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Economic Diversity, Growth, and Development in Early Nineteenth Century Connecticut

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This dissertation tests an important hypothesis about early nineteenth-century economic development: that higher levels of municipal economic diversity at an early stage of development can serve as predictors of long-term success. Subsidiary related hypotheses are that the advantages of diversity meant that the early urban system would be stable, and that transportation links played a significant role in early economic development. The study period of 1810 to 1850 includes the beginnings of industrialization and urbanization in southern New England, and is based upon the Connecticut Grand List of taxable property, which was collected at the level of the municipality (the basic unit of government in the state). The property data was divided into primary, secondary, and tertiary sector groupings. Additional data included a measure of economic diversity (a modified Herfindahl-Hirschman index), United States Census population figures, municipal boundaries, and transportation routes (turnpikes and railroads). Analyses of these data sought to identify patterns of concentration using the location quotient and focal location quotient, Getis-Ord G_i^* statistic (a measure of local clustering), and Local Moran's *I* (a measure of autocorrelation). Descriptive statistics found that the population and economic data became increasingly skewed over time, with a small number of high-value municipalities and many low-value

municipalities. The diversity index showed a modest reduction in skewness toward more significant diversity values over time. Overall, the statistical analysis found that excluding municipalities with significant urban populations, levels of diversity in the early stages of development are not sufficient to predict long-term municipal outcomes. A better predictor is proximity to New York City (that is, being located in southwestern Connecticut). In addition, Connecticut's urban system changed significantly between 1810 and 1850; access to the turnpike network was roughly equal across the state and had no discernible impact upon development trends; and the railroad network may have responded to existing conditions. The continuing dominance of the primary sector generally overwhelms the secondary and tertiary sector activity in this time period, but also reveals the key underlying patterns.

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Dedicated to the memory of

Charles Schroeder

my grandfather
who made it possible with the work of his hands

and

Dr. Alexander Vias

They are not long, the days of wine and roses
Out of a misty dream
Our path emerges for a while, then closes
Within a dream.

-- Ernest Dawson

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Chapter One

Introduction

1.1 Background of the Problem

In southern New England, the first half of the nineteenth century was a period of transition between a rural, agricultural economy and a rising urban, industrial economy. Before the American Revolution, economic development was channeled into smuggling and long-established trade relationships with the West Indies, while a shortage of investment funds hindered non-agricultural development. After 1850, the new patterns of urbanized social and economic activity became well established and the urbanizing process accelerated. Our understanding of the initial phases of American urbanization and industrialization is hampered by three things. First, analysis of the subject is complicated by the unstable nature of many early attempts to establish successful

manufacturing firms and strong urban places. Second, only limited economic data are available from the United States Census, and these are both incomplete and unreliable. Third, we lack a full theoretical framework for understanding early industrialization and its relationship to economic and urban growth. The object of this dissertation is to address the data problem with a set of new data from Connecticut, which will make it possible to propose solutions to the other problems.

The rise of the American manufacturing economy occurred first, during the early national period, in New England and the Middle Atlantic states, and depended on a number of elements. Among the first in importance was technological innovation. The mechanization of manufacturing, which increased output and decreased the need for skilled labor, was based on the invention of machines to do the work. Closely related to the innovation process were several factors with spatial components: the availability of experts capable of such inventions, of capital to finance their development, and of sources of power to run the machinery. Technological change, however, was not the only force at work. During the nineteenth century, even unmechanized activities began to be reorganized into factory locations that gathered workers together into single facilities instead of sending work to individuals to be carried out in their homes. The development of local and non-local markets for goods, and of a supply of cash money to pay for both the goods and for the necessary investment in production, played a role as well (Temin 2000, Rothenberg 2000, Hekman 1980).

Increasing urbanization over the same period was both a cause and an effect of these trends. Urban populations tended to have both money and a need to pay for items that rural farmers would produce themselves (Temin 2000). The location of

manufacturing in such urban places gave the firms access to a supply of workers and an existing transportation system – but in many cases, firms were also established in rural locations. These rural location decisions were based on access to a specific necessary resource, access to sources of water power especially but also to capital, or simply on the personal history of the decision-maker. In some cases, these decisions led to the establishment of new, flourishing villages and urban areas, but these regions also contain the ruins of many failed enterprises (Leblanc1969). There are also many places that contained successful manufacturing facilities but remained villages or relatively small cities into the twentieth century, and even places with an initial population advantage did not always compete successfully with others. It is not practical to examine the universe of individual historical decision-making processes, but we can examine patterns of population growth and their relationship to patterns of economic development, and thus understand the cumulative effect of those individual decisions. Central place theory holds that the presence of tertiary (and sometimes also secondary) firms in a place imparts a quality, "centrality," that attracts additional firms and population to the place. This does not, however, explain how and why these places initially developed this quality, and nor does it explain the success, failure, or stagnation of places.

This research proposes that industrialization and urbanization can be examined from the perspective of economic development, and in terms of changes in the structure of the economy. The industrialization process was not necessarily the simple series of changes from primary to secondary to tertiary bases postulated under the Clarke-Fisher hypothesis, but can also be seen as one of transition from primary/tertiary to secondary/tertiary, depending on the place and time. Peter Bauer (2000) has noted that

tertiary activity in the form of local and internal trade was and is an essential part of economic growth in the modern era, and Vance (1970) has shown that long-distance trade was a key factor in pre-industrial urbanization. Integrating the tertiary sector of the economy into theoretical and quantitative analysis is, clearly, an important step in comprehending historical economic development. The early nineteenth century did not see the completion of the transition from primary to secondary activities; as of 1850, the primary sector still dominated the economy of Connecticut, although its cities and some other places had substantial tertiary sectors. The secondary and tertiary sectors had grown substantially, however, and the question of where and how much of this growth occurred is a focus of this study. The role of the tertiary sector in economic development has been particularly neglected, most probably because of a lack of data on the sector; the U.S. Censuses of the period collected statistics only as occupations listed in the general population schedules, if at all. The fact that the data set used in this study does include tertiary sector information will make it possible to consider the relationship between secondary and tertiary development in more, and more locationally specific detail than has been possible before. Nonetheless, for the purpose of consistency, the modeling will only address combined secondary and tertiary data.

1.2 Problem Statement and Research Questions

The interactions between industrialization, the growth and development of urban places, and economic development are the subject of this study. These were all centripetal forces that in theory encouraged population growth and economic growth in specific places, but in practice often failed to do so. At the beginning of the study period, which has been set at 1810, Connecticut had a central place system composed of a certain

set of places of various sizes. At the end of the study period, in 1850, the influence of economic development had brought about changes in this system. The working hypothesis of this research, however, was that the ranks and membership of the system – that is, the locations of the dominant places – did not change significantly over the course of the study period, up to 1850. This allows examination of the characteristics and progress of the leading places across a longer time period.

Integral to this research is the development of a means of identifying central places and measuring their level of centrality. Traditional central-place studies generally rely on some combination of population size and number or type of firms to find and rank central places (King 1984). In contrast, an important aspect of this research is an attempt to measure the influence of the different sectors of the economy, over time, on the development of central places. Manufacturing was an important part of the growth of nineteenth-century central places, but central place theory usually emphasizes the role of tertiary activities. It is proposed that a proper measure of centrality is the level of sectoral diversity in a place's economy, which captures the relative level of activity in the primary, secondary, and tertiary sectors in Connecticut municipalities. Since in this historical context, a high level of economic diversity is expected to correspond with a high degree of centrality, a measure of diversity can be used as a measure of centrality. A similar approach has been used before, in a study of nation-level economic diversification at the world scale, as will be discussed in more detail in Chapter 2 (Imbs and Wacziarg 2003). The hypothesis here is that it was the most economically diverse places in Connecticut that experienced the highest levels of growth in population and economy.

As of 1790, the Connecticut economy, like that of the rest of the new United States, was primarily agricultural, with several levels of commercial entrepôts serving as central places. The largest and most economically important cities in Connecticut's greater urban system were actually Boston and New York City; this research is therefore limited to the set of lower-order centers that were located within Connecticut's borders. This local, mid-level system consisted of several urban centers and a larger group of secondary centers, with the remainder of the municipalities having extremely limited central place functions (Daniels 1979). As will be seen below, the data confirms that little had changed between 1790 and 1810, when this study begins. Although there was industrial activity in Connecticut and New England even prior to 1790, as of 1810 it had not yet reached a level at which its impact on the economy could be measurable, compared with other sectors; that growth process began after 1810, and during this study's period of analysis (Hekman 1980). Initial urban development in this region was based on commerce, and that pre-established spatial structure is hypothesized to have remained constant despite the steadily increasing role of manufacturing in the state's economy.

A final aspect of this complex economic and population study is the role of transportation systems in economic development. Central place theory has tended to take the existence of transport for granted, but in this period in the United States the transport system was rudimentary, and focused on water and roads of highly variable quality, until the rail system began substantial development in the 1840s.[1] Whether variation in the

[1] In Connecticut, the development of canals was short-lived (1830s and 1840s) and very limited in both spatial extent and length of existence; therefore, they are omitted from this study.

level of transport linkages significantly affected the population and economic development of Connecticut municipalities is therefore an additional component of this research. The question is whether the transportation system did, as would be expected, influence economic diversity, economic growth, and population growth during the study period, beyond the fact that the state's cities during the study period were all ports.

1.3 Importance of the Study

The study will provide the first statewide municipality-level analysis of industrialization, urbanization, and economic development in Connecticut for the early nineteenth century, a time period about which relatively little historical, economic, or geographic literature exists for this state. The availability of the data used here, and the overall picture of Connecticut's development that emerges, will be a valuable contribution to our understanding of the region's and the country's economic history and geography. The early development of industry and the growth of urban areas during the first part of the nineteenth century need better general description and explanation than have been possible before this study.

Examining relationships among the important geographic and economic processes of industrialization, and changes in centrality and economic development during the early nineteenth century will yield an improved view of how they interacted and evolved over time. In particular, questions about the roles of both tertiary and secondary economic activity will be explored using and statistical analysis. The results shed new light on emergent industrial economies and changing urban systems, which may be extended to other regions and times.

1.4 Outline of Dissertation

In Chapter Two, the literature related to the dissertation topics is discussed. This material includes both economic and geographic theory, with a particular focus on the role of economic diversity in economic development. A small group of comparable studies are also reviewed. These include, first, a set of studies of the New England Region, and, second, a group of studies of other United States regions that deal with similar topics.

Chapter Three outlines the study's data sources and methodology. The archival sources of the economic data are described, including the overall range of the original data and how they were collected, with more specifics on the categories that will actually be used in this study. The sources of the population data and the necessary spatial data are also identified. For the economic and population data, an initial look at their statistical characteristics is also provided. Information on the important limitations of these data sets and their utility are included as well. The methodologies to be employed are specified; these focus primarily on statistical analysis and modeling. The measures of population growth and concentration and of economic structure and diversity that will be used are identified.

The actual results from the analysis are presented in Chapter Four, beginning with a detailed analysis of population. Most of the chapter is taken up with the economic analyses, however, as full coverage requires working with the total value of the municipalities' economies, the primary sector along, the secondary and tertiary sectors combined, the secondary sector alone, and the tertiary sector alone. At the end of the

chapter, the conclusions suggested by the spatial patterns in the municipalities' economic structure and diversity are summarized.

Chapter Five presents a modest extension of the initial conclusions, supplemental to the minor and intermediate conclusions given in Chapter Four. This supplementary analysis examines the factors that, based upon the preceding analysis appear to influence the long-term population outcomes of the municipalities, which are identified as a useful proxy for long-term economic development.

Chapter Two

Literature Review

2.1 Introduction

The multiple topics of this research draw upon a wide array of geographic and historical literature, including works on urbanization, industrialization, and economic development; central place theory and transportation (within the topic of urbanization) and the location of manufacturing (within the topic of industrialization) also play a role. Certain works from the more purely historical literature are also relevant to this study. There is, overall, a lack of synthesis among these various concepts. While connections between some of them are frequently acknowledged, as (for example) the relationship between industrialization and urbanization, scholars often seem to treat their main topic

as a dependent variable, and others as independent variables. The materials are divided into two categories, one dealing with theoretical aspects of the matter and the other with examples of similar empirical studies and their conclusions. There is some overlap between the two, however, as some of the empirical studies also propose theoretical structures and explanations.

2.2 Economic and Geographic Theory

The idea that economic diversity itself is an important component of economic development has been proposed by Imbs and Wacziarg (2003), in a paper analyzing the relationships between diversification and per capita income across ninety-nine industrial and developing countries in the second half of the twentieth century. The data they used included employment share by all available sectors, value added by sector, and per capita income. Their primary conclusion was that as per capita income rose, national economies displayed sharply increasing sectoral diversification, followed by a shallower fall in diversification (or rising specialization). The findings appear to reconcile the contrasting theories that diversification and income should both increase, and that the influence of market opportunities should lead to increasing specialization (or agglomeration). They state that "increased sectoral specialization, although a significant development, applies only to high-income economies. Countries diversify over most of their development path" (64). Municipalities and countries are vastly different in scale, and the present research deals with the early nineteenth century rather than the late twentieth century, but the basic principle that a developing economy's level of diversity rises would be expected by economists to hold true in any context. A key difference between the work of Imbs and Wacziarg and the present research is that the former

makes no effort to analyze results geographically, while the geography of both economic development and diversity is a central concern of this project.

Bauer (2000) has noted that contemporary analyses of development economics tend to neglect the role of the internal tertiary sector (Imbs and Wacziarg do include tertiary activity data in their work, but without separate analysis). He is able to reference five works of historians dealing with Britain and Africa that emphasize the important role of local trade. In contrast, postwar development economists, he finds, neglect this facet of the economy entirely. This can partly be blamed, he suggests, on the general lack of data on such activity, but his article focuses much more on what he considers misguided theories that have led economists astray. It is the importance of tertiary activity in emerging economies and the paucity of data that are relevant to the present work; the economic data used here provide partial information on the tertiary sector, and the significant role of that sector is emphasized here.

Vance (1970) places the role of tertiary activity, in the form of wholesaling, at the center of his mercantile model of settlement. He approaches the topic from the direction of central place theory and the development of new or frontier settlement, such as occurred in North America in several phases; this angle may explain why Bauer is not familiar with this work. According to Vance's theory, there was and is a network of dealers in wholesale goods whose needs and experience strongly influenced the location and development of new urban places. Vance did not deny the existence of retail catchment areas or the notion of centrality, but rather argued, in effect, that the existence of each is a necessary but not sufficient condition for the development of an urban place. Under the mercantile model, then, the earliest cities in Connecticut developed because of

their locations at collection and transshipment points in the transportation network, which encouraged wholesalers to locate there both at the beginning of the places' history and on a continuing basis. Thus, economic diversity is an integral part of the mercantile model, although Vance does not express himself in such terms. The present work accepts the mercantile model and analyzes the persistence of the influence of tertiary economic activity over time, including into the early industrial period.

Vance also incorporates the notion of human agency and decision-making, a topic widely neglected in both the economic and the central place literature. Especially in the historic period (but to a certain extent in the present day as well), the mercantile network consisted of individual men whose often kinship-based personal connections, together with their experience, informed their decisions about where and from whom to buy goods and where to locate their offices. Once established, these relationships tended to be infrangible; moreover, the presence of one merchant in a place tended to attract others. Thus, if two or more places exist that have the same locational advantages, the human element can provide an explanation of why one is chosen above the others. Leblanc (1969) likewise notes the role of "chance and an early start," particularly the presence of experienced craftsmen and entrepreneurs, in the location of early manufacturing in New England (26). Chance and human agency are, from the perspective of historical economic geography, random elements that cannot be analyzed across the range of over a hundred municipalities. Therefore, the certain role of such factors must be noted but will not be dealt with here in any detail.

The relationship among central place theory, economic development, and simple population growth have been examined by Cromley and Hanink (2008) as a system in

which increases in numbers of people at a location leads to a greater amount and a greater variety of economic activities, which leads to the development of a hierarchy of central places across a region. In this model, population size is interpreted as market size, in line with analyses going back to Adam Smith and in contrast to more typical supply-side models of economic growth. As is explained by Cromley and Hanink, the rise of a central place system (sometimes known as an urban system) is a consequence, according to central place theory as developed by Christaller and Lösch, of two factors. First, the varying ability of different functions located in central places to draw customers there, or "the spatial extent of an activity's market," means that places containing more functions with a larger market area are located higher up in the hierarchy (385). Second, each function is held to have a minimum threshold population to support that activity in a given place. The abstract model proposed by Cromley and Hanink indicates that by employing population growth as the leading factor in determining spatial distribution of functions with different thresholds, a hierarchy of places can be derived. The present empirical study relies on this model's underlying assumption that population growth strongly affects diversity, but inverts the relationship to examine the effect that diversity *per se* has on both population and economic growth. This approach does not wholly contradict the basic model, however, because the model incorporates the idea that the presence of functions of varying thresholds will attract migrating population in addition to local natural growth.

Cromley and Hanink also find that their results are broadly consistent with those of Pred (1966), who described the development of the urban system of the United States as "a recursive central place process in which population growth, market expansion, and

industrial specialization interact" (403). More particularly, Pred asserts that Christaller's original theory, combined with Lösch's ideas about market areas, can encompass industrialization as an outcome of the rise of markets large enough to support consumer-oriented industries; then, the larger cities will, of course, also have more manufacturing functions. This approach addresses the fact that Christaller and Lösch, and other twentieth-century economists following their lead, emphasize the role of consumer markets (tertiary sector) rather than industrialization (secondary sector) (see Curtin and Church 2007). The present research explicitly includes both secondary and tertiary components as far as is possible, for the reason that both are clearly involved in the economic development of early nineteenth century Connecticut and also should be included in any analysis of central places and economic development.

Lukermann (1966) has noted that modern scholars focus on the hierarchical structure of the urban system, measured either by size or function, and on "the *nodal* character of its locational pattern" (20; emphasis in original). According to his analysis of these topics, neither is a satisfactory approach in and of itself. One reason he gives is that the typical rank-size hierarchy based on population produces a structure that is highly dependent on the specification of the class sizes (geared to produce a small number in the highest class, and the largest in the lowest), leading Lukermann to consider the changes in rank of places over time, rather than the question of whether a typical rank-size hierarchy existed. The hierarchy itself is best understood, he asserts, as a result of the nodal pattern, which itself is virtually devoid of meaning if the flows between the nodes are not considered; but, because of lack of data, or the small scope of research projects, or the design of the research, they usually are not considered.

