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Essays on the Impact of the Geographic Concentration of Industries on Competition and Knowledge Spillovers

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# Essays on the Impact of the Geographic Concentration of Industries on Competition and Knowledge Spillovers

By

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MA (Economics), University of Mumbai

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An abstract of
A dissertation submitted to the Faculty of the
James T. Laney School of Graduate Studies of Emory University
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**Abstract**

Essays on the Impact of the Geographic Concentration of Industries on Competition and Knowledge Spillovers

by Chirag Kasbekar

The two essays that constitute this dissertation examine the impact of geographic concentration on organization mortality and relocation. The geographic distribution of an industry determines geographical variation in the performance of organizations within it. In the first essay ("Local Competition, Mortality and Relocation: Geographic Concentration in the US Firearms Industry, 1790-1914"), I argue that a positive relationship between mortality and geographic concentration need not be caused by lower performance in concentrated areas relative to other areas. To test this argument, I use organizational relocation to construct and conduct an 'escape valve' test of local competition in the context of the US firearms industry. The results of the test indicate that organizational relocation and higher mortality rates are not driven by lower performance in dense areas. I put forward an alternative explanation for the results based on the idea that industry exit and and relocation are determined by entrepreneurial and organizational performance thresholds that are affected by geographic variation in opportunity costs. An increasing body of evidence suggests that the costs and benefits of locating in proximity to geographic concentrations of an industry depend on the local industrial organization. In the second essay ("Geographic Concentration and the Local History of Industrial Organization: Postbellum Firearms Firms in the Southern United States"), I argue that they also depend on the previous forms of local industrial organization experienced by organizations proximate to the focal firm. I use the US Civil War as an exogenous institutional shock that briefly changed the industrial organization of the firearms industry in the US South and created two groups of firms in the post-War period—those with experience of the shock and those without. Within this post-War period, I examine differences between the effects of concentrations of Civil War firms and the effects of concentrations of post-Civil War firms on organizational mortality and provide evidence in support of my argument.

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## Introduction

Most industries tend to be geographically concentrated, albeit to varying degrees (Ellison and Glaeser 1997; Ciccone 2002; Rosenthal and Strange 2004). Previous research suggests that this type of concentration creates geographic variation in the performance of organizations, though the nature of this influence depends on the industrial context. The positive effects of location in concentrated (or 'dense') areas on performance have been attributed to a number of localized externalities, particularly input sharing (Diamond and Simon 1990; Marshall 1920) and knowledge spillovers across co-located organizations (Almeida and Kogut 1999; Jaffe, Trajtenberg, and Henderson 1993; Krugman 1991; Marshall 1920). The negative effects have been ascribed to local competition.

Two issues are fundamental to a better understanding of the overall effects of geographic concentration on individual organizations: (1) the evaluation of these effects, in the face of the interplay of multiple mechanisms, and (2) the factors that determine variation in these effects across industrial settings. The two essays that comprise the dissertation examine these issues in the context of the US firearms industry.

### A. Evaluating the net effects of simultaneous localized processes

To understand which of the above mechanisms dominates in a particular setting, it is important to know how to evaluate their net effects. The usual strategy used in the empirical literature is to examine the impact of geographic concentration on an indicator of the performance of individual organizations and to attribute it to one or more of the candidate mechanisms. The assumption is that geographic variation in the indicator relates in a straightforward way to geographic variation in the performance of organizations. However, one of the most common measures used—the mortality rate of organizations—does not fit this assumption. Higher mortality rates in dense areas need not imply lower performance in these regions than in other areas. For example, it could be that entrepreneurs face higher opportunity costs to the continued operation of their business in a dense area than entrepreneurs at the same performance level in a sparse area.

In the first essay, to show that higher mortality rates need not be caused by differential performance, I conduct a test using organizational relocation patterns in the US firearms industry: if mortality rates are higher in concentrated areas because of low performance relative to other areas, organizations would relocate away from concentrated areas. Results indicate that despite higher mortality rates in dense regions, organizations were more likely to relocate if they were in dense areas but also more likely to choose a highly concentrated destination. I then discuss a generalizable explanation for these results that situates the differential performance interpretation in a broader theoretical framework. By this account, higher opportunity costs to the status quo can lead to higher performance thresholds for organizations and decision-makers in concentrated regions and thus to higher rates of both mortality and relocation, despite higher levels of performance.

**B. Understanding the factors that determine the dominance of particular localized mechanisms**

In order to understand why geographic concentration has different effects in different industries, we need to understand the particular factors that lead some localized processes to predominate over others. Recent research suggests that an important determinant is local industrial organization. In general, open and collaborative relations between organizations are expected to lead to greater knowledge spillovers and sharing of inputs and resources, and, therefore, to greater dominance of the performance-enhancing mechanisms engendered by geographic concentration, than are closed and competitive relations (Audia and Rider 2010; Rosenthal and Strange 2004; Saxenian 1996).

However, local industrial organization depends on local institutional environments. While these change over time, organizations do not change as quickly (Stinchcombe 1965). Thus, organizations at any given time retain features of their operation in past environments. In the second essay of this dissertation I argue that, due to this, the impact of the geographic concentration of an industry on individual organizations at any time is determined not only by a region's current form of industrial organization but also by its historical forms.

To test this, I examine the population of firearms firms in the US South between 1866 and 1914. Some firms operating in this period experienced the exogenous institutional shock of the Civil War, while others were founded in the post-War period. During the Civil War, the industry faced a centrally coordinated economy in which openness to technological transfer between organizations was privileged. In the post-War period the industry was market-oriented and rivalrous. I construct separate geographic concentration measures for these two groups of organizations and examine their impact on the survival of individual organizations. In support of my argument, the results of the analyses indicate that firearms firms that experienced the Civil War continued to offer positive externalities to proximate organizations even in the competitive post-War period, while post-War firms had a hazardous effect on co-located firms. I also find a convergence of the effects of the two groups of organizations, with concentrations of Civil War firms having a more hazardous impact over time. The results provide an illustration of the way in which changing institutional environments influence the evolution of local interorganizational relations.

# Essay One:
# Localized Competition, Mortality, and Relocation: Geographic Concentration in the US Firearms Industry, 1790–1914

## 1. INTRODUCTION

In this essay, I focus on the effect of local competition on organizational performance in concentrated areas. Existing empirical examinations of this effect tend to rely on organizational mortality as a measure of performance. For example, in a seminal study using data on the US footwear industry, Sorenson and Audia (2000) find that organizations are more likely to exit the industry if they are located in concentrated regions. They argue that this suggests geographic concentration can occur despite lower performance levels caused by local competition in dense areas, referred to hereafter as adverse performance differentials, because founding rates are higher in dense areas. However, variation in mortality rates need not be reflective of differential performance and can be explained by alternative mechanisms, particularly systematic differences in the opportunity costs of entrepreneurs and organizations. I discuss the implications of this difficulty in the interpretation of mortality rates for research on regional performance differences caused by geographic concentration.

The essay is structured as follows. First, I combine analyses of mortality and relocation patterns in the context of the US firearms industry from 1790 to 1914 to construct an 'escape valve' test. If mortality is higher in dense regions because of worse performance levels than in less dense regions, then organizations should relocate from more dense areas to less dense areas. The results of the test indicate that, despite exposure to greater mortality pressures, relocating organizations circulate within dense regions and prefer highly concentrated destinations. This provides evidence that geographic variation in mortality rates need not be driven by differences in performance.

Second, I locate the adverse performance differential within a theoretical framework that can explain the results of the escape valve test. The key element of this framework is the idea that higher opportunity costs increase the threshold levels of performance below which organizations and entrepreneurs decide to exit (Hopenhayn 1992; Asplund and Nocke 2006; Gimeno et al. 1997) or relocate. Opportunity costs and performance thresholds are higher in dense areas due to the

embedment of organizational actors in local networks (Sorenson and Audia 2000; Stuart and Sorenson 2005; Sorenson 2003) and the social interaction made possible by geographic proximity, which structure access to knowledge about opportunities. Thus, localized competition can cause higher mortality and relocation rates by decreasing performance in dense regions below threshold levels without leading to adverse performance differentials.

## 2. THE ESCAPE VALVE TEST

### A. Geographic concentration, localized competition and organizational mortality

From early work on location theory (Thünen 1966; Alonso 1964; Weber 1909) and Hotelling's model of monopolistic competition (Hotelling 1929) to contemporary research in economic geography (Krugman 1980; Davis and Weinstein 1998) and organizational ecology (Carroll and Wade 1991; Hannan and Carroll 1992; Swaminathan and Wiedenmayer 1991), local competition has been considered the primary cause of the external diseconomies caused by geographic concentration. As more organizations choose to locate in a particular area, access to local resources eventually decreases. Thus, organizations in these areas experience lower performance. Whether this causes performance levels to drop below those of less dense areas needs to be determined empirically. The investigation conducted by Sorenson and Audia (2000) is among a number of empirical studies that find mortality rates to be higher in dense areas. Studies in organizational ecology have found that the negative impact of increased density (number of organizations operating at a given time) on mortality is strongest at smaller geographical levels (Baum and Singh 1994a; Baum and Singh 1994b; Hannan et al. 1995). In the US automobile and tire industries, Klepper and Buenstorf find that, once spinoffs are accounted for, other organizations in concentrated areas are more likely to exit the industry (Klepper 2007; Buenstorf and Klepper 2009). Similar results are found in the German knitwear industry (Staber 2001). This work has been interpreted as providing supportive evidence for the existence of adverse performance differentials.

Caution must be exercised, however, when making inferences about regional performance differences on the basis of observed geographic variation in mortality rates. Prior research suggests that organizations can persist despite low performance or exit despite high performance. This divergence could occur due to several possible factors, including the competing interests of stakeholders (M. W. Meyer and Zucker 1989), the influence of the institutional environment (Carroll and Huo 1986), accumulated financial and non-financial assets (Levinthal 1991), cross-subsidization in large organizations (Barnett 1997), non-pecuniary benefits to entrepreneurs (Hamilton 2000), and the opportunity costs of the organization or the entrepreneur/owner (Hopenhayn 1992; Asplund and Nocke 2006; Gimeno et al. 1997). Of particular interest to the relationship between geographic concentration and mortality is attention to opportunity costs. I explore this relationship in my discussion of an alternative explanation for higher exit rates in dense areas.

**B. Geographic concentration, localized competition and organizational relocation**

To determine if higher mortality can occur in the absence of adverse performance differentials, I ascertain whether organizations attempt to escape mortality by relocating away from highly concentrated areas as predicted by models of localized competition. In existing models and theories of geographic concentration, local competition is proposed as a cause of geographic dispersion (Krugman 1991; Krugman 1998; Combes, Mayer, and Thisse 2010). While most empirical research has focused on organizational founding as the mechanism that drives this dispersion, relocation is also expected to contribute to it (Baldwin and Okubo 2005).

Organizational relocation has been relatively ignored in the literature. However, the existing empirical evidence on the determinants of relocation suggests that it is sensitive to performance pressures. For example, Romo and Schwartz (1995) find that New York manufacturing plants that are less embedded in local organizational communities relocate away from high-cost areas when they face performance declines caused by international competition. Research on relocation patterns in a number of European industries (based on a survey of businesses) suggests that organizational growth and the likelihood of relocation have a non-monotonic relationship: declining organizations that are

looking for lower cost areas and growing organizations that are seeking larger facilities are both likely to relocate (Brouwer, Mariotti, and Van Ommeren 2004).[1]

Evidence from the organizational ecology literature indicates that organizations escape death in crowded product markets by moving to less crowded product markets. Delacroix, Swaminathan, and Solt (1989) argue that overcrowding in a particular market segment or niche can lead organizations to shift to another closely related niche. Evidence for this is also found in the US wine industry (Delacroix and Swaminathan 1991), the day care center industry in metropolitan Toronto (Baum and Singh 1996), and the automobile industry in Europe (Dobrev, Kim, and Hannan 2001; T.-Y. Kim, Dobrev, and Solari 2003) and the United States (Dobrev, Kim, and Carroll 2003; Dobrev and Kim 2006). If these market niches are geographically bounded, as per localized competition theory, then a similar pattern of organizational relocation from relatively dense to relatively sparse areas should occur.

**C. The test**

The proposed test comprises three stages. In the first stage, I establish the positive relationship between geographic concentration and organizational mortality for which the adverse performance differential is a candidate causal mechanism. In the second and third stages, I examine two aspects of organizational relocation to observe if increased competition leads to a pattern of escape from concentrated areas. The *push* test assesses whether greater geographic concentration around an organization monotonically increases its chances of relocating. If the *push* analysis shows the expected result, then the *pull* test checks if the relocating organizations choose destinations with relatively low levels of concentration. If the *pull* test results in a positive monotonic relationship between concentration at potential destinations and their likelihood of being selected, then the outcome of the escape valve test, as a whole, would suggest that performance levels are not lower in dense areas.

[1] Knoben (2008, 99-100) finds an inverted-U relationship between growth and likelihood of relocation in his sample of Dutch automation services firms, suggesting that organizations with extremely low or negative growth are less likely to relocate. However, as the author suggests, this is probably due to the very low number of declining organizations in the sample used or due to the possibility that they exhibit such poor performance that they cannot risk the cost of relocation.

Other relocation patterns could be caused by adverse performance differentials, because different types of organizations react differently to competition and because geographic concentration produces positive externalities. Self-selection (Baldwin and Okubo 2005) may lead to geographic sorting of organizations. Highly efficient and productive organizations can better withstand the effects of competition, so they may be more likely to relocate from sparse areas to dense areas than the reverse. In contrast, inefficient and less productive organizations are more likely to be harmed by local competition, so they may be more likely to relocate from dense areas to relatively sparse ones. Thus, the following possible patterns would be consistent with adverse performance differentials: organizations relocating from concentrated to sparse areas, organizations relocating from sparse to concentrated areas (if productive organizations relocate in greater numbers than relatively unproductive organizations), and movements in both directions balancing each other out. Another possibility that is consistent with the performance differential theory is that geographic concentration has a non-monotonic effect in both *push* and *pull* analyses, because competition leads to lower performance only in the densest areas of concentration.

**D. The setting: the US firearms industry**

I conduct the test using data on the US firearms industry from 1790 to 1914. This setting meets two principal requirements. First, the industry faces greater hazards of failure in dense areas. As I discuss in the results section, an event history analysis of organizational mortality indicates that the nineteenth-century US firearms industry meets this qualification. Thus, the adverse performance differential due to local competition is a possible explanation for organizational outcomes in this industry. Second, relocation is not extremely rare. The US firearms industry experienced 915 relocation events in the studied period, with slightly more than seven percent of the observed firms migrating at least once. This is an adequate proportion of firms for the purposes of the study.

Additionally, a third reason that this setting is useful is that the industry experienced a high degree of geographic concentration during the studied period. There were two types of concentrated regions: concentrations of manufacturing firms in the New England area and concentrations of

service-oriented gunsmiths around urban areas across the country (Deyrup 1948). Production of firearms was concentrated in the Northeast, particularly in the New England region, in terms of percentage of industry capital, number of workers, and value of product (Deyrup 1948), even as it spread to the West, particularly along the Manufacturing Belt to the Midwest. Figure 1 shows this concentration.

---------- FIGURE 1 ABOUT HERE ----------

The US government suffered from the scarcity of domestically made arms during the War of American Independence in 1776, so it pushed for greater production. It established public armories at Springfield, Massachusetts, in 1795 and at Harper's Ferry, Virginia, (now in West Virginia) in 1802. It banned imports of arms to encourage domestic manufacturing. With these measures and greater government demand for small arms, the US firearms industry emerged (Deyrup 1948, 33-67). Principally through these public armories, American politicians, particularly Thomas Jefferson, who had been exposed during his visit to France to ideas about standardized production, initiated a movement towards greater uniformity in production standards, with interchangeable parts as the ultimate goal.

The armories, especially the one at Springfield, were laboratories for the development of advanced tools and techniques (D. R. Meyer 2006, 75-84; Deyrup 1948, 119). Using a contract system, the public armories developed relationships with private arms makers and helped the flow of technology to and from private armories (Deyrup 1948, 55-67). Another critical reason for the concentration of production in the Northeast was the convergence of metalworking technologies among a number of co-located industries, such as textile machinery, agricultural machinery, sewing machines, and bicycles, which led to the local emergence of the machine tool industry (D. R. Meyer 2006, 73-103; Rosenberg 1970; Rosenberg 1963). Service-oriented gunsmiths that catered to local communities spread across to the west of the country as the human population expanded in that direction. These gunsmiths also concentrated in cities.

I use the US firearms setting to assess the relationship between geographic concentration, mortality and relocation over a full industry life cycle, which would not be possible in most contemporary industrial settings. Figure 2 shows that the industry expanded steadily over the nineteenth century and underwent a shakeout at the turn of the century.

---------- FIGURE 2 ABOUT HERE ----------

There is no previous empirical or historical account of relocation in the firearms industry. The transition matrix presented in Table 1 suggests that most of the relocation took place within the main regions of the United States. The matrix also shows that much more relocation took place within the manufacturing centers of the Northeast and the Midwest. The maps in Figure 1 present evidence that relocation followed organizational density, first westward (along with the human population) and then eastward. Tables 2 and 3 report the top origins and destinations of relocating firms, respectively. The organizations appear to relocate from and to cities and towns that were within concentrated regions. The two lists are similar, suggesting that there was some amount of churn across these cities and towns.

---------- TABLES 1, 2 & 3 ABOUT HERE ----------

## E. Data and methods

### *Data*

The source of life history data on the US firearms industry is *American Gunsmiths* (Sellers 2008), a directory of gunsmiths and gun manufacturers from the seventeenth century to the present. This directory was compiled by a firearms industry historian and enthusiast, Frank Sellers. It contains information about firearms firms, including locations, operating years at those locations, product types, and patents. I exclude from analysis firms that made parts only or were involved only in retail and importation. Data for geographic coordinates and environmental control variables are from the National Historical Geographic Information System (NHGIS) at the Minnesota Population Center, University of Minnesota, and the US Census of Manufactures. Using fuzzy matching techniques to

match city and county names in the firearms dataset to the names of cities and counties in the NHGIS and Census datasets, I obtain a 95 per cent match. I exclude all observations on firms with unmatched observations.

I restrict the analysis to the period from 1790 to 1914 for several reasons. As previously mentioned, this period spans a whole industry cycle. Because an industry shakeout occurred before the First World War, most manufacturers and gunsmiths founded before the end of this period exited the industry. The periods during and after the First World War saw a resurgence of manufacturers in the industry, but these manufacturers were different from the mostly craft manufacturers of the nineteenth century. Thus, it simplifies interpretation to restrict the analysis to the period before 1914. Additionally, 1790 is an appropriate starting date, because it comes soon after the end of the War of Independence and the end of the colonial period, which had a sparse but historically distinct population of gunsmiths. The real resurgence of the industry began with the commencement of production at the National Armories at Springfield, MA, and Harper's Ferry, VA, in the early 1790s. Moreover, 1790 is convenient, because it is the date of the earliest census.

