366	1849	1839	1839
1483	1849	1840	1840
3987	1846	1845	1845
4131	1855	1845	1845
5068	1846	1847	1847
7015	1860	1850	1850
8591	1857	1851	1851
9839	1873	1853	1853
10032	1873	1853	1853
10038	1873	1853	1853
10047	1863	1853	1853
10206	1863	1853	1853
10278	1863	1853	1853
11240	1864	1854	1854
12494	1865	1855	1855
14206	1865	1856	1856
14359	1865	1856	1856
15376	1866	1856	1856
15514	1858	1856	1856
15637	1865	1856	1856
16228	1859	1856	1856
16334	1867	1857	1857
17307	1867	1857	1857
20593	1858	1859	1858
24466	1861	1859	1859
33041	1859	1861	1861
37223	1863	1862	1862
51784	1866	1865	1865
52330	1866	1867	1866
93498	1869	1870	1869

Table C.1: Patents that are recorded with different patent years in the Jim Shaw and HistPat datasets.

BIBLIOGRAPHY

Abramitzky, Ran, Leah Platt Boustan, and Katherine Eriksson (2012). “Europe's tired, poor, huddled masses: self-selection and economic outcomes in the Age of Mass Migration”. In: *American Economic Review* 102.5, pp. 1832–1856.

Acharya, Avidit, Matthew Blackwell, and Maya Sen (2016). “Explaining causal findings without bias: detecting and assessing direct effects”. In: *American Political Science Review* 110.3, pp. 512–529.

Achenbrenner, Evelyn (2009). *A history of Wayne State University in photographs.* Detroit: Wayne State University Press.

Adair, Wendy and Oscar Gutiérrez (2001). *University of Houston: our time: celebrating 75 years of learning and leading.* Virginia Beach, VA: The Donning Company Publishers.

Aghion, Philippe et al. (2009). “The causal impact of education on economic growth: evidence from the United States”. In: *Brookings Papers on Economic Activity*, pp. 1–73.

Aghion, Philippe et al. (2016). “Living the American dream in Finland: the social mobility of inventors”. Unpublished, University of Chicago.

Agrawal, Ajay, Iain Cockburn, and John McHale (2006). “Gone but not forgotten: knowledge flows, labor mobility, and enduring social relationships”. In: *Journal of Economic Geography* 6.5, pp. 571–591.

Aizer, Anna et al. (2016). “The long-run impact of cash transfers to poor families”. In: *American Economic Review* 106.4, pp. 935–971.

Akcigit, Ufuk, John Grigsby, and Tom Nicholas (2017). “The birth of American ingenuity: innovation and inventors of the golden age”. Unpublished, University of Chicago.

Alberts, Robert C. (1986). *Pitt: the story of the University of Pittsburgh, 1787-1987.* Pittsburgh: University of Pittsburgh Press.

Aldrich, James M. (1991). *Fair winds - stormy seas: 50 years of Maine Maritime Academy.* Stonington, ME: Penobscot Books, a division of Penobscot Bay Press.

Alexander, Ronald R. (1992). *West Virginia Tech: a history.* Charleston, WV: Pictorial Histories Publishing Co., Inc.

Allen, Robert C. (1983). “Collective invention”. In: *Journal of Economic Behavior and Organization* 4, pp. 1–24.

Allison, Paul D. and Richard P. Waterman (2002). “Fixed-effects negative binomial regression models”. In: *Sociological Methodology* 32.

Anderson, Keith W. (2015). *The Los Angeles State Normal School: UCLA's forgotten past: 1881-1919*.

Anderson, Nancy Scott (1993). *An improbable venture: a history of University of California, San Diego*. La Jolla, CA: The UCSD Press.

Andersson, Roland, John M. Quigley, and Mats Wilhelmsson (2004). “University decentralization as regional policy: the Swedish experiment”. In: *Journal of Economic Geography* 4.4, pp. 371–388.

— (2009). “Urbanization, productivity, and innovation: evidence from investment in higher education”. In: *Journal of Urban Economics* 66.1, pp. 2–15.

Andrews, Michael (2017a). “Comparing historical patent datasets”. Unpublished, University of Iowa.

— (2017b). “The role of universities in local invention: evidence from the establishment of U.S. colleges”. Unpublished, University of Iowa.

Angrist, Joshua D and Alan B Krueger (1992). “The effect of age at school entry on educational attainment: an application of instrumental variables with moments from two samples”. In: *Journal of the American Statistical Association*.

Ashcraft, Catherine and Anthony Breitzman (2007). *Who invents IT? An analysis of women's participation in information technology patenting*. Tech. rep. National Center for Women in Information Technology.

Baker, Eugene W. (1987). *To light the ways of time: an illustrated history of Baylor University, 1845-1986*. Waco, TX: Baylor University Press.

Balin, Fred (2001). *Homebrew's 26th birthday commemoration*. Unpublished e-mail; accessed online at http://www.bambi.net/bob/homebrew_reunion_article.txt on May 3, 2017.

Ballard, Michael B. (2008). *Maroon and white: Mississippi State University, 1878-2003*. Oxford, MS: University Press of Mississippi.

Banerjee, Abhijit et al. (2013). “The diffusion of microfinance”. In: *Science* 341.6144, pp. 363–370.

Banta, David Demaree (1889). *History of Indiana University: the siminary period (1820-1828)*. David Banta.

Barro, Robert J. (1991). “Economic growth in a cross section of countries”. In: *Quarterly Journal of Economics* 106.2, pp. 407–443.

Bartholomew, Karen, Claude Brinegar, and Roxanne Nilan (2001). *A chronology of Stanford University and its founders*. Stanford, CA: Stanford Historical Society.

Beal, Merrill D. (1952). *History of Idaho State College*. Merrill D. Beal.

Beaman, Lori et al. (2012). “Female Leadership Raises Aspirations and Educational Attainment for Girls: A Policy Experiment in India”. In: *Science* 335.6068, pp. 582–586.

Beeton, Beverly (1986). *Women Vote in the West: The Woman Suffrage Movement, 1869-1896*. New York: Garland Publishing.

Bell, Alex et al. (2016). “The lifecycle of inventors”. Unpublished, Harvard University.

Benhabib, Jess and Mark M. Spiegel (1994). “The role of human capital in economic development: evidence from aggregate cross-country data”. In: *Journal of Monetary Economics* 34.2, pp. 143–173.

Bertrand, Marianne, Claudia Goldin, and Lawrence F. Katz (2010). “Dynamics of the gender gap for young professionals in the financial and corporate sectors”. In: *American Economic Journal: Applied Economics* 2.3, pp. 228–255.

Beveridge, Allan and Graeme Yorston (1999). “I drink, therefore I am: alcohol and creativity”. In: *Journal of the Royal Society of Medicine* 92.12, pp. 646–648.

Bianchi, Nicola and Michela Giorcelli (2017). “Scientific education and innovation: from technical diplomas to university STEM degrees”. Unpublished, Northwestern University.

Bils, Mark and Peter J. Klenow (2000). “Does schooling cause growth?” In: *American Economic Review* 90.5, pp. 1160–1183.

Bishop, Morris (1962). *A history of Cornell*. Drawings by Alison Mason Kingsbury. Ithaca, NY: Cornell University Press.

Bleakley, Hoyt and Emily Owens (2010). “Volence beyond reason: temperance and lynching in the southern United States, 1890-1930”. Unpublished, Cornell University.

Bloomfield, Susanne George, Richard D. Schuessler, and Eric Melvin Reed (2005). *From the beginning: 1905-2005: a century of excellence: University of Nebraska at Kearney*. Kearney, NE: University of Nebraska at Kearney.

Blume, Lawrence E. et al. (2011). “Identification of social interactions”. In: *Handbook of Social Economics*. Ed. by Jess Benhabib, Alberto Bisin, and Matthew O. Jackson. Vol. 1B. Amsterdam: Elsevier.

Blundell, Richard, Rachel Griffith, and John Van Reenen (1995). "Dynamic count data models of technological innovation". In: *The Economic Journal* 105.429, pp. 333–344.

Bodenhorn, Howard (2016). "Blind tigers and red-tape cocktails: liquor control and homicide in late-nineteenth-century South Carolina". NBER Working Paper 22980.

Boles, John B. (2007). *University builder: Edgar Odell Lovett and the founding of the Rice Institute*. Baton Rouge, LA: Louisiana State University Press.

Bond, Beverley, Janann Sherman, and Frances Wright Breland (2012). *University of Memphis*. Charleston, SC: Arcadia Publishing.

Bond, Oliver James (1936). *The story of the Citadel*. Richmond, VA: Garrett and Massie Publishers.

Boney, F. N. (1984). *A pictorial history of the University of Georgia*. Athens, GA: University of Georgia Press.

Bonner, J. C., Myron W. House, and James W. Mathews (1998). *From A&M to state university: a history of the State University of West Georgia*. Carrollton, GA: State University of West Georgia Foundation.

Borgschulte, Mark (2014). "The effect of presidential service on life expectancy". Unpublished, University of California Berkeley.

Borgschulte, Mark and Jacob Vogler (2016). "The effect of executive service on life expectancy: evidence from US governors". Unpublished, University of Illinois.

Bound, John (1989). "The health and earnings of rejected disability insurance applicants". In: *American Economic Review* 79.3, pp. 482–503.

Bound, John and Sarah Turner (2002). "Going to war and going to college: did World War II and the G.I. Bill increase educational attainment for returning veterans?" In: *Journal of Labor Economics* 20.4, pp. 784–815.

Bowman, Rex and Carlos Santos (2013). *Rot, riot, and revellion: Mr. Jefferson's struggle to save the university that changed America*. Charlottesville, VA: University of Virginia Press.