Lukermann himself does not consider flows, but rather carries out an analysis of the changing ranks and locations of the 100 largest places in the U.S. between 1790 and 1890. Although this is not the kind of merely taxonomic analysis that he criticized, it nonetheless did little to address the need for "a closer look at our assumptions" that he also mentioned (20). He raises important questions about geographers' approach to studying urban systems, but for the better part of those questions he provides no answer. The present study also mostly sidesteps these questions; although nodality is implied by attention to population growth and transportation, it is not directly considered here, and neither is the urban hierarchy or urban system. In part, this is due to the fact that Connecticut is not, by itself, an "urban system" of the kind addressed by Lukermann and others – the municipalities considered here range from definite urban centers to extremely rural places. Further, any discussion of Connecticut as part of an urban system would have to include at least New York City and Boston, the major and nearby cities of the region, and the data to do that are not presently available.

Finally, it is important to also consider the approach to categorizing the economy that underlies this study, among many others. The division of an economy into three or more sectors for the purpose of analyzing economic development was first proposed by Fisher (1935, 1945) and Clark (1941) (cited in Bauer 1951 and Singh 1979). According to Singh, "[t]hey propounded the thesis that with economic development there is a progressive shift in labour force, first from primary to secondary sector and subsequently to tertiary employment" (545). Bauer's critique (1951) focuses on the difficulty of accurate measurement of tertiary sectoral employment (especially in developing economies with more labor than capital, and very incomplete specialization of

occupations), and the necessary importance of some tertiary activities in all times and places (against the portrayal of tertiary functions as luxuries). He concludes that "any observed correlation between economic progress and occupational distribution should be regarded as more in the nature of a statistical accident than as an indication or proof of a significant economic law" (752). He later revisits the subject making it clear that his primary concern is the negative effects of unrealistic analyses of developing regions on efforts to understand and assist the development of those regions (Bauer 2000). The present research project extracts from Bauer's critique, as from Vance's mercantile settlement model, the point that tertiary activity is a critical part of an economy in any stage of development, and evaluates the role of its presence, along with secondary activity, in local economic growth in the early stages of industrialization.

2.3 Comparable Studies

A variety of empirical studies deal with specific regions and subtopics related to economic development in the United States, as well as economic development itself. The discussion below organizes the material by the geographic area studied, beginning with the New England region and then other regions and the country as a whole. The review concentrates particularly on those studies that examine topics relevant to this study, such as the role of changes in economic structure, transportation, and population growth and concentration.

2.3.1 New England Regional Studies

These studies examine various aspects of economic development and related topics either across the New England region or in some sub-section of it. An early

attempt to evaluate early nineteenth century economic development in Connecticut is Bidwell's 1916 study of the state as of 1810. Distinguishing geographically between rural inland towns on the one hand, and commercial coastal and riverine towns on the other, he examined agricultural production, commerce, and manufacturing in both contexts. Because Bidwell's focus was on the state of the region's economy at the start of the nineteenth century, his work helps to define the initial economic conditions of the present study period. The chief difference between rural inland and coastal/riverine towns was that the latter were far more engaged in commerce, and also had substantial manufacturing components. In the rural areas, in which Bidwell had the most interest, he observed that while there was some manufacturing for local and external markets, "[i]t seems hardly an exaggeration to say that there were no inland manufacturing towns in New England at this date [1810]" (Bidwell 1916, 276). His implication was that up to that point, manufacturing for external markets was concentrated in some coastal and riverine towns in which commercial activity and population also were concentrated. Bidwell held that this division arose because up to about 1810, rural areas had neither the market access nor the fiscal and temporal wherewithal to develop industrial capacity outside of part-time, home-based manufactures.[2] The present research will examine the changes in economic structure across Connecticut and determine whether there was any change in the spatial organization of the economy as well.

Another early study, by Fuller (1915), examined the growth of manufacturing in Connecticut from about 1818. Although this work provides some geographic information – listing types of manufacturing enterprises by town, and calculating the changes in urban

[2] Part-time and small-scale manufacturing of items ranging from cider to shoes was commonplace on early nineteenth-century farms (Vickers 1990).

population through the nineteenth century – for the period before 1850 it relies on three unique data sources that are, for the reasons discussed in Chapter 3, not used for the present research project. In addition, Fuller provides uncomprehensive portraits of only two years (1818 and 1845), and her analysis is fundamentally historical rather than geographic. The main thrust of her analysis of the pre-1850 period is to demonstrate that while there was substantial and growing manufacturing activity in the state, on which its later development was based, manufacturing had not yet become the dominant economic activity as of 1845. The present project is engaged in analyzing the spatial patterns of manufacturing activity over the 1820-1850 period, and also agricultural and commercial activity, a quite different research topic.

Some works consider other limited aspects of economic development, most importantly the roles of finance and capital in localized areas. Buck (1998), for example, examines the problem of lack of access to capital in antebellum New England and the relationship between capital, railroad development, and industrial development. In looking at how capital formation and railroad development interacted in both successful and unsuccessful industrialization processes, Buck found that the sources and distribution of extremely limited capital underlay both success and failure during this period. His focus was on the shoemaking industry in Lynn, Massachusetts and Buckfield, Maine, and their very different industrialization outcomes. The two towns' results seemed to derive from their sources of capital: Buckfield residents' decision to fund a railroad line from their own capital left nothing to foster local industry, while Lynn's line was built with external capital and it became a flourishing industrial town. Whether these findings apply across a larger area than these two towns is not known, but they are suggestive, and

indicate that analysis of industrial location would benefit from information on capital, which is only partly available for the present study. Insofar as Buck's study draws a distinction between use of local versus external capital, however, it also deals with the random element of individual or small group decision-making, which cannot be analyzed systematically but only on a case-by-case basis. This, the present study will not attempt to do.

Concentration of population, or urbanization, is a subject related to economic development because in Europe and North America, it occurred in tandem with increasing industrialization during the eighteenth and nineteenth centuries. Fuller goes so far as to state that "[s]ince Connecticut possesses no important commercial center like New York or Boston it is fair to conclude that this increase in urban population [between 1840 and 1910] is also a growth in manufacturing population" (54). Bidwell (1917) also analyzes population concentration, across southern New England over the period 1810 to 1860, concluding that "[t]he causes of urban concentration are in general familiar: manufactures, the maritime industries, commerce, domestic and foreign, fishing, and shipbuilding," but giving manufacturing and maritime industries (including the shipping trade) particular credit and considerable detail (816). His article focuses more on Massachusetts than on the other two states, however, and does not provide a comprehensive portrait or database of all the municipalities in any of them. Consistent with its goals, the present research will address the topic of population change and population concentration in all Connecticut municipalities, with an emphasis on economic diversity rather than on specific sectors or individual industries.

The pattern of economic development under consideration in this study is that of increasing manufacturing-sector activity coincident with tertiary activity. A few geographic studies deal directly with the location of manufacturing in New England, most notably Hekman (1980) and Leblanc (1969). Although their studies are a valuable part of understanding industrialization, each only addresses a single aspect of it. Hekman's focus is on the textile industry, which was on the leading edge of industrialization in the Northeast in terms of size and technology, but his central thesis is more generally applicable. His conclusion is that the textile industry's pattern of development was one of diffusion of innovation, following several paths westward (into Connecticut) and northward (into Massachusetts) from the first-established facilities in Rhode Island. The movement of technical experts, combined with their continuing ability to visit and consult with one another, appears to have been a key component of the technical development of this and other specific industries that Hekman discusses.

Convincing though his argument is, however, it is not a complete and sufficient explanation. Only selected locations became the residences and workplace of these experts, but the problem of how these locations were selected is not addressed except in terms of proximity to preexisting locations, which was also a characteristic of non-selected places. Nor did Hekman consider the influence and persistence of these facilities. Further, with respect to the larger context of population growth and concentration, these factories' influence on the local economy did not necessarily lead to the rise of major urban places or even of economically diverse municipalities. In addition, the movement of these textile industry experts may have been a clearly geographic phenomenon, but the textile industry was not the only one in Connecticut (or

New England), and the movement of individuals is still, generally speaking, a matter of chance that can influence but not control other important factors in economic development, such as economic diversity.

Feeley (2005), similar to Hekman, suggests that one way to look at Connecticut's early nineteenth century economic development is to examine the development, location, and longevity of its mill-based industries. To a certain extent, this has been done by Leblanc (1980), who examines both theoretical and empirical aspects of a wide range of manufacturing enterprises in New England between 1831 (the earliest date of reliable data available to him) and 1900. On the theoretical side, as was noted above, Leblanc notes that random factors played a role in the establishment of factories and also in their success or failure. His empirical analysis shows that it was not until after 1850 that purely locational factors such as agglomeration and railroad transportation, as well as the increasing size of factories, began to significantly affect the pattern of industrial location. Chance also had a role during this phase, however, as local decision-makers could and did affect whether their municipalities would become part of the changing system or be left behind by it (as is also noted by Buck 1998, discussed above). In general, however, Leblanc finds that across the New England region, before 1850, manufacturing developed in an environment of "relative nondiscrimination of location" (132). Because of Leblanc's need to rely for data on the 1831 McLean Report on Manufacturing and the even less thorough federal censuses of 1810, 1820, and 1840, he supplements his analysis with the theoretical statement that the relatively even distribution of population and widespread turnpike road system did not incline manufacturing to concentrate. Upon this background, factors such as market access, investment capital, and diffusion of

technology operated to produce a dispersed pattern of location. As of 1850, when the first reliable census of manufactures was taken, statistics on employment in manufacturing indicated that a myriad of small facilities was scattered across the New England landscape, in addition to some major centers such as Boston. The present study, with its access to different but more complete data on manufacturing, should confirm the underlying notion of the relative spatial ubiquity of manufacturing up to 1850, at least in Connecticut, while also analyzing a wider range of topics than the location of manufacturing.

Other ways of looking at economic development and industrialization have been proposed by scholars such as Meyer (1988), who identified "advanced technology districts" in New England in the areas of textile and firearms production, emphasizing in his analysis the importance of social networks and general social economic conditions in the identified, informal districts. Davis (1958) conducted a detailed analysis of the occupations of investors in certain textile factories, finding that at least one-third were merchants, but making no attempt to consider geography. This theme of investigating capital sources was also followed by Lamoreaux (1994), who specifically considered the connections between banks, industrial development, and individual human interactions. Sokoloff (1984) examined the value of investments in different industries and how they changed over time, though not how they varied across space. Suggestive though these studies are, the data at hand are not comprehensive enough to expand this study into such topics.

Recent historical studies of the economic development of New England are dominated by "microhistories," which seek to describe and explain the economic and

social development of specific places – that is, of a single municipality, or a small group of adjacent municipalities. Their emphasis tends to be on the social implications of economic developments, which are described in detail but explained as being part of the generalized industrialization process. Jonathan Prude (1983), for example, examines the effect of industrial development on the workers and local governments of three Massachusetts towns. Christopher Clark (1990) considers the causes and socio-economic implications of the transition from a farm-based to a wage labor economy in six Massachusetts towns. Peter Temin (2000) takes a regional approach, specifically New England, and having identified the major reasons for industrialization and the progress of various manufactures, immediately passes on to consider the wide range of social and cultural effects of these trends. These are worthy scholarly works but in general are non-geographic and descriptive in nature. The only notable exceptions to this rule are studies that consider the development of market economies, but these too tend to focus on specific locales and the sociocultural implications of such developments (most recently, Rothenberg (1992)). Such works are illuminating with regard to the effects of industrialization, but shed little light on the spatial patterns of industrialization itself, which is the topic of the present research.

2.3.2 Other Regional Studies

Very often, the economic history literature addresses economic development, and sometimes associated sociocultural trends, at the regional or national level rather than at the state level. Such studies look at regional or national trends over time, or compare regions (the South, the Northeast) to one another, and focus on estimates of gross national product or personal income. Atack and Pasell (1994), for example, discuss the growth

and development of the whole United States and its major regions, relying on measurements of growth via estimates of gross national product, per capita income, output per capita, and employment by sector. These are all traditional measures, based on incomplete data carefully evaluated by economists, applied toward understanding economic and social change at the wide scale of region and nation. Engerman and Gallman (1983) survey the nature and status of antebellum U.S. economic development, and argue that the national scale is the most logical one at which to observe the process. They also state that national income or product is the best measure for this purpose, because "[i]t has direct bearing on human material welfare and is a constituent of the most widely used index of economic performance" (3-4). Measures of wealth or stock can serve as a useful proxy, they note, but are not preferred; the best approach would be to use both, where such data is available.

Steckel and Moehling (2004), in contrast, use wealth information based on property tax records, but that was because their research question is whether inequality in wealth distribution increased during the nineteenth century in Massachusetts as a whole. Rousseau and Sylla (2005) look at nation-wide economic growth as measured by increases in business incorporations and offerings of securities, with no attention to the geography of these developments. The present study takes the position that economic growth and development is adequately measurable through analysis of population growth and concentration, and of economic diversity; its focus is also on a much more limited area and much smaller units of measure (the municipality), and its attention is on the geographic patterns of change over time. Thus, these regional GNP and income studies offer little to our understanding of these topics.

The linkages between economic development and population growth are considered in Allan Pred's study of urbanization in the United States between 1840 and 1860, in which he has identified a group of twenty-nine "major urban places," including two in Connecticut (1980). While he also considers the development of small and medium-sized urban places, much of his analysis focuses on demonstrating the dominant role of the major centers in terms of growth in population and economy. His other concern is the involvement of industrialization in the urbanization process, for which he uses detailed studies of single industries to illustrate the economic linkages between the cities. This focus on linkages is consistent with his view of the greater urban system as a set of economically interdependent places, an emphasis that properly attempts to capture the role of economic flows in the growth process, as Lukermann suggested. Hence, Pred relies on individual industry and city studies, which support his argument, under the assumption that the example places used are representative. His conclusion that most population growth went to the larger places in the urban system is considered in the course of the present study. As was noted above, however, the concept of an urban system itself, and hence the relationships or linkages among the urban places, is not directly dealt with here.

Edward K. Muller (1976) studies early nineteenth-century urbanization, including medium and small urban places, in the Ohio Valley between 1800 and 1860. His particular focus is on the nodality of places, that is, their prominence as nodes in a transportation network. Such networks are an important part of economic development and related trends, such as urbanization. According to Muller's analysis, population increases and decreases in the Ohio Valley's various towns and cities are best explained

by their connections to successive waves of transportation improvements (that is, turnpikes, canals, and then railroads). The effects of improvements could be both beneficial and detrimental, depending on where places were located in the network and on their pre-existing relationships with other places. Muller also seeks to link the rise in manufacturing activity to improved nodality of certain places during the 1840-1860 period, when the railroads were constructed. The data Muller has to rely on for the period before 1840, however, includes a variety of non-comprehensive and selective sources such as state reports and gazetteers, providing partial information about manufacturing, agriculture, and population. Vance's ideas are cited and incorporated into Muller's work, but the latter's focus is on the analysis of the transport networks' influence, not on a synthesis of the several sources of explanation.

Muller elaborates and generalizes his model in a subsequent article (1977), while still acknowledging the importance of Vance's contribution. Here, Muller specifically defines nodality as "both the accessibility and connectivity of a location within a circulation network," including "the characteristics of circulation within it and between other networks" (23, n. 3). Notwithstanding this definition, the incompleteness of data on actual circulation means that his model and discussion focus more on population growth and the non-circulation characteristics of towns and urban places. As in his Ohio Valley article, Muller identifies three phases of what he calls selective urban growth, meaning growth that was localized and inconsistent, not a general trend across the whole area; across the United States as a whole, these phases occurred at different times in different regions.

First was the "pioneer periphery" phase, the initial period of settlement in which transportation routes were rudimentary, population was low but growing, and regions developed a three-tiered system of regional entrepôts, intermediate center, and district trade centers. In the second phase, the "specialized periphery," higher population and better transportation (turnpikes and canals) combined with a shift from mainly subsistence activities to specialization in some agricultural product or products. The system of places saw changes in its members' size and status based on old and new municipalities' locations in the modified transportation and production landscape, while the entrepôts generally remained dominant. The third phase, the "transitional periphery," saw the development of the railroads and of manufacturing centers and further reorganization of the urban system. The period covered by the current study of Connecticut fits, in theory, into the transitional periphery phase under Muller's scheme. Whether the Muller model applies directly to Connecticut alone, rather than Connecticut as part of the New England *region*, is much less clear. Processes do not always operate in the same way at different scales. Regardless, one thing that is clear is that Muller's scheme does not explain why a transportation route does not equally benefit all the places it passes through, but only some of them. The present study incorporates transportation routes into its analysis as a necessary but not sufficient condition for economic development; it is economic diversity that, in theory, takes the lead explanatory role, not access to transportation.

John R. Borchert (1967) discusses growth and change in the U.S. urban system in terms of the influence of technical changes in transportation and energy sources. These changes, he concludes, led to the growth or decline of urban areas in different time

periods, as changes in technology conferred advantages on some places and removed them from others. In his study, he divides the history of the U.S. from 1790 to 1960 into four epochs, including the "Sail-Wagon Epoch" from 1790-1830 and the "Iron Horse Epoch" between 1830 and 1870. During the first epoch, the urban population was concentrated on the eastern seaboard and its ports, with reliance on water transport and water power limiting the possibilities for change; during the second, the railroad and the use of anthracite coal helped develop urban populations further westward and furthered the industrialization of northeastern cities, among other changes. Muller's (1977) theory is similar to Borchert's, except that Muller incorporates a core/periphery approach into the technological development aspect. Likewise, Borchert does not attempt to explain why some places throve in the changing network, while others declined. The influence of local conditions (such as economic diversity), while clearly important, has rarely received research attention outside of the purely historical literature.

Studies of urbanization sometimes focus on population growth and population concentration as important, if not the only, measures of the process, rather than industrialization. For the contiguous United States, Samuel K. Otterstrom (2003) has proposed a three-phase model of population concentration. According to his model, the U.S. first went through a "Frontier Dispersion Phase," in which population concentration actually declined; an "Urban Amplification Phase," in which concentration rose significantly, and an "Equilibrium Seeking Phase," in which concentration varied somewhat between increasing and decreasing. Mapping the whole set of city-systems (held equivalent to major trading areas depicted in a 1990 atlas), however, shows regional patterns in these increases and decreases. Otterstrom concludes that each of the various

city-systems and regions might be in a different phase of development at any given time, but that they go through the same sequence of phases; that is, "concentration processes are very similar throughout time, even at different scales" (2003, 492). As a generalized model, this one is more satisfactory than Borchert's because it rests on observed population trends rather than specific technological changes with little supporting data. At the same time, however, Otterstrom does not attempt to explain the forces driving the observed processes. Again, as well, the question of scale must be raised; would such a pattern hold at the municipality-level scale of the present study? Neither urbanization nor industrialization is the direct object of this study, however, but rather the question of economic development as measured, in part, by population growth and increasing industrial activity, as well as total economic diversity.