The life history of each firm is split into firm-years. Several firms have gaps in their years of operation, in many cases during their relocation periods. I do not split firms into two on either side of these gaps (because pre-relocation experience is important for the analyses). I do perform robustness checks to see if this affects the results, and it does not. I treat firms as having stopped operations (even if temporarily) if they are taken over by another firm or gunsmith or if they merge with another firm or gunsmith. To simplify the analysis, I also do not consider subsidiaries of firms, principally because they are rare in the data.

### *Analyses and measures: Mortality*

I use event history methods to estimate the likelihood of firm mortality. Event history data structures allow the observation of the exact timing of the transition into mortality event and the values of the time-dependent variables at each point in time (Blossfeld, Golsch, and Rohwer 2007). The clock used is organizational age in years. I use a piecewise constant exponential model to estimate the

instantaneous hazard rate of organizational mortality. This model splits time into 'pieces' based on organizational age and assumes that transition rates are constant within each of them but vary across them. This is useful if the nature of the time-dependence process is not clear and mis-specification is an issue (Blossfeld, Golsch, and Rohwer 2007). The transition rate is specified as follows:

$$r(t) = \exp\{\alpha_l + A\alpha\} \qquad if\ t \in I_l \tag{1}$$

where $\alpha_l$ is a constant coefficient associated with the *l*th time piece. $A$ is a vector of covariates that measure features of organizations and environments, and $\alpha$ is a vector of coefficients that do not vary across time pieces. I use exploratory analysis to arrive at well-fitting stable models that use the following time pieces: less than 2 years, 2–5 years, 5–10 years, 10–15 years, and 15 or more years. Standard errors are clustered by firm. To deal with potential left-censoring issues, I exclude firms that were founded before 1790. This leaves a total of 12,684 firms available for the analysis.

The firm is the unit at risk and the mortality event is timed as occurring at the end of the year in which it occurs. The key explanatory variable used in this analysis is *proximity-weighted density*, which is an adaptation of the localized density measure used by Sorenson and Audia (2000) to operationalize geographical concentration:

$$PWD_{it} = \sum_{j_t} \frac{1}{1+d_{ij_t}} \tag{2}$$

where *j* is an index of all firms other than *i* at time *t* and *dij* is the distance between the centroids of the cities or counties that firms *i* and *j* are located in at time *t*.

A limitation of my analysis is the lack of data on firm size. To account for differences in firm quality, I use a number of firm-specific measures. I use a dummy variable to indicate whether a firm possesses one or more patents, another dummy variable to indicate whether a firm is a manufacturer of guns or a provider of gunsmithing services, and a dummy variable to indicate whether a firm is incorporated, since incorporated firms tended to be larger. A firm is identified as a manufacturer of guns if there is information available on the type of guns it made; otherwise, it is identified as a

service provider. Several environmental features are included. To account for carrying capacity, or the ability of the environment to support more firms, I use two variables: total population of people in the firm's county location and the national value of product sales, both of which provide a measure of demand for firearms. Following research on density dependence in the organizational ecology literature (Carroll and Hannan 2000; Hannan and Carroll 1992), I also use measures of national density and national density squared to capture the non-monotonic effects of the number of firms operating in the country in a given year.

### *Analyses and measures: Push test*

I use a piecewise constant exponential model set up in a manner similar to the mortality analysis to estimate the instantaneous hazard rate of organizational relocation. Again, the key explanatory variable is *proximity-weighted density*. The relationship between geographic concentration and the likelihood of relocation may differ with the magnitude of the change, in terms of distance travelled. As a robustness check, therefore, I study two additional models, one in which only relocations beyond the state boundaries are considered and one in which only relocations within state boundaries are considered. In addition to the controls used in the mortality analysis, I also include the number of firm foundings in the previous year to account for differences between growing and mature areas.

### *Analyses and measures: Pull test*

I model choice of destination county as conditional on a firm having relocated. I include as possible choices in the analysis all US counties existing at a particular time that have at least once in their history been the home of at least one firearms firm. This excludes counties that may lack the capacity to host firearms firms and thus are not viable choices. There are 1,684 counties in the risk set. For the sake of robustness, I also ran models with these counties included in the risk set. This did not substantially change the key results, so I do not report them here. The most appropriate approach to such an analysis is conditional logit modeling. The model has the following specification:

$$P_{ij} = \frac{exp\{x_{ijt}'\beta\}}{\sum_j exp\{x_{ijt}'\beta\}} \quad (3)$$

where x*ijt* is a vector of features of county *j* in year *t* with respect to entrant *i,* and $\beta$ is a vector of coefficients. The key explanatory variable is the *mean proximity-weighted density* in a county.

Control variables in this analysis account for differences in the quality and carrying capacities of possible destinations. As previously mentioned, manufacturing firms and incorporated firms tended to be located in areas with high availability of metalworking and gunsmithing skills and access to raw materials (Deyrup 1948; D. R. Meyer 2006). Urban areas had local demand for gunsmiths and a pool of qualified engineers and inventors. I therefore include numbers of manufacturers of firearms, numbers of incorporated firms, and the total human population in the county. I also include numbers of firms owning at least one patent, to account for the presence of innovative firms and individuals. All explanatory variables are lagged by a year.

## F. Results

Tables 4 and 5 present summary statistics for the mortality and push analyses. The minimum firm age is 0.5 years, because a handful of firms experience multiple episodes in the course of a single year. To address this issue, I code the duration of each spell as a fraction of a year, reflecting the number of episodes that exist in that year. The correlation table does not raise concerns about multicolinearity.

---------- TABLES 4 & 5 ABOUT HERE ----------

### *Mortality*

Model 1 in Table 6 estimates the impact of the control variables and the time pieces used in the analysis. They have the expected effects. The proxies for firm quality have a negative effect on the mortality hazard. National density of firms has a U-shaped effect as per findings in organizational ecology. Model 2 introduces the measure of geographic concentration, *proximity-weighted density*. It appears that firms are more likely to die in areas of concentration. This confirms that the firearms industry is an appropriate context for this study.

---------- TABLE 6 ABOUT HERE ----------

### *Push test*

Model 3 in Table 7 presents the baseline model with the control variables and the time pieces. Patent-holding firms and manufacturers are more likely to migrate, and larger incorporated firms are less likely to migrate. Firearms firms also seem less likely to migrate from areas that saw greater founding in the previous period, suggesting that they do not move away from growing areas or areas where growth is expected. Model 4 introduces the key explanatory variable used in the *push* analysis. The positive effect of *proximity-weighted density* suggests that firms are more likely to migrate when they are located in a dense area. Model 5 includes *squared proximity-weighted density*. This measure does not have a significant effect. Models 6 and 7 replace the weighted density terms with the number of firms in a county, *county density,* and a square of this term, *county density squared,* to account for the possibility that firms respond to local competition only at the local county level. Neither measure has a significant effect. Models 8 and 9 in Table 8 estimate relocations to areas outside state boundaries. The estimates do not change significantly, thus the results appear to be robust to distance. However, prior-year foundings do not appear to have an effect in this case. Models 10 and 11 estimate within-state relocations. Again, the estimates are not significantly different. The magnitude of the positive effect of *proximity-weighted density* on relocation appears to be larger in the case of within-state relocations than in the case of out-of-state relocations. This suggests that the greater mobility of firms in dense areas may not indicate that they move far away from the original dense areas.

---------- TABLES 7 & 8 ABOUT HERE ----------

### *Pull test*

Tables 9 and 10 present the summary statistics for variables used in the pull test. Models 12–20 in Table 11 present models analyzing the choice of destination counties by relocating firms. It appears that firms are more likely to migrate to counties that have more manufacturers and incorporated firms. This suggests that either proximity to such firms or the regions in which manufacturers and incorporated firms are located offer perceived benefits to the relocating firms. Contrary to the

prediction of adverse performance differentials caused by local competition, firms appear to be more likely to migrate to areas with greater organizational concentration. This seems to hold for both out-of-state and within-state relocations, as models 17–20 in Table 11 show, though the effect is smaller for the longer distances. Model 14 includes *squared county mean proximity-weighted density*. This appears to have a significant result. However, the point at which the effect turns negative is outside the observed range of the data and thus the effect of *mean proximity weighted density* cannot be considered non-monotonic. The effect of *local county density* (Model 15) is also positive, suggesting that organizations appear to be more likely to relocate to an area if it has greater local density. The negative effect of the squared term in Model 16 is also not meaningful: the effect of *local county density* is monotonic in the observed range of the data.

---------- TABLES 9, 10 & 11 ABOUT HERE ----------

**G. Local competition and organizational relocation**

The results of the escape valve test provide evidence that, though mortality rates increase as concentration increases, organizations are more likely to relocate from one concentrated area to another. This is consistent with the findings of Buenstorf and Guenther (2011) that machine-tool firms relocating from East Germany to West Germany after World War II tended to choose locations that were relatively dense. The results suggest that lower performance relative to less dense regions is not a good explanation for the variation in mortality rates, since organizations appear not to be escaping dense areas. This is consistent with the study conducted by Folta, Cooper, and Baik (2006), which finds that organizational mortality rates in the US biotechnology industry are higher in dense areas, despite higher performance in such areas. Since the observed relationship between concentration and relocation appears to be monotonic within the observed range of the data, the results do not fit with any of the previously discussed patterns that are consistent with the differential performance argument. Questions remain, however, about the interpretation of these results.

Sørensen and Sorenson (2003) show in the context of local TV stations in the United States that potential entrepreneurs systematically underestimate the adverse impact of local competition.

This might suggest that organizations relocate to dense areas because they underestimate the impact of local competition on performance. However, Sørensen and Sorenson also find that, despite being underestimated, local competition does dissuade entry. Thus, if local competition drives mortality via adverse performance differentials, we would still expect relocating organizations to be dissuaded from entering dense areas, particularly if they are relocating because of the adverse effects of concentration. It can be argued that *proximity-weighted density* is not a perceptible quantity and, therefore, organizations are dissuaded by greater numbers of organizations only in a bounded geographical space. The use of county density measures in the analysis, however, does not support this argument. These measures appear to have a similar effect to *proximity-weighted density*. Also, as Baum and Lant (2003) observe in the context of the Manhattan hotel industry, organizations appear to overestimate the validity of geographic proximity as a measure of their similarity to other organizations. Given this, if organizations are more likely to identify similar organizations as competitors, then we expect them to be sensitive to any local competition.

It is also possible that organizations relocate to avoid the high costs associated with congestion in dense areas, but they do not move very far (Ghosh, Rodriguez, and Sirmans 1995). In other words, their destinations on the periphery of congested areas still have relatively high values of *proximity-weighted density*. However, the results hold even when local density, or the numbers of organizations in a county, is used to assess local competition. Moreover, as Table 11 shows, the organizations are likely to relocate to relatively dense areas even when they are longer distance moves.

## 3. GEOGRAPHIC CONCENTRATION AND DIFFERENTIAL THRESHOLDS

The escape valve test suggests that rising geographic concentration can increase mortality even if local competition is not intense enough to drive performance levels lower. I offer the key elements of an overarching framework that explains these results but also allows for the occurrence of adverse

performance differentials. I use historical accounts of the firearms industry and the results of the empirical analyses to apply the framework to the present context.

**A. Geographic concentration and performance thresholds**

Empirical studies have consistently found a positive correlation between mortality rates and founding rates across industries (Geroski 1995). Economic models explaining this process of organizational turnover suggest that markets with higher opportunity costs exhibit higher mortality rates at higher performance levels than other markets. This is because the threshold level of performance required to cover costs is greater (Hopenhayn 1992; Asplund and Nocke 2006). I argue here that differences in performance thresholds based on higher opportunity costs in concentrated areas can account for the results of the escape valve test because opportunity costs vary by level of geographic concentration.

I first consider the question of whose opportunity costs prevail within organizations. Concerns about power and control within organizations (Cyert and March 1963; M. W. Meyer and Zucker 1989; Fligstein 1985) are important for research on the location of organizations. Prior research has found that organizations tend to be founded close to the social environment that entrepreneurs or owners are embedded in (Dahl and Sorenson 2009) or prefer (Falck et al. 2010), despite forgone pecuniary benefits. Therefore, it is important to account for the performance thresholds of entrepreneurs/owners and other groups with organizational control.

Gimeno, Folta, Cooper, and Woo (1997) employ a formulation of performance thresholds that is determined by the opportunity costs of entrepreneurs or owners to explain the relationship between performance and mortality rates. I generalize this formulation in two ways. First, I explicitly include the opportunity costs of both organizations and influential individuals or groups. Second, I use these thresholds to explain decisions to exit the industry and to relocate. If mortality and relocation are conceptualized as organizational changes of state, according to the generalized threshold argument put forward in this essay, organizations will change state when:

$$\text{Economic performance in status quo} < W_{1.}[\text{Expected economic performance after changing state}] + W_{2.}[\text{Perceived benefits from changed state for individuals and groups with control}] - W_{3.}[\text{Perceived benefits from status quo for individuals and groups with control}] - W_{4.}[\text{Cost of switching states for organizations}] - W_{5.}[\text{Cost of switching states for individuals with control}]$$

The right hand side represents opportunity costs and $W_{1\text{-}5}$ are weights that depend on the degree to which individuals and groups control the organization.

Such changes of state are more likely in denser areas because the opportunity costs of maintaining an organization's original state is higher. There are two reasons to expect this. First, there are more alternative paths available to organizations and to the individuals and groups that exert control within them. Second, access to these alternative opportunities dissipates with geographic distance similar to the way that access to entrepreneurial opportunities are constrained by the location of incumbent businesses (Sorenson 2003; Sorenson and Audia 2000; Stuart and Sorenson 2005) because organizational actors are embedded in local networks.

As pointed out by the theory of structural inertia (Hannan and Freeman 1984; Barnett and Carroll 1995; Hannan, Polos, and Carroll 2003a; Hannan, Polos, and Carroll 2003b), switching costs (and perceived benefits from the status quo for individuals and groups with control) tend to be extremely high and thus organizations tend to be slow to change in response to environmental stimuli. However, for a given level of inertia, we would expect threshold levels of performance to be higher when opportunity costs are higher. Similarly, we would expect higher thresholds with greater opportunity costs for a given degree of entrepreneurial embeddedness (Dahl and Sorenson 2009).

All else being equal, local competition can lower performance levels below threshold levels and push organizations and influential individuals and groups to pursue alternative opportunities, even if performance levels are higher than in less dense areas. Adverse performance differentials are

possible within this theoretical framework if performance levels drop low enough, but the results of the escape valve test suggest that in the context under consideration here they do not.

**B. Geographic concentration and mortality**

In organizations that are controlled by owners/founders, in particular, the performance threshold is determined by the pecuniary benefits possible in alternative employment, the psychic benefits from alternate employment relative to those from self-employment, and the switching costs of moving into employment. Evans and Jovanovic (1989) put forward a model of the decision to enter self-employment that takes account of the opportunity costs of self-employment in terms of wage employment. Gimeno, Folta, Cooper, and Woo (1997) show that the potential benefits to an entrepreneur from alternative wage employment can also determine the decision to fold the firm after it has been established.

Both number of employment opportunities and access to them are likely to be greater in concentrated areas and so are the psychic benefits from employment, given the thicker labor markets. It is also likely that switching costs are lower in dense areas given lower search costs. This would increase the performance threshold of entrepreneurs/owners as concentration increases around them (Cooper and Folta 2000, 363; Folta, Cooper, and Baik 2006) and make such entrepreneurs more likely to exit than other entrepreneurs that face the same level of performance. The results of the mortality analysis suggest that younger firms (particularly very young firms) were more likely to exit, while incorporated firms and manufacturing firms were less likely to do so. Since younger and smaller service-oriented firms are more likely to be controlled by entrepreneurs or owners, the results provide some support for the explanation provided here.

When the degree of entrepreneurial control is mitigated, or when entrepreneurs are driven by the organization's pecuniary interests, the performance thresholds that determine whether firms exit an industry may be driven by opportunities available to them in other industries and the switching costs of moving to those industries. In empirical studies that consider only single industries or define exit only in terms of exit from a particular industry, this would not be captured. As

previously described, concentrated areas of the firearms industry, such as those in the Northeast, also had high concentrations of other metalworking industries that were technologically related. Given the localized and extensive interconnectedness among these industries (Rosenberg 1970; Rosenberg 1963; D. R. Meyer 2006), firms in these concentrated regions are likely to have had more opportunities.

**C. Geographic concentration and relocation**

Higher performance thresholds in concentrated areas can also explain the relocation patterns observed in the test conducted. The opportunities available to organizations that choose to relocate to dense areas are the same opportunities available to organizations that originate there: positive localized externalities. Historical accounts of the firearms industry highlight the localized nature of technological spillovers in an industry that was at the center of technological development in the nineteenth century (D. R. Meyer 2006, 1-21; Hounshell 1985, 15-65). They provide evidence for the localization, within the manufacturing center of the industry, of the processes that contemporary research has identified as key facilitators of knowledge spillovers: inter-organizational connections, the movement of personnel, and spin-offs.

Manufacturers in this region collaborated on government projects as contractors and sub-contractors under the contract system. They continued to be inter-dependent, when the contract system dissolved and the industry became more market-oriented and dominated by large manufacturers, such as Robbins & Lawrence of Windsor, Vermont, Colt Patent Fire Arms Manufacturing Company of Hartford, Connecticut, Ames Manufacturing Company of Chicopee, Massachusetts, and Smith & Wesson of Springfield, Massachusetts (Deyrup 1948, 55-132). Meyer points out that inter-organizational relationships in this region were embedded in interpersonal relationships that developed between entrepreneurs and employees of firms within the firearms industry and in other industries that were related through technology (D. R. Meyer 2006, 85):

> Private armories… operated in communities of practice consisting of firms with extensive metalworking experience whose family, friendship, and business ties bound firms in the same sector and across them. Owners and top mechanics used their networks to share tacit

> knowledge about building metal parts and equipment and to share architectural knowledge about organizing equipment in a production process. They experimented with a division of labor in shops and small factories and with a mechanization of production through hand-powered equipment or waterpowered machinery.
>
> The private armories also could learn from the small firms in the Connecticut Valley, which increased production of metal consumer goods, such as tinware and hardware, for sale beyond their shops' immediate vicinity. Similarly, investors and mechanics in this valley, as well as in the Blackstone Valley, started manufacturing cotton yarn for nonlocal sale, and their mills housed machine shops. These firms challenged the craft ethos by focusing on increasing total production for sale in larger market areas.
>
> New England armories drew on these skills and ideas to surmount limitations of the craft traditions and to meet the War Department's increasingly stringent demands for a system of uniformity in manufacturing firearms.

There was also considerable movement of personnel from one firm to another within the region, as firms tried to obtain the expertise that these personnel possessed. This led to 'gentlemen's agreements between firms not to lure away one another's workers' (Deyrup 1948, 167). Such agreements were not always honored.