Boyer, John W. (2015). *The University of Chicago: a history*. Chicago: The University of Chicago Press.

Brady, Tim (2008). *The land deal*. University of Minnesota Alumni Association.

Bratton, Mary Jo Jackson (1986). *East Carolina University: the formative years, 1907-1982*. Greenville, NC: East Carolina University Alumni Association.

Breschi, Stefano and Francesco Lissoni (2009). "Mobility of skilled workers and co-invention networks: an anatomy of localized knowledge flows". In: *Journal of Economic Geography* 9.4, pp. 439–468.

Brooks, F. Erik (2014). *Tigers in the tempest: Savannah State University and the struggle for civil rights*. Macon, GA: Mercer University Press.

Brooks, Lyman Beecher (1983). *Upward: a history of Norfolk State University*. Washington, DC: Howard University Press.

Brown, Dee (1958). *The Gentle Tamers: Women of the Old West*. University of Nebraska Press.

Brown, Pete (2014a). *Shakespeare's pub: a barstool history of London as seen through the windows of its oldest pub - the George Inne*. New York: St. Martin's Griffin.

Brown, Ray (2014b). *Mississippi colleges that have closed, merged, or changed names*. College History Garden, website, https://collegehistorygarden.blogspot.com/2014/12/mississippi-colleges-that-have-closed.html, accessed Sep. 9, 2016.

Brown, Ronald C. and David C. Nelson (1999). *Up the hill, down the years: a century in the life of the college in San Marcos, Southwest Texas State University, 1899-1999*. Marceline, MO: Walsworth Publishing Company.

Brown, Titus (2003). *Albany State University: a centennial history: 1903-2003*. Charl eston, SC: Arcadia Publishing.

Brydges, Maggie et al. (2000). *Old Dominion University: from the Great Depression to the new millennium, 1930-2000*. Norfolk, VA: Old Dominion University.

Buckley, William H. (2004). *The Citadel and the South Carolina Corps of Cadets*. Charleston, SC: Arcadia Publishing.

Burnes, Brian (2014). *Missou175: the remarkable story of Missouri's flagship university from 1839 to 2014*. Kansas City, MO: Rockhill Books.

Burr, Nelson R. (1942). *Education in New Jersey, 1630-1871*. Princeton, NJ: Princeton University Press.

Butler, William and William Strode, eds. (1992). *Drexel University: a century of growth and challenge*. Prospect, KY: Harmony House Publishers.

Callcott, George H. (1966). *A history of the University of Maryland*. Baltimore, MD: Maryland Historical Society.

Cameron, A. Colin, Jonah B. Gelbach, and Douglas L. Miller (2011). "Robust inference with multiway clustering". In: *Journal of Business & Economic Statistics* 29.2, pp. 238–249.

Cameron, Colin A. and Douglas L. Miller (2015). “A practitioner’s guide to cluster-robust inference”. In: *Journal of Human Resources* 50.2, pp. 317–372.

Cantoni, Davide and Noam Yuchtman (2014). “Medieval universities, legal institutions, and the commercial revolution”. In: *Quarterly Journal of Economics* 129.2, pp. 823–887.

Carey, Bill (2003). *Chancellors, commodores, and coeds: a history of Vanderbilt University*. Nashville, TN: Clearbrook Press Publishing, LLC.

Carey, James C. (1977). *Kansas State University: the quest for identity*. Lawrence, KS: The Regents Press of Kansas.

Cary, Harold Whiting (1962). *The University of Massachusetts: a history of one hundred years*. Amherst, MA: University of Massachusetts.

Celik, Murat Alp (2015). “Does the cream always rise to the top? The misallocation of talent in innovation”. Unpublished, University of Pennsylvania.

Chaffee, Eugene B. (1970). *Boise College: an idea grows*. Boise, ID: SYMS-YORK Company.

Chaffin, Nora Campbell (1950). *Trinity College, 1839-1892: the beginning of Duke University*. Durham, NC: Duke University Press.

Chamberlin, Ralph V. (1960). *The University of Utah: a history of its first hundred years, 1850 to 1950*. Salt Lake City, UT: University of Utah Press.

Chandler, Alfred D. (1990). *Scale and scope: the dynamics of industrial capitalism*. Cambrdige, MA: Belknap Press.

Chattopadhyay, Raghabendra and Esther Duflo (2004). “Women as policy makers: Evidence from a randomized policy experiment in India”. In: *Econometrica* 72.5, pp. 1409–1443.

Cheever, Susan (2015). *Drinking in America: our secret history*. New York: Twelve.

Clark, Geoffrey W. (2000). *History of Stevens Institute of Technology: a record of broad-based curricula and technogenesis, 1870-2000*. Jersey City, NJ: Jensen/Daniels, Publishers.

Cline, Platt (1983). *Mountain campus: the story of Northern Arizona University*. Flagstaff, AZ: Northland Press.

Coale, Ansley J. and Norfleet W. Rives (1973). “A Statistical Reconstruction of the Black Population of the United States 1880-1970: Estimates of True Numbers by Age and Sex, Birth Rates, and Total Fertility”. In: *Population Index* 39.1, pp. 3–26.

Cohen, Wesley M. (2010). "Fifty years of empirical studies of innovative activity and performance". In: *Handbook of the Economics of Innovation*. Ed. by Bronwyn H. Hall and Nathan Rosenberg. Vol. 1. Amsterdam: Elsevier.

Cole, Terrence (1994). *The cornerstone on College Hill: an illustrated history of the University of Alaska Fairbanks*. Fairbanks, AK: University of Alaska Press.

Combs, Earl William (1921). "A history of the Illinois State Normal Schools from 1857-1920". Unpublished Master's Dissertation, University of Chicago.

Conley, Timothy G. and Christopher R. Udry (2010). "Learning about a new technology: pineapple in Ghana". In: *American Economic Review* 100.1, pp. 35–69.

Contosta, David R. (1995). *Villanova University: America - Catholic - Augustinian, 1842-1992*. University Park, PA: Pennsylvania State University Press.

Cook, Lisa D. (2004). "African American inventors data set".

— (2011). "Inventing social capital: evidence from African American inventors, 1843-1930". In: *Explorations in Economic History* 48.4, pp. 507–218.

— (2014). "Violence and economic activity: evidence from African American patents, 1870-1940". In: *Journal of Economic Growth* 19.2, pp. 221–257.

Cook, Lisa D. and Chaleampong Kongcharoen (2010). "The idea gap in pink and black". NBER Working paper 16331.

Cook, Lisa D., Trevon D. Logan, and John M. Parman (2013). "Distinctively black names in the American past". NBER Working Paper 18802.

— (2014). "Distinctively black names in the American past". In: *Explorations in Economic History* 53, pp. 64–82.

Correia, Sergio (2016). "Linear models with high-dimensional fixed effects: an efficient and feasible estimator". Unpublished, Board of Governors of the Federal Reserve System.

Couper, William (1939). *One hundred year at V.M.I.* Vol. 1. Richmond, VA: Garrett and Massie, Incorporated.

Cowan, Brian (2005). *The social life of coffee: the emergence of the British coffeehouse*. New Haven, CT: Yale University Press.

Cowan, Robin and Natalia Zinovyeva (2013). "University effects of regional innovation". In: *Research Policy* 42.3, pp. 788–800.

Crackel, Theodore J. (2002). *West Point: a bicentennial history*. Lawrence, KS: University Press of Kansas.

Cramer, Clarence H. (1976). *Case Western Reserve: a history of the university, 1826-1976*. Boston, MA: Little, Brown and Company.

— (1980). *Case Institute of Technology: a centennial history, 1880-1980*. Cleveland, OH: Case Western Reserve University.

Craver, Rebecca McDowell and Charles H. Martin, eds. (1992). *Diamond days: an oral history of the University of Texas at El Paso*. El Paso, TX: Texas Western Press.

Crawford, Robert Platt (1925). *These fifty years: a history of the College of Agriculture of the University of Nebraska*. Lincoln, NE: University of Nebraska Press.

Cruikshank, Jeffrey L. and Chloë G. Kline (2008). *In peace and war: a history of the U.S. Merchant Marine Academy at Kings Point*. Hoboken, NJ: John Wiley & Sons.

Currie, Janet and Enrico Moretti (2003). "Mother's education and the intergenerational transmission of human capital: evidence from college openings". In: *Quarterly Journal of Economics* 118.4, pp. 1495–1532.

Curti, Merle and Vernon Carstensen (1949). *The University of Wisconsin: a history, 1848-1925*. Vol. 1. Madison, WI: University of Wisconsin Press.

Dabney, Virginius (1981). *Mr. Jefferson's university: a history*. Charlottesville, VA: University of Virginia Press.

Dale, Stacy Berg and Alan B. Krueger (2002). "Estimating the payoff to attending a more selective college: an application of selection on observables and unobservables". In: *Quarterly Journal of Economics* 117.4, pp. 1491–1527.

Daley, John M. (1957). *Georgetown University: origin and early years*. Washington, DC: Georgetown University Press.

Dansby, B. Baldwin (1953). *A brief history of Jackson College: a typical story of the survival of education among negroes in the south*. New York: American Book-Stratford Press.

Davis, Larry D. (1991). *A history of Oklahoma State University at Okmulgee*. Stillwater, OK: Oklahoma State University.

Davis, Neil (1992). *The College Hill chronicles: how the University of Alaska came of age*. Fairbanks, AK: University of Alaska Foundation.

Davis, William E. (1965). *Glory Colorado! A history of the University of Colorado, 1858-1963*. Boulder, CO: Pruett Press.

Dethloff, Henry C. (1975). *A centennial history of Texas A&M University, 1876-1976, Vol. I*. College Station, TX: Texas A&M University Press.