A work on economic development that is much more recent than Bidwell (1916) and covers the same study period as the current project, though not the same area, is Diane Lindstrom's study of the Philadelphia region between 1810 and 1850 (1978). Its explicit purpose is "to examine the changes in economic structure that ensured sustained growth" (vii). For data she uses the 1820 and 1840 U.S. Censuses, an 1810 U.S. report on manufactures, real estate valuations collected every three years (similar to Connecticut's), foreign imports and exports, and a great deal of information about intra-regional trade. Further, despite its apparent similarity to the present research, Lindstrom's study is focused on economic growth *per se*, more than on its implications for economic development and its variation across space and time. The prominence of Philadelphia yields, in her interpretation, a straightforward core/periphery economic organization for the region. At the same time, Lindstrom also does consider the

important sub-topics of economic diversification and urbanization in the study. In summary, the book examines the economic relationship between Philadelphia, which increasingly specialized in manufacturing, and its rural hinterland, a relationship that formed the basis for a long-term growth trend that permitted Philadelphia to become a major force in extra-regional commerce after about 1840.

Lindstrom's conclusions relate to her interest in the core/periphery model and the effect of extraregional economic influences on the region's economic development. Her data indicate that the region's hinterland clearly dominated primary sector income in 1840, but also that the core did not completely dominate in the secondary sector. Her further analysis of these results suggested that hinterland manufacturers specialized in goods that could be competitively priced in the core market, and vice versa. The pattern of dispersed location of manufacturing described in the Philadelphia region is consistent with Leblanc's (1969) analysis of New England during the same time period. The main difference between the present study and Lindstrom's (aside from the geographic region) is that this research does not involve a dominant urban area like Philadelphia, but a larger region with multiple development foci, and focuses on the role of diversity in economic development, without reference to core/periphery models.

On a broader scale but the more limited topic of the influence of capital on development, Rousseau and Sylla (2005) have determined that in the whole United States between 1790 and 1850, the increasing volume of banks, securities, and money stocks correlated well with increases in domestic investment and new business incorporations, which indicate in turn a rising level of manufacturing activity. According to Rousseau and Sylla, these factors have been widely ignored in economic history because before the

1980s, economists believed that finance followed economic growth. They note that recent analyses of historic trends, in contrast, suggested that the opposite is true, and their own research supports this hypothesis. In the context of the present study, although data on stock ownership is available, its coverage of stock types is highly variable and it is not certain that there is a relationship between stock owners' residence (where their holdings would have been listed) and the location of businesses. Therefore, this analysis of Connecticut's economic development will use data on capital investment only insofar as that investment is represented by ownership of land and other facilities in the Grand List data.

2.4 Summary

The theoretical literature on economic development supports the importance of economic diversity, the tertiary sector, and central place theory in understanding how and where population and economic growth occurs, as well as the presently unquantifiable human decision-making element. Some of the literature also emphasizes the interaction of multiple factors, usually while concentrating on a smaller number of them. Nonetheless, there is not a unified theory that seeks to fully explain historical trends in economic development. Empirical studies suffer from incomplete data, or the need to use proxy data, making their conclusions more tentative than definitive. In addition, while they sometimes acknowledge the need to consider multiple factors, most studies concentrate on one or two aspects of the problem – linkages, nodality, or even specific classes of industry. Where they exist, spatial analyses tend to be very simple, as with Bidwell's coastal/non-coastal division, or Lindstrom's core/periphery model. Thus, full explanations of observed economic development have also proven to be elusive.

Chapter Three

Data and Methodology

3.1 Introduction

Analysis of the spatial patterns of early nineteenth-century American economic development has been hampered by a scarcity of comprehensive economic data. This scarcity is partly corrected, for Connecticut, by the existence of the Connecticut Grand List of taxable property, discussed in more detail below. Used with awareness of their limitations, these data make possible a close analysis of economic and population changes across time and space, at the level of the municipality, during the earliest stages of American industrialization. The methodologies employed include both simple descriptive statistics and more sophisticated inferential statistics. The key data are sectoral economic information and certain indices of diversity, discussed below, which

provide measurements of economic diversity whose influence can then be analyzed along with the other important factors discussed here.

3.2 Data Sources and Formats

This project utilizes economic data in the form of property valuations and counts of firms, population count data, factory-related incorporations, spatial data sets of the municipalities' changing boundaries, and spatial data on transportation routes.

3.2.1 Economic Data

Relatively comprehensive economic data at the municipality level are found in the "State Grand List," which the State of Connecticut collected throughout the study period of 1810 to 1850. It consists of information about the taxable property of the state's residents, and was used to fairly apportion the burden of taxes for the support of the state government. These data were gathered annually by officials for each municipality and compiled into ledgers by the Office of the Comptroller.[1] The categories of property used provide insight into the overall level of activity in the primary, secondary, and tertiary sectors of the state's economy. The only known academic use of such data is a study of the Philadelphia region by Lindstrom (1978), discussed above.

Difficulties with these data begin with the fact that the total number of municipalities increased from year to year – from 119 (1810) to 122 (1820) to 130 (1830) to 139 (1840) and finally to 148 (1850). This means that direct comparisons between municipalities from year to year are impracticable. Further, it must be noted that

[1] The ledgers used for this study are held in the collections of the Connecticut State Library (Hartford, CT) as "Connecticut Grand Lists," in two volumes catalogued as Record Group 8, Volume 2.

Connecticut handled its municipal data collection in a manner that privileged historic towns over the newer cities and boroughs, treating the latter entities as part of the towns within which they were located. For example, although the City of Hartford existed as an entity separate from the Town of Hartford between 1784 and 1896, the Comptroller's listings include only one entry for Hartford, conflating the city and town. This is why this study uses the general term "municipality" rather than the specific term "town." During the study period, there was only a small number of cities (no more than six), but they played a large role in the state's economic structure.

Another issue is the fact that the information collected was not consistent from year to year, as the table in Appendix A shows in detail. Only six categories of property were valued in all five panel years: dwelling houses, acres of land, horses, riding carriages, timepieces, and money at interest. Even in the years 1820, 1830, and 1840, which are the most consistent, there was some variation. More importantly, before 1818 each type of property was assigned a standard value according to its general quality. Thus, in the 1810 Grand List there were ten different sub-categories of farm land, valued at between $1.67 and $0.09 per acre (see Appendix B), as well as ten classes of riding carriage and four classes of house, each with its own standardized value. After 1818, in contrast, valuations were calculated according to the property's "selling value," an estimate of the sale value of the structure, acreage, and any other component of the property thought applicable by the tax assessor (Jones 1896). Comparisons between the 1810 figures and those of succeeding years will, therefore, be approached with caution. In addition, the 1810 and 1850 data do not separate the secondary and tertiary sector data, although the 1820, 1830, and 1840 data do; this is discussed in more detail below.

The 1810 data to be used for the study (taken from the Grand List and from the official incorporations) are given in Table 3.1, below; for specific details about the sub-categories included in the Grand List schedules, refer to Appendix B. Data for all but two of the 119 municipalities were supplied by the list for 1810; two municipalities, Lyme and Norfolk, failed to report in 1810, and their data are supplied by the lists for 1809, which followed the same categorization.

Table 3.1. 1810 Data Particulars

Study Category	*Schedule Category*	*Count*	*Value Given*
Primary (Agriculture)	Acres of Land + Neat Cattle	Acres, head	Per acre, per head
Secondary + Tertiary	Stores + Assessments	Stores only	Per store, total assessments

As has been mentioned, the values in the Grand List are derived from pre-determined values for each sub-category, which are specified in Appendix B. The several categories of cattle were limited to animals of an age to have meaningful sale values. The mixture of the secondary and tertiary categories arises from the legislature's failure to require the listing of the secondary items as a separate category in the reporting. The 1808 Connecticut statutes did call for taxation at a rate of $150 for "each run of stones" in "[e]ach corn-mill [grist mill], standing on a stream sufficient to carry the same through the various seasons of the year, and so situated that they are constantly supplied with custom"; the rate had been changed in 1804 from that set in 1782 (C.G.S. (1808), Title CII, Ch. I, § 15). The same section went on to call for taxation of "all other corn-mills of less advantages whether wind-mills or others at a less sum in proportion, according to the best judgment of the listers," a requirement dating to 1782. Finally, § 15 contained the sweeping provision that:

> "the listers shall assess owners of slitting mills, oil-mills, saw-mills and all other water-works (except ironworks) by which profits arise, and that all other works and occupations followed by any persons by which profits arise, and which are not enumerated in this act (except business in any public office, husbandry and common labour for hire) shall be assessed by the best judgment of the listers in due proportion to the rules given in particular instances in this act."

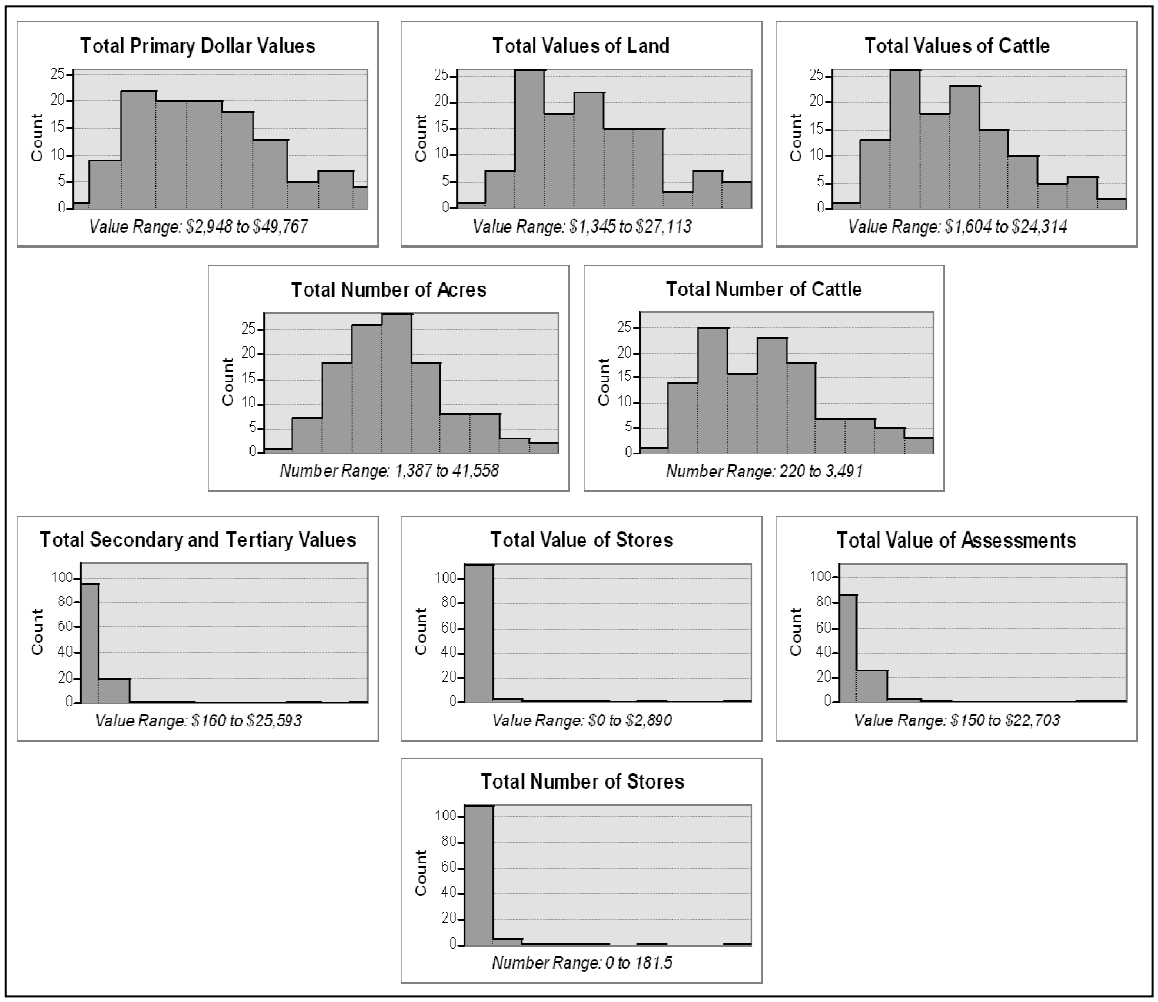
Some tertiary activities also were singled out in the statute, in § 16. Practicing attorneys, physicians and surgeons, "traders of all kinds," "[p]ersons carrying on mechanical business of any kind," and tavernkeepers were all to be taxed "according to their profits," each with a minimum and maximum amount – with a low of $10 for mechanics and a high of $300 for attorneys and traders. These items could be only placed by the comptroller (and the listers in their reports to him) in the general "Assessments" category, since the statutes specified the categories that were to be used (see Appendix A). A transcript of the tax list from 1810 for the municipality of Redding confirms this mixing of categories, including in its assessment list, in addition to the tertiary categories listed above, tailors, drovers, blacksmiths, joiners, shoemakers/tanners, and other secondary activities (Reeve 2010).

The values for Assessments ranged from $150 in Franklin to $22,703 in New Haven, numbers that are suggestive of the comprehensive nature of this category in 1810. They also were reported only in dollar values, with no count of taxpayers thus assessed. As a result of these characteristics of the data, the analysis for 1810 can only examine two-dimensional diversity as shown in Table 3.1, instead of separate categories for the primary, secondary, and tertiary sectors. The total study category values for each municipality have been calculated for this project. Where applicable, the average value

for each category in each municipality has also been calculated, in order to investigate the relationship between the counts and the total values.

Figure 3.1, below, provides histograms of the several categories of the 1810 data. There is significant contrast between the Primary Sector and the combined Secondary and Tertiary data, with the former appearing to have a nearly normal distribution (skewed slightly to the lower values) and the latter having a distribution radically skewed toward

Figure 3.1. Histograms of 1810 Economic Data, by Municipality (119 Municipalities).



the low values of the range. These have proven to be consistent patterns across the study years.

Comparison of the data between the study years will be easiest for the years 1820, 1830, and 1840, which were complete for each year, because the relevant categories used in those years were consistent (see Appendix A) and are easily divided into the three basic sectoral categories, as shown in Table 3.2. The values provided in the Grand List for these years represented a percentage of the total assessed value, either 3% or 6%. For this project, the total values have been re-calculated to restore the full assessed values and to make the amounts properly comparable across all the categories. The specific meanings of the schedules' terms are as follows. In the Primary study category, the assessed value of "Land" reflected the use to which it was being put at the time of the assessment; for example, an acre of plowed and planted land would be worth more than an acre of forest. Specifically, "[l]ands and separate lots (excepting house-lots as

Table 3.2. 1820, 1830, and 1840 Data Particulars

Study Category	*Schedule Category*	*Count*	*Value Given*
Primary (Agriculture)	Acres of Land + Cattle	Acres, head	3% of total, 6% of total
Secondary (Industry)	Mills + Distilleries + Manufactories	Firms	3% of total
Tertiary	Stores + Assessments	Stores only	3% of total, total

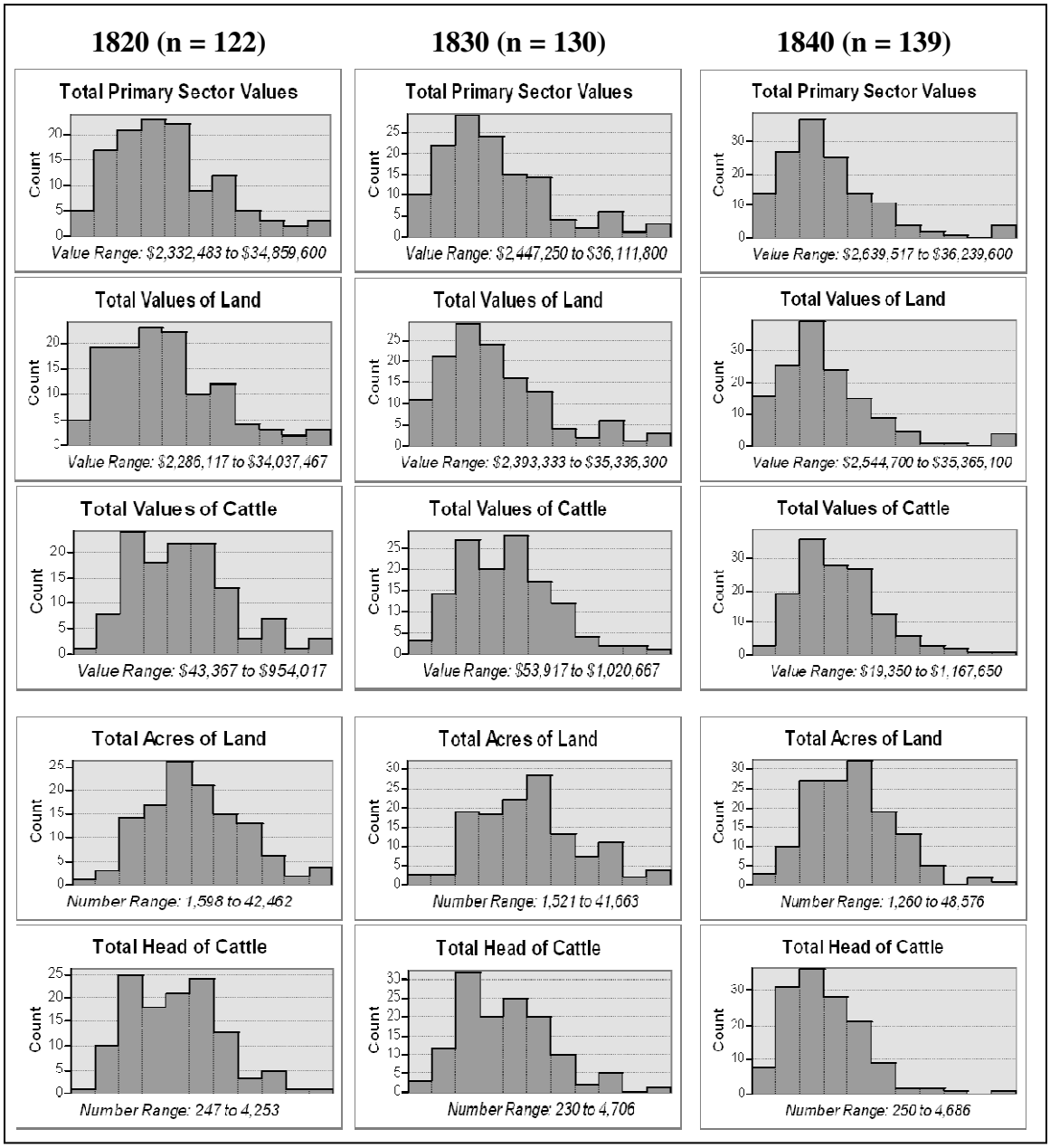
aforesaid) shall be valued and assessed by the acre, at such average rate as each entire tract or lot is worth in money, with reference to the advantages of soil, situation and income" (C.G.S. (1835), Title 105, Ch. 4, §2). This was a self-assessment, corrected only by the owner's willingness to risk substantial penalties, and their peers' knowledge of and willingness to report under-assessment. As such, the reporting is vulnerable to inflation or deflation based on general economic trends. Nonetheless, at any given point in time

the land values reflect the economic well-being and capital holdings of farmers and the agricultural sector, which is important to the relative strength of the sector in the economy as a whole.