Another source of the circulation of knowledge within dense areas was the generation of spinoff firms. As recent research shows, organizations are breeding grounds for entrepreneurs (Freeman 1986; Audia and Rider 2006; Klepper and Sleeper 2005; Buenstorf and Klepper 2010; Klepper and Thompson 2010). The firearms firms of the Northeast were particularly good training environments for entrepreneurs, through the apprenticeship system (Deyrup 1948, 107), the 'inside contractor' system (Deyrup 1948, 101), and the specialized training under the factory system. Deyrup provides the example of the firm of Robbins and Lawrence (Deyrup 1948, 122): 'As a firm it was outstanding for the many experts whom it trained and who later scattered throughout New England and played an important part in the development of arms manufacture and kindred industries, particularly the machine tool industry.' Consistent with the findings of recent studies (Buenstorf and Klepper 2009; Thompson 2005; Simons and Roberts 2008) founders of new firms brought technological knowledge from previous firms and offered potential benefits to other firms located in proximity to them.

Meyer illustrates the benefits of location in proximity to dense regions by highlighting the performance differences between the Springfield and Harper's Ferry armories. He argues that the Springfield Armory benefitted from its geographical proximity to these networks in a way that the Harper's Ferry Armory could not, despite attempts by supervisors at Harper's Ferry to visit and better understand the Springfield system (D. R. Meyer 2006, 82). This advantage is reflected in their relative performance. Individual entrepreneurs and owners also benefitted from the collaborations and interconnections with other gunsmiths and machinists, which allowed them to improve their technical knowledge and future earning potential. Location in dense areas insured against organizational failure to meet threshold levels of performance and allowed access to more alternative employment opportunities in the eventuality of such a failure.

More business opportunities and greater circulation of knowledge of these opportunities in dense areas raised the opportunity costs of remaining in dense areas, relative to the opportunity costs experienced at locations in other areas. The finding that manufacturer firms were more likely to relocate and move to areas where other manufacturers were located suggests that opportunities to collaborate and subcontract with other firms factored in their decisions to relocate. Evidence that firms with patents were more likely to relocate also supports the above argument. Lamoreaux and Sokoloff argue that, as the nineteenth century progressed and legal and brokerage institutions facilitating the obtaining and licensing of patents emerged, inventors in high-technology industries became less likely to produce their inventions themselves (Lamoreaux and Sokoloff 2001; Lamoreaux and Sokoloff 2000; Lamoreaux and Sokoloff 1999). This led to a geographical separation of invention and production as the inventors came to be located close to cities where the intermediary services were concentrated and producers located in proximity to traditional centers of production (Lamoreaux and Sokoloff 2000), which sometimes were in proximity to the big cities and sometimes were not. In these situations, inventors that produced (i.e. most of the firms that possessed patents) had an incentive to relocate closer to centers of firearms production (if they were initially located in centers of invention close to the biggest cities).

## 4. CONCLUSION

The theories of geographic concentration discussed in this essay address the opposing forces associated with geographic concentration, positive local externalities and adverse local competition. These forces combine to create variation in performance across regions. If the positive externalities dominate, then performance is better, founding is higher, and mortality is lower in areas where geographic concentration is greater. If local competition increases, then performance worsens, foundings decrease, and mortality increases in areas where concentration is greater. Sorenson and Audia (2000) point out that founding can be greater even when mortality is higher.

The results of the escape valve test suggest that, even when mortality rates increase as concentration increases, performance differences that are caused by heightened local competition may not be the driving cause. Organizations do not relocate from more dense areas to less dense areas as would be expected if adverse performance differentials existed. Rather, they are more likely to circulate within the concentrated areas. Combining the notion of performance thresholds from industrial organization economics with notions of the local embeddedness of organizational actors from economic sociology, I present an overarching framework that can explain the observed results but leave space for adverse performance differentials. Within this framework, geographic variation in mortality and relocation depends not just on performance variation across geographical regions, but also on variation in the performance thresholds of organizations and influential individuals and groups within them. These thresholds are higher in dense areas because the opportunity costs of not making the choice to either exit the industry or relocate are greater in dense areas.

The key implication of this theory regarding the impact of geographic concentration on organizational performance is that even when local competition drives performance levels below threshold levels in dense areas and thus leads to more organizational changes of state—such as exit or relocation—the performance levels need not be lower than performance in less dense areas. Since adverse performance differentials are possible within this theoretical framework, however, empirical

efforts should be directed at using this framework to ascertain whether the performance levels do fall low enough for the differentials to occur in any given setting.

An important advantage of the escape valve test is that it allows the broadening of the framework to cover organizational outcomes other than mortality and founding. This allows us to explore the idea that higher concentration leads to greater organizational churn: not just higher levels of founding and mortality (Sorenson and Audia 2000; Sorenson 2003) but also other types of changes of state, such as relocation. This type of churn could lead to greater circulation of knowledge in dense regions—as individuals move from employment into entrepreneurship and back into employment, or move from one location to another—and further increase the likelihood of organizational churn by increasing the opportunity costs of the status quo.

**Essay Two:**
**Geographic Concentration and the Local History of Industrial Organization: Postbellum Firearms Firms in the Southern United States**

## 1. INTRODUCTION

The net benefit of geographic co-location with competitors accruing from localized externalities is an important consideration in organizations' location decisions (Alcácer and Chung 2013; Alcácer and Chung 2007; Shaver and Flyer 2000). An increasing body of evidence suggests that the overall effect of these externalities on organizations is determined by the way an industry is locally organized, both in terms of the types of organizations that are co-located (Audia and Rider 2010; Rosenthal and Strange 2003a; Chung and Kalnins 2001) and the structure of interactions and relations between them (Alcácer and Chung 2013; Porter, Bunker Whittington, and Powell 2005; Saxenian 1996). This literature provides snapshots of the net benefit to co-location at any given time. Most industrial regions, however, are not static and undergo periodic transformations, often due to changes in their socio-economic and policy environments. Such a process of institutional change affects both the composition and the relational structures of local organizational populations and an understanding of the process, therefore, is important for a fuller knowledge of the outcome of organizational location decisions.

In this study I address the question: how do changes in local industrial organization affect the impact of the co-location of competitors on organizational performance? Building on the idea that environmental change has a hysteretic effect on organizations—as environments change, incumbent organizations do not change fast enough, continuing to reflect the industrial organization of previous environments (Stinchcombe 1965)—I argue that inter-organizational variation in the propensity to contribute to localized externalities is

created by differences in the forms of inter-organizational interaction experienced by organizations in their past, and that this variation dissipates over time.

To test this argument empirically, I use the following strategy. I choose an industry that experienced a strong exogenous shock that briefly changed its structure. I use this shock to assign organizations to two groups in the post-shock period: organizations that were exposed to the shock and organizations that were not. I then examine separate geographic concentrations of each of these two types of organizations and compare their impact on the mortality chances of proximate organizations. To understand whether differences between the two types of organizations dissipate, I observe the effect of time on the impact of these two types of concentrations.

The U.S. Civil War between 1861 and 1865 was such an institutional shock for firearms firms of the U.S. South. During the Civil War, the Confederate Government representing the Southern states faced the task of building up firearms manufacturing capacity in the Confederate states. It invested heavily in the industry and exercised tight control over the industry. This led to greater openness between organizations due to the transfer of technology and resources between firms by the government. Firms that survived the War, therefore, lacked experience with competitive rivalry and were open to knowledge flows. After the War, in the new market environment, the industry saw a large number of fresh entrants. The supportive Confederate Government had ceased to exist and firms operated independently. Rivalry was fiercer than before. The institutionalized openness between organizations that led to technological transfers during the Civil War had disappeared. This created two cohorts of firms in the aftermath of the War, each having experienced a different institutional environment: one cohort having developed in a centrally coordinated economy and the other having developed in a competitive market. I focus my

analysis on the post-War period of market competition in the South and construct separate concentrations by cohort. I then test the impact of each concentration on the mortality of firms located within or in proximity to them.

## 2. GEOGRAPHIC CONCENTRATION AND LOCAL INDUSTRIAL ORGANIZATION

Previous research in economic geography suggests that the impact of geographic concentration on the performance of individual organizations is affected by the way in which an industry is locally organized in terms of the structure of interorganizational relations and types of organizations it comprises. For example, in a well-known qualitative study Saxenian (1996) presents a contrast between the closed and rivalrous relations among electronics and information technology companies located in the Route 128 region and the open and collaborative interactions among companies from the same industry located in Silicon Valley. She argues that the latter form of interaction leads to greater circulation of knowledge and information and therefore more benefits to co-located organizations. Rosenthal and Strange (2003b) examine the impact of geographic concentration on the setting up of new establishments and the size of new establishments in six industries in the United States. They find that smaller establishments tend to offer more spillover benefits than medium and large firms. They interpret that as suggesting support for Saxenian's argument that concentrations comprising open, involved and innovative firms engender more knowledge flow and spillover benefits. Audia and Rider (2010) show that proximity to organizations with headquarters in a concentrated region can reduce the adverse effects of competition in that region and they attribute this to the greater local engagement of such organizations.

There is growing evidence to suggest that this effect of local industrial organization has broader institutional antecedents. For example, Gilson (1999) argues that one important cause for the greater openness of Silicon Valley, relative to Route 128, is the state of California's non-enforcement of non-compete agreements, which allows the flow of personnel across organizations. In support of

this argument, Stuart and Sorenson (2003) and Marx, Strumsky and Fleming (2009) find empirical evidence for the importance of non-compete policy for knowledge flows between organizations.

**A. The influence of past local industrial organization**

However, institutional environments change; and even as they do, organizations change at a slower rate, if at all. Thus, the institutional environment and local industrial organization can have an enduring effect on organizations and their interactions with other organizations. This creates heterogeneity among co-located organizations in the types of interactions they have with other organizations, caused by differences in the past environments they have operated in.

Environmental imprinting theory argues that entrepreneurs establish organizations using a blueprint that is based on organizational routines, structures and behaviors prevalent in the environment at the time of the founding process, and that these blueprints have a lasting impact on the operations of organizations (Stinchcombe 1965; Kimberly 1975; Boeker 1989). Founding blueprints have an enduring effect due to the effects of organizational inertia (Hannan and Freeman 1984; Hannan, Polos, and Carroll 2003b; Hannan, Polos, and Carroll 2003a). Thus organizations that are founded during a period in which open, non-rivalrous relations are privileged would tend to exhibit more openness to other organizations even as their environment changes around them and organizations that faced a competitive environment at founding would continue to engage in more rivalrous conduct.

**B. Slow change through learning from others**

Organizations do, however, manage to change over time in response to changes in their environment. Knowledge can be obtained vicariously through the observation of the successes and failures of other organizations (J. Y. Kim and Miner 2007; Haunschild and Miner 1997) or through the flow of personnel and information across organizations (Almeida and Kogut 1999; Rosenkopf and Almeida 2003; Almeida, Dokko, and Rosenkopf 2003; Owen-Smith and Powell 2004; Whittington, Owen-Smith, and Powell 2009). These changes are reflective of the organizational

routines and repertoires (Tilly 1977) that are available in the environment at a given time. The effects of inertia, however, limit the degree and speed with which organizations can imitate their competitors. Technologies, routines and practices adopted during past institutional environments would make it difficult to incorporate those privileged in the current institutional environment. Thus changes made to founding blueprints leave lasting environmental imprints on organizations as well.

Barnett (2008; Barnett and Hansen 1996) formulates a theory of hysteretic competition to explain this form of change in the face of organizational inertia. He characterizes competitive intensity as better performance than other organizations according to the 'logic of competition' that determines success in a particular environment, leading to a drop in the performance of rivals (Barnett 2008). This logic is not immediately clear to organizations and entrepreneurs. It is learnt through a process of iterative adaptation. Adaptation is difficult and, therefore, needs to be triggered by a fall in an organization's performance due to the actions of a rival. Every event of competitive rivalry provides information about the logic and organizations develop over time by building structures and routines in response to this feedback. Since the logic of competition changes over time, along with the institutional environment, this can cause maladaptation: routines and structures built in response to competition within in the original logic of competition become misaligned with the new logic.

The hysteretic effect of local industrial organization on organizations would create variation in the composition of geographic concentrations and in the impact of co-located organizations on each other. To understand the impact of geographic concentration on the performance of individual organizations at any time, therefore, it would be necessary to know how the past institutional environments of a region continue to affect the organizations that constitute it.

## 3. EMPIRICAL STRATEGY

To examine how a region's history of interorganizational interaction can influence the impact of geographic concentration in the present, I begin with an adaptation of the formulation of geographic concentration used by Sorenson and Audia (2000):

$$PWD_i = \sum_j \frac{1}{1+d_{ij}} \quad (1)$$

where *i* represents the focal organization and *j* represents all organizations other than *i* existing at a particular time in the entire population or industry being studied, and *d* is the distance between *i* and *j*. If differences in the histories of relations among the organizations that constitute this measure influence the effect of geographic concentration on organizational mortality, we would need to include a measure of these differences.

Barnett's model of competition (Barnett 2008) points to one way to incorporate these histories into the geographic concentration measure:

$$H_i = \sum_j \frac{T_j}{1+d_{ij}} \quad (2)$$

where $T_{jt}$ is the number of organization-years of interactions with other organizations experienced by rival *j* before the present time.

The fundamental problem with this strategy is that the construct is difficult to interpret: it is difficult to differentiate the impact of the organization-years of past interactions from the impact of the geographic concentration of organizations. A simple way out of this would be to assume that interactions are restricted to a particular geographical unit—such as a county or a state—and that distance between organizations within that unit, or beyond it, will have no impact on the rivalry. Barnett uses this strategy in his study of competitive processes in the commercial banking industry in the US state of Illinois (Barnett and Hansen 1996; Barnett 2008, 90-131). He was able to do so because Illinois law during the period of analysis geographically proscribed markets, thus rendering

irrelevant the question of proximity. In cases where such assumptions cannot be made, we need another empirical strategy. Within a given interorganizational environment, we need to account for differences in the impact of geographic concentrations on organizational mortality that can be attributed to heterogeneity in the histories of organizations' relationships with other organizations.

The strategy I follow involves four steps: (1) I identify the type of relationships structured by the current institutional environment of the industrial setting being used in the study and the overall influence this has on the effect of geographic concentration on mortality; (2) then I identify organizations that underwent an exogenous institutional shock in their past that structured a different type of relationship from that of the present, and (3) in the current institutional environment, I examine the separate effects of concentrations of those organizations that underwent the shock and of those that did not; and finally, (4) I study the effect of time since the shock on these separate effects.

## 4. 'A DICTATORSHIP OF PRODUCTION': THE US CIVIL WAR AND THE SOUTHERN FIREARMS INDUSTRY

An appropriate setting for this study would be an economy undergoing a transition from centralized coordination to a competitive market environment. Transition economies contain two types of organizations: some that were formed or operated during the centralized period and some that were formed in the market period. The firearms industry in the US South after the Civil War was a transition economy. During the Civil War between 1861 and 1865, the Confederate government exerted complete control over the industry in order to build it up. A number of firearms firms that operated during this time survived into the post-War period and this provides an opportunity to observe the co-existence of two cohorts of organizations that differed in the institutional environment they developed in.

The firearms industry in the US South was underdeveloped before the Civil War relative to the firearms industry in the North. It lacked access to the industrial infrastructure and technological

and organizational knowledge that firearms manufacturers in the North had access to. Whisker (2012:99) writes:

> With the introduction of the modern factory method of production…almost all domestic arms manufacture had been carried out by the two national armories and a relatively small handful of like-developed factories such as Colt. The days of letting contracts to small private armories had passed. Even while small private armory production was still popular, only one contract in the percussion era and one in the flintlock era had been offered to firms in the South. There were only two other brief flirtations with martial arms making in the South. One was the Virginia Manufactory of Arms which made small arms in the flintlock period; the other was carried out by William Glaze in his Palmetto Armory in South Carolina. He purchased machinery from Tryon of Philadelphia and made copies of the Model 1841 rifle and 1842 musket for the State of South Carolina. Essentially martial arms were made in the North and supplied to the South on various contracts.

Thus, during the Civil War, the new Confederate government faced a severe shortage of firearms, having been cut off from supplies of guns from manufacturers in the North. It relied heavily on imports from European countries, but because of naval blockades put in place by the Union government these imports became uncertain. To be able to build the Southern firearms industry up from scratch the Confederate government needed to take control. Over the course of the War, the industry became a centrally coordinated industry—with the Ordnance Bureau, led by Josiah Gorgas, at the helm (Whisker 2012; Vandiver 1980). Vandiver points out that this was the case with many industries that were important to the Southern War effort (1980:161):

> Control exercised by the Confederate Government over private industries had already grown to such proportions as to dictate completely the activity of most such plants—excepting, of course, the exasperatingly independent textile factories in North Carolina.

There were a number of ways in which central coordination was imposed, each of which dampened competition and created a more open flow of knowledge and resources between organizations. One of the principal ways in which the Ordnance Bureau did this was by setting up and operating its own armories. Prominent among these were the Richmond Armory (which was earlier the Virginia Manufactory of Arms), the Fayetteville Armory and the Macon Arsenal (Whisker 2012). Public

armories historically served as open laboratories through which technology was disseminated across to private producers (Deyrup 1948; D. R. Meyer 2006).

The Bureau also shored up private firms through subsidies, contracts and transfer of technology and equipment across organizations (Whisker 2012: 100; Vandiver 1980: 160-161). Much of this technology was obtained from a takeover of the Harper's Ferry National Armory and through machinists and gunsmiths migrating from large Northern factories. Equipment, personnel and resources were also transferred across firms in order to preserve capacity as Northern forces advanced towards firearms establishments (Whisker 2012).

This greater availability of technology and resources led to a number of entrepreneurs entering the industry to take advantage. Most of these did not have the pre-entry expertise necessary to deliver quality firearms or even deliver at all. However, this did not necessarily lead to the failure of their firms as the Ordnance Bureau supported them and even loosened standards of quality in order to feed the need for firearms on the battlefield. The bureau even took over production of a number of plants that were not performing to the expected levels. This account is typical of a number of production facilities of the period (Monzingo 2011):

> Confederates approached Tyler gunsmith J.C. Short in 1862 to manufacture Mississippi rifles for the boys in grey. Short, plagued by a lack of steel barrels, other supplies and adequate manpower, turned them down. A second request from the Confederates prompted him to enlist the help of Tyler merchant George Yarbrough and farmer and gunsmith William Briscoe to open an arms manufacturing facility. Short, Briscoe and Co. signed a contract with the Confederacy to put 5,000 guns in the hands of troops at $30 per weapon. By September 1862, though, only a little of the order had been filled and the government stepped in, purchasing the three-story brick facility for $100,000. The purchase proved timely for the Confederacy.

Despite this support from the government, however, firms were under constant threat from the advancing army. The approach of the army appears to have been the most common reason for the closure of firms (Whisker 2012).