Dills, Angela and Jeffrey Miron (2004). “Alcohol prohibition and cirrhosis”. In: *American Law and Economics Review* 62.

Dilworth, Richardson and Scott Gabriel Knowles, eds. (2017). *Building Drexel: the university and its city, 1891-2016*. Philadelphia: Temple University Press.

Ding, Waverly W., Fiona Murray, and Toby E. Stuart (2006). “Gender differences in patenting in the academic life sciences”. In: *Science* 313.5787, pp. 665–666.

Dirksen, Larry L. (1989). “Gold, silver, and the Black Hills: South Dakota School of Mines and Technology”. In: *From idea to institution: higher education in South Dakota*. Ed. by Herbert T. Hoover et al. Vermillion, SD: University of South Dakota Press.

Doherty, Jr., William T. and Festus P. Summers (1982). *West Virginia University: symbol of unity in a sectionalized state*. Morgantown, WV: West Virginia University Press.

Doll, Don (1990). *Creighton University*. Louisville, KY: Harmony House.

Donovan, Charles F., David R. Dunigan, and Paul A. FitzGerald (1990). *History of Boston College: from the beginnings to 1990*. Chestnut Hill, MA: University Press of Boston College.

Dooley, Vince (2011). *History and reminiscences of the University of Georgia*. Decatur, GA: Looking Glass Books.

Doten, Samuel Bradford (1924). *An illustrated history of the University of Nevada*. The University of Nevada.

Drowne, Kathleen (2005). *Spirits of defiance: national prohibition and jazz age literature*. Columbus, OH: Ohio State University Press.

Dry, Dan (1987). *The Citadel: the military college of South Carolina*. Louisville, KY: Harmony House Publishers.

Dunaway, Wayland Fuller (1946). *History of the Pennsylvania State College*. Lancaster, PA: Lancaster Press, Inc.

Dunbar, Willis F. and George S. May (1995). *Michigan: a history of the wolverine state*. Third. First edition 1965. Grand Rapids, MI: William B. Eerdmans Publishing Co.

Dunkle, Amy and V.J. Smith (2003). *The college on the hill: a sense of South Dakota State University history*. Sioux Falls, SD: Pine Hill Press.

Duranton, Giles and Diego Puga (2004). “Micro-foundations of urban agglomeration economies”. In: *Handbook of Urban and Regional Economics*. Ed. by J. Vernon Henderson and Jacques-Francois Thisse. Vol. 4. Amsterdam: Elsevier.

Durkin, Joseph T. (1964). *Georgetown University: first in the nation’s capital*. Garden City, NJ: Doubleday & Company, Inc.

Dutton, Harry I. (1984). *The patent system and inventive activity during the Industrial Revolution, 1750-1852*. Manchester: Manchester University Press.

Dyer, John P. (1966). *Tulane: the biography of a university, 1834-1965*. New York: Harper & Row.

Eaton, Edward Dwight (1928). *Historical sketches of Beloit College*. New York: A. S. Barnes and Company.

Eckley, Wilton (2004). *Rocky mountains to the world: a history of the Colorado School of Mines*. Virginia Beach, VA: Donner Company Publishers.

Economist, The (2012). “Something in the air: why birds of a tech feather flock together”. In: *The Economist*. accessed online at http://www.economist.com/news/special-report/21565001-why-birds-tech-feather-flock-together-something-air on April 30, 2017.

Elliott, Orrin Leslie (1937). *Stanford University: the first twenty-five years*. Stanford University, CA: Stanford University Press.

Ellis, Aytoun (1956). *The penny universities: a history of the coffee houses*. Secker & Warburg.

Ellis, William Arba and Grenville Mellen Dodge (1911). *Norwhich University, 1819-1911: her history, her graduates, her roll of honor, vol. I: general history, 1819-1911*. Montpelier, VT: Capital City Press.

Ellis, William E. (2005). *A history of Eastern Kentucky University: the school of opportunity*. The University Press of Kentucky.

Engstrand, Iris and Clare White (1989). *The first forty years: a history of the University of San Diego, 1949-1989*. San Diego, CA: University of San Diego.

Evans, Mary F. et al. (2016). “The developmental effect of state alcohol prohibitions at the turn of the twentieth century”. In: *Economic Inquiry* 54.2, pp. 762–777.

Fagan, George V. (2006). *Air Force Academy heritage: the early years*. Golden, CO: Fulcrum Publishing.

Fan, J. and I. Gijbels (1996). *Local polynomial modelling and its applications*. New York: Chapman & Hall.

Feigenbaum, James J. (2015). “Automated census record linkage”. Unpublished, Harvard University.

Fenton, Edwin (2000). *Carnegie Mellon: 1900-2000, a centennial history*. Pittsburgh: Carnegie Mellon Press.

Ferrie, Joseph P. (1996). “A new sample of males linked from the public use microdata sample of the 1850 US federal census of population to the 1860 US federal census manuscript schedules”. In: *Historical Methods: A Journal of Quantitative and Interdisciplinary History* 29.4, pp. 141–156.

Ferrier, William Warren (1930). *Origin and development of the University of California*. Berkeley, CA: The Sather Gate Book Shop.

Fisher, Irving (1927). *Prohibition at its worst: revised*. New York: Alcohol Information Committee.

Fleming, Walter L. (1936). *Louisiana State University: 1860-1896*. Baton Rouge, LA: Louisiana State University Press.

Fletcher, Robert Samuel (1943). *A history of Oberlin College: from its foundation through the Civil War, volume I*. Oberlin, OH: Oberlin College.

Florida, Richard (2002). *The rise of the creative class: and how it's transforming work, leisure, community and everday life*. New York: Basic Books.

— (2005). *Cities and the creative class*. New York: Routledge.

Fogli, Alessandro and Laura Veldkamp (2016). “Germs, social networks and growth”. NBER Working Paper 18470.

Foley, C. Fritz and William Kerr (2013). “Ethnic Innovation and U.S. Multinational Firm Activity”. In: *Management Science* 59.7, pp. 1529–1544.

Fountain, Charles (1998). “Profiles of the presidents who forged Northeastern”. In: *Tradition and innovation: reflections on Northeastern University's first century*. Ed. by Linda Smith Rhoads. Boston: Northeastern University Publications.

French, John C. (1946). *A history of the university founded by Johns Hopkins*. Baltimore, MD: The Johns Hopkins Press.

Frenette, Marc (2009). “Do universities benefit local youth? Evidence from the creation of new universities”. In: *Economics of Education Review* 28, pp. 318–328.

Frietsch, Rainer et al. (2009). “Gender-specific patterns in patenting and publishing”. In: *Research Policy* 38.4, pp. 590–599.

Frusciano, Thomas J. and Marilyn H. Pettit (1997). *New York University and the city: an illustrated history*. New Brunswick, NJ: Rutgers University Press.

Frykman, George A. (1990). *Creating the people's university: Washington State University, 1890-1990*. Pullman, WA: Washington State University Press.

Furman, Jeffrey L. and Megan J. MacGarvie (2007). "Academic science and the birth of industrial research laboratories in the U.S. pharmaceutical industry". In: *Journal of Economic Behavior & Organization* 63.4, pp. 756–776.

Gallot, Mildred B. G. (1985). *A history of Grambling State University*. Lanham, MD: University Press of America.

Galpin, William Freeman (1952). *Syracuse University: the pioneer days*. Syracuse, NY: Syracuse University Press.

García-Jimeno, Camilo (2016). "The political economy of moral conflict: an empirical study of learning and law enforcement under prohibition". In: *Econometrica* 84.2, pp. 511–570.

Gates, Charles M. (1961). *The first century at the University of Washington*. Seattle, WA: University of Washington Press.

Geiger, Louis G. (1958). *University of the northern plains: a history of the University of North Dakota, 1883-1958*. Grand Forks, ND: The University of North Dakota Press.

George Washington University (1996). *From strength to strength: a pictorial history of the George Washington University, 1821-1996*. Washington, DC: The George Washington University.

Gerber, John C. et al. (2005). *A pictorial history of the University of Iowa: an expanded edition*. First edition 1988. Iowa City, IA: University of Iowa Press.

Gibbs, Clifford L. (1939). "The establishment of Texas Technological College". Lubbock, TX.

Gibbs, Rafe (1962). *Beacon for mountain and plain: story of the University of Idaho*. Regents of the University of Idaho.

Gibbs, Warmoth T. (1966). *History of the North Carolina Agricultural and Technical College: Greensboro, North Carolina*. Dubuque, IA: Wm. C. Brown Book Company.

Gilman, Daniel C. (1894). "The Johns Hopkins University (1874-1894)". In: *United States Bureau of Education Circular of Information No. 2, 1894, Contributions to American Educational History*. Ed. by Bernard C. Steiner. Washington, DC: Government Printing Office.

Glaeser, Edward L. and Joshua D. Gottlieb (2009). “The wealth of cities: agglomeration economics and spatial equilibrium in the United States”. In: *Journal of Economic Literature* 47.4, pp. 983–1028.

Glaeser, Edward L. et al. (1992). “Growth in cities”. In: *Journal of Political Economy* 100.6, pp. 1126–1152.

Godson, Susan H. et al. (1993). *The College of William & Mary: a history: volume I, 1693-1888*. Williamsburg, VA: King and Queen Press.

Goldin, Claudia and Lawrence F. Katz (1999). “The shaping of higher education: the formative years in the United States, 1890 to 1940”. In: *Journal of Economic Perspectives* 13.1, pp. 37–62.

— (2008). *The race between education and technology*. Cambridge, MA: The Belknap Press of the Harvard University Press.