"Cattle" refers to cows and steers raised either for dairying or meat purposes. Sheep are omitted from the present study because they were only counted in 1830 and 1840, and their total value was only a small proportion of the taxable property; swine, though commonly owned, were not counted at all until 1850, and from this it can be deduced that before that point they were, perhaps, more important for subsistence than for profit (see Appendix A). Histograms of the Primary Sector data and the several categories across these three years (1820, 1830, and 1840) are provided in Figure 3.2. The patterns are fairly consistent across time and across categories, and are similar to the 1810 data in that they reflect a distribution that is only somewhat skewed toward the left or smaller end of the scale. The counts and values related to Cattle show the greatest variability, probably reflecting volatility in the market for cattle products.

The Secondary study category includes the facility type "Mills." This class of property included not only fabrication facilities such as textile mills, but also processing facilities such as grist mills, lumber mills, oil mills, and fulling mills. At least one study of early nineteenth-century manufacturing in the Northeast (Sokoloff 1982) includes flour mills, grist mills, and tanneries as manufacturing facilities. The 1840 federal census, which collected partial data on the products of agriculture and industry, also classified grist mills and saw mills (or lumber mills) as manufacturing activity (U.S. Department of State 1841). The present study likewise includes these processing facilities as important components of the secondary sector. In addition, as a practical matter it is impossible to

Figure 3.2. Histograms of Primary Sector Data, by Municipality: 1820, 1830, and 1840.

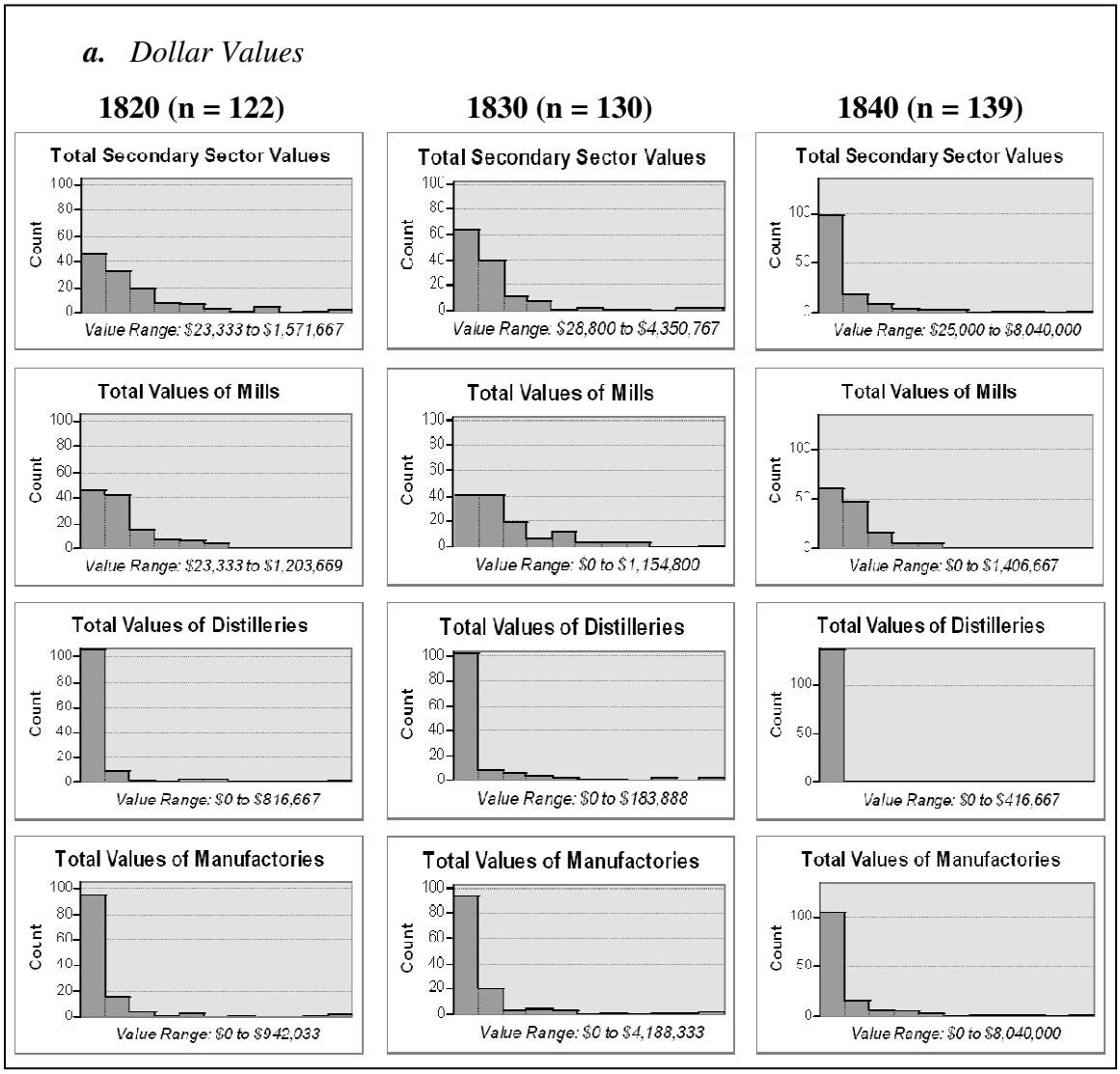


separate them in the data set. Lindstrom (1978), among others, treats them as secondary sector activity even where it is possible for them to be separated out from the rest of the data.

The other two components of the Secondary study category are Distilleries and Manufactories. The term "Distilleries" refers to facilities for the production of liquor, which are included in this study because they were arguably producing value-added goods, and because some municipalities had high values in this category, although many also had none (as the histographs in Figure 3.3a and 3.3b show). "Manufactory" was the term for "factory" during this period, and covered the production in specialized workshops of articles ranging from shoes to hats to buttons. Both distilleries and manufactories were qualitatively different from the ordinary home manufacture of similar items, with which farmers had supplemented their income for centuries and which are not believed to be included in this category of the Grand List (Bidwell 1916). The overall value of such home-based activity, and hence the potential effect of its omission on this analysis, is not known. Nonetheless, the appearance of separate manufacturing facilities, however small, marked the beginning of the major economic shifts that were to come; the state's awareness of their existence and growing importance is reflected in their addition to the Grand List beginning in 1820.

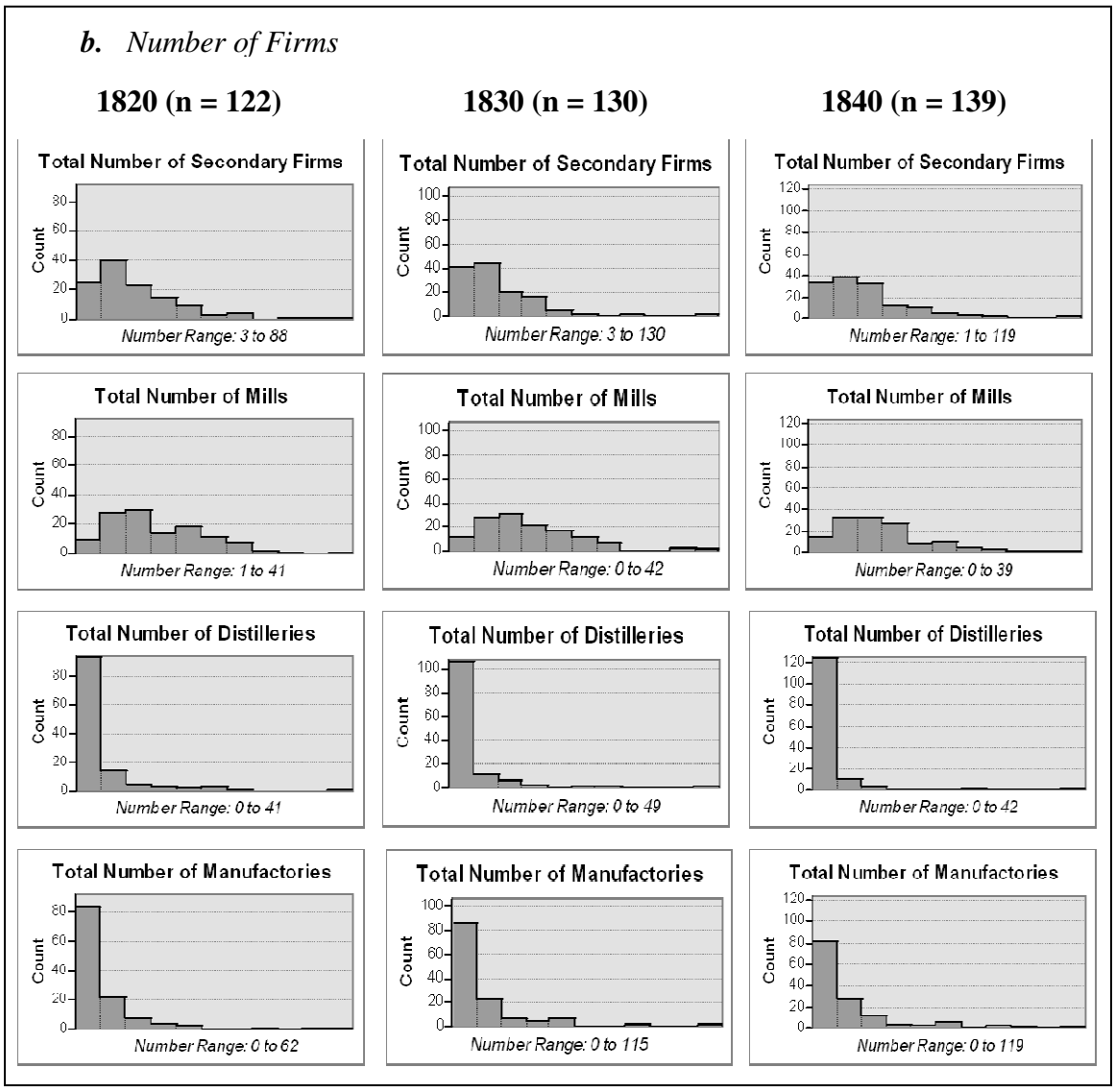
A further issue with the data from 1820 is that as a means of encouraging economic development, the state exempted textile manufacturing enterprises from taxation between 1817 and 1825. Their number and values are, therefore, not included in the Secondary Sector data for 1820. To partially correct for this, the State's incorporation records are used to supplement the data on the number of firms for 1820, but dollar

Figure 3.3. Histograms of Secondary Sector Data, by Municipality: 1820, 1830, and 1840.



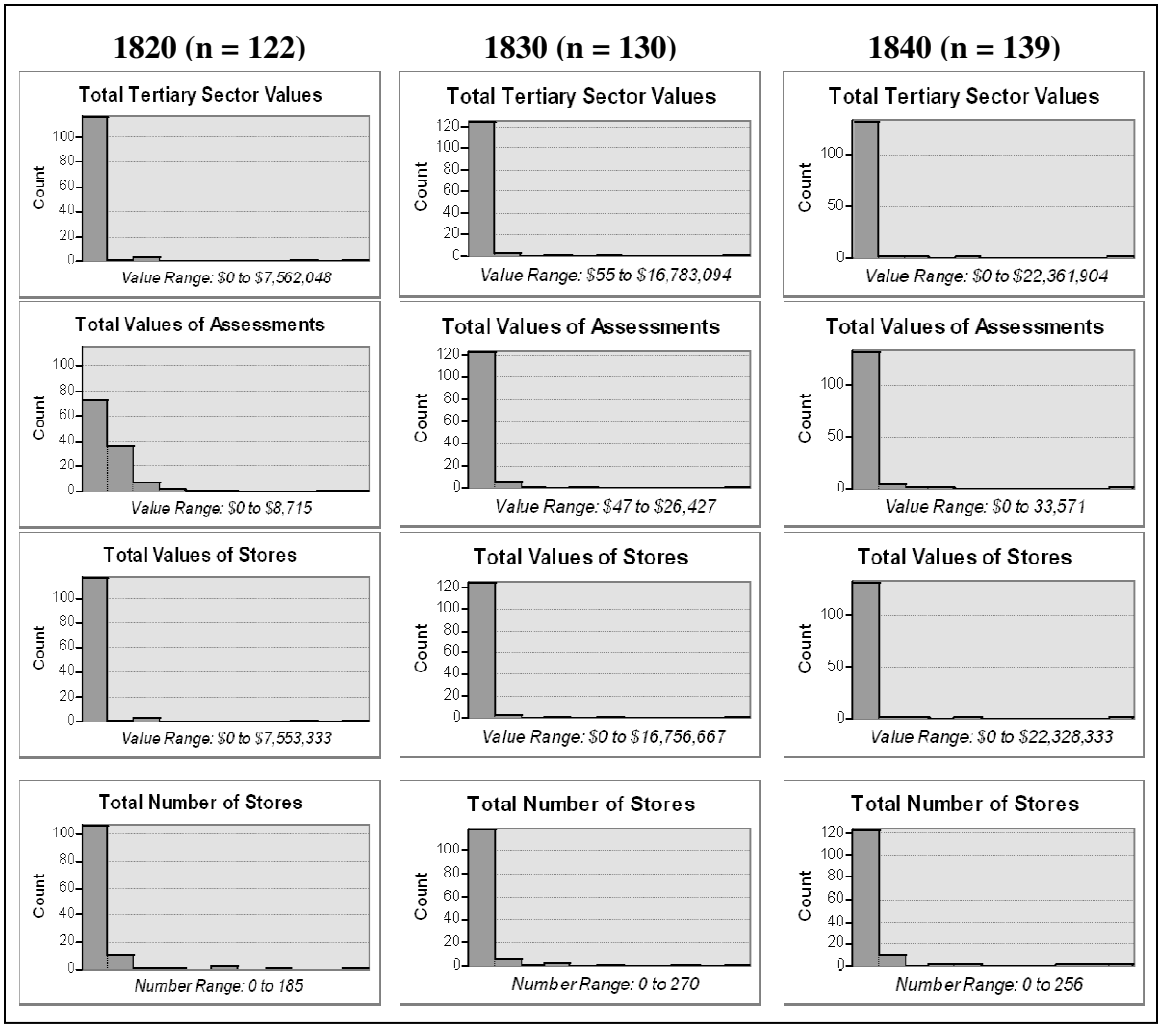
values for these firms' property are not available. As these were capital-intensive businesses requiring special legal status in order to sell stock, the incorporation information is believed to be fairly complete; however, it has not been possible to determine whether all of them were in fact still in business in 1820. In the absence of definitive information on any given firm's earlier closure, it has been retained

Figure 3.3. Histograms of Secondary Sector Data, by Municipality: 1820, 1830, and 1840.



The Tertiary study category includes Stores and Assessments, and histographs of these data are provided in Figure 3.4. Stores were retail establishments, selling goods to the general public or in some cases making them to order. Grocers, general stores, and milliners are all examples of stores. According to statute, the valuation of "[m]ills, stores, distilleries and buildings … shall be valued with respect to situation, and present income" (C.G.S. (1835), Title 105, Ch. 4, §2). "Assessments" in these years refers to

Figure 3.4. Histograms of Tertiary Sector Data, by Municipality: 1820, 1830, and 1840.



"faculty assessments," a valuation designed to apply to members of professions, and capture something of the value of their businesses in the Grand List. According to the General Statutes of 1835, "Attornies [*sic*], physicians, surgeons, traders of all kinds, mechanics, taverners, brokers and distillers shall be assessed ... according to the value and income of their business, occupation or profession" (C.G.S. (1835), Title 105, Ch. 4, §4). Attorneys, then, would be assessed based on their income, with perhaps their office and its furniture; taverners on their income, building, and stock; and so on. In 1820, these

total values ranged from zero (Union) to $8,715 (Hartford), with a median value of $624. In 1840, they ranged from zero (five municipalities) to $33,571 (Hartford), with a median value of $339.50. The histographs show that like the Secondary Sector, the Tertiary Sector was highly skewed towards the left or lower end of the scale.

These assessment values are very small when compared to those for all the other data categories (wherever the value is greater than zero), and unlike the rest they include businesses that consisted almost entirely of income. As was discussed above, the categories of land, manufactories, and the like all included an income component, poorly defined but mentioned in the statutes, but also a large property component. The income component of a factory may have been a smaller proportion of its value than the business of an attorney, but it was still present. Thus, the smaller values of the assessments reflect both the small number of people involved in them at this time and the lower capitalization required. This was not the service-based economy of the modern era; the main source of income for most people in the economy as a whole was still agriculture, not commerce, industry, or "faculties."