Since it couldn't take over all of the firms in operation, it had to resort to alternative mechanisms of control in order to achieve coordination. Its principle mechanisms of power were control of key resources and infrastructure required by firearms firms. Vandiver (1980:162) writes:

> The Chief of Ordnance, who may well have felt considerable sympathy for the average private contractor who was earnestly trying to do his job, nevertheless found that he had vast authority over each factory under contract with the Ordnance Bureau. This authority rested, in large measure, upon the conscription laws which held the Confederacy's manpower supply tightly in the hands of the military. Bureau chiefs wielded the power to decide who should and should not receive labor exemptions from the ranks, and who should and should not retain the details that had already been granted, although final decisions rested with enrolling officers. In this power lay a coercive potential strong enough to command co-operation from almost all private industrialists who wished to stay in operation. Gorgas, however, had an even stronger authoritative weapon to use, after passage of the Exemption Act of October 11, 1862. This law had superseded the inadequate Exemption Act of April 21, 1862, and replaced it with a much more detailed list of those who were considered indispensable. It included all those artisans, mechanics, and employees working in government munitions plants and in contract agencies. The law provided that exemptions of ordnance technicians should not be made until "the Chief if the Ordnance bureau, or some ordnance officer authorized by him for the purpose, shall approve of the number of the operatives required for such establishments.

Another important mechanism was control of railroads, which determined the transportation of key raw materials. Vandiver notes (1980:162) that:

> Gorgas had the advantage accruing to supply bureaus of the virtual government control of railroads. This last advantage almost completed the Confederate industrial monopoly…. This, of course, made every factory dependent on the government for raw materials… this dictatorship of production… made almost every producer a government ward…

This authority over the industry was expressed in the coordination of all aspects of the production of firearms: product design, process choice, quantity, price and quality. This meant that firearms firms that operated in this period were not able to pick up the skills necessary to engage in competitive rivalry. On the other hand, they were perforce left open to other organizations.

Firms founded after the end of the Civil War, on the other hand, faced a diametrically opposite institutional environment. While there is not much historical information on the nature of the industry in this period, we know enough to be confident that it faced a competitive market-based environment. After the War, the southern economy as a whole lay devastated and had to undergo a gradual reconstruction (Licht 1995, 117-124). The firearms industry was not a priority any more. Moreover, the Confederate Government, which was the main source of resources and coordination

during the War, had ceased to exist. This meant that firms founded in this period lacked the easy access to resources that were available to firms that operated during the Civil War. On the other hand, the withdrawal of government coordination and support in the industry and the entry of a large number of firms in the post-War period (see Figure 1) created an environment that facilitated competition. The mechanisms through which competition was suppressed had disappeared. In the competitive market environment, they had to be more cautious in the protection of their resources and technological knowledge than were Civil War firms.

---------- Figure 1 about here ----------

**A. Two types of concentrations of Southern firearms firms in the post-War institutional environment**

I begin by specifying the overall effect of geographic concentration on mortality in any given period. The impact of geographic concentration on mortality can be expressed as follows:

$$r_i = h_i . \exp\left[c \sum_j \frac{1}{1+d_{ij}}\right] \quad (3)$$

where $r_i$ is the mortality rate of firm *i* at the present time, and $h_i$ represents the effect of control factors on mortality.

We expect the post-War institutional environment to be competitive, privileging rivalrous relations between firms. Given this intensified competition, geographic concentration would have a hazardous effect on organizational mortality. In other words, $c > 0$. I verify this empirically. Within this post-War setting, I identify organizations that experienced the Civil War. We would expect the Civil War to have been a period during which geographic concentration would have had positive spillover effects due to the government-facilitated transfers of technology and resources and, thus during this period, $c < 0$. Again, this is empirically verified. I mark organizations by whether they underwent the Civil War shock or not, which allows me to include separate geographic concentration terms for the two different types of organizations:

$$r_i = h_i . \exp\left[m \sum_p \frac{1}{1+d_{ip}} + n \sum_q \frac{1}{1+d_{iq}}\right] \quad (4)$$

where *p* is an index of post-War firms and *q* indexes Civil War firms.

Due to the enduring effects of past industrial organization, I predict that the Civil War firms will continue to exhibit openness in terms of the transfer of technology in the post-War period and therefore concentrations of Civil War firms will continue to offer the positive spillover externalities they did during the Civil War. Co-located Civil War firms, on the other hand, will exhibit the rivalrous interaction privileged by the post-War environment.

> **Hypothesis 1:** Greater geographic concentration of Civil War firearms firms will decrease firm mortality in the post-War period, while greater geographic concentration of post-Civil War firms will increase firm mortality in the same period; or $n < 0 < m$.

If, over time, Civil War firms are able to learn how to adopt the competitive practices of the post-War environment, we should expect geographic concentrations of Civil War firms to become more competitive over time. We should expect, in other words, a convergence in the effects of the two types of organizations, facilitated by the prevailing post-War institutional environment. We can express this variation over time as follows:

$$r_i = h_i . \exp\left[m \sum_p \frac{1}{1+d_{ip}} + n \sum_q \frac{1}{1+d_{iq}} + l\left\{\left(\sum_q \frac{1}{1+d_{iq}}\right)(w - w_0)\right\}\right] \quad (5)$$

where $w$ is the current calendar period and $w_0$ is the first calendar period since the shock. I predict the following.

> **Hypothesis 2:** Civil War firearms firms will become more competitive with time since the shock and, thus, the negative relationship between the geographic concentration of Civil War firms and firm mortality will dissipate over time; or $l > 0$.

## 5. DATA AND ANALYSIS

I restrict the main analysis to the period after the war—after 1865—but before the First World War. I also run analyses on the entire period from 1790 to 1914 to better understand the role of the Civil War as treatment. I restrict my analysis to the set of Southern states that seceded from the Union and were part of the Confederate States of America (South Carolina, Mississippi, Florida, Alabama, Georgia, Louisiana, Texas, Virginia, Arkansas, North Carolina and Tennessee) because they form a common institutional environment.

### A. Data

The histories of firms from the firearms industry in the Southern US have been constructed from a directory of gunsmiths and gun manufacturers put together by amateur firearms historian, Frank Sellers, *American Gunsmiths* (Sellers 2008), which contains information on firm locations, years of operation, patents possessed and the class of products produced. Data for economic and demographic controls and geographical distance calculation was obtained from the National Historical Geographic Information System (NHGIS) at the Minnesota Population Center, University of Minnesota and the US Census of Manufactures. For the sake of simple interpretation, I exclude firms that only made parts of guns or were only in retail or importation. In total 995 firms are examined in the main analysis.

Figure 3 presents changes in the number of Southern firearms firms over the period from 1790 to 1914. This figure tracks the numbers of the national US population of firearms firms over the period. It evidences the same steady increase in the numbers over this period and the same dramatic shakeout originating at the end of the nineteenth century. One observation that might be made is that the numbers spike around 1850 and 1860, which were Census years. This might suggest the existence of missing data. There are four reasons not to be concerned about this. First, the data are sourced from a large number and diversity of primary sources apart from Census records (Sellers 2008) and do not appear to be biased towards any particular group of firms. Second, the fact that the Southern subsample of the national population tracks the evolution of the national population (and

also the subsample of Northern firms) provides additional reassurance that the missing data are not systematically biased. Third, small firms, which would be the most likely to be missing from the data, dominate the observed data. Fourth, given the historic significance of the Civil War, we would expect post-Civil War firms to be more heavily represented in the missing data than Civil War firms; but they are also more heavily represented in the observed data. Also, the two spikes appear before the Civil War—before the period of the main analysis conducted here—and so do not directly affect the results.

**B. Method of analysis**

I use event history methods to estimate models of the likelihood of firm mortality given that a firm has not exited yet. I use a piecewise constant exponential model to estimate the hazard rate of firm mortality. Firm age, in years, is set as the clock; and analysis time is split according to specific age ranges. This assumes that transition rates are constant within each time 'piece' but vary across them. I use this model so as to reduce the dangers of mis-specifying the time-dependence process (Blossfeld, Golsch, and Rohwer 2007). I estimate the model of organizational mortality expressed in (5). The history of each firm is split into firm-years. I use the following time pieces: 0-5 years, 5-10 years, 10-15 years, and 15 or more years. I use models that cluster standard errors by firm. Even though the data do not exhibit left-censoring, to simplify interpretation, I exclude the few firms that were founded before 1790.

**C. Assessing the changing effects of the institutional environment**

To observe the overall effects of the changing institutional environment on the impact of geographic concentration on firm mortality, I run piecewise-constant exponential models on the entire sample of Southern firms from 1790 to 1914. The key explanatory variable *geographic concentration of Southern firms* is constructed as per (1). To verify if the post-War institutional environment privileged competitive rivalry (that is, in terms of (3), to assess whether $c > 0$ in the post-War period), I interact *geographic*

*concentration of Southern firms* with the dummy variable, *after Civil War*, equal to one if the focal firm-year observation is between 1866 and 1914.

To validate the use of the Civil War as a shock (that is, in terms of (3), to assess whether $c < 0$ during the Civil War), I interact *geographic concentration of Southern firms* with another dummy variable, *during Civil War*, equal to one if the observation occurs between 1861 and 1865.

To account for the possibility that *geographic concentration of Southern firms* is picking up the effects of location close to clusters of Northern firms, I include a measure of *geographic concentration of non-Southern firms*.

**D. Comparing the effects of concentrations of Civil War and post-Civil War firms**

To test Hypothesis 1, as per (4) and (5) I split *geographic concentration of Southern firms* by type, creating two variables: *geographic concentration of Civil War firms* and *geographic concentration of post-Civil War firms*. I identify Civil War firms as those firms that operated during the Civil War (1861-1865) and survived into the post-War period (1866-1914). I mark post-Civil War firms as those firms that were founded after the Civil War, that is between 1866 and 1914. To test for the effect of time since the end of the Civil War (that is, to see if $l < 0$, as per Hypothesis 2), I interact the two geographic concentration measures with the variable, *time since Civil War*.

One limitation of this dataset is that it does not contain information on firm size. However, I do construct measures to account for differences in firm quality. As a measure of innovativeness, I use a dummy variable if a firm possesses at least one patent in a given year. To indicate whether a firm is a manufacturer of guns or merely a provider of gunsmithing services, I create a dummy variable equal to one if there is any information available on the type of guns a firm made. I also include a dummy variable equal to one if a firm is incorporated. Additionally, a number of environmental features are taken account of. To account for carrying capacity, or the ability of the environment to support a greater numbers of firms, I use two variables: *total population of people* within the county in which the firm is located and the *value of national product sales*, both of which provide a measure of demand for firearms. To account for the non-monotonic effects of national firm density

as discussed in the organizational ecology literature (Carroll and Hannan 2000), I include standardized measures of national density and national density squared. To account for unobserved heterogeneity associated with time and place, I include state and decade fixed effects.

## 6. RESULTS

Tables 12 and 13 present the summary statistics for the period between 1790 and 1914 and the period between 1866 and 1914, respectively. The national density measures appear to be correlated with the geographic concentration measures, but that is something to be expected. The tables provide evidence to suggest that very few Southern firearms firms possessed patents. This is likely to be partly because firms in the South did not have the kind of access to technological expertise that firms of the North did. It is also seen in these tables that very few Southern firms were incorporated. Which suggests that most of these firms were not very large. Both these observations may also be indicative of the likelihood that Southern firms did not have access to the legal institutions and agencies necessary for patenting and incorporation.

---------- Tables 12 & 13 about here ----------

### A. Effects of the changing institutional environment

Table 14 presents results on event history models of mortality run on the entire sample of Southern firearms firms from 1790 to 1914. The purpose of these models is to evaluate the Civil War as a shock and assess the post-Civil War institutional environment. Model 1 includes only the control variables and provides a picture of the Southern firearms industry. Most variables have expected effects. National density appears to have a non-monotonic effect, consistent with previous studies in organizational ecology. Manufacturing firms appear to have a survival advantage, which is to be expected, particularly if they are larger than non-manufacturing firms. One variable that does not present a predictable result is *incorporated:* incorporated firms appear to be less likely to survive over all. This might be because such firms are more in direct competition with similar firms from the

North that have access to better technology and skilled labor. Model 2 includes dummy variables for the Civil War and post-Civil War periods. The reference period here is the pre-War era. The Civil War period appears to be the most hazardous, followed by the post-War period. Despite the role of the government in supporting Civil War firms, this is not surprising since, as mentioned earlier in the description of the Southern firearms industry during the war, the War was extremely destructive and the advance of the enemy was the most frequent cause of failure. The post-War hazardousness is also to be expected given the fact of widespread economic devastation coupled with a high degree of entry into the industry (Figure 3), which heightened competition for resources.

---------- Table 14 about here ----------

Model 3 introduces separate *geographic concentration* measures of Southern and Northern firms. Proximity to concentrations of Southern firms overall appears to have a hazardous impact on Southern firms. This is consistent with results obtained in analyses, not reported here, of the whole population of national firms. The *geographic concentration of northern firms* appears to have no overall effect, suggesting that there was a regional element to inter-organizational interactions and effects. Interestingly, the *after Civil War* dummy loses significance. One explanation for this is that most of the hazardousness of the post-War period is due to localized competition, which is accounted for by the *geographic concentration* measure.

Model 4 assesses variation in the effects of the proximity-weighted density measures across the time periods. While the Civil War period in general remains hazardous to firearms firms, proximity to concentrations of firms during this time appears to be advantageous rather than hazardous. This provides confidence in the use of the Civil War as a shock; as per (3), $c < 0$ during the Civil War. On the other hand, proximity to concentration remains hazardous in the pre-War and post-War periods; $c > 0$ after the Civil War, as per (3). This is a good indicator that inter-firm relations during the War were different from inter-firm relations in other periods. More specifically, they were less rivalrous in nature.

**B. Differing impacts of the two types of concentrations**

Table 15 presents the main results. These are the results of models of mortality run on the sample of firms operating in the post-War period. Model 5 provides more evidence that *geographic concentration of Southern firms* overall has a hazardous effect in the post-War period. It also suggests that the period itself gets more hazardous as time elapses since the War. Model 6 presents evidence in support of Hypothesis 1. The impact of *geographic concentration of Southern Civil War firms* is beneficial and the effect of *geographic concentration of Southern post-Civil War firms* is hazardous. Thus, as per (4), $n < 0 < m$.

---------- Table 15 about here ----------

Figures 4 and 5 illustrate the effects of concentrations of Civil War firms and post-Civil War firms, respectively, on the mortality rates of firms. For each variable they present the multiplier of the baseline rate of mortality. It is obtained by exponentiating the product of the estimated coefficient associated with the variable and the observed range of values of the variable. The figures show differences in the effects of the two types of concentrations. Figure 4 shows the negative effect of *geographic concentration of Civil War firms* on firm mortality over the observed range, while Figure 5 displays the positive effect of *geographic concentration of post-Civil War firms* on mortality.

---------- Figures 4 & 5 about here ----------

Model 7 accounts for the variation of these effects over time and provides support for Hypothesis 2: while *geographic concentration of Southern Civil War firms* initially has a beneficial effect, this effect becomes more hazardous with time since the War; as per (5), $l > 0$. This indicates that firms that operated during the Civil War learnt how to engage in competitive rivalry over time.

## 7. A POSSIBLE ALTERNATIVE EXPLANATION

It is important to disentangle two explanations for the result that concentrations of Civil War firms have a negative effect on the mortality of proximate organizations. Barnett argues that as logics of

competition change over time, this can lead to 'competency traps' as organizations having aligned with older logics becoming maladapted to new ones (Barnett and Hansen 1996; Barnett 2008; Barnett and Pontikes 2008). Thus it is possible that it is not, as I assume, that the beneficial impact of Civil War organizations occurs because these organizations have been exposed to an open system of industrial organization and so offer more technological spillovers, but simply that they are not used to the *particular* logic of competition existing in the new era and, therefore, allow new entrants to gain market share.

Two sets of analyses provide reason to discount this explanation. In the main set of analyses discussed above, as seen in Model 6, Civil War firms appear to be more viable than post-Civil War firms.[2] This is an indication that they are able to retain their intrinsic strengths in terms of resources and technology in the post-War period. However, as Barnett notes, an organization's viability can diverge from its 'competitiveness' or impact on the mortality of other organizations (Barnett 1997; Barnett and McKendrick 2004). There is the possibility that Civil War firms did not know how to grow their share of the market because of their maladaptation to the new rules of competition and thereby opened up a space for other firms in their vicinity. Therefore, this result needs to be interpreted with caution. There are two other findings in the main set of results discussed above that support the discounting of the alternative explanation: (1) The results provide evidence of positive externalities during the period of the shock; that is, $c < 0$ during the Civil War; and (2) and these positive externalities continue even in the competitive period, that is, $n < 0$, indicating that the environmental changes did not merely dampen competition.

Furthermore, in an additional set of analyses, I look for more direct evidence of the existence of technological spillovers to explain the negative effect of concentrations of Civil War firms on the mortality of firms. I split concentrations of Civil War and post-War firms each into sub-variables using indicators of technological proficiency: ownership of patents and the manufacture of

[2] This may seem to contradict the finding that firms were more likely to fail during the Civil War. However, as discussed earlier, the main reason for firms to die during the War was the advancing army (Whisker 2012). Given the resources pumped into firearms firms during the War, it would not be surprising for those firms that survived into the post-War period to be relatively strong.

firearms (as opposed to the mere supply of gunsmithing services). If concentrations of technologically proficient Civil War firms offer more benefits to proximate firms than other Civil War firms, we would have evidence supporting Hypothesis 1. The results of this analysis, presented in Table 16, provide suggestive evidence in support of the idea that it is technological spillovers that drive the positive impact of geographic concentrations on proximate firms. Model 8 splits *geographic concentration of Southern Civil War firms* and *geographic concentration of Southern post-Civil War firms* each into concentration measures for manufacturing and non-manufacturing firms. It appears that concentrations of Civil War manufacturers had a more beneficial effect on firms than did non-manufacturing Civil War firms, indicating that the positive effects of location close to Civil War firms in the post-War period were likely due to technological spillovers. Model 9 splits the geographic concentration measures according to the ownership of patents by constituent firms. While the results are not significant for concentrations of Civil War firms, patent-owning post-War firms do appear to have a negative impact on the mortality of firms, while non-patent-owning post-War firms appear to have a hazardous impact. This indicates two things: (1) that patents became a more important differentiator in the market environment of the post-War setting and (2) that technological spillovers played a part in the development of the Southern firearms industry.

---------- Table 16 about here ----------

## 8. CONCLUSION

This study investigated the influence of a region's history of industrial organization on the impact of the co-location of an industry's organizations on organizational mortality. It presented the argument that differences in past industrial organization experienced by organizations of a region would create inter-organizational variation in contributions to localized externalities and that this variation would reduce over time. To empirically test this theory, it used an exogenous shock—the U.S. Civil War—to assign firearms firms from the

U.S. South to two groups: those that had in the past experienced centralized control, dampened competition and heightened technological transfers, and those that had not. It constructed different concentrations of these two groups of firms and examined how proximity to each of these types of concentrations within a common post-War competitive environment affected the mortality chances of individual firms. Consistent with the theory, it found that proximity to concentrations of firearms firms that operated during the Civil War benefitted firms even in the period following the War. Such proximity, however, became hazardous over time as Civil War firms developed more experience in the competitive post-War conditions, providing support for the idea that firms with different histories converge in their impact over time in a direction determined by the prevailing institutional environment.