— (2011). “Putting the “co” in education: timing, reasons, and consequences of college coeducation from 1835 to the present”. In: *Journal of Human Capital* 5.4, pp. 377–417.

Goldstein, Israel (1951). *Brandeis University: chapter of its founding*. New York: Bloch Publishing Company.

Goodstein, Judith R. (1991). *Millikan's school: a history of the California Institute of Technology*. New York: W. W. Norton & Company.

Google Patents Team, The (2016). *Your Google Patents question*. electronic correspondence, February 16, 2016.

Gould, Philip (1992). *Louisiana Tech University: then and now*. Louisville, KY: Harmony House.

Granovetter, Mark (2005). “The impact of social structure on economic outcomes”. In: *Journal of Economic Perspectives* 19.1, pp. 33–50.

Green, Donald E. (1990). *A history of the Oklahoma State University Division of Agriculture*. Stillwater, OK: Oklahoma State University.

Green, Edwin L. (1916). *A history of the University of South Carolina*. Columbia, SC: The State Company.

Greene, John (2000). *The hill: an illustrated biography of Syracuse University, 1870-present*. Syracuse, NY: Syracuse University Press.

Greene, William (2005). “Functional form and heterogeneity in models for count data”. In: *Foundations and Trends in Econometrics* 1.2, pp. 113–218.

Greenstone, Michael, Richard Hornbeck, and Enrico Moretti (2010). "Identifying agglomeration spillovers: evidence from winners and loser of large plant openings". In: *Journal of Political Economy* 118.3, pp. 536–598.

Griffin, Clifford S. (1974). *The University of Kansas: a history.* Lawrence, KS: University Press of Kansas.

Griliches, Zvi (1990). "Patent statistics as economic indicators: a survey". In: *Journal of Economic Literature* 28.4, pp. 1661–1707.

Grimes, Alan (1967). *The Puritan Ethic and Woman Suffrage.* New York: Oxford University Press.

Guimaraes, Paulo (2008). "The fixed effects negative binomial model revisited". In: *Economics Letters* 99.1, pp. 63–66.

Gumprecht, Blake (2003). "The American college town". In: *Geographical Review* 93.1, pp. 51–80.

Haggard, Theodore M. (1985). *Florida Southern College, Lakeland, Florida: the first 100 years.*

Hailwood, Mark (2014). *Alehouses and good fellowship in early modern England.* Woodbridge, England: The Boydell Press.

Halkola, David T. (1985). *Michigan Tech Centennial, 1885-1985.* Chelsea, MI: Book Crafters, Inc.

Hall, Bronwyn H., Adam B. Jaffe, and Manuel Trajtenberg (2001). "The NBER patent citation data file: lessons, insights and methodological tools". NBER Working Paper.

Hall, Clyde W. (1991). *One hundred years of educating at Savannah State College, 1890-1990.* East Peoria, IL: Versa Press, Inc.

Hall, Colby D. (1947). *History of Texas Christian University: a college of the cattle frontier.* Fort Worth, TX: Texas Christian University Press.

Halvorsen, Robert and Raymond Palmquist (1980). "The interpretation of dummy variables in semilogarithmic equations". In: *American Economic Review* 70.3, pp. 474–475.

Hamilton, Nancy (1988). *UTEP: a pictorial history of the University of Texas at El Paso.* El Paso, TX: Texas Western Press.

Hanawait, Leslie L. (1968). *A place of light: the history of Wayne State University.* Detroit: Wayne State University Press.

Hancks, Jeffrey W. and Adam J. Carey (2009). *Western Illinois University*. Chicago, IL: Arcadia Publishing.

Hansen, James E. (1977). *Democracy's college in the Centennial State: a history of Colorado State University*. Fort Collins, CO: Colorado State University.

Hardin, John A. (1987). *Onward and upward: a centennial history of Kentucky State University 1886-1986*. Frankfort, KY: Kentucky State University.

Hardy, Deborah (1986). *Wyoming Universityy: the first 100 years, 1886-1986*. University of Wyoming.

Hart, Irving H. (1951). *The first 75 years*. Cedar Falls, IA: The Iowa State Teachers College.

Hausman, Jerry, Bronwyn H. Hall, and Zvi Griliches (1984). "Econometric models for count data with an application to the patents-R&D relationship". In: *Econometrica* 52.4, pp. 909–938.

Hausman, Naomi (2013). "University innovation, local economic growth, and entrepreneurship". Unpublished, Hebrew University.

Hawkins, Hugh (1960). *Pioneer: a history of the Johns Hopkins University, 1874-1889*. Ithaca, NY: Cornell University Press.

Hayter, Earl W. (1974). *Education in transition: the history of Northern Illinois University*. DeKalb, IL: Northern Illinois University Press.

Hicken, Victor (1970). *The purple and the gold: the story of Western Illinois University*. Macomb, IL: Western Illinois University Foundation.

Hicks, Joshua A. et al. (2011). "Expecting innovation: psyochactive drug primes and the generation of creative solutions". In: *Experimental and Clinical Psychopharmacology* 19.4, pp. 314–320.

Hildebrand, William H. (2009). *A most noble enterprise: the story of Kent State University, 1910-2010*. Kent, OH: Kent State University Press.

Hilty, James W. (2010). *Temple University: 125 years of service to Philadelphia, the nation, and the world*. Philadelphia: Temple University Press.

Hines, Gustavus (1868). *Oregon and its institutions: comprising a full history of the Willamette University, the first established on the Pacific Coast*. New York: Sabin Americana.

Hippel, Eric von (1988). *The sources of innovation*. Oxford: Oxford University Press.

Hoagland, Monica (1989). “Organizing the system of higher education: the South Dakota Board of Regents”. In: *From idea to institution: higher education in South Dakota*. Ed. by Herbert T. Hoover et al. Vermillion, SD: University of South Dakota Press.

Hobbs, Allyson (2014). *A chosen exile: a history of racial passing in American life*. Cambridge, MA: Harvard University Press.

Holic, Nathan and the UCF Alumni Association (2009). *University of Central Florida*. Charleston, SC: Arcadia Publishing.

Holton, Will (1998). “The best of all possible worlds: a historical view of Northeastern’s environs”. In: *Tradition and innovation: reflections on Northeastern University’s first century*. Ed. by Linda Smith Rhoads. Boston: Northeastern University Publications.

Hope, Arthur J. (1978). *Notre Dame: one hundred years*. South Bend, IN: Icarus Press, Inc.

Hopkins, James F. (1951). *The University of Kentucky: origins and early years*. Lexington, KY: University of Kentucky Press.

Hornbeck, Richard (2010). “Barbed wire: property rights and agricultural development”. In: *Quarterly Journal of Economics* 125.2, pp. 767–810.

Howes, Charles C. (1963). *Kansas State University: a pictorial history: the first century, 1863-1963*. Manhattan, KS: Kansas State University.

Hsieh, Chang-Tai et al. (2016). “The allocation of talent and US economic growth”. Unpublished, Chicago Booth.

Hughes, Riley (1944). *Our Coast Guard Academy: a history and guide*. New York: The Devin-Adair Company.

Hunt, Jennifer et al. (2012). “Why don’t women patent?” IZA Discussion Paper 6886.

Hytche, William Percy (2002). *Polishing the diamon: a history of the University of Maryland Easter Shore*. Four-G Publishers.

Igami, Mitsuru and Jai Subrahmanyam (2015). “Patent statistics as an innovation indicator? Evidence from the hard disk drive industry”. Unpublished, Yale University.

Iliffe, Rob (1995). “Material doubts: Hooke, artisan culture and the exchange of information in 1670s London”. In: *The British Journal for the History of Science* 28.3, pp. 285–318.

Isbell, Egbert R. (1971). *A history of Eastern Michigan University 1849-1965*. Ypsilanti, MI: Eastern Michigan University Press.

Jablonsky, Thomas J. (2007). *Milwaukee's Jesuit university: Marquette, 1881-1981.* Milwaukee, WI: Marquette University Press.

Jacks, David, Krishna Pendakur, and Hitoshi Shigeoka (2016). "Infant mortality and the repeal of federal prohibition". Unpublished, Simon Fraser University.

Jackson, Matthew O. (2011). "An overview of social networks and economic applications". In: *Handbook of Social Economics*. Ed. by Jess Benhabib, Alberto Bisin, and Matthew O. Jackson. Vol. 1A. Amsterdam: Elsevier.

Jackson, Matthew O. and Leeat Yariv (2011). "Diffusion, strategic interaction, and social structure". In: *Handbook of Social Economics*. Ed. by Jess Benhabib, Alberto Bisin, and Matthew O. Jackson. Vol. 1A. Amsterdam: Elsevier.

Jacobs, Jane (1961). *The death and life of great American cities*. New York: Random House.

Jaffe, Adam B. (1989). "Real effects of academic research". In: *American Economic Review* 79.5, pp. 957–970.

Jaffe, Adam B., Manuel Trajtenberg, and Rebecca Henderson (1993). "Geographic localization of knowledge spillovers as evidenced by patent citations". In: *Quarterly Journal of Economics* 108.3, pp. 577–598.

Jaffee, Walter W. (1996). *The track of the Golden Bear: the California Maritime Academy schoolships*. Palo Alto, CA: Glencannon Press.

Jarrold, Rachel M. and Glenn E. Fromm (1955). *Time the great teacher: a history of one hundred years of the New Jersey State Teachers College at Trenton, 1855-1955.* Princeton, NJ: Princeton University Press.

Jaspin, Elliot (2007). *Buried in the bitter waters: the hidden history of racial cleansing in America*. New York: Basic Books.

Joffe, Marshall M. and Tom Greene (2009). "Related causal frameworks for surrogate outcomes". In: *Biometrics* 65.2, pp. 530–538.