As Appendix A and Table 3.3 show, the 1850 Grand List data were collected under yet another very different system, which reflected an important shift in legislators' perceptions of the state's tax base – namely, from a focus on physical property to the inclusion of financial investments of many kinds. For this project, value data for one municipality, New London, were taken from the 1851 list instead of the 1850 list (from which it was missing). In addition, count values for 1850 will not be analyzed, because

Table 3.3. 1850 Data Particulars

Study Category	*Schedule Category*	*Count*	*Value Given*
Primary (Agriculture)	Acres of Land + Neat Cattle	Acres, head	3% of total
Secondary + Tertiary	Mills, Stores &c.	Firms	3% of total

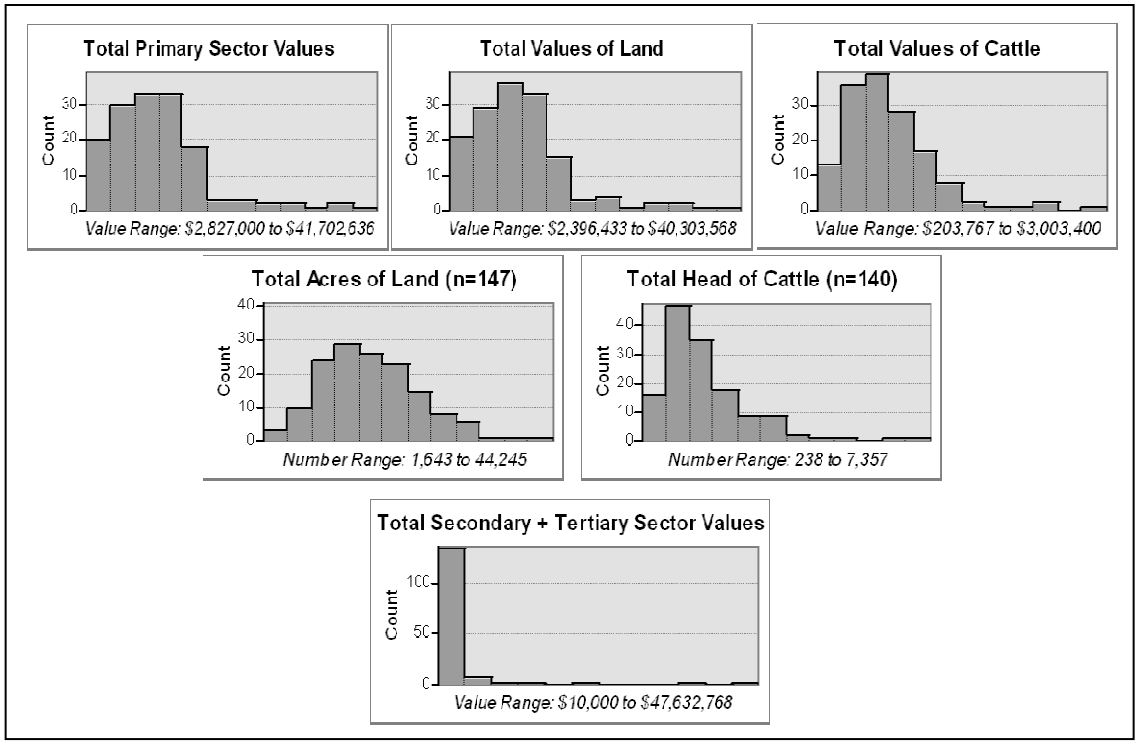
too many of the municipalities failed to provide counts for acres of land (one missing), cattle (eight missing), and mills and stores (thirty-five missing) in the Grand List reports for both 1850 and 1851.

The most notable change from prior years is that the comptroller's ledger categories included investments in various types of businesses, as well as a wide variety of stocks – a substantial change from assessment mainly of physical property. It also added more separate categories of taxable personal property and, unfortunately for the purposes of this study, dropped the faculty assessment and apparently conflated business property into one category, headed "Mills, stores, &c [*sic*]." This change appears to be drawn from the statutes, which stated that "[m]ills, stores and distilleries, and buildings used for manufacturing purposes, shall be valued and assessed at their present, true, and just value" (C.G.S. (1854), Title LV, Ch. I, § 7). The statutes also made taxable all personal property not specifically exempted; the list of exemptions is long, and seems focused on exempting a minimum amount of basic household, farm and even specific business property (farming tools, mechanics' tools, fishing apparatus) (C.G.S. (1854), Title LV, Ch. I, §§ 6, 8). It is possible that business property such as larger mechanics' firms, attorneys, taverners, and the like was captured in the category "All other taxable property" in the 1850 ledger; but it is also likely that much other property having nothing to do with business but not given its own category in the ledger was included, such as silver utensils, listed in their own category in prior years (see Appendix A). Because of this problem, this study will analyze only the "Primary (Agriculture)" study category and the "Secondary + Tertiary" study category as defined above.

The change in reporting on business property will make a three-sector categorization of the 1850 data impractical, as it is for the 1810 data. The histographs in Figure 3.5 include only the categories that will be analyzed, and show a noticeable shift to the left or lower end of the scale in the Primary Sector, while the highly skewed counts for the combined Secondary and Tertiary Sectors are consistent with previous years.

The total dollar values of the municipal economies are also an important part of this analysis, and are available across all five study years. As is shown in Figure 3.6 below, the 1810 data, perhaps because of the data collection methodology, showed a definite slant toward the lower end of the spectrum, but not an extreme one. Over the succeeding decades, the number of municipalities with total economies in the lowest categories increased, while the total size range increased. In 1840 and 1850, the

Figure 3.5. Histograms of 1850 Data, by Municipality (148 Municipalities).



minimum end of the range even fell by almost $2 million, while the 1850 maximum surpassed $80 million, more than double what it was in 1820. This pattern of increasingly skewed values over time is, as we have seen, common to nearly all of the economic and even population data during the study period.

3.2.2 Population Data

The U.S. Census of population for each year will be used for the necessary population data. The municipality data were disaggregated from the county-level federal compilations by the Connecticut Department of Environmental Protection (1996), and a copy was downloaded from the website of the Map and Geographic Information Center at the University of Connecticut for this project. Figure 3.7, below, presents histograms of the population for each study year, showing that in 1810 there was a fairly wide range of municipal sizes. By 1850, however, it is clear that almost all of the municipalities fell into the lowest two categories. As the total population of the state continued to rise, the

Figure 3.6. Histograms of Total Dollar Values of Municipal Economies, 1810-1850.

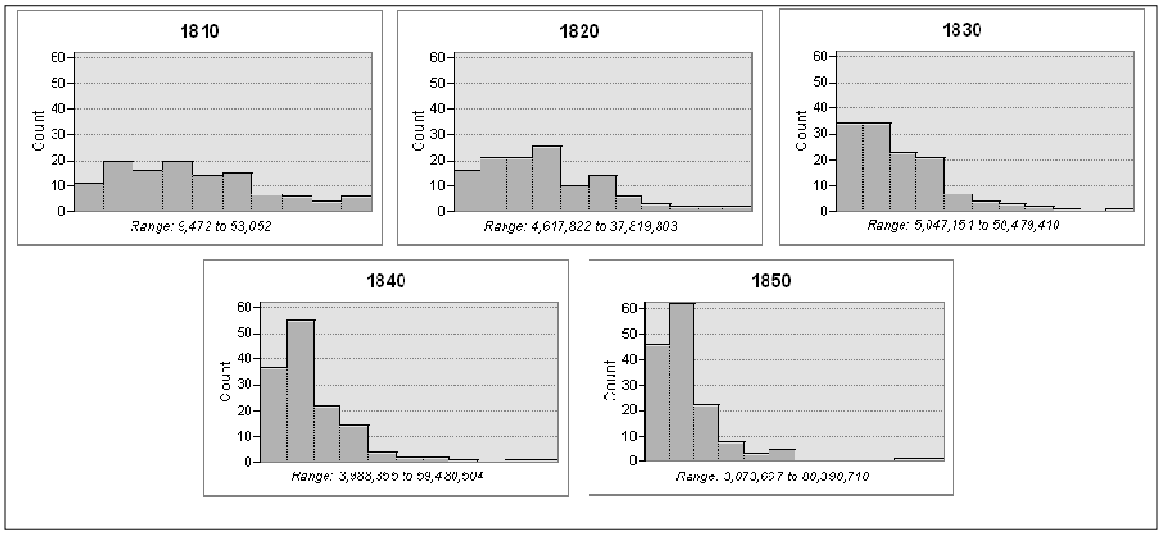
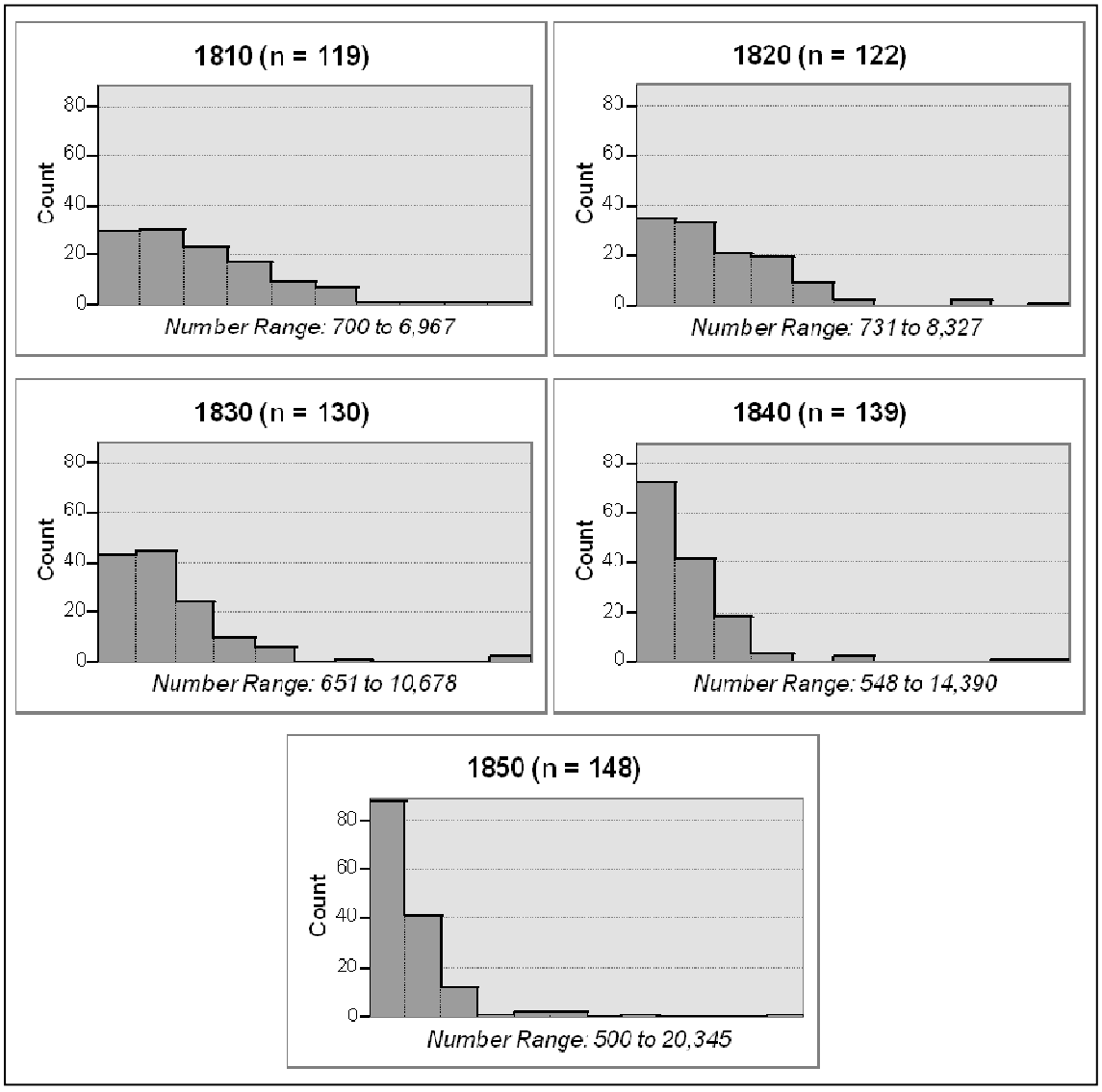


Figure 3.7. Histograms of Municipal Population, 1810-1850.



change strongly suggests increasing concentration of population in a relatively small number of large municipalities over the course of the years from 1810 to 1850. This phenomenon will be examined in more detail in Chapter 4.

3.2.3 Spatial Data

For each panel year of the study, there are either two or three spatial data layers: one of the municipal boundaries, and either one or two of the transportation network. The municipal boundary data are based on the modern boundary files produced by the Connecticut Department of Environmental Protection (1994) and downloaded from the website of the Map and Geographic Information Center at the University of Connecticut for this project. The unpublished historic municipal boundary files used in the study were created for it, by modifying the modern boundaries based on historic and cartographic research.[3] Figure 3.8 shows the municipal boundaries and also illustrates the previously mentioned changes in the boundaries that occurred between each study year, showing the municipalities that were new in each study year.

The unpublished transportation data layers are depicted in Figure 3.9 below. They consist of, first, the turnpike network as it changed over time, and were created for this project based on the research conducted by Wood (1919). The information he compiled was as complete as the records allowed him to make it, and is sufficient to determine the presence or absence of turnpikes in any given municipality. The second transportation data layer set also was created for this project and reflects the modest railroad network that was developed in Connecticut between 1837 and 1850, based on research conducted by Turner and Jacobus (1989). The striking aspects of these maps are how extensive the turnpike network had become by 1840, and how rapidly it had begun to wither away after the opening stages of the railroad network's development as of 1850.

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[3] The research and boundary modifications were done by W. Keegan and the author.

3.2.4 Delimitations and Limitations

Three additional sources of economic data for the study period also exist but are not being used for this study. Pease and Niles (1819) is a gazetteer that identifies the industrial and commercial enterprises in the state's municipalities, but only sometimes includes data on production or property values. The "McLane Report," as it is commonly known (U.S. Dept. of the Treasury 1833) and Tyler (1845) collected data only on specific branches of industry that were of interest to the state and federal government, rather than all industries, and not tertiary enterprises. Pease and Niles and Tyler were the sources relied upon by Fuller (1915), but they are not adequate to the purposes of this study. Finally, although the U.S. Census did collect information on manufactures in 1810, 1820, and 1840, a lack of planning and data collection standards meant that its returns are unreliable (Fishbein 1963). This study will rely primarily on the Grand List, referencing other sources only as they are judged to be needed.

In general, the lack of comprehensive data on industrial activity prior to about 1820 is consistent with the relatively low economic profile of that sector. Although most Connecticut municipalities had one or more of grist mills, saw mills, fulling mills, and tanneries, and frequently produced potash, pearlash, and lime, in general these activities were a small, though essential, part of the economic landscape (Cooper 2003). Further, although the population of New England produced quantities of manufactured items ranging from candles to earthenware, most of these items were made by farm families or small craftsmen's shops and did not have substantial impact on the overall economy or workforce (Bidwell 1916, Cooke 2003). In addition, while political entities at both the federal and state level were interested in fostering and monitoring the development of

Figure 3.8. Connecticut Municipal Boundaries and Changes, 1810-1850.

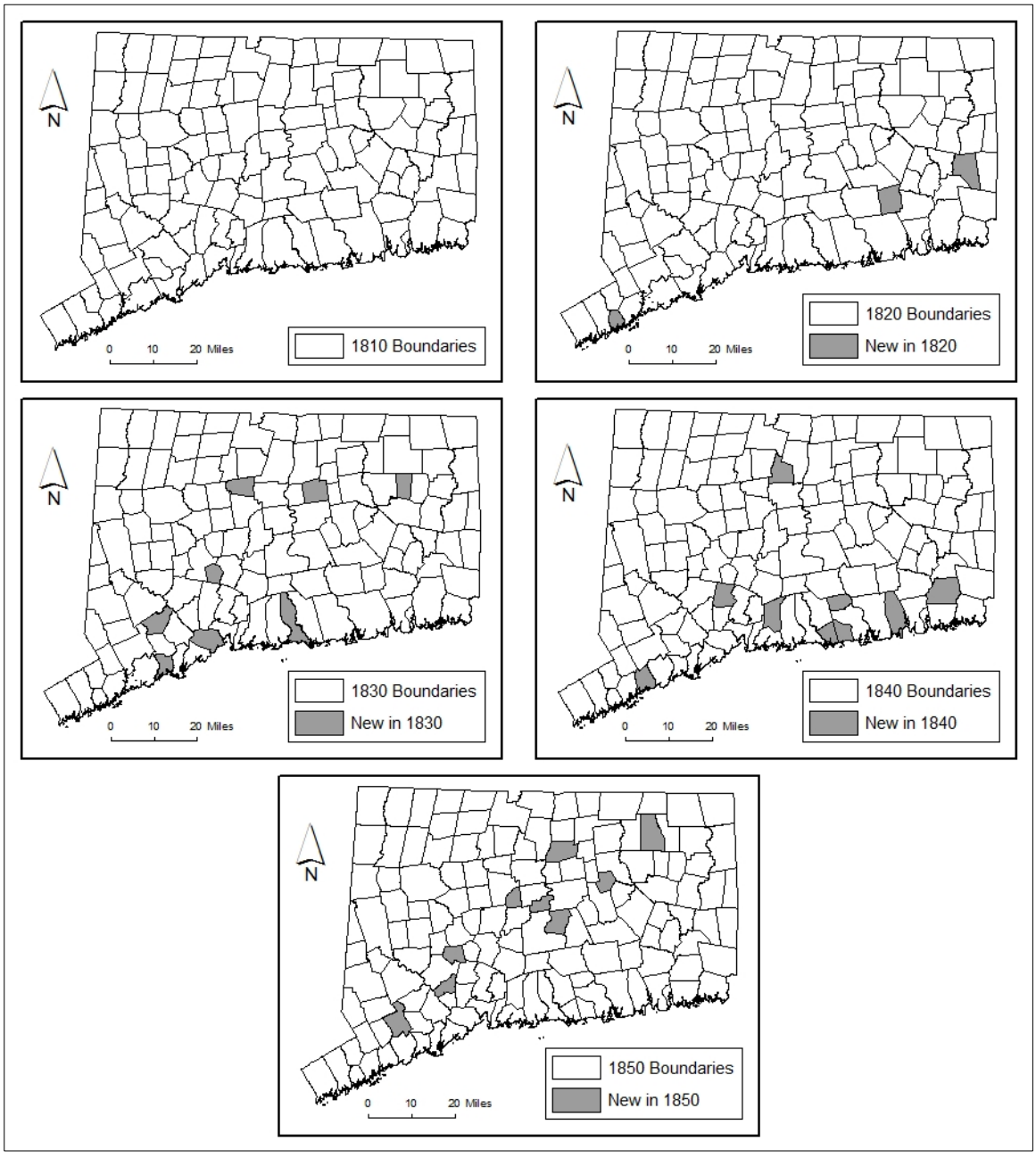
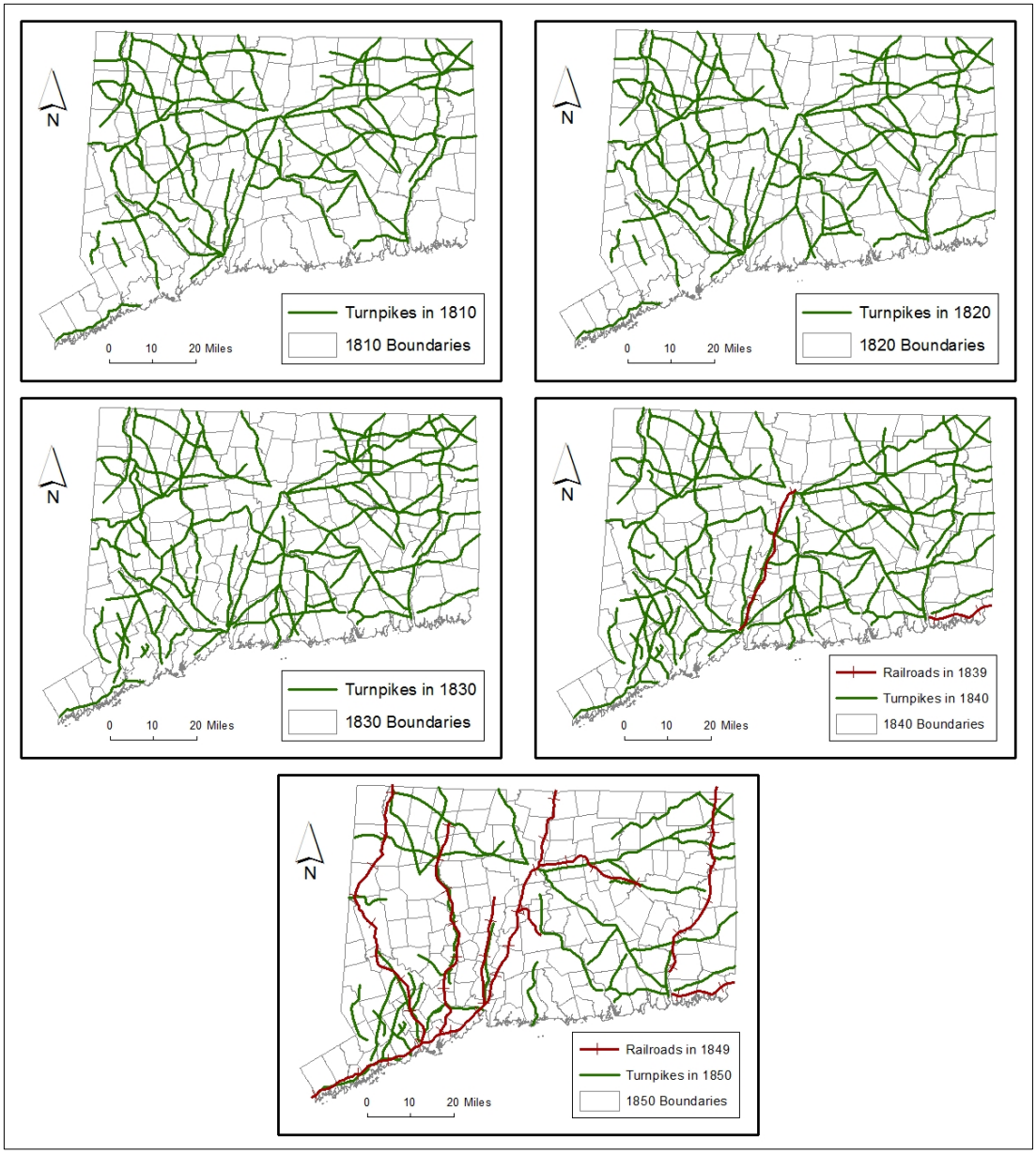