The study makes a contribution to research on the impact of geographic concentration on organizational performance by providing a greater appreciation of the role of the history of local industrial structure. By showing how local organizational populations respond to environmental changes over time, it presents a better understanding of the evolution of local concentrations and clusters. It suggests that a sole focus on present-day composition and interactions might prove treacherous if local organizations change in response to their changing environment. By introducing a way to think of how past and future local organizational composition and inter-organizational interaction patterns might affect decisions to co-locate with competitors, it informs location strategies. One limitation of this analysis is that it does not provide direct evidence on the mechanisms by which the localized externalities are created and captured by organizations. Future studies could directly examine the manner in which knowledge spillover mechanisms are affected by environmental change. For example, they could study how local inter-organizational networks that transport knowledge across organizations (Porter, Bunker Whittington, and

Powell 2005) are transformed by changes in industrial organization over time. They could also examine localized spinoff processes (Klepper 2007; Buenstorf and Klepper 2009), which transfer knowledge from incumbent organizations to startups, and investigate whether organizations with certain kinds of histories generate more and better quality spinoffs.

Further research is also needed to directly observe the localization of the processes that allow and constrain the convergence of co-located organizations over time in accordance with the changes in the local institutional environment. Attention is due to both knowledge spillover and legitimation processes. Studies of localized knowledge spillover processes that allow co-located organizations to learn how to adjust to new institutional and industrial environments would need to examine the role of the interorganizational mobility of people from new organizations to older organizations, and the use of mergers and acquisitions by older organizations to obtain knowledge about the changed rules of competition. It would be important to consider differences in the impact of institutional change on different types of organizations. In particular, we would expect small organizations to be affected and to respond in a way different from large organizations. Investigations of localized legitimation processes will need to examine the role of the geographic boundedness of institutional environments and the geographic extent of the taken-for-grantedness of particular rules of competition. Of particular interest would be the geographic extent of the legitimation of new organizational forms engendered by exogenous local institutional changes. Through a careful attention to the particular processes that drive the geographic diffusion of these changes, future studies could provide occasion to revisit earlier findings about the geographic boundedness of legitimation and competitive processes (Hannan et al. 1995; Swaminathan and Wiedenmayer 1991; Carroll and Wade 1991).

This work would also be of interest to policy makers. The development of regional clusters of industries is one of the top concerns of local and national governments the world over (Bresnahan, Gambardella, and Saxenian 2001). Given the path dependent nature of the development of these diverse regions, it would be very useful to understand the ways in which history constrains attempts to imitate successful clusters.

**REFERENCES**

Alcácer, Juan, and Wilbur Chung. 2007. "Location Strategies and Knowledge Spillovers." *Management Science* 53 (5) (May): 760–776.

Alcácer, Juan, and Wilbur Chung. 2013. "Location Strategies for Agglomeration Economies." *Strategic Management Journal* (November 11).

Almeida, Paul, and Bruce Kogut. 1999. "Localization of Knowledge and the Mobility of Engineers in Regional Networks." *Management Science* 45 (7): 905–917.

Almeida, Paul, Gina Dokko, and Lori Rosenkopf. 2003. "Startup Size and the Mechanisms of External Learning: Increasing Opportunity and Decreasing Ability?." *Research Policy* 32 (2) (February): 301–315.

Alonso, W. 1964. *Location and Land Use*. Cambridge, MA: Harvard University Press.

Asplund, Marcus, and Volker Nocke. 2006. "Firm Turnover in Imperfectly Competitive Markets." *The Review of Economic Studies* 73 (2) (January 1): 295–327.

Audia, Pino G, and Christopher I Rider. 2006. "Entrepreneurs as Organizational Products: Revisited." In *The Psychology of Entrepreneurship*, edited by Joel A. C. Baum, R A Baron, and M Frese, 113–133. Hillsdake, NJ: Lawrence Erlbaum Associates.

Audia, Pino G, and Christopher I Rider. 2010. "Close, but Not the Same: Locally Headquartered Organizations and Agglomeration Economies in a Declining Industry." *Research Policy* 39 (3): 360–374.

Baldwin, Richard, and Toshihiro Okubo. 2005. "Heterogeneous Firms, Agglomeration and Economic Geography: Spatial Selection and Sorting." *NBER Working Paper Series*. http://www.nber.org/papers/w11650.

Barnett, William P. 1997. "The Dynamics of Competitive Intensity." *Administrative Science Quarterly* 42 (1) (March 20): 128–160.

Barnett, William P. 2008. *The Red Queen Among Organizations*. Princeton, NJ: Princeton University Press.

Barnett, William P, and David G McKendrick. 2004. "Why Are Some Organizations More Competitive Than Others? Evidence From a Changing Global Market." *Administrative Science Quarterly* 49 (4) (December 1): 535–571.

Barnett, William P, and Elizabeth G Pontikes. 2008. "The Red Queen, Success Bias, and Organizational Inertia." *Management Science* 54 (7) (July 1): 1237–1251.

Barnett, William P, and Glenn R. Carroll. 1995. "Modeling Internal Organizational Change." *Annual Review of Sociology* 21 (January 1): 217–236.

Barnett, William P, and Morten T Hansen. 1996. "The Red Queen in Organizational Evolution." *Strategic Management Journal* 17 (S1) (July 5): 139–157.

Baum, Joel A. C., and Jitendra V Singh. 1994a. "Organizational Niches and the Dynamics of Organizational Founding." *Organization Science* 5 (4) (January 1): 483–501.

Baum, Joel A. C., and Jitendra V Singh. 1994b. "Organizational Niches and the Dynamics of Organizational Mortality." *American Journal of Sociology* 100 (2) (January 1): 346–380.

Baum, Joel A. C., and Jitendra V Singh. 1996. "Dynamics of Organizational Responses to Competition." *Social Forces* 74 (4): 1261–1297.

Baum, Joel A. C., and Theresa K Lant. 2003. "Hits and Misses: Managers' (Mis)Characterization of Competitors in the Manhattan Hotel Industry." *Advances in Strategic Management* 20: 119–156.

Blossfeld, Hans-Peter, Katrin Golsch, and Gotz Rohwer. 2007. *Event History Analysis with Stata*. Psychology Press.

Boeker, Warren. 1989. "The Development and Institutionalization of Subunit Power in Organizations." *Administrative Science Quarterly* 34 (3) (September 1): 388–410.

Bresnahan, Timothy, Alfonso Gambardella, and AnnaLee Saxenian. 2001. "'Old Economy' Inputs for "New Economy" Outcomes: Cluster Formation in the New Silicon Valleys." *Industrial and Corporate Change* 10 (4) (January 1): 835–860.

Brouwer, Aleid E., Ilaria Mariotti, and Jos N. Van Ommeren. 2004. "The Firm Relocation Decision: an Empirical Investigation." *The Annals of Regional Science* 38 (2): 335–347.

Buenstorf, Guido, and Christina Guenther. 2011. "No Place Like Home? Relocation, Capabilities, and Firm Survival in the German Machine Tool Industry After World War II." *Industrial and Corporate Change* 20 (1): 1–28.

Buenstorf, Guido, and Stephen Klepper. 2009. "Heritage and Agglomeration: the Akron Tyre Cluster Revisited." *The Economic Journal* 119 (537): 705–733.

Buenstorf, Guido, and Stephen Klepper. 2010. "Why Does Entry Cluster Geographically? Evidence From the US Tire Industry." *Journal of Urban Economics* 68 (2): 103–114.

Carroll, Glenn R., and James Wade. 1991. "Density Dependence in the Organizational Evolution of the American Brewing Industry Across Different Levels of Analysis." *Social Science Research* 20 (3): 271–302.

Carroll, Glenn R., and Michael T. Hannan. 2000. *The Demography of Corporations and Industries*. Princeton University Press.

Carroll, Glenn, and Yanchung Paul Huo. 1986. *Organizational Task and Institutional Environments in Ecological Perspective*.

Chung, Wilbur, and Arturs Kalnins. 2001. "Agglomeration Effects and Performance: a Test of the Texas Lodging Industry." *Strategic Management Journal* 22: 969–988.

Ciccone, Antonio. 2002. "Agglomeration Effects in Europe." *European Economic Review* 46: 213–227.

Combes, Pierre-Philippe, Thierry Mayer, and Jacques-Francois Thisse. 2010. *Economic Geography*. Springer Verlag.

Cooper, Arnold C, and Timothy B Folta. 2000. *Entrepreneurship and High Technology Clusters*. Oxford: Blackwell Publishers, Inc.

Cyert, Richard M, and James G March. 1963. *A Behavioural Theory of the Firm*. Upper Saddle, NJ: Prentice Hall.

Dahl, Michael S, and Olav Sorenson. 2009. "The Embedded Entrepreneur." *European Management Review* 6 (3): 172–181.

Davis, Donald R, and David E Weinstein. 1998. "Market Access, Economic Geography, and

Comparative Advantage: an Empirical Assessment." 6787. NBER Working Paper.

Delacroix, Jacques, Anand Swaminathan, and Michael E Solt. 1989. "Density Dependence Versus Population Dynamics: an Ecological Study of Failings in the California Wine Industry." *American Sociological Review* 54 (2) (April 1): 245–262.

Delacroix, Jacques, and Anand Swaminathan. 1991. "Cosmetic, Speculative, and Adaptive Organizational Change in the Wine Industry: a Longitudinal Study." *Administrative Science Quarterly*: 631–661.

Deyrup, Felicia Johnson. 1948. *Arms Makers of the Connecticut Valley*. Smith College.

Diamond, Charles A., and Curtis J. Simon. 1990. "Industrial Specialization and the Returns to Labor." *Journal of Labor Economics*: 175–201.

Dobrev, Stanislav D, and Tai-Young Kim. 2006. "Positioning Among Organizations in a Population: Moves Between Market Segments and the Evolution of Industry Structure." *Administrative Science Quarterly* 51 (2) (June): 230–261.

Dobrev, Stanislav D, Tai-Young Kim, and Glenn R. Carroll. 2003. "Shifting Gears, Shifting Niches: Organizational Inertia and Change in the Evolution of the U.S. Automobile Industry, 1885-1981." *Organization Science* 14 (3) (January 1): 264–282.

Dobrev, Stanislav D, Tai-Young Kim, and Michael T. Hannan. 2001. "Dynamics of Niche Width and Resource Partitioning." *American Journal of Sociology* 106 (5) (March): 1299–1337.

Ellison, Glen, and Edward L Glaeser. 1997. "Geographic Concentration in U.S. Manufacturing Industries: a Dartboard Approach." *Journal of Political Economy* 105 (5): 889–927.

Evans, D S, and B Jovanovic. 1989. "An Estimated Model of Entrepreneurial Choice Under Liquidity Constraints." *The Journal of Political Economy*.

Falck, Oliver, Christina Guenther, Stephan Heblich, and William R Kerr. 2010. "From Russia with Love: the Impact of Relocated Firms on Incumbent Survival." *NBER Working Paper* No. 16141 (June 24).

Fligstein, Neil. 1985. "The Spread of the Multidivisional Form Among Large Firms, 1919-1979."

*American Sociological Review* 50 (3) (January 1): 377–391.

Folta, Timothy B, Arnold C Cooper, and Yoon-suk Baik. 2006. "Geographic Cluster Size and Firm Performance." *Journal of Business Venturing* 21 (2) (March): 217–242. doi:10.1016/j.jbusvent.2005.04.005.

Freeman, John H. 1986. "Entrepreneurs as Organizational Products: Semiconductor Firms and Venture Capital Firms." In, 1:33–52. Advances in the study of entrepreneurship, innovation and economic growth.

Geroski, P A. 1995. "What Do We Know About Entry?." *International Journal of Industrial Organization* 13 (4) (December): 421–440.

Ghosh, Chinmoy, Mauricio Rodriguez, and C F Sirmans. 1995. "Gains From Corporate Headquarters Relocations: Evidence From the Stock Market." *Journal of Urban Economics* 38 (3) (November): 291–311.

Gilson, R J. 1999. "The Legal Infrastructure of High Technology Industrial Districts: Silicon Valley, Route 128, and Covenants Not to Compete." *New York University Law Review* 74.

Gimeno, J, T B Folta, A C Cooper, and C Y Woo. 1997. "Survival of the Fittest? Entrepreneurial Human Capital and the Persistence of Underperforming Firms." *Administrative Science Quarterly*.

Hamilton, Barton H. 2000. "Does Entrepreneurship Pay? an Empirical Analysis of the Returns to Self-Employment." *Journal of Political Economy*.

Hannan, Michael T., and Glenn Carroll. 1992. *Dynamics of Organizational Populations*. Oxford University Press, USA.

Hannan, Michael T., and John H. Freeman. 1984. "Structural Inertia and Organizational Change." *American Sociological Review* 49 (2) (April 1): 149–164.

Hannan, Michael T., Glenn R. Carroll, E.A. Dundon, and J.C. Torres. 1995. "Organizational Evolution in a Multinational Context: Entries of Automobile Manufacturers in Belgium, Britain, France, Germany, and Italy." *American Sociological Review*: 509–528.

Hannan, Michael T., Laszlo Polos, and Glenn R. Carroll. 2003a. "Cascading Organizational Change."

*Organization Science* 14 (5) (September 1): 463–482.

Hannan, Michael T., Laszlo Polos, and Glenn R. Carroll. 2003b. "The Fog of Change: Opacity and Asperity in Organizations." *Administrative Science Quarterly* 48 (3) (September 1): 399–432.

Haunschild, P R, and A S Miner. 1997. "Modes of Interorganizational Imitation: the Effects of Outcome Salience and Uncertainty." *Administrative Science Quarterly*.

Hopenhayn, Hugo. 1992. "Entry, Exit, and Firm Dynamics in Long Run Equilibrium." *Econometrica* 60 (5) (September): 1127–1150.

Hotelling, Harold. 1929. "Stability in Competition." *The Economic Journal* 39 (153): 41–57.

Hounshell, D. 1985. *From the American System to Mass Production, 1800-1932: the Development of Manufacturing Technology in the United States*. The Johns Hopkins University Press.

Jaffe, Adam .B., Manuel Trajtenberg, and Rebecca Henderson. 1993. "Geographic Localization of Knowledge Spillovers as Evidenced by Patent Citations." *The Quarterly Journal of Economics* 108 (3): 577.

Kim, J Y, and A S Miner. 2007. "Vicarious Learning From the Failures and Near-Failures of Others: Evidence From the US Commercian Banking Industry." *Academy of Management Journal* 50 (3) (June 1): 687–714.

Kim, Tai-Young, Stanislav D Dobrev, and Luca Solari. 2003. "Festina Lente: Learning and Inertia Among Italian Automobile Producers, 1896-1981." *Industrial and Corporate Change* 12 (6) (December 1): 1279–1301.

Kimberly, J R. 1975. "Environmental Constraints and Organizational Structure: a Comparative Analysis of Rehabilitation Organizations." *Administrative Science Quarterly*.

Klepper, Stephen. 2007. "Disagreements, Spinoffs, and the Evolution of Detroit as the Capital of the US Automobile Industry." *Management Science* 53 (4): 616–631.

Klepper, Stephen, and Peter Thompson. 2010. "Disagreements and Intra-Industry Spinoffs." *International Journal of Industrial Organization* 28 (5): 526–538.

Klepper, Stephen, and Sally Sleeper. 2005. "Entry by Spinoffs." *Management Science*: 1291–1306.

Knoben, Joris. 2008. *Firm Mobility and Organizational Networks: Innovation, Embeddedness and Economic Geography*. Cheltenham: Edward Elgar.

Krugman, Paul. 1980. "Scale Economies, Product Differentiation, and the Pattern of Trade." *American Economic Review* 70 (5): 950–959.

Krugman, Paul. 1991. *Geography and Trade*. Vol. 99. MIT Press.

Krugman, Paul. 1998. "What's New About the New Economic Geography?." *Oxford Review of Economic Policy* 14 (2): 7–17.

Lamoreaux, Naomi R, and Kenneth L Sokoloff. 1999. "Inventive Activity and the Market for Technology in the United States, 1840-1920." *NBER Working Paper No. 7107*.

Lamoreaux, Naomi R, and Kenneth L Sokoloff. 2000. "The Geography of Invention in the American Glass Industry, 1870–1925." *The Journal of Economic History* 60 (03) (June 26).

Lamoreaux, Naomi R, and Kenneth L Sokoloff. 2001. "Market Trade in Patents and the Rise of a Class of Specialized Inventors in the 19th-Century United States." *American Economic Review* 91 (2): 39–44.

Levinthal, Daniel A. 1991. "Random Walks and Organizational Mortality." *Administrative Science Quarterly* 36 (3) (September 1): 397–420.

Licht, Walter. 1995. *Industrializing America*. Baltimore and London: The Johns Hopkins University Press.

Marshall, Alfred. 1920. *Principles of Economics*. London: Macmillan and Co. Ltd.

Marx, M, D Strumsky, and L Fleming. 2009. "Mobility, Skills, and the Michigan Non-Compete Experiment." *Management Science* 55 (6) (June 10): 875–889.

Meyer, David R. 2006. *Networked Machinists: High-Technology Industries in Antebellum America (Johns Hopkins Studies in the History of Technology)*. annotated edition. The Johns Hopkins University Press.

Meyer, Marshall W, and Lynne G Zucker. 1989. *Permanently Failing Organizations*. Sage Publications, Inc.

Monzingo, Tim. 2011. "Tyler Once Home to Civil War-Era Ordnance Works." *Tyler Morning Telegraph*, July 25. http://www.tylerpaper.com/article/20110725/NEWS08/110729848/-1/RSS01.

Owen-Smith, Jason, and Walter W Powell. 2004. "Knowledge Networks as Channels and Conduits: the Effects of Spillovers in the Boston Biotechnology Community." *Organization Science* 15 (1) (January): 5–21.

Porter, Kelley, Kjersten Bunker Whittington, and Walter W Powell. 2005. "The Institutional Embeddedness of High-Tech Regions: Relational Foundations of the Boston Biotechnology Community." In *Clusters, Networks, and Innovation*, edited by Stefano Breschi and Franco Malerba, 261–296. New York: Oxford University Press.

Romo, Frank P., and Michael Schwartz. 1995. "The Structural Embeddedness of Business Decisions: the Migration of Manufacturing Plants in New York State, 1960 to 1985." *American Sociological Review* 60 (6): 874–907.

Rosenberg, Nathan. 1963. "Technological Change in the Machine Tool Industry, 1840–1910." *The Journal of Economic History* 23 (04) (December 1): 414–443.

Rosenberg, Nathan. 1970. "Economic Development and the Transfer of Technology: Some Historical Perspectives." *Technology and Culture* 11 (4): 550–575.