Johnson, E. Bird, ed. (1910). *Forty years of the University of Minnesota*. Minneapolis: The General Alumni Association.

Johnson, Eldon Lee (1956). *"From turnip patch to university": the University of New Hampshire at Durham*. New York: The Newcomen Society in North America.

Johnston, Norman J. (2003). *The fountain and the mountain: the University of Washington campus in Seattle*. University of Washington.

Jones, Benjamin F. (2009). “The burden of knowledge and the “death of the renaissance man”: is innovation getting harder?” In: *Review of Economic Studies* 76.1, pp. 283–317.

— (2010). “Age and great invention”. In: *Review of Economics and Statistics.*

Jones, Charles (2005). “Growth and ideas”. In: *Handbook of Economic Growth.* Ed. by Philippe Aghion and Steven Durlauf. Vol. 1B. Amsterdam: Elsevier.

Jones, Maxine D. and Joe M. Richardson (1990). *Talladega College: the first century.* Tuscaloosa, AL: University of Alabama Press.

Jones, Nancy Bondurant (2004). *Rooted on Blue Stone Hill: a history of James Madison University.* Santa Fe, NM: Center for American Places, Inc.

Jones, Theodore Francis (1933). *New York University: 1832 : 1932.* New York: The New York University Press.

Jung, Taehyun and Olof Ejermo (2014). “Demographic patterns and trends in patenting: gender, age, and education of inventors”. In: *Technological Forecasting and Social Change* 86, pp. 110–124.

Kaiser, Jocelyn (2008). “Zerhouni’s parting message: make room for young scientists”. In: *Science* 322.5903, pp. 834–835.

Kale, Wilford (2007). *Hark upon the gale: an illustrated history of the College of William and Mary in Virginia.* Williamsburg, VA: Botetourt Press.

Kamins, Robert M. and Robert E. Potter (1998). *Malamalama: a history of the University of Hawai’i.* Honolulu, HI: University of Hawai’i Press.

Kamm, Robert B., Carolyn G. Hanneman, and Carol L. Hiner (1990). *The first hundred years: Oklahoma State University: people, programs, places.* Stillwater, OK: Oklahoma State University.

Kammen, Carol (2003). *Cornell: glorious to view.* Ithaca, NY: Cornell University Library.

Kantor, Shawn and Alexander Whalley (2014). “Knowledge spillovers from research universities: evidence from endowment value shocks”. In: *Review of Economics and Statistics* 96.1, pp. 171–188.

— (2016). “Research proximity and productivity: long-term evidence from agriculture”. Unpublished, Florida State University.

Kayser, Elmer Louis (1970). *Bricks without straw: the evolution of George Washington University.* New York: Appleton-Century-Crofts.

Kennedy, Peter E. (1981). “Estimation with correctly interpreted dummy variables in semilogarithmic equations”. In: *American Economic Review* 71.4, p. 801.

Kentucky State University (2016). *History*. Kentucky State University: About KSU, website, http://kysu.edu/about-ksu/history/, accessed Mar. 15, 2016.

Kentucky Writers’ Project of the Works Project Administration (1939). *A centennial history of the University of Louisville*. Louisville, KY: University of Louisville.

Kerr, William and William Lincoln (2010). “The supply side of innovation: H-1B visa reforms and US ethnic invention”. In: *Journal of Labor Economics* 28.3, pp. 473–508.

Kerr, William R. (2008a). “Ethnic scientific communities and international technology diffusion”. In: *Review of Economics and Statistics* 90.3, pp. 518–537.

— (2008b). “The ethnic composition of US inventors”. HBS Working Paper 08-006.

— (2010). “The agglomeration of U.S. ethnic inventors”. In: *Agglomeration Economics*. Ed. by Edward Glaeser. Chicago: University of Chicago Press.

Khan, B. Zorina (2009). *The democratization of invention: patents and copyrights in American economic development, 1790-1920*. New York: Cambridge University Press.

Khan, B. Zorina and Kenneth L. Sokoloff (1993). “”Schemes of practical utility”: entrepreneurship and innovation among ”great inventors” in the United States, 1790-1865”. In: *Journal of Economic History* 53.2, pp. 289–307.

Kilgore, Kathleen (1991). *Transformations: a history of Boston University*. Boston: Boston University.

King, Brayden, Marie Cornwall, and Eric Dahlin (2005). “Winning Woman Suffrage One Step at a Time: Social Movements and the Logic of Legislative Process”. In: *Social Forces* 83.3, pp. 1211–1234.

Kinnear, Duncan Lyle (1972). *The first 100 years: a history of Virginia Polytechnic Institute and State University*. Blacksburg, VA: Virginia Polytechnic Institute Educational Foundation, Inc.

Klaperman, Gilbert (1969). *The story of Yeshiva University: the first Jewish university in America*. London: Macmillan Company.

Kline, Lloyd W. (1993). *A history of Goldey-Beacom College*. Wilmington, DE: Goldey-Beacom College.

Kline, Patrick and Enrico Moretti (2014a). “Local economic development, agglomeration economies, and the big push: 100 years of evidence from the Tennessee Valley Authority”. In: *Quarterly Journal of Economics* 129.1, pp. 275–331.

Kline, Patrick and Enrico Moretti (2014b). "People, places, and public policy: some simple welfare economics of local economic development programs". In: *Annual Review of Economics* 6, pp. 629–662.

Knight, George W. and John R. Commons (1891). *The history of higher education in Ohio*. United States Bureau of Education Circular of Information No. 5, 1891, Contributions to American Educational History, edited by Herbert H. Adams. Washinton, DC: Government Printing Office.

Knutson, Wayne S. (1989). "A story of faith and endurance: the University of South Dakota". In: *From idea to institution: higher education in South Dakota*. Ed. by Herbert T. Hoover et al. Vermillion, SD: University of South Dakota Press.

Kreisman, Arthur (2002). *Remembering: a history of Southern Oregon University*. Eugene, OR: University of Oregon Press.

Kropp, Simon F. (1972). *That all may learn: New Mexico State University, 1888-1964*. New Mexico State University.

Krueger, Alan B. and Mikael Lindahl (2001). "Education for growth: why and for whom?" In: *Journal of Economic Literature* 39.4, pp. 1101–1136.

Kuhn, Madison (1955). *Michigan State: the first hundred years, 1855-1955*. The Michigan State University Press.

Lamoreaux, Naomi R. and Kenneth L. Sokoloff (2005). "The decline of the independent inventor: a Schumpeterian story". NBER Working Paper 11654.

Landis, Lawrence A. (2015). *A school for the people: a photographic history of Oregon State University*. Corvallis, OR: Oregon State University Press.

Larson, Taft (1971). "Emancipating the West's Dolls, Vassals and Hopeless Drudges: the Origins of Women's Suffrage in the West". In: *Essays in Western History in Honor of T. A. Larson*. Ed. by Roger Daniels. University of Wyoming Press.

Leggett, M. D. (1874b). *Subject-matter index of patents for invention issued by the United States Patent Office from 1790 to 1873, inclusive*. Vol. 1. Washington, DC: Government Printing Office.

— (1874c). *Subject-matter index of patents for invention issued by the United States Patent Office from 1790 to 1873, inclusive*. Vol. 2. Washington, DC: Government Printing Office.

— (1874d). *Subject-matter index of patents for invention issued by the United States Patent Office from 1790 to 1873, inclusive*. Vol. 3. Washington, DC: Government Printing Office.

Leggett, M. D. (1874a). *Subject-matter index of patents for invention issued by the United States Patent Office from 1790 to 1873, inclusive*. Vol. 1-3. Washington, DC: Government Printing Office.

Leone, Janice M. and John Lodl (2011). "Middle Tennessee State Normal School comes to Murfreesboro, 1909-1911". In: *Middle Tennessee State University: a centennial legacy*. Ed. by Janice M. Leone. Twin Oaks Press.

Levy, David W. (2005). *The University of Oklahoma: a history: volume 1, 1890-1917*. Norman, OK: University of Oklahoma Press.

Lewis, Michael (2008). "Access to saloons, wet voter turnout, and statewide prohibition". In: *Social Science History* 32.3.

Li, Guan-Cheng et al. (2014). "Disambiguation and co-authorship networks of the U.S. Patent Inventor Database (1975-2010)". In: *Research Policy* 43.6, pp. 941–955.

Lifton, Sarah and Annette Moore (2007). *The University of Southern California: 1880 to 2005*. Los Angeles: Figueroa Press.

Lindsay, Julian Ira (1954). *Tradition looks forward: the University of Vermont: a history, 1791-1904*. Burlington, VT: The University of Vermont and State Agricultural College.

List, John A., Sally Sadoff, and Mathis Wagner (2011). "So you want to run an experiment, now what? Some simple rules of thumb for optimal experimental design". In: *Experimental Economics* 14.4, pp. 439–457.

Liu, Shimeng (2015). "Spillovers from universities: evidence from the land-grant program". In: *Journal of Urban Economics* 87, pp. 25–41.

Livingston, Gary (1997). *Cradled in glory: Georgia Military Institute: 1851-1865*. Cooperstown, NY: Caisson Press.

Logan, Trevon D. and John M. Parman (2017). "The national rise in residential segregation". In: *Journal of Economic History* 77.1, pp. 127–170.

Logsdon, Guy William (1977). *The University of Tulsa: a history, 1882-1972*. Norman, OK: University of Oklahoma Press.

London, Jack (1913). *John Barleycorn*. New York: The Century Company.

Long, Jason and Joseph Ferrie (2013). "Intergenerational occupational mobility in Great Britain and the United States since 1850". In: *American Economic Review*.