Figure 3.9. Connecticut Transportation Networks, 1810-1850.



industrial enterprises in the United States, that interest did not immediately translate into useful data collection. The 1810 federal census did include a separate questionnaire on manufacturing enterprises, but it is well known that the information thus collected was incomplete and unreliable (Fishbein 1963). In addition, these data – and those in the later, somewhat more comprehensive manufacturing schedules – were compiled by the Census at the county level, which is not directly useful for the present purpose. This study concerns economic diversification at the scale of the municipality, which in Connecticut was (and is) the primary governmental and social unit. The economic data that are being used for this study were compiled at the level of the municipality, consistent with the state authorities' perception of Connecticut's organization.

The various data sets actually used here are problematic in two important ways. First, studies of changes in the structure of economies normally use data on employment, as worker participation in different sectors of the economy is an important measure of the sectors' roles and their influence on economic structure and trends. The economic data used here are of a different type, namely, lists and valuations of taxable property. Further, they are not exhaustive lists of property, but rather of property deemed by the government to be valuable enough, or important enough in the economy, to be taxable. These data, however, are comparable to the capital stock of the economy, which can be used "to describe the scale, structure, and growth of the economy" (Gallman 1986). The elements selected from the larger data set are those that can be assigned to the three standard economic sectors. This eliminates a great deal of information, but hews to the traditional approach of most economists by analyzing the productive sectors of the economy.

The second problem is that using Connecticut municipality data for a study involving urban and central places is fundamentally misleading, because Connecticut municipalities usually were not, administratively speaking, urban or semi-urban areas distinct from the surrounding countryside, which would be expected in most other states. It would be more correct, if more cumbersome, to describe the analysis here as producing evidence of the existence of one or more central places or concentrations of population or industry within the boundaries of the municipalities (some of which were officially incorporated cities or boroughs, and some of which were not). The diversification index indices therefore incorporate the rural agricultural component of the municipalities' economies while also highlighting the presence of manufacturing and commercial activities. Omitting the primary sector would take the secondary and tertiary data out of the agricultural context and eliminate any sense of the relatively small scale of non-agricultural economic development in this time period, and also the significant overall changes in the local structure of the economy over these forty years.

Finally, the differences between the statistics collected in the different years are not the only reason that direct comparisons between years are not attempted in this study; the other reason, as noted above, is that the municipality boundaries changed over time. Between 1810 and 1820, three new municipalities were created out of those that existed in 1810; between 1820 and 1830, eight; between 1830 and 1840, nine; and between 1840 and 1850, another nine (see Figure 3.8 above). That is a total of twenty-nine changes. Some of the changes involved simply dividing an existing municipality into two, but others involved taking portions of up to three adjacent municipalities to create the new one. While it would be possible to develop data aggregations that permit direct

comparisons, the analyses already being employed on the distinct data sets are sufficient to identify patterns and models; adding yet larger spatial areas to the analyses would only confuse the results.

3.3 Methodology

The analysis will begin with a set of simple descriptive statistics applied to the population and economic data sets discussed above. Second, a traditional analysis of urbanization in Connecticut, as reflected by the growth and concentration of population, will be conducted, identifying patterns and trends in the data that may be related to the economic changes in the state. Third will be an analysis of the economic structure of Connecticut municipalities at the five points in time, examining the level of spatial autocorrelation and clustering (or lack thereof) in the economic data. These analyses will be applied to both the basic sectoral economic data and to the diversification index that will be developed as part of the project. At each stage, multiple statistical methods will be used, in order to determine how robust the results are across varying analytical techniques and approaches. Ultimately, the results will be examined to see whether they conform to the expectations of stability of the urban system, and of a strong influence on development of a place's from economic diversity and access to transportation.

3.3.1 Statistical Analysis

The population and economic data are examined for the characteristics of each study year and for trends across the study period. The frequency distributions, measures of central tendency, and measures of dispersion are followed by a discussion of changes in the municipalities' ranks in the several data categories and the overall levels of the

sectors' economic activity over time. This analysis of the data's general characteristics helps to determine the applicability of more advanced statistical tests and establishes the context of the analysis. The basic level of urban concentration is evaluated by comparing the proportion of the sum of the ten largest values to the statewide totals, before the exploration of more complex statistics.

3.3.2 Statistics of Population Growth and Concentration

In the study of population concentration, there are several statistical options. Here, the Hoover Index and the location quotient (LQ) will identify municipalities with high population concentrations and show how these locations changed or did not change over the study period. Although shift-share analysis would be an ideal method here, it cannot be applied because of the changes in the number of municipalities from study year to study year.

Otterstrom (2003) uses the Hoover Index to measure the concentration of population in the nation's city-systems, in a manner similar to that employed here. The formula is:

$$H_t = 1/2\left(\sum_{i=1}^{k}\left|P_{it} - a_i\right|\right)x100 \qquad (3.1)$$

where P_{it} = proportion of the state's population contained in municipality i in year t

a_i = each municipality's proportion of the state's land area, and

k = [1, 2, 3 ...].

The equation yields a value of between 0 and 100, with 0 indicating completely even distribution of population, and 100 indicating complete concentration. Changes in H_t indicate increases or decreases in concentration across the whole system.

This measure provides information only about the total concentration of the population and cannot pinpoint specific areas of concentration. There could be a single high-concentration area or several scattered areas within Connecticut; the Hoover Index only describes how much overall concentration there is. Comparison of the values across the four panel years might be expected to show some increase in concentration between 1810 and 1850, but this reveals little about what was happening at the individual municipality level. The Hoover Index is derived, however, from a summation of the absolute value of each municipality's difference in percentage of population and percentage of area; thus, a decomposition of these numbers, $|P_{it} - a_i|$ in equation 3.1, will also be investigated and mapped. These results are more detailed and useful for this study's purposes than the overall Hoover Index value.

Another applicable statistic is the location quotient (LQ). Instead of providing a single overall index number, the LQ yields a value for each municipality, and thus will not need to be decomposed in order to evaluate the spatial patterns within the data. Specifically, the LQ measures the spatial distribution of levels of an activity at a set of locations as compared to a base, often but not necessarily the total of whatever the activity is. In the present study, the LQ analysis will instead calculate the ratio of each municipality's population and area proportions. The formula is

$$LQ_i = \frac{A_i / \sum A_i}{B_i / \sum B_i} \qquad (3.2)$$

where A = population of municipality i and

B = area of municipality i.

For each municipality, where LQ > 1 there is a relative concentration of the activity compared with the region as a whole; where LQ = 1 its share is consistent with the whole; and where LQ < 1 its share is less than that of the region as a whole (Barber 1988). Although the LQ is fundamentally descriptive, not explanatory, any patterns that it reveals can be further analyzed for possible explanatory factors.

As Cromley and Hanink (2012) have noted, however, the standard LQ lacks an evaluation of the statistical significance of the resulting values and calculates each value in spatial isolation. They proposed a focal location quotient (FLQ) that includes geographically weighted aggregation, using the formula

$$FLQ_i = \left(\sum_j w_{ij} e_j \,/\, \sum_j w_{ij} E_j\right)/(e/E) \qquad (3.3)$$

where e = an observed value

E = an expected value, and

w_{ij} = a spatial weight.

The resulting values are comparable to the original LQ in that they express the divergence of a given e from its expected value if all the proportions were equal, but since they also incorporate spatially weighted values, they reflect spatial concentration of values as well. According to empirical testing of the FLQ, a value of less than one is likely to not be statistically significant, while a value of greater than one is likely to be statistically significant. For this project, a spatial weight matrix will be calculated as a Gaussian function of distance. Like the LQ, this measure is descriptive in nature, but its results can also be subjected to additional examination.

In order to more completely understand the spatial patterns present in the population data, the general and local Getis-Ord *G** and Moran's *I* statistics also will be calculated for the raw population values. This will identify any areas of statistically significant value concentration or spatial autocorrelation, to be compared to the LQ and FLQ results. These two statistical methods are discussed in more detail in Section 3.3.3.

3.3.3 Economic Structure and Diversity

Analysis of economic structure requires data that, ideally, can be classified into at least the three basic categories of economic activity (the primary, secondary, and tertiary sectors). As was discussed in Section 3.2.1, the Connecticut Grand List data meet this requirement for three of the five study years. The purpose of such classification is to help determine which category is dominant in the economy, if any. Based on that information, the researcher can understand the economy's level of development in terms of the historically observed progression from a primary-based economy to a secondary and then a tertiary-based economy. The present research seeks to determine whether economic diversity – the presence of a mixture of economic activities, especially a substantial tertiary sector, rather than the simple dominance of one – played a substantial role in the development and growth of urban places in Connecticut in the early nineteenth century. Thus, in order to assess the level of each municipality's economic diversity, several measures of concentration will be used.

Concentration indices are frequently used by economists to evaluate the level of diversity within and between industries despite the absence of a theoretical justification for their use. Although there are many possible ways to measure this characteristic, probably the most commonly used is the Herfindahl-Hirschman Index (sometimes known

simply as the Herfindahl index) (Schmalensee 1977). On its face, the HH index has the advantage of simplicity, as the formulation given below shows. Hall and Tidemann (1967) further argue that it has all six properties they consider desirable in a concentration index: (1) that it be unambiguous and one-dimensional; (2) that concentration should be a function of the relative shares of the measured entities, not of the number of entities; (3) that changes in any of the shares should affect the index value; (4) that changes in the number of entities should affect the index value; (5) "[w]hen an industry is divided into N equal-sized firms, a measure of concentrations should be a decreasing function of N" such that "many firms mean less concentration, fewer firms mean more concentration" (a condition not met, they assert, by the Gini coefficient of the Lorenz curve); and (6) for simplicity's sake, that it should have a range from 0 to 1, or be transformable to such a range without altering its properties. The other commonly-used concentration index that Hall and Tidemann discuss is the concentration ratio, which they state violates rules 3 and 4 because it relies on a specified subset of the largest *L* entities in the set.

Notwithstanding the HH index's conformance to their stated preferences, however, Hall and Tidemann are not completely satisfied with it. By weighting each entity (or firm, in their terminology) according to its relative share, the index "implies that the relative sizes of firms are more important than the absolute number of firms in determining concentration" (Hall and Tidemann 1967: 165). They propose a different measure to overcome this problem, but in the present study the relative size of the firms (which for this study are only two or three economic sectors) is exactly the topic of analysis. The overall conclusion of Hall and Tidemann is that researchers should use the

measure of concentration best suited to their goals, not a nonexistent "best" measure of concentration.

By this standard, the HH index is well suited to the present research, save for the fact that it is nonspatial in nature. As was noted above, the basic Herfindahl-Hirschmann index equation is a simple one:

$$HH = \sum_{i=1}^{N} P_i^2 \quad \text{for all } P \qquad (3.4)$$

where P_i is a given entity's share in the total of the research subject, and N is the number of entities. The economic literature, of course, usually defines the entities as firms and analyzes them within and between industries, but there is no reason why this equation must be restricted to such definitions. Imbs and Wacziarg (2003), for example, use it as one of several measures of sectoral variation in employment and value added among late twentieth century countries.

To pursue the research project's interest in economic diversity within the municipalities, we will define the research subjects as each municipality's economy, and the entities as each sector's share in the municipality's economy. Thus, for each individual municipality, we calculate

$$HH_i = \sum_{j=1}^{N} \left(s_{ij}\right)^2 \qquad (3.5)$$

where i = a municipality

j = a sector

s_{ij} = a sector's share in a total municipal economy, and

N = the total number of sectors.

For each calculation, there would be either two or three shares for the sectors (N = 2 or 3), and the HH_i value would be calculated once for each municipality to yield its economy's level of sectoral concentration or diversity.

Both this equation and equation 3.4 cannot, however, produce a range of results between 0 and 1, because the base of the formula is a proportion that can never be zero. Further, a simple 0 to 1 range is not entirely adequate; because the value of *N* changes in certain years, the results for each year will necessarily be different regardless of the underlying level of concentration. An additional step to transform the results is required, as follows:

$$HH' = \left[\frac{\left(HH - \frac{1}{N}\right)}{1 - \frac{1}{N}}\right] \times 100 \qquad (3.6)$$

Here, each *HH* value is transformed by subtracting from it the theoretical minimum HH value (1/*N*) and then dividing that result by the difference between the theoretical maximum (that is, 1) and the theoretical minimum. The final result is then expressed as a percentage, such that HH' reflects a distance above the theoretical minimum. These values can be compared across study years without concern about the potential effect of the varying *N* values. This is particularly important with respect to calculation of the overall diversity of Connecticut's economy in each study year, also part of this study. These calculations use equation 3.4 such that P_i = each sector's share of the total state economy (not the individual municipality's economy) in that year (again with N being either 2 or 3, depending on the year). Expression of these results as a percentage as noted above will allow meaningful comparison between the statewide economy's level of concentration and that of any given municipality.

An additional consideration is that the HH_i value itself only measures the overall level of sector diversity in the municipality. As with the Hoover Index, decomposition of this value by sector will yield further information on the spatial variations in sectoral activity that is summarized by the municipalities' overall index values – showing, for example, which municipalities had the largest proportion of tertiary activity. The implications of these results with respect to the relationship between population size and economic diversification, and especially the question of which changes first in any given location, will be explored further in the analysis section of this study. The HH_i and HH' values will also be among the variables subjected to further statistical analysis.

The location quotient, discussed in Section 3.3.2 above, will be employed to analyze the municipalities' shares of each of the two or three economic sectors. Although it is clear that the secondary and tertiary sectors (alone or combined) are highly skewed, the more extreme LQ values can and will be examined to determine whether and how their locations and levels of variation from the average change over time. In particular, it will be used with respect to the primary, secondary, tertiary, and combined secondary and tertiary values and firms, as applicable. The analysis will also include the newer focal location quotient (FLQ), discussed in Section 3.3.2 above, as part of the work to discover any spatial clustering in the data, which is discussed in more detail below.

In addition to mapping the LQ and FLQ results, we can also analyze the same information by treating the areas as points and looking for patterns among them, rather than considering only whether or not the activities are evenly distributed over space. The Getis-Ord General G* statistic is a global measure that indicates whether there is significant spatial clustering of values across the whole of the data set. Its formula is

$$G^* = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{i,j}x_i x_j}{\sum_{i=1}^{n}\sum_{j=1}^{n} x_i x_j}, j \neq i \qquad (3.7)$$

with *n* representing the number of features in the data set, x_i and x_j representing attributes for features *i* and *j*, and $w_{i,j}$ representing the spatial weight between *i* and *j*. The local version of this statistic is the Getis-Ord G_i* statistic, which tests whether the region surrounding a given location constitutes a cluster of non-average values of the variable of interest. Where *x* is the variable of interest, *s* is its sample standard deviation, and $w_{ij}(d)$ is set at one if the region *j* is within distance *d* of region *I*, and zero otherwise, we calculate

$$G_i^* = \frac{\sum_j w_{ij}(d)x_j - W_i^*\bar{x}}{s\left\{\left[nS_{1i}^* - W_i^{*2}\right]/(n-1)\right\}^{1/2}} \qquad (3.8)$$

where $W_i^* = \sum_j w_{ij}(d)$ and $S_{1i}^* = \sum_j w_{ij}^2$. The test is treated as a standard normal random variable, so that the resulting statistic can be tested for significance with respect to the null hypothesis that the subject region is not part of a region of higher values (Rogerson 2001). In other words, in the present research project this test will determine whether significant clusters of secondary, tertiary, or combined secondary and tertiary activity exist among the municipalities of Connecticut. It is possible that while the general test to find no significant concentration across the whole study area, the local test can find areas of significant concentration that are not large enough, in terms of area or local variation, to be detected by the global test.