Rosenkopf, Lori, and Paul Almeida. 2003. "Overcoming Local Search Through Alliances and Mobility." *Management Science*: 751–766.

Rosenthal, Stuart S, and William C Strange. 2003a. "Geography, Industrial Organization, and Agglomeration." *Review of Economics and Statistics* 85 (2): 377–393.

Rosenthal, Stuart S, and William C Strange. 2003b. "Geography, Industrial Organization, and Agglomeration." *The Review of Economics and Statistics* 85 (2) (May 1): 377–393.

Rosenthal, Stuart S, and William C Strange. 2004. "Evidence on the Nature and Sources of Agglomeration Economies." *Handbook of Regional and Urban Economics*.

Saxenian, AnnaLee. 1996. *Regional Advantage: Culture and Competition in Silicon Valley and Route 128*.

Harvard University Press.

Sellers, Frank. 2008. *American Gunsmiths*. 2nd ed. Blue Book Publications, Inc.

Shaver, Myles J., and Frederick Flyer. 2000. "Agglomeration Economies, Firm Heterogeneity, and Foreign Direct Investment in the United States." *Strategic Management Journal* 21 (12): 1175–1193.

Simons, Tal, and P.W. Roberts. 2008. "Local and Non-Local Pre-Founding Experience and New Organizational Form Penetration: the Case of the Israeli Wine Industry." *Administrative Science Quarterly* 53 (2): 235.

Sorenson, Olav. 2003. "Social Networks and Industrial Geography." *Journal of Evolutionary Economics* 13 (5) (December 1): 513–527. http://www.springerlink.com/index/LBHQV1HY6BNWTG9U.pdf.

Sorenson, Olav, and Pino G Audia. 2000. "The Social Structure of Entrepreneurial Activity: Geographic Concentration of Footwear Production in the United States, 1940–19891." *American Journal of Sociology* 106 (2): 424–462. http://www.jstor.org/stable/3081182.

Staber, Udo. 2001. "Spatial Proximity and Firm Survival in a Declining Industrial District: the Case of Knitwear Firms in Baden-Württemberg." *Regional Studies* 35 (4) (June): 329–341. doi:10.1080/00343400125106.

Stinchcombe, Arthur L. 1965. "Social Structure and Organizations." In *Handbook of Organizations*, edited by John G March, 142–193. Chicago, IL: Rand-McNally.

Stuart, Toby, and Olav Sorenson. 2003. "Liquidity Events and the Geographic Distribution of Entrepreneurial Activity." *Administrative Science Quarterly*: 175–201.

Stuart, Toby, and Olav Sorenson. 2005. "Social Networks and Entrepreneurship." *Handbook of Entrepreneurship Research*.

Swaminathan, Anand, and Gabriele Wiedenmayer. 1991. "Does the Pattern of Density Dependence in Organizational Mortality Rates Vary Across Levels of Analysis? Evidence From the German Brewing Industry." *Social Science Research* 20 (1) (March): 45–73.

Sørensen, Jesper B, and Olav Sorenson. 2003. "From Conception to Birth: Opportunity Perception

and Resource Mobilization in Entrepreneurship." *Advances in Strategic Management* 20: 89–118.

Thompson, Peter. 2005. "Selection and Firm Survival: Evidence From the Shipbuilding Industry, 1825-1914." *Review of Economics and Statistics* 87 (1): 26–36.

Thünen, von, J. H. 1966. *The Isolated State*. Pergamon Press.

Tilly, Charles. 1977. "Repertoires of Contention in America and Britain, 1750-1830." In *The Dynamics of Social Movements*, edited by Mayer N Zald and John D McCarty, 126–155. Cambridge, MA: Winthrop.

Vandiver, Frank E. 1980. *Ploughshares Into Swords: Josiah Gorgas and Confederate Ordnance*. College Station, TX: Texas A&M University Press.

Weber, A. 1909. *Theory of the Location of Industries*. Chicago, IL: University of Chicago Press.

Whisker, James Biser. 2012. *U.S. and Confederate Arms and Armories During the American Civil War*. Vol. 4. Lampeter, UK: Edwin Mellen Press.

Whittington, Kjersten Bunker, Jason Owen-Smith, and Walter W Powell. 2009. "Networks, Propinquity, and Innovation in Knowledge-Intensive Industries." *Administrative Science Quarterly* 54 (1) (March 1): 90–122.

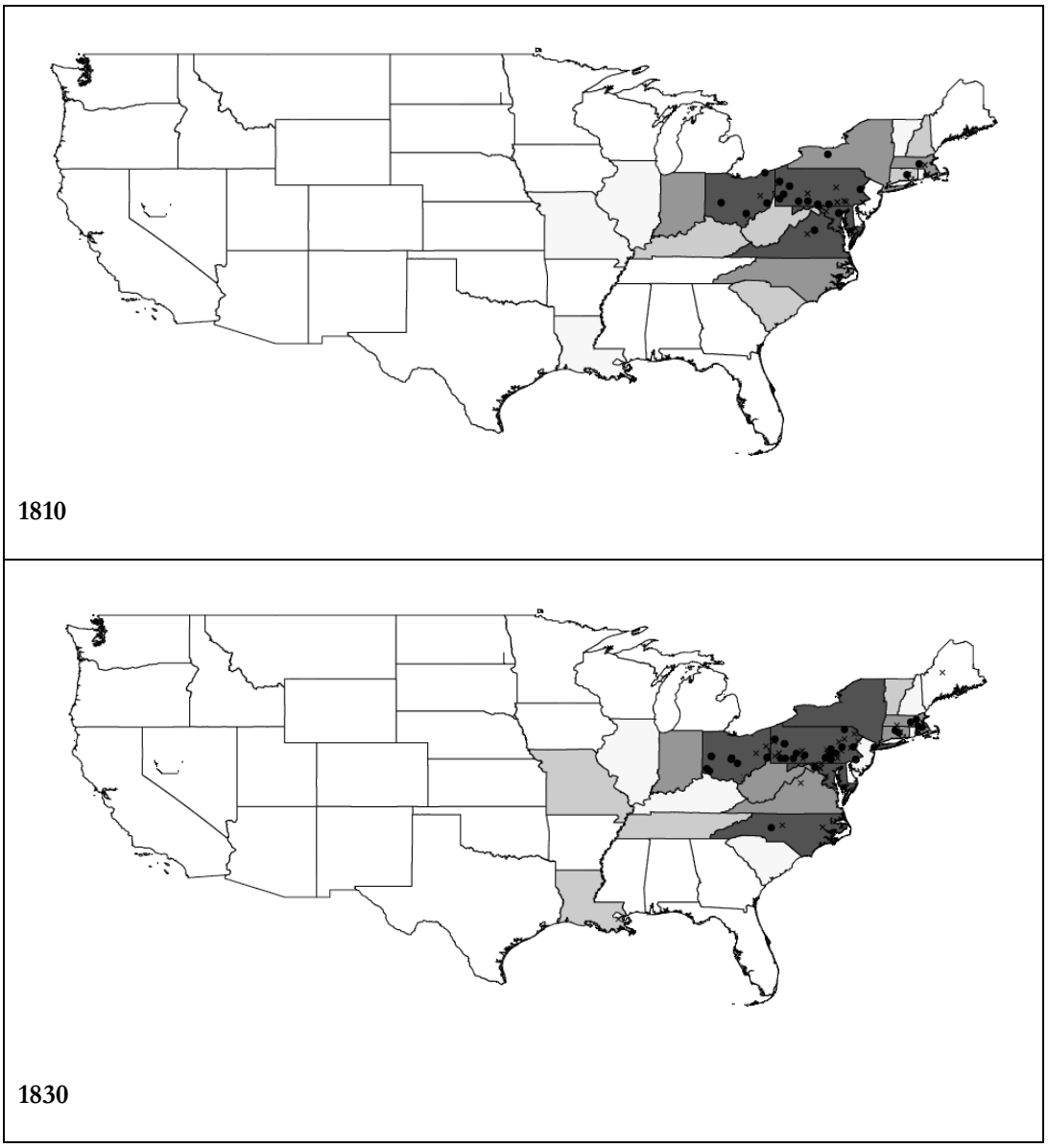
**Figure 1: Organizational density and organizational relocation in the US firearms industry**