Lossing, Benson J. (1867). *Vassar College and its founder*. New York: C.A. Alvord Printer.

Lott, John R. and Lawrence W. Kenny (1999). “Did women’s suffrage change the size and scope of government?” In: *Journal of Political Economy* 107.6, pp. 1163–1197.

Lucas, Robert E. and Benjamin Moll (2014). “Knowledge growth and the allocation of time”. In: *Journal of Political Economy* 122.1, pp. 1–51.

Ludlow, Helen W. and Elaine Goodale (1885). *Hampton Institute, 1868-1885: its work for two races*. Hampton, VA: Normal School Press Print.

Marco, Alan C. et al. (2015). “The USPTO historical patent data files: two centuries of invention”. Unpublished, USPTO Economic Working Papter No. 2015-1.

Marshall, Alfred (1890). *Principles of economics*. London: Macmillan and Co.

Martin, Douglas D. (1960). *The lamp in the desert: the story of the University of Arizona*. Tucson, AZ: The University of Arizona Press.

Martin, Frank C., Aimee R. Berry, and William C. Hine (2000). *South Carolina State University*. Charleston, SC: Arcadia Publishing.

Marx, Matt, Jasjit Singh, and Lee Fleming (2015). “Regional disadvantage? Employee non-compete agreements and brain drain”. In: *Research Policy* 44.2, pp. 394–404.

Marx, Matt, Deborah Strumsky, and Lee Fleming (2009). “Mobility, skills, and the Michigan non-compete experiment”. In: *Management Science* 55.6, pp. 875–889.

McCaffrey, Donna T. (1992). “Introduction”. In: *Then and now: Providence College*. Louisville, KY: Harmony House.

McCann, Dennis P. (1998). “The foundling university: reflections on the early history of DePaul”. In: *DePaul University: centennial essays and images*. Ed. by John L. Rury and Charles S. Suchar. Chicago: DePaul University.

McCaughey, Robert A. (2003). *Stand, Columbia: a history of Columbia University in the city of New York, 1754-2004*. New York: Columbia University Press.

McGee, Ryan and Rebecca McFarland-Fenton (2004). *A century of service: Oklahoma City University*. Oklahoma Heritage Association.

McGlynn, Terrence D. (1984). *Montana Tech, 1893-1984*. Butte, MT: Montana Tech Foundation.

McGrane, Reginald C. (1963). *The University of Cincinnati: a success story in urban higher education*. New York: Harper & Row, Publishers.

McLaughlin, Andrew C. (1891). *Higher education in Michigan*. Washington, DC: Government Printing Office.

McMath Jr., Robert C. et al. (1985). *Engineering the new south: Georgia Tech, 1885-1985*. Athens, GA: The University of Georgia Press.

Meister, Richard (1998). "DePaul University: Catholic, Vincentian and urban". In: *DePaul University: centennial essays and images*. Ed. by John L. Rury and Charles S. Suchar. Chicago: DePaul University.

Merriam, H. G. (1970). *The University of Montana, a history*. Missoula, MT: University of Montana Press.

Mihelich, Dennis N. (2006). *The history of Creighton University, 1878-2003*. Omaha, NE: Creighton University Press.

Miller, Grant (2008). "Women's suffrange, political responsiveness, and child survival in American history". In: *Quarterly Journal of Economics* 123.3, pp. 1287–1327.

Miller, Jim (2016a). *Jim Shaw Historical Patent Data*. electronic correspondence, October 24, 2016.

— (2016b). *Jim Shaw Historical Patent Data*. electronic correspondence, November 1, 2016.

Miller, John E. (1989). "Science, service, and learning in the land grant tradition: South Dakota State University". In: *From idea to institution: higher education in South Dakota*. Ed. by Herbert T. Hoover et al. Vermillion, SD: University of South Dakota Press.

Miller, Perry (1961). "Introduction". In: *America: a sketch of its political, social, and religious character*. Belknap/Harvard.

Mitch, David (1999). "The role of education and skill in the British Industrial Revolution". In: *The British Industrial Revolution: an economic perspective*. Ed. by Joel Mokyr. 2nd ed. Boulder, CO: Westview Press, pp. 241–279.

Mitchell, Betty (1993). *Southern Illinois University: a pictorial history*. St. Louis, MO: G. Bradley Publishing, Inc.

Moehring, Eugene P. (2007). *The University of Nevada, Las Vegas: a history*. Reno, NV: University of Nevada Press.

Mokyr, Joel (2002). *The gifts of Athena: historical origins of the knowledge economy*. Princeton, NJ: Princeton University Press.

— (2005). "The intellectual origins of modern economic growth". In: *Journal of Economic History* 65.2, pp. 285–351.

Montgomery, James Riley, Stanley J. Folmsbee, and Lee Seifert Greene (1984). *To foster knowledge: a history of the University of Tennessee, 1794-1970*. Knoxville, TN: The University of Tennessee Press.

Moore, Joseph Thomas (2008). *Montclair State University: a century of triumph over circumstance*. Montclair, NJ: Montclair State University.

Moore, Lucia W., Nina W. McCornack, and Gladys W. McCready (1949). *The story of Eugene*. New York: Stratford House.

Moran, Peter L. and Roger L. Williams (2013). "Saving the land grant for the Agricultural College of Pennsylvania". In: *The land-grant colleges and the reshaping of American higher education*. Ed. by Roger L. Geiger and Nathan M. Sorber. New Brunswick, NJ: Transaction Publishers.

Moretti, Enrico (2004). "Estimating the social return to higher education: evidence from longitudinal and repeated cross-sectional data". In: *Journal of Econometrics* 121.1-2, pp. 175–212.

Morgan, Chester M. (2010). *Treasured past, golden future: the centennial history of the University of Southern Mississippi*. The University of Southern Mississippi and University Press of Mississippi.

Morgan, James Henry (1933). *Dickinson College: the history of one hundred and fifty years*. Carlisle, PA: Dickinson College.

Morrow, Ralph E. (1996). *Washington University in St. Louis: a history*. Missouri Historical Society Press.

Moser, Petra (2005). "How do patent laws influence innovation? Evidence from ninet eenth-century world's fairs". In: *American Economic Review* 95.4, pp. 1214–1236.

— (2016). "Patents and innovation in economic history". In: *Annual Review of Economics* 8, pp. 241–258.

Mowery, David C. (1990). "The development of industrial research in U.S. manufacturing". In: *American Economic Review* 80.2, pp. 345–349.

Munroe, John A. (1986). *The University of Delaware: a history*. Newark, DE: University of Delaware.

Nagaoka, Sadao, Kazuyuki Motohashi, and Akira Goto (2010). "Patent statistics as an innovation indicator". In: *Handbook of the Economics of Innovation*. Ed. by Bronwyn H. Hall and Nathan Rosenberg. Vol. 2. Amsterdam: Elsevier, pp. 1083–1127.

National Park Service, United States Department of the Interior (1969). *National Register of Historic Places: inventory - nomination form: Bellona Arsenal*.

Nauman, Robert Allen (2004). *On the wings of modernism: the United States Air Force Academy*. Urbana and Chicago, IL: University of Illinois Press.

Neyland, Leedell W. and John W. Riley (1963). *The history of Florida Agricultural and Mechanical University*. Gainesville, FL: University of Florida Press.

Nicholas, Tom (2009). "Spatial diversity in invention: evidence from the early R&D labs". In: *Journal of Economic Geography* 9.1, pp. 1–31.

— (2010). "The role of independent invention in U.S. technological development, 1880-1930". In: *Journal of Economic History* 70.1, pp. 57–82.

— (2011). "Cheaper patents". In: *Research Policy* 40.2, pp. 325–339.

Nicholson, Patrick J. (1977). *In time: an anecdotal history of the first fifty years of the University of Houston*. Houston, TX: Pacesetter Press.

Nix, Emily and Nancy Qian (2015). "The Fluidity of Race: "Passing" in the United States, 1880-1940". Unpublished.

Nojeim, Michael J. and Frank D. Jackson (2011). *Down that road: a pictorial history of Prairie Valley View A&M University*. Virginia Beach, VA: Donning Company Publishers.

Norlander, Torsten (1999). "Inebriation and inspiration? A review of the research on alcohol and creativity". In: *Journal of Creative Behavior* 33.1, pp. 22–44.

Oberdorfer, Don (1995). *Princeton University: the first 250 years*. Princeton, NJ: The Trustees of Princeton University.

Okrent, Daniel (2010). *Last call: the rise and fall of Prohibition*. New York: Scribner.

Oldenburg, Ray (1989). *The great good place: cafés, coffee shops, bookstores, bars, hair salons and other hangouts at the heart of a community*. Philadelphia: Da Capo Press.

Olenski, Andrew R., Matthew V. Abola, and Anupam B.Jena (2015). "Do heads of government age more quickly? Observational study comparing mortality between elected leaders and runners-up in national elections of 17 countries". In: *British Medical Journal* 351, pp. 1–7.

Olshansky, S. Jay (2011). "Aging of US presidents". In: *The Journal of the American Medical Association* 306.21, pp. 2328–2329.

Olson, Diane (1999). *Idaho State University: a centennial chronicle*. Pocatello, ID: Idaho State University.

Ousley, Clarence (1935). *History of the Agricultural and Mechanical College of Texas.* Bulletin of the Agricultural and Mechanical College of Texas, Fourth Series, Vol. 6, No. 8. College Station, TX: Agricultural and Mechanical College of Texas.

Owens, Emily G. (2011). “The birth of organized crime? The American temperance movement and market-based violence”. Unpublished, Cornell University.

Packalen, Mikko and Jay Bhattacharya (2015a). “Cities and ideas”. NBER Working Paper.