A similar test, Moran's *I*, calculates the degree of spatial autocorrelation and provides a valuable comparison with the results of the G_i* statistic. The formula for this

test transforms the variable under study into a *z*-score (an expression of its deviation from the mean) and then calculates

$$I = \frac{n\sum_i \sum_j w_{ij} z_i z_j}{(n-1)\sum_i \sum_j w_{ij}} \qquad (3.9)$$

where w_{ij} measures the spatial proximity between each region (municipality, in the present case) and z is the z-score for either *i* or *j*. The statistic yields a general result in which values approaching 1 indicate strong positive spatial autocorrelation, values near –1 indicate strong negative spatial autocorrelation, and values near 0 suggest there is no spatial pattern (Rogerson 2001). The field of statistics has tended to treat autocorrelation as a problem to be corrected as much as possible, but in a geographical context such as the present study, the identification of spatial autocorrelation can be considered information rather than something to be ameliorated (see, *e.g.*, Goodchild 2009). Where the Getis-Ord General G* statistic evaluates whether the region's values are significantly clustered, Moran's *I* evaluates whether there is a statistically significant relationship among the region's values.

A local version of Moran's *I* has also been developed and will be employed here. It calculates values for observations that reflect potential influence of adjacent values on any given value. As implemented in ArcGIS 10, the formula is

$$I_i = \frac{(x_i - \bar{X})}{s_i^2} \sum_{j=1, j \neq i}^{n} w_{i,j}(x_i - \bar{X}) \qquad (3.10)$$

where x_i = attribute for feature *i*

$\bar{X}$ = the mean of the attribute *x*

Wi,j = the spatial weight between features *i* and *j*

N = total number of features, and

s_i^2 = feature i's deviation from the mean of x, squared.

Comparison of the results of the LQ, FLQ, G*, G_i*, I, and I_i will indicate whether any spatial relationships within the data sets are statistically robust.

3.3.4 Influences on Economic Development

The third phase of this research is to determine how economic diversity and transportation access in Connecticut affect economic development. The data sets used here permit analysis of the influence of primary, secondary, and tertiary economic activity, or economic structure, on the short-term and long-term population growth outcomes of these nineteenth-century municipalities. The mercantile model presented by Vance (1970) holds that initial urban place formation is driven by the wholesale rather than the retail trade, in opposition to Adam Smith's assumption, because the existence of wholesale trade is a necessary precursor to the existence of pure retail trade. Both models rest on a tertiary foundation, and Vance's model is convincing with respect to the earliest phases of urban development, including in Connecticut. Once the initial stage is past, however, new factors come into play, notably the rise of manufacturing and, perhaps, the inertia of place. A model for this time period must take these factors into account.

Otterstrom's model of population concentration in the United States (2003) describes a pattern of urban development that begins in the mercantile period and ends in the post-industrial period, but does not attempt to explain the underlying reasons for it. As was noted above, Borchert (1967) proposed another multi-phase model, one in which transportation technology plays a key role, a concept further emphasized by Muller (1976, 1977). There is considerable, though not perfect, congruence between Otterstrom's growth phases and the changes in transportation technology proposed by

Borchert and Muller, because the two models are describing the same phenomenon. Otterstrom uses the Hoover index of population concentration, together with some other basic statistics, maps, and charts. Borchert makes extensive use of general descriptive statistics on population and economic factors, in the form of tables, charts, and maps, but offers no sophisticated or inferential statistical analysis. Muller (1976) does use a regression model of population growth, but does not specify the independent variables (or even the formula) that he used. Given the lack of location-specific economic data for most times and places, especially for earlier periods, the lack of statistical modeling techniques using them is only to be expected, however.

For this research, more complex modeling was ultimately rejected as a useful approach. Standard analyses over time of the spatial patterns in municipal population, size of economy, and level of economic diversity yield conclusions regarding the influence of the diversity and transportation factors on the municipalities' development.

3.4 Summary and Conclusions

This research employs economic data not previously available and compiled specifically for this project, municipal boundary and transportation data layers developed for the project, and census population data disaggregated to the municipal level. The Secondary Sector and Tertiary Sector economic data are visibly skewed toward the lower range in histograms of them, while the Primary Sector data approach a normal distribution. The population data are also visibly skewed toward the lower range, and more so over time. These are characteristics of the underlying data that need to be kept in mind as the more in-depth analyses progress and will be explored further in the development of descriptive statistics for each data set.

Because population growth and economic growth are closely linked, the spatial patterns of Connecticut's municipal populations in each study year will be closely analyzed, with particular attention to the possibility of increasing concentration in a smaller number of municipalities. The Hoover Index, the location quotient, and the focal location quotient will be employed for this purpose. The economic data will be analyzed in two ways, first to calculate the level of diversity within them via the Herfindahl-Hirschmann index. Second, the spatial patterns of the sectoral data and the diversity index results will be analyzed, using the location quotient and the focal location quotient, the global and local Getis-Ord G* statistic, and the global and local Moran's *I* statistic.

The results of these statistical analyses will be used to evaluate the contributions of economic diversity and access to transportation to the size of Connecticut's municipal populations and municipal economies in each of the years 1810, 1820, 1830, 1840, and 1850. Analysis of the influence of this factor will extend our understanding of economic and population growth beyond the simple correlation of population size with the economy's size, leading to a more nuanced comprehension of the earliest stages of the important industrialization and urbanization trends of the nineteenth century.

Chapter Four

Analysis

4.1 Introduction

Because the number of municipalities changes from year to year, it is not feasible to compare how each municipality's numbers and rankings change over time. Nonetheless, in order to interpret the data and the results, it is important to know the identity of the municipalities that most strongly influence them. Therefore, for each study year, a listing of the municipalities with the ten largest data values in each category is provided. The changes in the membership of these groups of ten, as well as in their data values, offer insight into the changes and consistencies in the data sets over time. Each of these groups will be referred to as the "maximal cohort" for that data category and study year. Each set of data is also analyzed using descriptive statistics and the inferential statistical methods identified in Chapter 3.

4.2 Analysis of Population Data

Although the populations of Connecticut municipalities changed dramatically during the nineteenth century as a whole, during the study period of 1810 to 1850 this process was only in its beginning phases, and was most marked in the last decade. The purpose of this section is to describe the population context of the study period. Table 4.1 reports the statistics of population for the five study period years. During these forty years, the state added 102,533 people, the size of the largest municipality nearly

Table 4.1. Statistics of State Population

Statistic	1810	1820	1830	1840	1850
N	119	122	130	139	149
Minimum	700	731	651	548	500
Maximum	6,967	8,327	10,678	14,390	20,345
Mean	2,201.19	2,251.29	2,289.82	2,230.78	2,441.83
Median	1,950.50	1,984.00	1,935.00	1,789.50	1,848.00
SD	1,120.17	1,230.73	1,467.29	1,791.17	2,337.20
Sum	261,942	274,657	297,677	310,078	363,833

Source: Connecticut Department of Environmental Protection 1996.

tripled, and (setting aside the slight increase in the period 1810-1820), the size of the smallest place fell by 28.6%, or nearly one-third. The mean population first rose slightly, then fell, then rose again; the standard deviation more than doubled. This appears to indicate a pattern of increasing population concentration, but a closer analysis is called for to confirm this.

The method that permits examination of individual municipalities is to consider the portion of the population that was found in the maximal cohorts for each year, as in Table 4.2. There, it can be seen that in 1810, the places with the ten largest populations

Table 4.2. Maximal Cohorts and Statistics for Population, 1810 – 1850

	1810		1820		1830		1840		1850	
% of Total	18.43%		18.70%		20.06%		21.98%		24.94%	
% if Even	8.40%		8.20%		7.69%		7.19%		6.71%	
Min (of 10)	3,961		3,873		4,226		3,921		5,036	
Max	6.967		8,327		10,678		14,390		20,345	
Rank	**Municipality**	**Pop'tn**	**Municipality**	**Pop'tn**	**Municipality**	**Pop'tn**	**Municipality**	**Pop'tn**	**Municipality**	**Pop'tn**
1	**New Haven**	6,967	**New Haven**	8,327	**New Haven**	10,678	**New Haven**	14,390	**New Haven**	20,345
2	**Hartford**	6,003	**Hartford**	6,901	**Hartford**	9,789	**Hartford**	12,793	**Hartford**	13,555
3	**Middletown**	5,382	**Middletown**	6,479	**Middletown**	6,892	Norwich	7,239	Norwich	10,265
4	Litchfield	4,639	Groton	4,664	*Norwich*	5,179	**Middletown**	7,210	New London	8,991
5	Groton	4,451	Litchfield	4,610	Saybrook	5,018	New London	5,519	**Middletown**	8,441
6	Stamford	4,440	Saybrook	4,165	Groton	4,805	*Bridgeport*	4,570	Bridgeport	7,560
7	Lyme	4,321	Fairfield	4,151	Litchfield	4,456	Danbury	4,504	Danbury	5,964
8	Fairfield	4,125	*Guilford*	4,131	*New London*	4,356	Litchfield	4,038	*Stonington*	5,431
9	Saybrook	3,996	Lyme	4,069	Danbury	4,311	*New Milford*	3,974	*Waterbury*	5,137
10	Wethersfield	3,961	*Danbury*	*3,873*	Fairfield	4,226	*Greenwich*	3,921	Greenwich	5,036

Source: Connecticut Department of Environmental Protection 1996. Entries that are new in that year are in italics; those that persist across all years are in bold; city-containing municipalities are marked with dashed underlining.

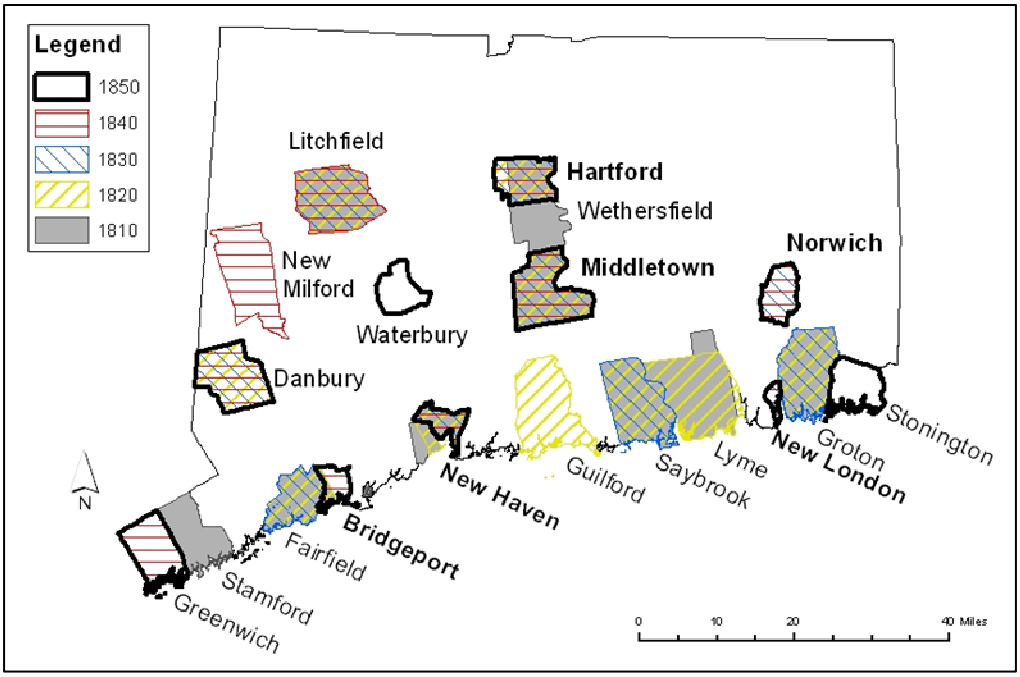
contained 18.43% of the population, whereas if the distribution of population had been even across all the municipalities, it would have been only 8.40%. Similar and increasing disparities between the actual and theoretical proportions occurred over succeeding study years, until by 1850 only ten of 149 municipalities contained nearly 25% of the state's population. Further, the rapid increase of the highest population values is consistent with the increasingly skewed population distributions, as seen in Figure 3.6. The changes in membership in the maximal cohorts are also of interest. In 1810, the municipalities containing the cities of Norwich and New London ranked 15th and 19th, respectively, in population size, meaning that seven of the ten places with the highest population in that year did not contain formally recognized urban areas. By 1850, all six of the city-containing municipalities were included in the maximal cohort, leaving only four non-city places in that group. In addition, the table shows that the scale of population size had begun to change dramatically: in 1810, the largest municipality had just under 7,000 people, while in 1850 the three largest all had over 10,000. By later standards (several places in the state would ultimately reach populations of over 100,000) this is still small, but these places were clearly at the leading edge of the urbanizing trend – especially considering that in 1850 the size of the smallest place had fallen to just 500.

In terms of geography, as shown in Figure 4.1, in 1810 all the members of the maximal cohort for population but Litchfield were located on major navigable rivers or the coast, or both; in 1850, all the ten largest but Waterbury were so located. Daniels (1979) has noted the relationship between levels of trade and municipalities' size as of 1790, consistent with the mercantile model of Vance (1970), as well as the fact that the

first-settled areas were along the coast and navigable rivers, which Bidwell (1916) also noted.

Changes at the top level of municipal population were not unusual throughout Connecticut's early history, however. The earliest available census is from 1762, and eight of the ten largest places in that year were the same as in the next, dated 1774 (Connecticut 1762). At the time of the first federal census in 1790, five of 1774's ten largest had changed (New Haven, Hartford, Middletown, Wallingford and Stratford). The 1810 list likewise contains only half of the 1790 municipalities (Middletown, New Haven, and Hartford, plus Fairfield and Wethersfield). But on at least this superficial level, the data suggest that *after* 1850 there was less change in population rank. Between

Figure 4.1. Map of the Maximal Cohorts for Population, 1810-1850.



City-containing municipalities are shown in boldface type.

1850 and 1880, only three municipalities dropped from the top ten list (New London, Stonington, and Greenwich being replaced by Meriden, New Britain, and Norwalk), and between 1880 and 1910, only one did (Stamford joined the list in place of Middletown). In the eighty years between 1910 and 1990, only two of the top ten changed (Bristol and West Hartford replacing Meriden and Norwich) (all referenced data except 1762 are from Connecticut Department of Environmental Protection 1996). The picture this provides is one of great volatility in population growth trends prior to 1850, followed by increasing stability. This is consistent with Pred's (1966) findings with respect to population changes in major cities across the United States, indicating that this kind of variability occurred at lower levels of the hierarchy of places as well as at the top level that he studied.

Another approach to analyzing population increases is to consider how much of the state's total population increase went to the largest places, similar to Pred's (1980) approach with respect to national urban growth. Table 4.3 shows that in each of the four time periods, the municipalities with the ten largest populations received between 24.26% and 68.12% of the state's population increase in any given decade. If population growth had been even across all the municipalities, that of the ten largest in any given year would have taken only between 8.2% and 6.71% of the statewide total. Interestingly, that largest proportion going to the maximal cohort was in 1840, a year when the statewide population increase fell dramatically in terms of both numbers and percent change. Indeed, the numbers indicate that between 1830 and 1840, the largest places grew at

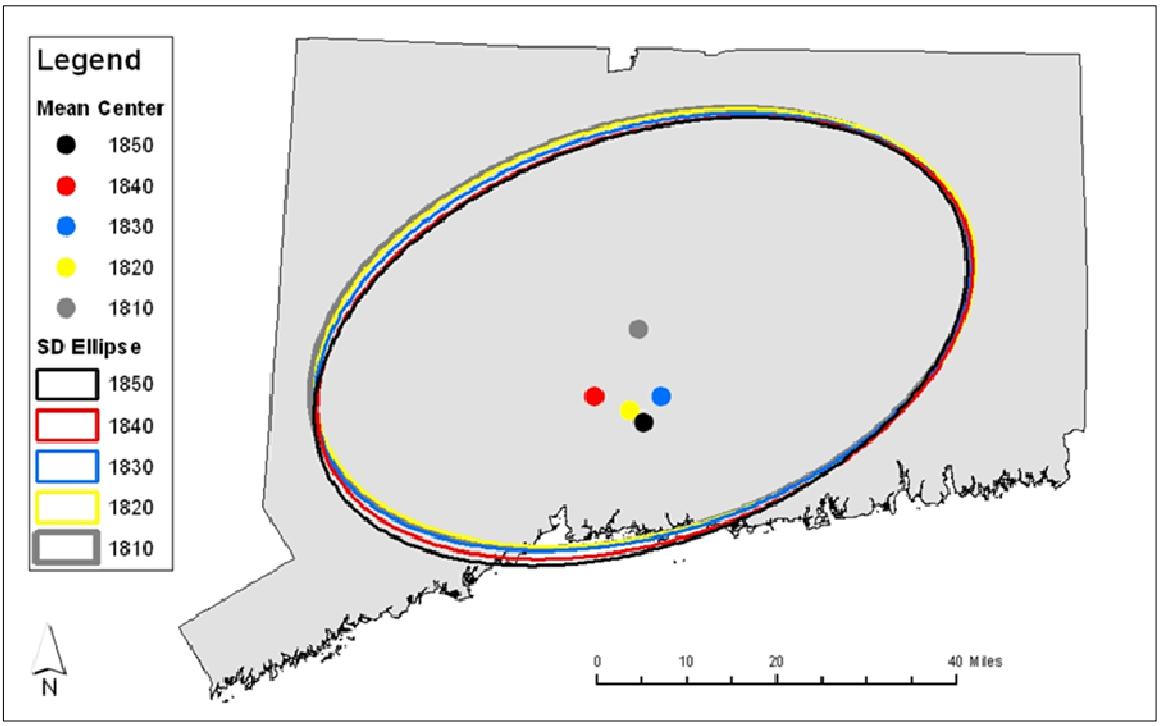
Table 4.3. Maximal Cohort and Statewide Population Changes, 1810-1850

	1810	1820	1830	1840	1850
Totals					
Statewide	261,942	274,657	297,677	310,078	363,833
Maximal Cohort	48,285	51,370	59,710	68,158	90,725
Changes					
Statewide	n/a	12,715	23,020	12,401	53,755
Maximal Cohort	n/a	3,085	8,340	8,448	22,567
% Change in Totals					
Statewide	n/a	4.85	8.38	4.17	17.34
Maximal Cohort	n/a	6.39	16.24	14.15	33.11
Maximal Cohort's Actual % of Statewide Change					
	n/a	24.26	36.23	68.12	41.98
Maximal Cohort's % of Statewide Change if Growth Were Even					
	n/a	8.20	7.69	7.19	6.71

nearly the same rate as in the previous decade, even as the statewide rate fell by half, a fact undoubtedly due to larger economic trends.