**Legend:**

**Darker shading = Higher organizational density**

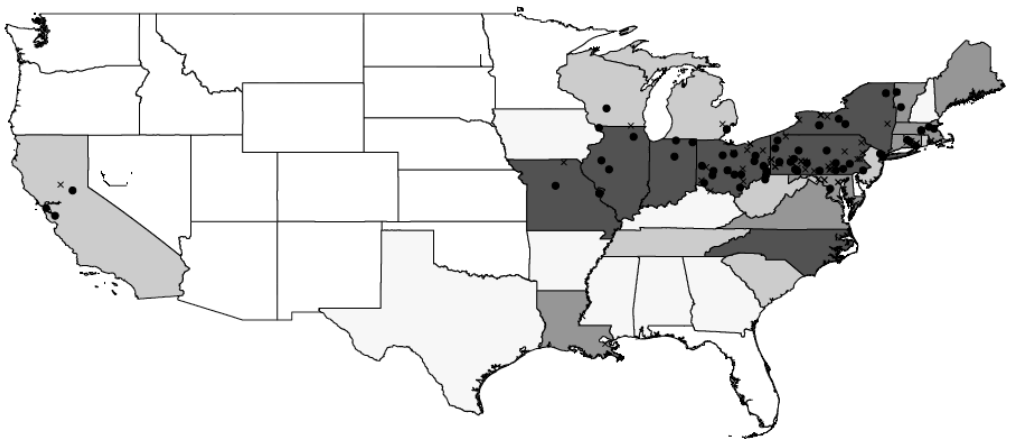
**• = Migrated firms in current year**

x **= Original locations of these migrated firms**

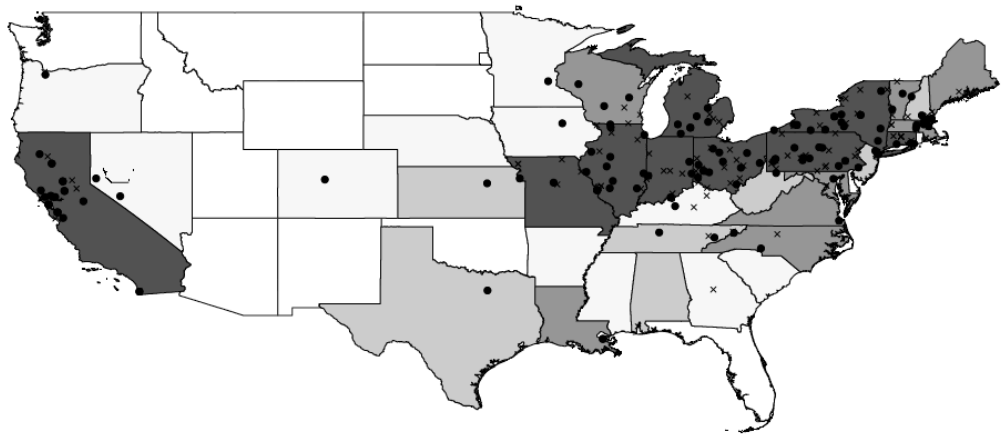


**1810**

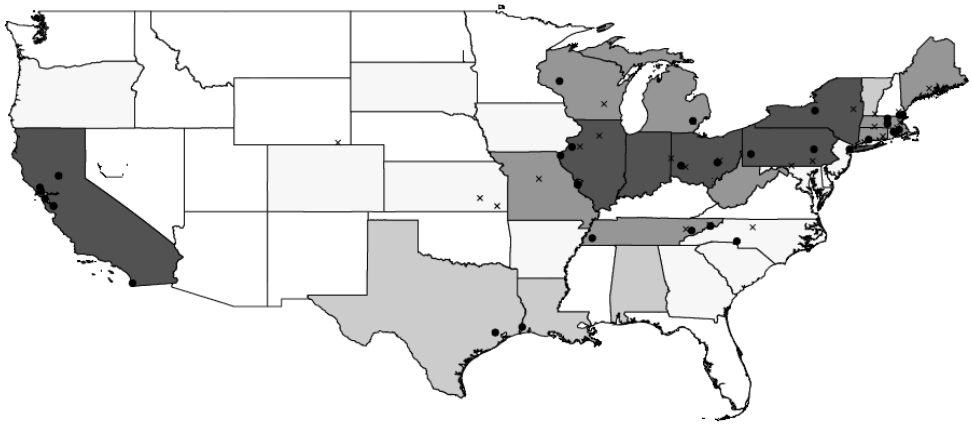
**1830**



**1850**



**1870**



**1900**

**Figure 2: National density of firearms manufacturers and gunsmiths**

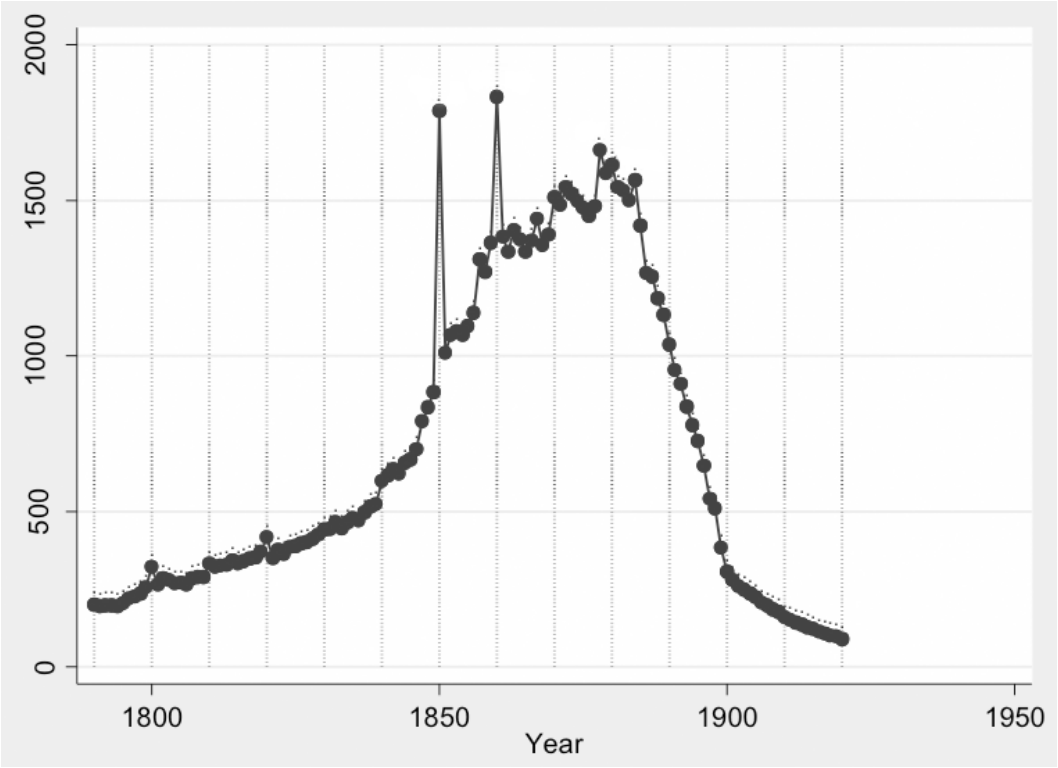


**Figure 3: Number of Southern US firearms firms**

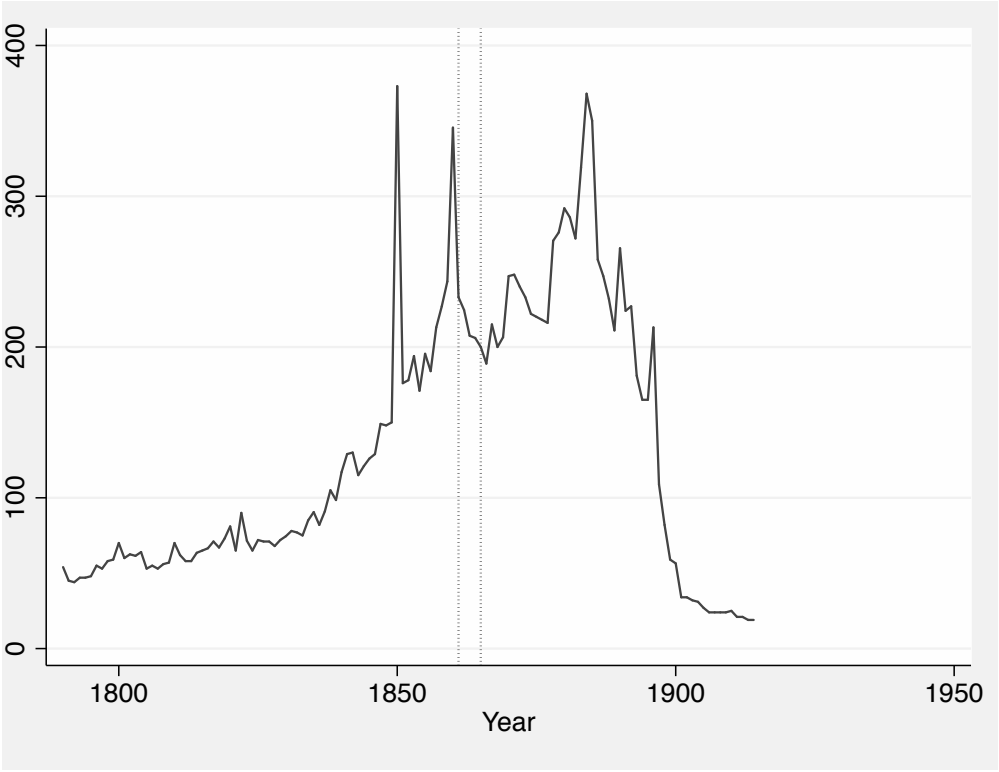


**Figure 4: Multiplier of mortality rate, geographic concentration of Civil War firms**

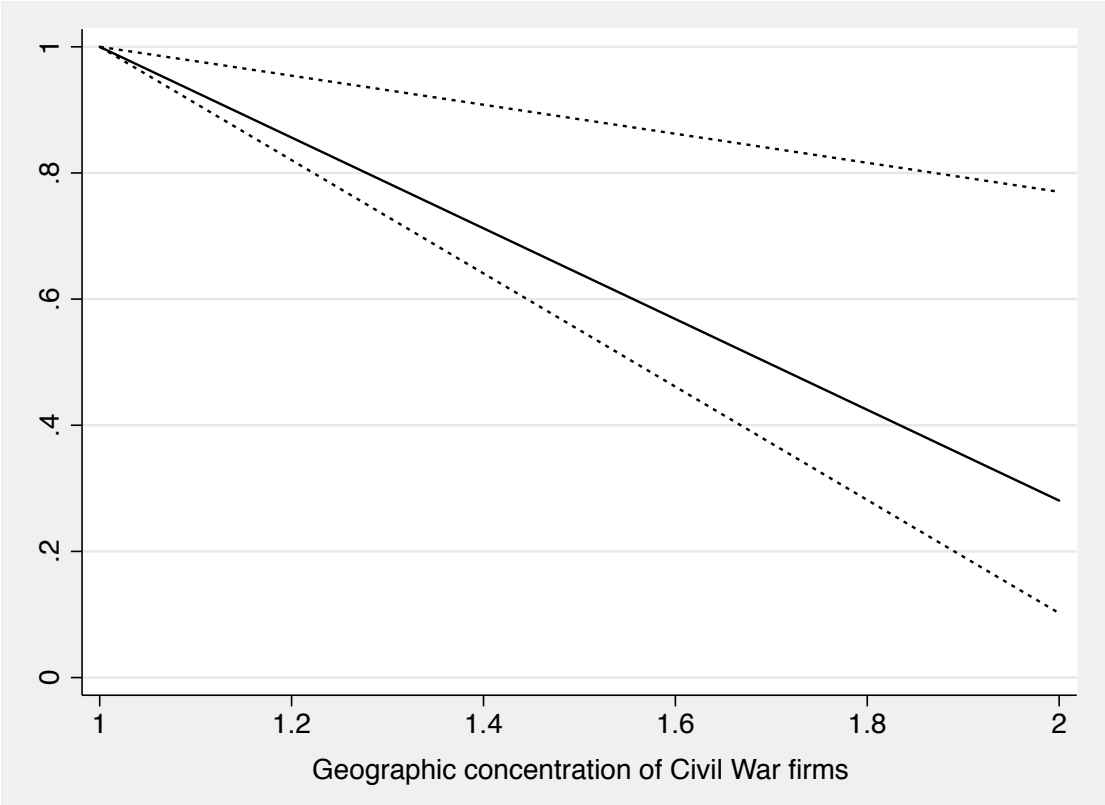


**Figure 5: Multiplier of mortality rate, geographic concentration of post-Civil War firms**

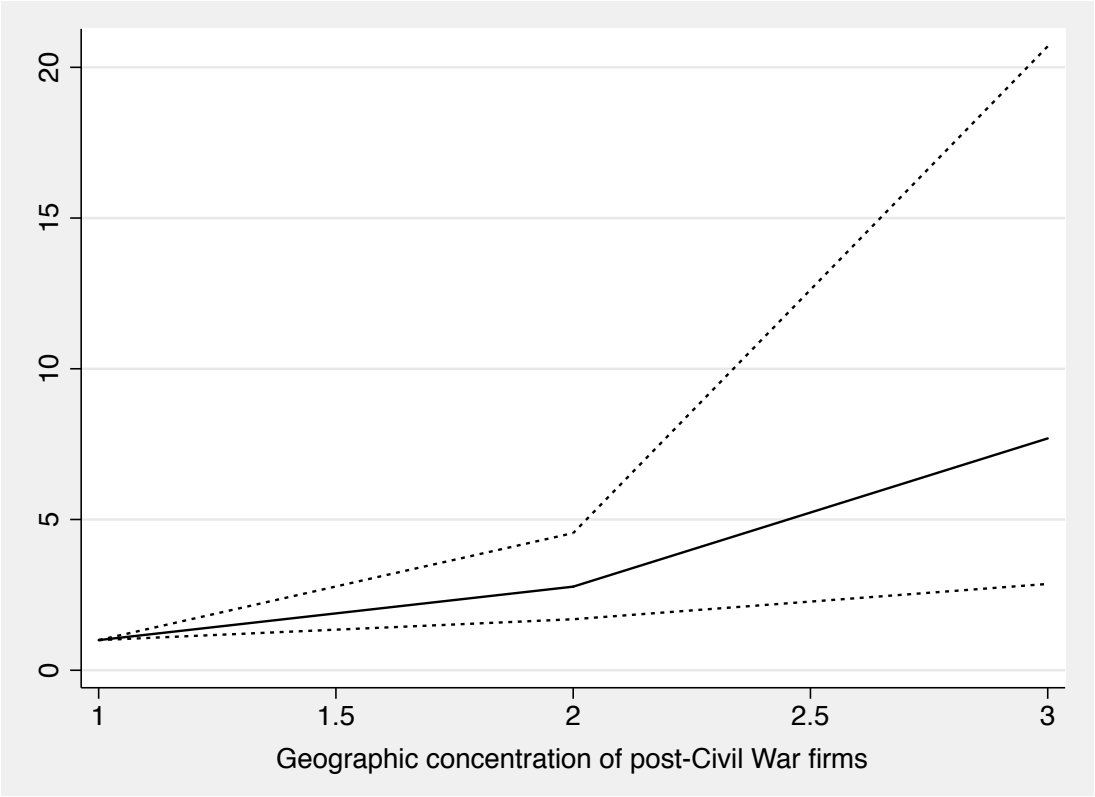


**Table 1: Transition matrix: Relocation across regions of the United States**

| | Destination | | | | |
|---|---|---|---|---|---|
| Origin | Northeast | Midwest | South | West | Total |
| Northeast | **266** | 51 | 20 | 21 | 358 |
| Midwest | 10 | **322** | 12 | 39 | 383 |
| South | 18 | 26 | **62** | 6 | 112 |
| West | 1 | 2 | 1 | **58** | 62 |
| Total | 295 | 401 | 95 | 124 | 915 |

**Table 2: Top origin cities**

| | **Destination Region** | | | | |
|---|---|---|---|---|---|
| **Origin** | **NE** | **MW** | **S** | **W** | **Total** |
| **San Francisco** | 2 | 1 | 1 | 21 | 25 |
| **Saint Louis** | 2 | 10 | 4 | 7 | 23 |
| **Lancaster** | 14 | 5 | 2 | 0 | 21 |
| **New York** | 14 | 3 | 1 | 3 | 21 |
| **Rochester** | 15 | 1 | 0 | 5 | 21 |
| **Philadelphia** | 8 | 3 | 3 | 4 | 18 |
| **Chicago** | 1 | 11 | 1 | 2 | 15 |
| **Washington** | 3 | 3 | 6 | 1 | 13 |
| **Hartford** | 10 | 2 | 0 | 0 | 12 |
| **Baltimore** | 3 | 4 | 3 | 1 | 11 |
| **Cincinnati** | 0 | 9 | 2 | 0 | 11 |
| **Columbus** | 0 | 9 | 2 | 0 | 11 |
| **Fayette County** | 4 | 5 | 2 | 0 | 11 |
| **Springfield** | 4 | 7 | 0 | 0 | 11 |
| **Cleveland** | 0 | 7 | 1 | 0 | 8 |
| **Boston** | 4 | 2 | 0 | 1 | 7 |
| **Norwich** | 7 | 0 | 0 | 0 | 7 |
| **Washington County** | 3 | 4 | 0 | 0 | 7 |
| **Worcester** | 7 | 0 | 0 | 0 | 7 |
| **Total** | **58** | **46** | **12** | **30** | **146** |

**Table 3: Top destination cities**

| | Region Of Origin | | | | |
|---|---|---|---|---|---|
| **Destination** | **NE** | **MW** | **S** | **W** | **Total** |
| **San Francisco** | 6 | 6 | 3 | 12 | 27 |
| **Saint Louis** | 4 | 12 | 5 | 0 | 21 |
| **New York** | 10 | 1 | 2 | 0 | 13 |
| **Denver** | 1 | 7 | 0 | 3 | 11 |
| **Lancaster** | 7 | 2 | 2 | 0 | 11 |
| **Springfield** | 4 | 6 | 0 | 0 | 10 |
| **Columbus** | 2 | 4 | 3 | 0 | 9 |
| **Sacramento** | 0 | 6 | 1 | 1 | 8 |
| **Syracuse** | 8 | 0 | 0 | 0 | 8 |
| **Chicago** | 2 | 4 | 1 | 0 | 7 |
| **Pittsburgh** | 6 | 1 | 0 | 0 | 7 |
| **Baltimore** | 3 | 0 | 3 | 0 | 6 |
| **Boston** | 5 | 0 | 0 | 1 | 6 |
| **Marysville** | 5 | 1 | 0 | 0 | 6 |
| **Norwich** | 6 | 0 | 0 | 0 | 6 |
| **Rochester** | 5 | 0 | 0 | 1 | 6 |
| **Washington** | 3 | 1 | 2 | 0 | 6 |
| **Worcester** | 6 | 0 | 0 | 0 | 6 |
| **Total** | **28** | **31** | **12** | **13** | **84** |

**Table 4: Summary statistics, mortality, and push analyses**

| Variable | Observations | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| **Firm age** | 107878 | 13.60399 | 13.17437 | 0.5 | 103 |
| **Relocated firm** | 12684 | 0.0721381 | 0.2587267 | 0 | 1 |
| **Proximity-weighted firm density** | 107878 | 4.994586 | 2.552298 | 0.0583323 | 24.75804 |
| **County density of firms** | 107878 | 8.380452 | 13.03715 | 0 | 76 |
| **Patent owner** | 12684 | 0.0357931 | 0.1857813 | 0 | 1 |
| **Manufacturer** | 12684 | 0.153264 | 0.3602559 | 0 | 1 |
| **Incorporated** | 12684 | 0.0258594 | 0.0258594 | 0 | 1 |
| **National density of firms/100** | 107878 | 13.85256 | 5.939154 | 1.71 | 24.55 |
| **(Number of foundings)$_{t-1}$** | 107878 | 0.9463839 | 2.542427 | 0 | |
| **County human population/10000** | 107878 | 1.093674 | 9.556827 | 0 | 3051.837 |
| **Value of national industry product/100000** | 107878 | 31.82495 | 20.97911 | 0.06524132 | 94.26869 |

**Note:** In the case of non-dummy variables, the number of observations reflects firm-year spells.

**Table 5: Correlation table, mortality, and push analyses**

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 **Firm age** | 1 | | | | | | | | | | | | | |
| 2 **Relocated firm** | 0.1956 | 1 | | | | | | | | | | | | |
| 3 **Proximity-weighted firm density** | -0.0284 | -0.0661 | 1 | | | | | | | | | | | |
| 4 **Proximity-weighted firm density squared** | -0.0185 | -0.0511 | 0.9393 | 1 | | | | | | | | | | |
| 5 **County density of firms** | -0.0527 | -0.0737 | 0.1553 | 0.1271 | 1 | | | | | | | | | |
| 6 **County density of firms squared** | -0.0511 | -0.0652 | 0.118 | 0.0947 | 0.9404 | 1 | | | | | | | | |
| 7 **Patent owner** | 0.0584 | 0.0968 | 0.0173 | 0.0161 | 0.049 | 0.025 | 1 | | | | | | | |
| 8 **Manufacturer** | 0.1765 | 0.0623 | 0.0847 | 0.0743 | 0.026 | 0.0195 | -0.0075 | 1 | | | | | | |
| 9 **Incorporated** | 0.0045 | -0.0154 | -0.0095 | -0.0036 | 0.0593 | 0.0317 | 0.0154 | 0.0549 | 1 | | | | | |
| 10 **National density of firms/100** | -0.0875 | -0.0022 | 0.5808 | 0.5055 | -0.0132 | -0.0206 | 0.0205 | -0.0619 | -0.0052 | 1 | | | | |
| 11 **National density of firms squared/10000** | -0.0862 | -0.0023 | 0.5818 | 0.5302 | -0.0101 | -0.0151 | 0.0165 | -0.0615 | -0.004 | 0.9777 | 1 | | | |
| 12 **(Number of foundings)$_{t-1}$** | -0.08 | -0.0508 | 0.0518 | 0.0345 | 0.5441 | 0.5088 | 0.016 | 0.0102 | 0.031 | -0.0273 | -0.0348 | 1 | | |
| 13 **County human population/10000** | 0.0205 | -0.0095 | -0.0000 | 0.0007 | 0.1142 | 0.1001 | 0.0296 | -0.0042 | 0.0292 | -0.0048 | -0.0052 | 0.0559 | 1 | |
| 14 **Value of national industry product/100000** | 0.2209 | 0.0673 | 0.0644 | 0.0603 | -0.162 | -0.1569 | 0.0876 | -0.0874 | 0.0899 | 0.4872 | 0.4875 | -0.1346 | 0.0382 | 1 |

**Table 6: Piecewise exponential models of organizational mortality**

| | (1) | (2) |
|---|---|---|
| **Age < 2 years** | -1.368*** | -1.226*** |
| | (0.209) | (0.212) |
| **Age 2 - 5 years** | -2.448*** | -2.297*** |
| | (0.210) | (0.213) |
| **Age 5 - 10 years** | -2.695*** | -2.546*** |
| | (0.210) | (0.213) |
| **Age 10 - 15 years** | -2.768*** | -2.620*** |
| | (0.211) | (0.214) |
| **Age > 15 years** | -2.886*** | -2.734*** |
| | (0.211) | (0.214) |
| **Proximity-weighted firm density** | | 0.0762*** |
| | | (0.00605) |
| **Patent owner** | -0.291*** | -0.282*** |
| | (0.0482) | (0.0477) |
| **Manufacturer** | -0.504*** | -0.505*** |
| | (0.0234) | (0.0234) |
| **Incorporated** | -0.186*** | -0.172*** |
| | (0.0559) | (0.0551) |
| **National density of firms** | -0.176*** | -0.186*** |
| | (0.0163) | (0.0163) |
| **National density of firms squared** | 0.00734*** | 0.00684*** |
| | (0.000442) | (0.000445) |
| **County human population** | 0.0000879 | 0.0000863* |
| | (0.0000598) | (0.0000501) |
| **Value of national industry product** | -0.0100*** | -0.00888*** |
| | (0.00151) | (0.00151) |
| Log pseudo-likelihood | -19426.788 | -19367.014 |
| Number of exits | 12520 | 12520 |
| Observations | 107,880 | 107,880 |
| State FE | YES | YES |
| Decade FE | YES | YES |

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

**Table 7: Piecewise exponential models of organizational relocation**

| | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|
| **Age < 2 years** | -4.149*** | -3.867*** | -3.882*** | -4.143*** | -4.162*** |
| | (0.776) | (0.779) | (0.779) | (0.777) | (0.777) |
| **Age 2 - 5 years** | -4.920*** | -4.567*** | -4.583*** | -4.916*** | -4.938*** |
| | (0.780) | (0.783) | (0.783) | (0.780) | (0.781) |
| **Age 5 - 10 years** | -5.338*** | -4.983*** | -4.999*** | -5.334*** | -5.354*** |
| | (0.779) | (0.781) | (0.782) | (0.779) | (0.779) |
| **Age 10 - 15 years** | -5.328*** | -4.990*** | -5.005*** | -5.324*** | -5.344*** |
| | (0.782) | (0.785) | (0.785) | (0.782) | (0.783) |
| **Age > 15 years** | -5.656*** | -5.310*** | -5.323*** | -5.651*** | -5.670*** |
| | (0.783) | (0.786) | (0.786) | (0.783) | (0.783) |
| **Proximity-weighted firm density** | | 0.140*** | 0.202*** | | |
| | | (0.0187) | (0.0559) | | |
| **(Proximity-weighted firm density)^2** | | | -0.00369 | | |
| | | | (0.00314) | | |
| **Density in county** | | | | 0.00214 | 0.0138 |
| | | | | (0.00293) | (0.00864) |
| **(Density in county)^2** | | | | | -0.000230 |
| | | | | | (0.000168) |
| **Patent owner** | 1.175*** | 1.214*** | 1.218*** | 1.171*** | 1.166*** |
| | (0.122) | (0.122) | (0.122) | (0.122) | (0.122) |
| **Manufacturer** | 0.286*** | 0.288*** | 0.287*** | 0.288*** | 0.289*** |
| | (0.0780) | (0.0785) | (0.0786) | (0.0783) | (0.0783) |
| **Incorporated** | -0.482* | -0.444* | -0.443* | -0.490* | -0.510* |
| | (0.265) | (0.265) | (0.265) | (0.265) | (0.265) |
| **(Foundings in county)$_{t-1}$** | -0.0586*** | -0.0533*** | -0.0538*** | -0.0648*** | -0.0667*** |
| | (0.0186) | (0.0183) | (0.0184) | (0.0205) | (0.0209) |
| **County human population** | -0.000341 | -0.000243 | -0.000217 | -0.000620 | -0.000924 |
| | (0.000640) | (0.000518) | (0.000497) | (0.00111) | (0.00254) |
| **Value of national industry product** | -0.0131** | -0.00398 | -0.00427 | -0.0131** | -0.0134** |
| | (0.00609) | (0.00597) | (0.00600) | (0.00609) | (0.00610) |
| Log pseudo-likelihood | -3791.4904 | -3769.263 | -3768.6358 | -3791.2684 | -3790.1619 |
| Number of relocations | 915 | 915 | 915 | 915 | 915 |
| Observations | 96,507 | 96,507 | 96,507 | 96,507 | 96,507 |
| State FE | YES | YES | YES | YES | YES |
| Decade FE | YES | YES | YES | YES | YES |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

**Table 8: Piecewise exponential models of organizational relocation (by distance)**

| | (8) Out of state | (9) Out of state | (10) Within state | (11) Within state |
|---|---|---|---|---|
| **Age < 2 years** | -4.808*** | -4.611*** | -5.047*** | -4.697*** |
| | (1.099) | (1.099) | (1.095) | (1.099) |
| **Age 2 - 5 years** | -5.407*** | -5.160*** | -5.980*** | -5.544*** |
| | (1.093) | (1.092) | (1.108) | (1.112) |
| **Age 5 - 10 years** | -5.636*** | -5.389*** | -6.527*** | -6.087*** |
| | (1.097) | (1.096) | (1.101) | (1.104) |
| **Age 10 - 15 years** | -5.871*** | -5.635*** | -6.245*** | -5.823*** |
| | (1.103) | (1.102) | (1.102) | (1.106) |
| **Age > 15 years** | -6.171*** | -5.932*** | -6.553*** | -6.123*** |
| | (1.107) | (1.106) | (1.104) | (1.108) |
| **Proximity-weighted firm density** | | 0.112*** | | 0.153*** |
| | | (0.0326) | | (0.0210) |
| **Patent owner** | 1.382*** | 1.411*** | 1.061*** | 1.096*** |
| | (0.169) | (0.170) | (0.154) | (0.154) |
| **Manufacturer** | 0.463*** | 0.460*** | 0.159 | 0.167* |
| | (0.117) | (0.118) | (0.0989) | (0.0993) |
| **Incorporated** | -0.579 | -0.553 | -0.212 | -0.177 |
| | (0.417) | (0.417) | (0.314) | (0.315) |
| **(Foundings in county)$_{t-1}$** | -0.00966 | -0.00678 | -0.117*** | -0.110*** |
| | (0.0166) | (0.0166) | (0.0352) | (0.0346) |
| **County human population** | 0.000365 | 0.000369 | -0.0607 | -0.0568 |
| | (0.000371) | (0.000369) | (0.0510) | (0.0520) |
| **Value of national industry product** | -0.00714 | 0.000134 | -0.0172** | -0.00765 |
| | (0.0104) | (0.0102) | (0.00720) | (0.00708) |
| Log pseudo-likelihood | -1901.7356 | -1896.1559 | -2660.1512 | 2642.4247 |
| Number of relocations | 361 | 361 | 554 | 554 |
| Observations | 102,458 | 102,458 | 102,458 | 102,458 |
| State FE | YES | YES | YES | YES |
| Decade FE | YES | YES | YES | YES |