— (2015b). “New ideas in invention”. NBER Working Paper.

Paschal, George Washington (1935). *History of Wake Forest College: volume I, 1834-1865.* Winston-Salem, NC: Wake Forest College.

Patterson, Zella J. Black (1979). *Langston University: a history.* Norman, OK: University of Oklahoma Press.

Payne, Darwin (2016). *One hundred years on the hilltop: the centennial history of Southern Methodist University.* Dallas, TX: Southern Methodist University.

Perlman, Elisabeth Ruth (2015). “Dense enough to be brilliant: patents, urbanization, and transportation in nineteenth century America”. Unpublished, Boston University.

Petersen, Keith C. (1987). *This crested hill: an illustrated history of the University of Idaho.* Moscow, ID: University of Idaho Press.

Petralia, Sergio, Pierre-Alexandre Balland, and David L. Rigby (2016a). “Data descriptor: unveiling the geography of historical patents in the United States from 1836-1975”. In: *Nature: Scientific Data* 3. Article number: 160074, pp. 1–14.

— (2016b). *Historical Patent Dataset.* http://dx.doi.org/10.7910/DVN/BPC15W, accessed September 15, 2016.

Pieterse, Janice Bullard (2014). *Our work is but begun: a history of the University of Rochester, 1850-2005.* Rochester, NY: Meliora Press.

Pileggi, Leah (2013). *How to design a world-class engineering college: a history of engineering at Carnegie Mellon University.* Pittsburgh: Carnegie Mellon University Press.

Pittard, Homer (1973). “Union: Murfreesboro’s other university”. In: *Rutherford Coun ty Historical Society* 1, pp. 29–69.

Plucker, Jonathan A., Andrea McNeely, and Carla Morgan (2009). “Controlled sub stance-related beliefs and use: relationships to undergraduates’ creative personality traits”. In: *Journal of Creative Behavior* 43.2, pp. 94–101.

Poirier, Alexandre and Nicolas L. Ziebarth (2016). "Estimation of models with multiple-valued explanatory variables". Unpublished, University of Iowa.

Pollard, James E. (1952). *History of the Ohio State University: the story of its first seventy-five years, 1873-1948*. Columbus, OH: The Ohio State University Press.

Posey, Josephine McCann (1994). *Against great odds: the history of Alcorn State University*. Jackson, MS: University Press of Mississippi.

Powers, Madelon (1999). *Faces along the bar: lore and order in the workingman's saloon, 1870-1920*. Chicago, IL: University of Chicago Press.

Presley, Delma Eugene (2006). *The southern century: Georgia Southern University, 1906-2006*. Statesboro, GA: Georgia Southern University.

Pridmore, Jay (2012). *Northwestern University: a history*. Evanston, IL: Northwestern University Press.

Proctor, Samuel and Wright Langley (1986). *Gator history: a pictorial history of the University of Florida*. Gainesville, FL: South Star Publishing Company.

Putnam, Daniel (1899). *A history of the Michigan State Normal School (now Normal College) at Ypsilanti, Michigan, 1849-1899*. Ypsilanti, MI: The Scharp Tag, Label & Box Co.

Putnam, Robert D. (2000). *Bowling alone: the collapse and revival of American community*. New York: Simon & Schuster.

Quincy, Josiah (1860). *The history of Harvard University*. Boston: Crosby, Nichols, Lee, and Co.

Raider, Ran (2016). *Patent Data*. electronic correspondence, October 21, 2016.

Reagan, Alice Elizabeth (1987). *North Carolina State University: a narrative history*. Ann Arbor, MI: Edwards Brothers, Inc.

Reel, Jerome V. (2011). *the high seminary: a history of the Clemson Agricultural College of South Carolina, 1889-1964*. Vol. 1. Clemson, SC: Clemson University Digital Press.

Rees, David and Audrey Walsworth (1989). *The University of Missouri: 150 years*. Marceline, MO: Walsworth Publishing Company.

Reynolds, John Hugh and David Yancey Thomas (1910). *History of the University of Arkansas*. Fayetteville, AR: University of Arkansas.

Richardson, Joe M. (1980). *A history of Fisk University: 1865-1946*. Tuscaloosa, AL: University of Alabama Press.

Richardson, Susan R. (2013). ““An elephant in the hands of the state”: creating the Texas land-grant college”. In: *The land-grant colleges and the reshaping of American higher education*. Ed. by Roger L. Geiger and Nathan M. Sorber. New Brunswick, NJ: Transaction Publishers.

Ricketts, Palmer C. (1914). *History of Rensselaer Polytechnic Institute, 1824-1914*. London: John Wiley and Sons.

Ricks, Joel Edward (1938). *The Utah State Agricultural College: a history of fifty years, 1888-1938*. The Deseret News Press.

Roberts, Claren N. (1946). *History of the University of Missouri School of Mines and Metallurgy, 1871-1946*.

Roberts, William Pittman (1998). *Georgia's best kept secret: a history of North Georgia College*. Dahlonega, GA: W.P. Roberts and the Alumni Association of North Georgia College.

Rodgers, Robert L. (1890). *An historical sketch of the Georgia Military Institute, Marietta, Ga.* Atlanta, GA: Letterpress Offset Printing.

Rogers, Everett M. (2003). *The diffusion of innovation, 5th edition*. New York: Free Press.

Rogers, John A. R. (1903). *Birth of Berea College: a story of providence*. Philadelphia: Henry T. Coates & Company.

Rogers, Kenneth C. (1979). *Fundamentals first: the story of Stevens Institute of Technology*. New York: The Newcomen Society in North America.

Rogers, William Warren (1960). “The establishment of Alabama's land grant college”. In: *The Alabama Review*.

Ronde Furman, Franklin de, ed. (1905). *Morton memorial: a history of the Stevens Institute of Technology with biographies of the trustees, faculty and alumni and a record of the achievements of the Stevens family of engineers*. Hoboken, NJ: Stevens Institute of Technology.

Rorabaugh, W. J. (1979). *The alcoholic republic: an American tradition*. Oxford: Oxford University Press.

Ross, Earle D. (1942). *A history of the Iowa State College of Agriculture and Mechanic Arts*. Ames, IA: The Iowa State College Press.

— (1958). *The land-grant idea at Iowa State College: a centennial trial balance, 1858-1958*. Ames, IA: The Iowa State College Press.

Rushing, Jane Gilmore and Kline A. Nall (1975). *Evolution of a university: Texas Tech's first fifty years*. Austin, TX: Madrona Press, Inc.

Sachar, Abram L. (1995). *Brandeis University: a host at last*. Hanover, NH: Brandeis University Press.

Sampat, Bhaven N. (2006). "Patenting and US academic research in the 20th century: the world before and after Bayh-Dole". In: *Research Policy* 35.6, pp. 772–789.

Sansing, David G. (1999). *The University of Mississippi: a sesquicentenniel history*. Oxford, MS: University Press of Mississippi.

Sarada, Michael Andrews, and Nicolas L. Ziebarth (2017). "The demographics of inventors in the historical United States". Unpublished, University of Iowa.

Saxenian, AnnaLee (1996). *Regional advantage: culture and competition in Silicon Valley and Route 128*. Cambrdige, MA: Harvard University Press.

Schell, Herbert S. (1975). *History of South Dakota*. 3rd. first edition 1961. Lincoln, NE: University of Nebraska Press.

Schlereth, Thomas J. (1976). *The University of Notre Dame: a portrait of its history and campus*. Notre Dame, IN: University of Notre Dame Press.

Schmeltzer, Michael (2012). *Celebrating Gonzaga: the university and its people*. Santa Barbara, CA: Sea Hill Press.

Schmookler, Jacob (1957). "Inventors past and present". In: *The Review of Economics and Statistics,* 39.3, pp. 321–333.

— (1966). *Invention and economic growth*. Cambridge, MA: Harvard University Press.

Schoenberg, Wildred P. (1963). *Gonzaga University: seventy-five years, 1887-1962*. Spokane, WA: Lawton Printing Company.

Sechrist, Robert P. (2012). *Prohibition movement in the United States, 1801-1920*. ICPSR08343-v2. http://doi.org/10.3886/ICPSR08343.v2. Ann Arbor, MI.

Secrest, William B. and Lanny Larson (2011). *California State University, Fresno: a century of excellence, 1911-2011*. St. Louis: Reedy Press.

Sellers, Charles Coleman (1973). *Dickinson College: a history*. Middletown, CT: Wesleyan University Press.

Sellers, James B. (1953). *History of the University of Alabama: volume I: 1818-1902*. Tuscaloosa, AL: University of Alabama Press.

Seton Hall University (1956). *The summit of a century: the centennial story of Seton Hall University, 1856-1956*. South Orange, NJ: Seton Hall University.

Shaw, Jim. *Utility Patents 1-65000*. http://www.ptrca.org/history, accessed February 28, 2017. Hutchinson, KS.

— *Utility Patents 100001-146119*. http://www.ptrca.org/history, accessed February 28, 2017. Hutchinson, KS.

— *Utility Patents 65000-100000*. http://www.ptrca.org/history, accessed February 28, 2017. Hutchinson, KS.

Sheldon, Henry D. (1940). *History of the University of Oregon*. Portland, OR: Binfords & Mort, Publishers.

Shelley, Thomas J. (2016). *Fordham: a history of the Jesuit University of New York: 1841-2003*. New York: Fordham University Press.

Shriver, Phillip R. (1960). *The years of youth: Kent State University, 1910-1960*. Kent, OH: Kent State University Press.

Singh, Jasjit (2005). "Collaborative networks as determinants of knowledge diffusion patterns". In: *Management Science* 51.5, pp. 756–770.