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

**Table 9: Summary statistics (conditional logit analysis)**

| Variable | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|
| **Mean proximity-weighted density$_{t-1}$** | 3.075242 | 2.568734 | 0 | 20.89759 |
| **Mean proximity-weighted density squared $_{t-1}$** | 16.06404 | 21.2973 | 0 | 436.7094 |
| **Foundings $_{t-1}$** | 0.0979758 | 0.5251265 | 0 | 47 |
| **Patent-owning firms $_{t-1}$** | 0.0491667 | 0.4004432 | 0 | 12 |
| **Manufacturing firms $_{t-1}$** | 0.2486806 | 0.9822811 | 0 | 36 |
| **Incorporated firms $_{t-1}$** | 0.0255721 | 0.2537895 | 0 | 8 |
| **Human population $_{t-1}$ [standardized]** | 0.2018453 | 1.253554 | 0 | 399.9256 |

**Table 10: Correlation table (conditional logit analysis)**

| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| 1 | **Mean proximity-weighted density $_{t-1}$** | 1 | | | | | | |
| 2 | **Mean proximity-weighted density squared $_{t-1}$** | 0.9176 | 1 | | | | | |
| 3 | **Foundings $_{t-1}$** | 0.1828 | 0.1979 | 1 | | | | |
| 4 | **Patent-owning firms $_{t-1}$** | 0.1442 | 0.1495 | 0.2781 | 1 | | | |
| 5 | **Manufacturing firms $_{t-1}$** | 0.2902 | 0.3022 | 0.4285 | 0.5484 | 1 | | |
| 6 | **Incorporated firms $_{t-1}$** | 0.1155 | 0.1194 | 0.3353 | 0.603 | 0.5039 | 1 | |
| 7 | **Human population $_{t-1}$ [standardized]** | 0.0852 | 0.089 | 0.099 | 0.1764 | 0.1819 | 0.178 | 1 |

**Table 11: Conditional logit analyses of choice of county destination**

| | (12) Overall | (13) Overall | (14) Overall | (15) Overall | (16) Overall | (17) Out of state | (18) Out of state | (19) Within state | (20) Within state |
|---|---|---|---|---|---|---|---|---|---|
| **Mean prox.-weighted density (t-1)** | | 0.169*** | 0.328*** | | | | 0.0473* | | 0.245*** |
| | | (0.0160) | (0.0595) | | | | (0.0283) | | (0.0184) |
| **Mean prox.-weighted density squared (t-1)** | | | -0.0161*** | | | | | | |
| | | | (0.00585) | | | | | | |
| **Local firm density (t-1)** | | | | 0.0911*** | 0.231*** | | | | |
| | | | | (0.00673) | (0.0166) | | | | |
| **Local firm density squared (t-1)** | | | | | -0.00362*** | | | | |
| | | | | | (0.000486) | | | | |
| **Foundings (t-1)** | 0.0604*** | 0.0663*** | 0.0697*** | -0.0345* | 0.0635*** | 0.119*** | 0.120*** | -0.0172 | -0.00330 |
| | (0.0193) | (0.0173) | (0.0159) | (0.0187) | (0.0201) | (0.0234) | (0.0232) | (0.0360) | (0.0316) |
| **Patent-owning firms (t-1)** | -0.0917 | -0.0636 | -0.0546 | -0.0722* | -0.00544 | -0.115 | -0.109 | -0.0600 | -0.00813 |
| | (0.0604) | (0.0543) | (0.0521) | (0.0410) | (0.0342) | (0.0776) | (0.0756) | (0.0905) | (0.0788) |
| **Manufacturing firms (t-1)** | 0.163*** | 0.129*** | 0.124*** | | | 0.121*** | 0.112*** | 0.203*** | 0.153*** |
| | (0.0177) | (0.0162) | (0.0153) | | | (0.0260) | (0.0266) | (0.0228) | (0.0198) |
| **Incorporated firms (t-1)** | 0.245*** | 0.239*** | 0.241*** | 0.0650 | -0.0199 | 0.417*** | 0.411*** | 0.0923 | 0.125 |
| | (0.0721) | (0.0686) | (0.0677) | (0.0736) | (0.0544) | (0.0741) | (0.0730) | (0.136) | (0.144) |
| **Human population (t-1)** | 0.0101*** | 0.00899*** | 0.00960*** | 0.00352 | 0.00529 | 0.0117*** | 0.0117*** | 0.00689 | -0.0324 |
| | (0.00205) | (0.00272) | (0.00242) | (0.0102) | (0.00627) | (0.00217) | (0.00219) | (0.00681) | (0.0670) |
| Log pseudo-likelihood | -3921.87 | -3840.06 | -6601.40 | -6538.49 | -6528.75 | -2669.72 | -2667.904 | -3921.8661 | -3840.0638 |
| Pseudo R-square | 0.026 | 0.0463 | 0.0278 | 0.037 | 0.0385 | 0.034 | 0.0346 | 0.026 | 0.0463 |
| Number of relocations | 915 | 915 | 915 | 915 | 915 | 361 | 361 | 554 | 554 |
| Observations | 1,539,176 | 1,539,176 | 1,539,176 | 1,539,176 | 1,539,176 | 626,448 | 626,448 | 912,728 | 912,728 |
| Robust standard errors in parentheses | *** p<0.01, ** p<0.05, * p<0.1 | | | | | | | | |

**Table 12: Summary statistics: 1790-1914**

| | | Mean | S.D. | Min | Max | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Geog. concentration of Southern firms | 0.563 | 0.467 | 0.018 | 7.283 | 1 | | | | | | | | | | |
| 2 | Geog. concentration of Non-South firms | 2.157 | 1.239 | 0.125 | 10.268 | 0.47 | 1 | | | | | | | | | |
| 3 | During Civil War | 0.07 | 0.255 | 0 | 1 | 0.04 | 0.13 | 1 | | | | | | | | |
| 4 | After Civil War | 0.593 | 0.491 | 0 | 1 | 0.12 | 0.01 | -0.33 | 1 | | | | | | | |
| 5 | Patent owner | 0.016 | 0.125 | 0 | 1 | 0.02 | -0.03 | -0.01 | 0.07 | 1 | | | | | | |
| 6 | Manufacturer | 0.252 | 0.434 | 0 | 1 | -0.15 | 0.02 | 0.09 | -0.23 | 0.01 | 1 | | | | | |
| 7 | Incorporated | 0.026 | 0.159 | 0 | 1 | -0.04 | -0.01 | 0.11 | 0 | 0.05 | 0.06 | 1 | | | | |
| 8 | National density of firms/10 | 14.041 | 5.801 | 1.71 | 24.55 | 0.46 | 0.64 | 0.14 | 0.35 | 0 | -0.08 | 0 | 1 | | | |
| 9 | National density of firms squared/1000 | 230.806 | 148.016 | 2.924 | 602.703 | 0.47 | 0.65 | 0.11 | 0.31 | 0 | -0.07 | 0 | 0.98 | 1 | | |
| 10 | County human population | 0.433 | 0.615 | 0 | 3.576 | -0.23 | -0.25 | -0.03 | 0.15 | 0.1 | -0.05 | 0.1 | 0.01 | 0.01 | 1 | |
| 11 | Value of national industry product | 32.729 | 20.186 | 0.065 | 94.269 | 0.1 | 0.16 | -0.03 | 0.84 | 0.08 | -0.14 | 0.06 | 0.49 | 0.48 | 0.19 | 1 |

**Table 13: Summary statistics: 1866-1914**

| | | Mean | S.D. | Min | Max | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Geog. concentration of South CW firms | 0.177 | 0.172 | 0.004 | 2.082 | 1 | | | | | | | | | | |
| 2 | Geog. concentration of South post-CW firms | 0.432 | 0.291 | 0.009 | 3.752 | -0.02 | 1 | | | | | | | | | |
| 3 | Geog. concentration of Non-South firms | 2.172 | 1.094 | 0.125 | 8.567 | 0.53 | 0.08 | 1 | | | | | | | | |
| 4 | Civil War firm | 0.324 | 0.468 | 0 | 1 | 0.26 | -0.29 | 0.17 | 1 | | | | | | | |
| 5 | Patent owner | 0.023 | 0.15 | 0 | 1 | 0.12 | -0.05 | -0.05 | 0.1 | 1 | | | | | | |
| 6 | Manufacturer | 0.169 | 0.375 | 0 | 1 | 0.01 | -0.2 | 0.04 | 0.42 | 0.05 | 1 | | | | | |
| 7 | Incorporated | 0.026 | 0.159 | 0 | 1 | -0.02 | -0.1 | -0.03 | 0.03 | 0.08 | 0.12 | 1 | | | | |
| 8 | National density of firms/10 | 15.738 | 4.602 | 1.71 | 20.54 | 0.4 | 0.19 | 0.62 | 0.05 | -0.05 | 0.01 | -0.06 | 1 | | | |
| 9 | National density of firms squared/1000 | 268.859 | 118.615 | 2.924 | 421.892 | 0.4 | 0.15 | 0.61 | 0.07 | -0.04 | 0.02 | -0.04 | 0.98 | 1 | | |
| 10 | County human population | 0.512 | 0.712 | 0 | 3.576 | -0.19 | -0.3 | -0.29 | 0.12 | 0.1 | 0.01 | 0.12 | -0.13 | -0.11 | 1 | |
| 11 | Value of national industry product | 46.842 | 10.889 | 29.225 | 94.269 | 0.2 | -0.39 | 0.09 | 0.19 | 0.04 | 0.15 | 0.1 | 0.03 | 0.19 | 0.12 | 1 |

**Table 14: Piecewise constant exponential models of firm mortality: 1790-1914**

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| **Age: 0-5 years** | -0.0862 | -0.102 | -0.187 | -0.251 |
| | (0.368) | (0.452) | (0.452) | (0.463) |
| **Age: 5-10 years** | -1.166*** | -1.165** | -1.227*** | -1.292*** |
| | (0.381) | (0.461) | (0.461) | (0.472) |
| **Age: 10-15 years** | -1.212*** | -1.248*** | -1.310*** | -1.386*** |
| | (0.380) | (0.463) | (0.463) | (0.472) |
| **Age: 15 or more years** | -1.251*** | -1.278*** | -1.324*** | -1.397*** |
| | (0.382) | (0.465) | (0.465) | (0.474) |
| **Geog. concentration of Southern firms** | | | 0.259*** | 0.108*** |
| | | | (0.0488) | (0.0394) |
| **Geog. concentration of Non-Southern firms** | | | 0.0157 | 0.0956* |
| | | | (0.0540) | (0.0549) |
| **During Civil War** | | 4.427*** | 4.083*** | 4.252*** |
| | | (0.619) | (0.628) | (0.680) |
| **(Civil War) x (Geog. concentration of South firms)** | | | | -0.244* |
| | | | | (0.145) |
| **(Civil War) x (Geog. concentration of Non-South firms)** | | | | -0.000830 |
| | | | | (0.0877) |
| **After Civil War** | | 0.841*** | 0.455 | 1.081*** |
| | | (0.311) | (0.327) | (0.358) |
| **(After Civil War) x (Geog. concentration of South firms)** | | | | 0.326** |
| | | | | (0.144) |
| **(After Civil War) x (Geog. conc. of Non-South firms)** | | | | -0.213*** |
| | | | | (0.0659) |
| **Patent owner** | 0.161 | 0.177 | 0.142 | 0.142 |
| | (0.223) | (0.220) | (0.227) | (0.227) |
| **Manufacturer** | -0.615*** | -0.617*** | -0.603*** | -0.605*** |
| | (0.0849) | (0.0855) | (0.0854) | (0.0845) |
| **Incorporated** | 0.408*** | 0.366*** | 0.363*** | 0.387*** |
| | (0.127) | (0.127) | (0.129) | (0.128) |
| **National density of firms** | -0.312*** | -0.693*** | -0.648*** | -0.660*** |
| | (0.0381) | (0.0592) | (0.0610) | (0.0661) |
| **National density of firms squared** | 0.0135*** | 0.0241*** | 0.0217*** | 0.0223*** |
| | (0.00119) | (0.00182) | (0.00192) | (0.00203) |
| **County human population** | -0.378*** | -0.407*** | -0.357*** | -0.321*** |
| | (0.0744) | (0.0737) | (0.0766) | (0.0772) |
| **Value of national industry product** | 0.00409 | -0.0250*** | -0.0197*** | -0.0213*** |
| | (0.00442) | (0.00586) | (0.00609) | (0.00619) |
| **Pseudo-loglikelihood** | -2506.862 | -2478.5697 | -2462.9249 | -2451.2287 |
| **Number of failures** | 1634 | 1634 | 1634 | 1634 |
| **Number of firms** | 1664 | 1664 | 1664 | 1664 |
| **Observations** | 10,151 | 10,151 | 10,151 | 10,151 |
| **State fixed effects** | YES | YES | YES | YES |
| **Decade fixed effects** | YES | YES | YES | YES |

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

**Table 15: Piecewise constant exponential models of firm mortality: 1866-1914**

| | (5) | (6) | (7) |
|---|---|---|---|
| **Age: 0-5 years** | 3.244** | 4.678*** | 6.294*** |
| | (1.450) | (1.522) | (1.654) |
| **Age: 5-10 years** | 2.422* | 3.914** | 5.520*** |
| | (1.446) | (1.527) | (1.660) |
| **Age: 10-15 years** | 2.242 | 3.786** | 5.375*** |
| | (1.455) | (1.537) | (1.669) |
| **Age: 15 or more years** | 2.052 | 4.020*** | 5.645*** |
| | (1.464) | (1.541) | (1.678) |
| **Geog. concentration of Southern firms** | 0.479*** | | |
| | (0.136) | | |
| **Geog. concentration of Non-Southern firms** | -0.147 | 0.0210 | 0.0702 |
| | (0.0908) | (0.0852) | (0.0856) |
| **Geog. concentration of South CW firms** | | -1.271** | -2.862*** |
| | | (0.515) | (1.108) |
| **Geog. concentration of South post-CW firms** | | 1.020*** | 0.490* |
| | | (0.252) | (0.278) |
| **Civil War firm** | | -0.683*** | -0.681*** |
| | | (0.154) | (0.154) |
| **Time since Civil War** | 0.0302* | 0.00154 | -0.0336 |
| | (0.0180) | (0.0191) | (0.0233) |
| **(Time since CW) x (Geog. concentration of South CW firms)** | | | 0.115* |
| | | | (0.0636) |
| **(Time since CW) x (Geog. concentration of South post-CW firms)** | | | 0.0235 |
| | | | (0.0144) |
| **Patent owner** | -0.0412 | 0.190 | 0.205 |
| | (0.221) | (0.267) | (0.261) |
| **Manufacturer** | -0.442*** | -0.392** | -0.398** |
| | (0.150) | (0.159) | (0.160) |
| **Incorporated** | 0.184 | 0.273 | 0.274 |
| | (0.199) | (0.202) | (0.203) |
| **National density of firms** | -0.676*** | -0.779*** | -0.648*** |
| | (0.123) | (0.126) | (0.0610) |
| **National density of firms squared** | 0.0237*** | 0.0257*** | 0.0217*** |
| | (0.00394) | (0.00396) | (0.00192) |
| **County human population** | -0.274** | -0.434*** | -0.389*** |
| | (0.113) | (0.0975) | (0.103) |
| **Value of national industry product** | -0.0228** | -0.0187* | -0.0222** |
| | (0.0102) | (0.00864) | (0.0102) |
| **Pseudo-loglikelihood** | -1380.0038 | -1347.9571 | -1344.4901 |
| **Number of failures** | 978 | 978 | 978 |
| **Number of firms** | 995 | 995 | 995 |
| **Observations** | 6,022 | 6,022 | 6,022 |
| **State fixed effects** | YES | YES | YES |
| **Decade fixed effects** | YES | YES | YES |
| Robust standard errors in parentheses | *** p<0.01, ** p<0.05, * p<0.1 | | |

**Table 16: Technological proficiency: piecewise constant exponential models of firm mortality: 1866-1914**

| | (8) | (9) |
|---|---|---|
| **Age < 5 years** | 4.938*** | 4.288*** |
| | (1.550) | (1.558) |
| **Age 5-10 years** | 4.139*** | 3.503** |
| | (1.556) | (1.559) |
| **Age 10-15 years** | 3.935** | 3.346** |
| | (1.565) | (1.565) |
| **Age ≥ 15 years** | 3.826** | 3.229** |
| | (1.567) | (1.568) |
| **Geog. concentration of southern CW manufacturing firms** | -2.260*** | |
| | (0.867) | |
| **Geog. concentration of southern CW non-manufacturing firms** | -0.377 | |
| | (0.318) | |
| **Geog. concentration of southern post-CW manufacturing firms** | -6.797 | |
| | (17.27) | |
| **Geog. concentration of southern post-CW non-manufacturing firms** | 1.455*** | |
| | (0.470) | |
| **Geog. concentration of southern CW patent-owning firms** | | -5.679 |
| | | (5.920) |
| **Geog. concentration of southern CW non-patent-owning firms** | | -0.864 |
| | | (0.762) |
| **Geog. concentration of southern post-CW patent-owning firms** | | -1.505*** |
| | | (0.391) |
| **Geog. concentration of southern post-CW non-patent-owning firms** | | 1.111*** |
| | | (0.235) |
| **Proximity-weighted density of non-southern firms** | -0.0157 | -0.0378 |
| | (0.0875) | (0.0926) |
| **Time since Civil War** | -0.00227 | 0.00796 |
| | (0.0197) | (0.0194) |
| **Possesses patent** | 0.0637 | 0.0660 |
| | (0.219) | (0.226) |
| **Manufacturer** | -0.484*** | -0.524*** |
| | (0.149) | (0.155) |
| **Incorporated** | 0.261 | 0.277 |
| | (0.200) | (0.202) |
| **National density of firms** | -0.816*** | -0.771*** |
| | (0.129) | (0.128) |
| **National density of firms squared** | 0.0270*** | 0.0258*** |
| | (0.00404) | (0.00399) |
| **County human population** | -0.445*** | -0.439*** |
| | (0.0952) | (0.0992) |
| **Value of national industry product** | -0.0207** | -0.0177* |
| | (0.0100) | (0.0101) |
| **Pseudo-loglikelihood** | -1355.9694 | -1353.5918 |
| **Number of failures** | 978 | 978 |
| **Number of firms** | 995 | 995 |
| **Observations** | 6,022 | 6,022 |
| **State fixed effects** | YES | YES |
| **Decade fixed effects** | YES | YES |
| Robust standard errors in parentheses | *** p<0.01, ** p<0.05, * p<0.1 | |