Sismondo, Christine (2011). *America walks into a bar: a spirited history of taverns and saloons, speakeasies and grog shops*. Oxford: Oxford University Press.

Skelcher, Bradley (2000). *Delaware State University*. Charleston, SC: Arcadia Publishing.

Smith, Baxter Perry (1878). *The history of Dartmouth College*. Boston: Houghton, Osgood and Company.

Smith, David (2004). *Georgia State University: an institutional history, 1913-2002*. Higher Education History Publication.

Smith, David C. (1979). *The first century: a history of the University of Maine, 1865-1965*. Orono, ME: University of Maine at Orono Press.

Smith, Laurence N. and Paul C. Heaton (1999). *Eastern Michigan University: a sesquicentennial portrait*. Ypsilanti, MI: Eastern Michigan University.

Snider, William D. (1992). *Light on the hill: a history of the University of North Carolina at Chapel Hill*. Chapel Hill, NC: The University of North Carolina Press.

Sokoloff, Kenneth L. (1988). "Inventive activity in early industrial America: evidence from patent records, 1790-1846". In: *Journal of Economic History* 48.4, pp. 813–850.

Sokoloff, Kenneth L. and B. Zorina Khan (1990). "The democratization of invention during early industrialization: evidence from the United States, 1790-1846". In: *Journal of Economic History* 50.2, pp. 363–378.

Solberg, Winton U. (1968). *The University of Illinois: 1867-1894: an intellectual and cultural history*. Urbana, IL: University of Illinois Press.

Solow, Robert M. (1956). "A contribution to the theory of economic growth". In: *Quarterly Journal of Economics* 30.1, pp. 65–94.

Song, Jaeyong, Paul Almeida, and Geraldine Wu (2003). "Learning by hiring: when is mobility more likely to facilitate interfirm knowledge transfer?" In: *Management Science* 49.4, pp. 351–365.

Squicciarini, Mara P. and Nico Voigtländer (2015). "Human capital and industrialization: evidence from the Age of Enlightenment". In: *Quarterly Journal of Economics* 130.4, pp. 1825–1883.

Standage, Tom (2005). *A history of the world in 6 glasses*. New York: Bloomsbury Publishing.

Starr, Raymond (1995). *San Diego State University: a history in word and image*. San Diego, CA: San Diego State University Press.

Steckel, Richard and Nicolas L. Ziebarth (2013). "A troublesome statistic: traders and the westward movement of slaves". In: *Journal of Economic History* 73.3, pp. 792–809.

Steger, Joseph A. (1995). *University of Cincinnati*. New York: The Newcomen Society of the United States.

Stemmons, Walter (1931). *Connecticut Agricultural College: a history*. Research in collaboration with André Schenker. New Haven, CT: The Tuttle, Morehouse & Taylor Company.

Stewart, Larry (1999). "Other centres of calculation, or, where the Royal Society didn't count: commerce, coffee-houses and natural philosophy in early modern London". In: *The British Journal for the History of Science* 32.2, pp. 133–153.

Sturdy, Henry Francis (2015). "The establishment of the Naval School at Annapolis". In: *The U.S. Naval Institute on the U.S. Naval Academy: the history*. Ed. by Thomas J. Cutler. U.S. Naval Institute Proceedings, April 1946. Annapolis, MD: Naval Institute Press.

Sweetman, Jack (1995). *The U.S. Naval Academy: an illustrated history*. Second. Revised by Thomas J. Cutler; first edition 1979. Annapolis, MD: Naval Institute Press.

Tebeau, Charlton W. (1976). *The University of Miami: a golden anniversary history, 1926-1976*. Coral Gables, FL: University of Miami Press.

The Commissioner on Patents (Various Years). *Annual report of the Commissioner of Patents for the year ...* Government Printing Office.

Thomas, George E. and David B. Brownlee (2000). *Building America's first university: an historical and architectural guide to the University of Pennsylvania*. Philadelphia: University of Pennsylvania Press.

Thomas, Leroy (2004). "Expediency, vision, and leadership: factors in the development and growth of the New Jersey Institute of Technology, 1881-2002". Unpublished PhD dissertation, Fordham University.

Thomas, Mary Martha Hosford (1974). *Southern Methodist University: founding and early years*. Dallas, TX: SMU Press.

Thorie, Kevin (1990). *Interpreting the dream: a Stout history*. Menomonie, WI: University of Wisconsin-Stout.

Thrasher, Max Bennett (1900). *Tuskeegee: its story and its work*. Boston: Small, Maynard, & Company.

Thursby, Jerry G. and Marie C. Thursby (2005). "Gender Patterns of Research and Licensing Activity of Science and Engineering Faculty". In: *Journal of Technology Transfer* 30.4, pp. 343–353.

Toivanen, Otto and Lotta Väänänen (2016). "Education and invention". In: *Review of Economics and Statistics* 98.2, pp. 382–396.

Tolman, William Howe (1894). *History of higher education in Rhode Island*. United States Bureau of Education Circular of Information No. 1, 1894, Contributions to American Educational History, edited by Herbert H. Adams. Washinton, SC: Government Printing Office.

Topping, Robert W. (1988). *A century and beyond: the history of Purdue University*. West Lafayette, IN: Purdue University Press.

Turner, Fred H. (1932). "Misconceptions concerning the early history of the University of Illinois". In: *Transactions for the Year 1932: Proceedings of the Annual Meeting, Papers Presented at that Time, Contributions to State History*. Vol. 39. Illinois State Historical Library.

Turner, Ralph J. (1986). *Marshall memories: a pictorial history of Marshall University, 1837-1987*. Huntington, WV: Marshall University.

Tymeson, Mildred McClary (1965). *Two towers: the story of Worcester Tech, 1865-1965*. Worcester, MA: Worcester Polytechnic Institute.

University of Illinois (1950). *Illini years: a picture history of the University of Illinois, 1868-1950*. University of Illinois Press.

University of New Hampshire (1941). *History of the University of New Hampshire*. Durham, NH: University of New Hampshire.

Valero, Anna and John Van Reenen (2016). "The economic impact of universities: evidence from across the globe". Unpublished, NBER Working Paper 22501.

Vansteelandt, Sijn (2009). "Estimating direct effects in cohort and case-control studies". In: *Epidemiology* 20.6, pp. 851–60.

Wachter, Till von, Jae Song, and Joyce Manchester (2011). "Trends in employment and earnings of allowed and rejected applicants to the Social Security Disability Insurance Program". In: *American Economic Review* 101.7, pp. 3308–3329.

Wagoner, Jay J. (1970). *Arizona Territory, 1863-1912: a political history*. University of Arizona Press.

Walker, Kenneth R. (1992). *History of Arkansas Tech University 1909-1990*. Russellville, AR: Arkansas Tech University.

Wallenstein, Peter (1997). *Virginia Tech, land-grant university, 1872-1997: history of a school, a state, a nation*. Blacksburg, VA: Pocahontas Press, Inc.

Wardner, Dorothy Gittinger (1939). "The territorial University of Oklahoma". Unpublished Master's Thesis, University of Oklahoma.

Weitzman, Martin (1998). "Recombinant growth". In: *Quarterly Journal of Economics* 113.2, pp. 331–360.

Welskopp, Thomas (2013). "Bottom of the barrel: the US brewing industry and saloon culture before and during national prohibition, 1900-1933". In: *Behemoth: A Journal on Civilization* 6.1, pp. 27–54.

Wertenbaker, Thomas Jefferson (1996). *Princeton, 1746-1896*. First edition 1946. Princeton, NJ: Princeton University Press.

Westbrook, Jack R. (2007). *Central Michigan University*. Charleston, SC: Arcadia Publishing.

Widmer, Ted (2015). *Brown: the history of an idea*. New York: Thames & Hudson Inc.

Wilkinson, Ernest L., ed. (1975). *Bringham Young University: the first one hundred years, volume 1*. Provo, UT: Bringham Young University Press.

Williams, Joseph A. (2013). *Four years before the mast: a history of New York's Maritime College*. Bronx, NY: Fort Schuyler Press.

Williamson, Harold F. and Payson S. Wild (1976). *Northwestern University: a history, 1850-1975*. Evanston, IL: Northwestern University.

Willis, James F. (2009). *Southern Arkansas University: the mulerider school's centennial history, 1909-2009*. Bloomington, IN: Xlibris Corporation.

Wills, Martee and Joan Perry Morris (1987). *Seminole history: a pictorial history of Florida State University*. Gainesville, FL: South Star Publishing Company.

Wise, Henry A. (1978). *Drawing out the man: the VMI story*. Charlottesville, VA: University Press of Virginia.

Woodburn, James Albert (1891). *Higher education in Indiana*. United States Bureau of Education Circular of Information No. 1, 1891, Contributions to American Educational History, edited by Herbert H. Adams. Washinton, DC: Government Printing Office.

Wozniak, Stephen (1984). "Homebrew and how the Apple came to be". In: *Digital deli: the comprehensive, user-lovable menu of computer lore, culture, lifestyles, and fancy*. Ed. by Steve Ditlea. New York: Workman Publishing Company.

Wyeth, John Allan (1907). *History of La Grange Military Academy and the Cadet Corps, 1857-1862*. New York: The Brewer Press.

Wylie, Francis E. (1975). *M.I.T. in perspective: a pictorial history of the Massachusetts Institute of Technology*. Boston: Little, Brown and Company.

Yates, Bowling C. (1968). *History of the Georgia Military Institute, Marietta, Georgia, including the Confederate Military Service of the Cadet Battalion*. Marietta, GA.

Zucker, Lynne G., Michael R. Darby, and Jeff Armstrong (1998). "Geographically localized knowledge: spillovers or markets?" In: *Economic Inquiry* 36.1, pp. 65–86.