Consistent with the spatial arrangement of the largest municipalities in Figure 4.1, the mean weighted center of population in each year lies in the south-central part of the state, as shown in Figure 4.2, although the 1810 center is noticeably more northerly. The standard deviational ellipses are very close to one another (the 1810 and 1820 ellipses are nearly indistinguishable, visually), but show a slight southwestward shift in the spatial trend of the state's population. All of this information indicates that while Connecticut saw substantial population growth during the study period, and that growth was disproportionately concentrated on a changing cohort of larger places, in spatial terms those larger places were consistently located either (1) on the coast, (2) on a navigable river, or (3) in the west-central part of the state. Other than the southward shift of

Figure 4.2. Map of Mean Weighted Centers and Standard Deviational Ellipses of Population. 1810-1850.



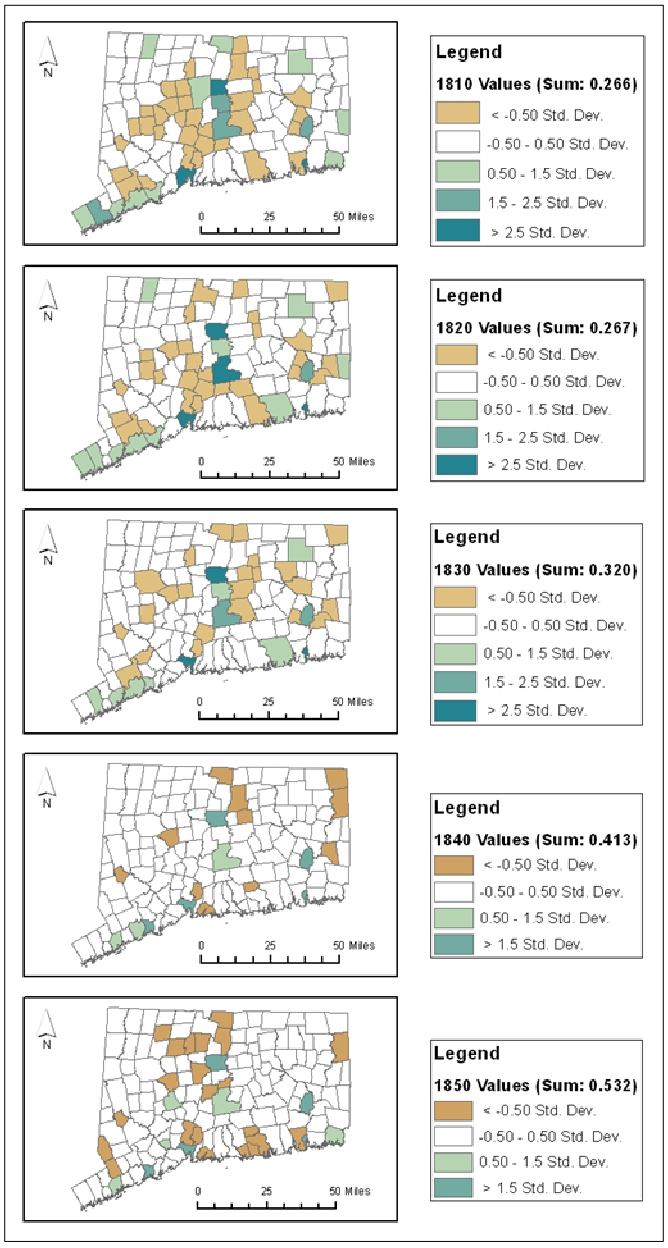
population after 1810 (which can be attributed to the growing coastal populations), the locations of the mean weighted centers were relatively consistent over the study years. The standard deviational ellipses, similarly, retained the same orientation and roughly the same shape, overlapping one another very closely. Thus, despite the variations from year to year, the overall pattern of population location remained much the same.

Returning to the topic of population concentration, the Hoover Index analysis finds noticeably increasing concentration across the state between 1810 and 1850, relatively speaking: In 1810 the *H* value is 13.29, in 120 it is 13.34, in 1830 it is 15.98, and 1840 it is 20.65, and in 1850 it is 26.60. Given that the upper limit of the Hoover

Index is 100, this cannot be considered a high level of concentration, yet this low level did double between 1810 and 1850, after rising very slightly between 1810 and 1820. The change was also relatively slight between 1820 and 1830, and then accelerated between 1830 and 1850. These results are consistent with the pattern suggested by the histograms in Figure 3.6 and the population changes shown in Table 4.2.

Part of the Hoover Index equation (see Equation 1) is $P_{it} - a_i$, which reflects the difference between each municipality's fraction of the total population in a given year (P_{it}), and its fraction of the state's total area (a_i). Positive numbers indicate that the population proportion is higher than the areal proportion. The maps in Figure 4.3 show the contributions of each municipality to the Hoover Index calculation, $|P_{it} - a_i|$, classified by standard deviation from the mean. Since the equation uses absolute values, the maps portray the magnitude of the difference between (1) each municipality's proportion of the total population for each year, and (2) its proportion of the state's total area. The sums of these absolute values (also shown in the figure) also represent another measure of concentration. The results suggest that as the state's overall level of population concentration increased, there was relatively less variation in the differences, as indicated by the increasing number of municipalities falling within half a standard deviation of the mean. In 1850, 116 of the 148 municipalities' values fell into that class, compared with 69 of 119 (still a large proportion) in 1810. Again, this is consistent with increasing concentration of population in certain municipalities, several of which appear as substantially deviating from the mean in terms of their contribution to the Hoover Index numbers (classed in the maps as 1.5 or more standard deviations).

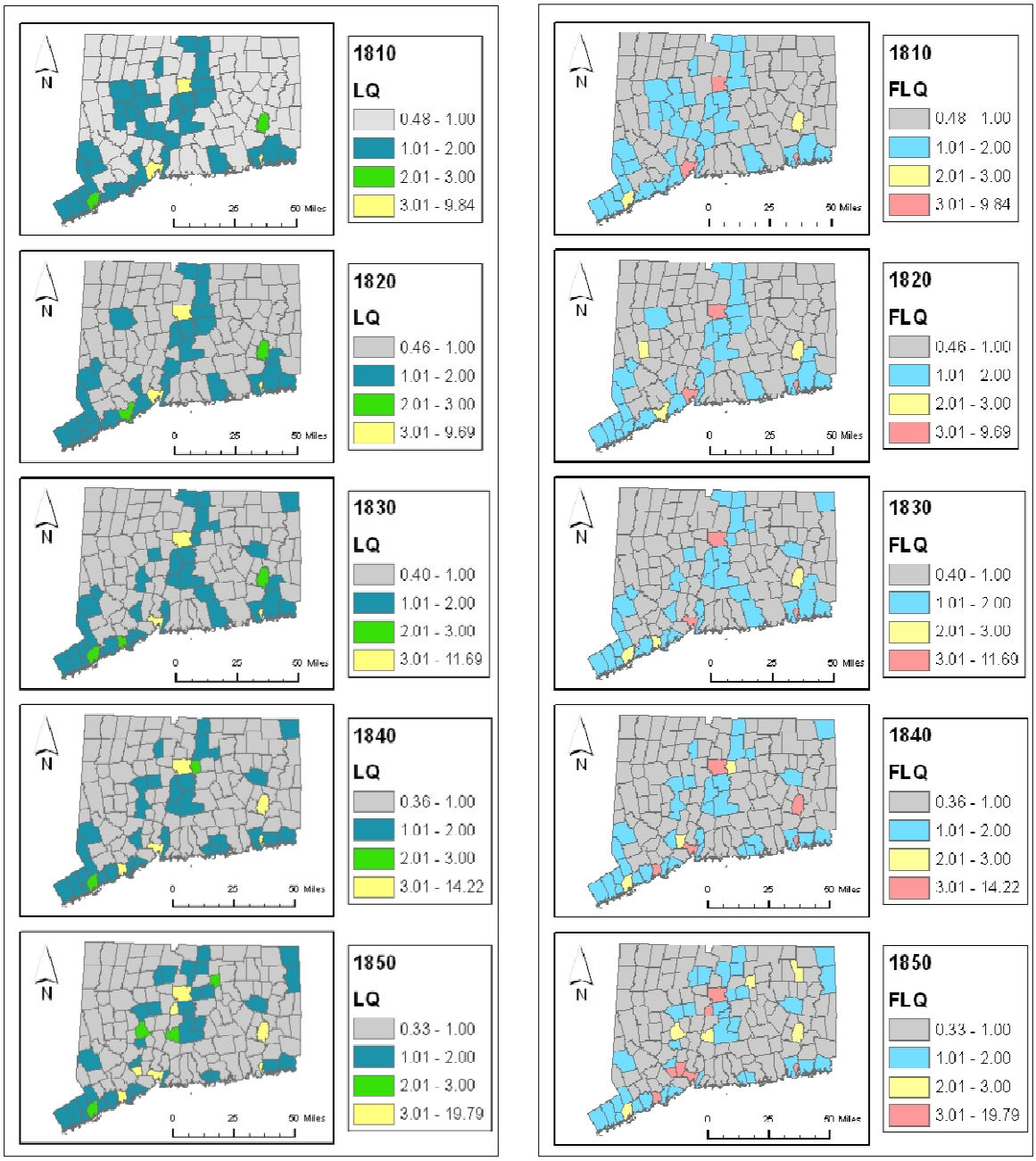
Figure 4.3. Maps of Absolute Differences Between Municipal Percentages of Population and Area ($|P_{it} - a_i|$), 1810-1850



The location quotient (LQ) determines how close each municipality's proportion of the population is to its proportion of the state's area. These figures are, naturally, strongly influenced by the sizes of the municipalities, so that, for example, relatively high-population places with small areas (especially New London through the whole period, and New Haven after 1810) have higher LQ values than high-population areas with larger areas (such as Hartford and Norwich). This measure also reflects substantial divergence between most of the state's municipalities and a small set of higher-population municipalities. Figure 4.4 shows the results of this analysis for all the study years, classified to separate the values of 1.0 or less from the rest. The upper limit of the LQ value doubles over the study period (9.8 to 19.8), while the lower limit drifts slightly downward (from 0.5 to 0.3). Interestingly, the mean of the values in the category "less than or equal to 1.0" is 0.8 in the first three years, falling to 0.7 in 1840 and to 0.6 in 1850. The number of municipalities in that lowest category increased over time, as would be expected: from 78 in 1810, then 88, 91, 99, and finally 104 in 1850. These results plainly reflect a slow drift of population out of the more rural places, which has already been noted.

The focal location quotient (FLQ) results are also shown in Figure 4.4. The bandwidth for the calculations was set at twenty miles, as for the other inferential statistics (see Section 4.3, below). For this population data, the FLQ results were very similar to those for the ordinary location quotient. In fact, only a handful of municipal FLQ values were different from the LQ values: three in 1810, five in 1820, and six in each of the remaining years. There was little consistency in which of these differences

Figure 4.4. Maps of LQ and FLQ Results for Population, 1810-1850.



occurred in which municipality across the different years; in addition, some were changes in low values, others to middle or high values. These results continue to reflect the relative spatial isolation of these municipalities from one another during this time period.

The next question is whether any of these areas of relative concentration also show clustering that is statistically significant. The following table (4.4) reports the numerical results of the general forms of the Getis-Ord *G** statistic and the Moran's *I* statistic, each of which is discussed in more detail below. The *G** statistic was calculated using a zone of indifference with a ten-mile threshold distance, representing the distance that early nineteenth-century people would be willing to travel on a regular basis. As Table 4.4

shows, the general Getis-Ord *G** statistic found no statistically significant difference from randomness in any of the study years. The general *I* calculations (also done with a zone of indifference distance method and a ten-mile threshold distance) found some evidence of autocorrelation – a 95% probability of clustering – for only the first two

Table 4.4. Results of General Spatial Clustering Analyses for Population, 1810-1850

	1810	1820	1830	1840	1850
*General G**					
Obs. G*	0.048212	-0.048980	0.049267	0.049027	0.049927
Z score	-0.269952	-0.240621	-0.536155	-0.501782	-0.913641
p-value	0.787197	0.809849	0.591852	0.615821	0.360906
Moran's *I*					
I	0.115841	0.092599	0.057459	-0.020321	-0.049718
Z score	2.390617	2.030112	1.449039	-0.320952	-1.168571
p-value	*0.016820*	*0.042345*	0.147327	0.748246	0.242577

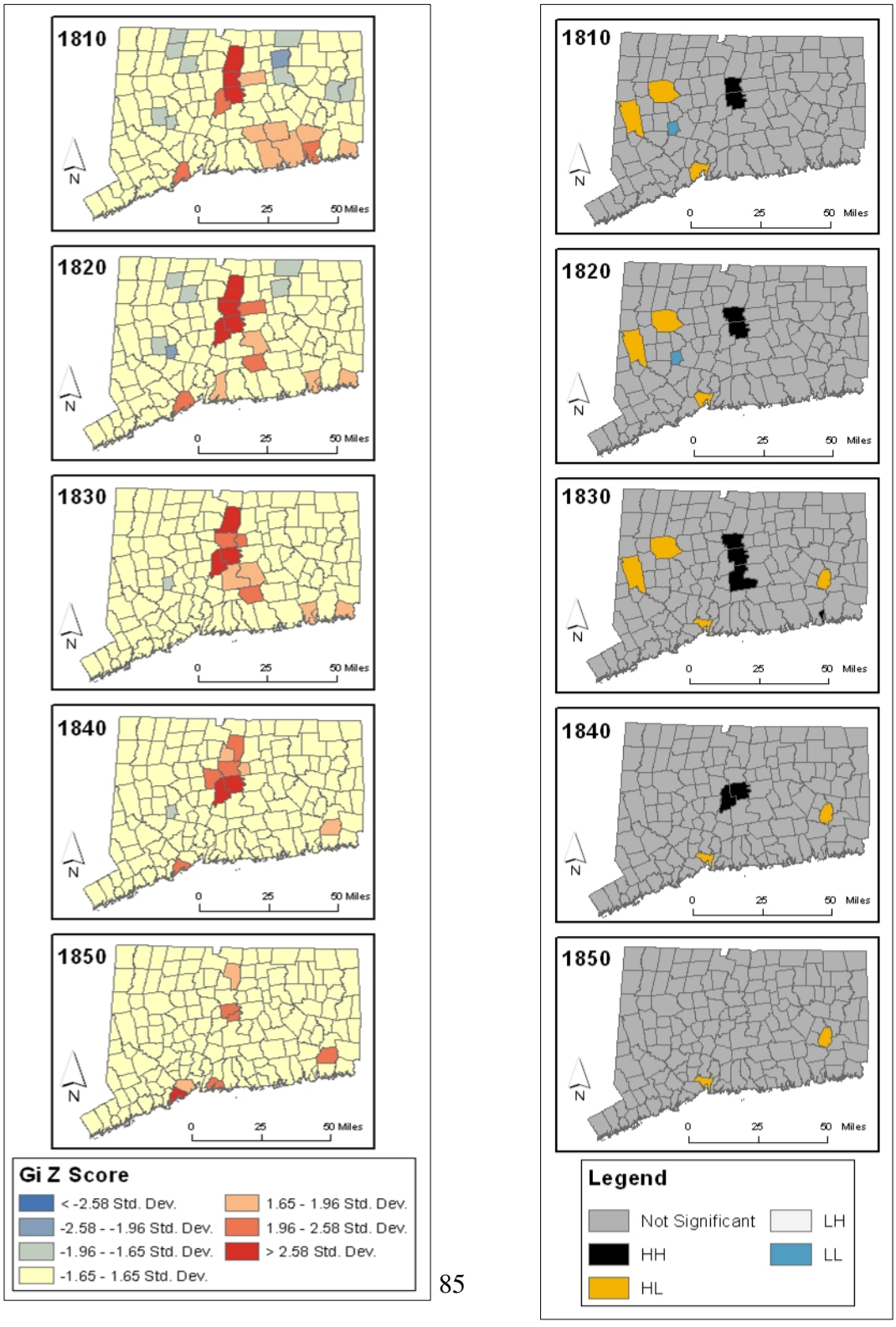
Significant p-*values are presented in italics.*

study years, but no difference from random results in the last three years. Thus, overall, through 1850 it appears that the municipalities' populations were generally neither clustered nor dispersed enough (especially with respect to the higher values) for these general statistics to detect any pattern.

The local versions of the Getis-Ord *G** and Moran's *I* statistics, as calculated in ArcGIS 10.1, produce maps of each statistic's Z scores for each municipality and that counter the general picture to a modest degree. Figure 4.5 shows the results of the Getis-Ord Local G_i^* statistic, calculated using a zone of indifference with a ten-mile threshold distance. These local results show some clustering of high values around a small number of municipalities in the north-central part of the state, centered on Hartford and the Connecticut River, from 1810 through 1840. In 1810, there was another area of clustering of high values on the eastern shoreline, and some isolated municipalities with significantly high or low values. Through 1850, however, the number of municipalities showing clustering (especially of low values) declined until only seven places showed any sign of value clustering at all.

The local spatial autocorrelation statistic results (Moran's *I*, calculated with the same parameters and presented in the same figure) show some significant high-value autocorrelation (HH) in from 1810 through 1840, and none in 1850, which is consistent with the Getis-Ord Local *G** results. In 1850, only New Haven and Norwich showed local autocorrelation, and that was of the High/Low variety. This indicates that these places were significantly different, in terms of their population size, than adjacent places.

Figure 4.5. Maps of Getis-Ord Local *G and Local Moran's *I* Statistic Results for Population, 1810-1850.**



New Haven appeared this way in all five study years, while a scattering of other places were so classified in various different years.

These statistical results indicate that urbanization was still spatially restricted in 1850, meaning that it had not yet reached a level that would significantly interact with the population characteristics of adjacent municipalities. The clustering of high values in the earlier years is more likely to relate to the agricultural prosperity of those places than to any clustering of population within their borders. As we have seen, the data sets include population data that in 1810 ranges from 700 to 6,967 (mean of 2,210), with 119 spatial units ranging in size from six square miles to ninety-eight (mean of forty-two). By 1850, the population range is 500 to 20,345 (mean of 2,452), with 148 spatial units ranging in size from six square miles to eighty-one (mean of thirty-four). As the leading municipalities grew ever larger in population, while the majority failed to grow or even lost population, such flattening of the majority's numbers led to this reduction in the appearance of clustering and autocorrelation. In such a context, even most of the city-containing municipalities failed to stand out, in statistical terms.

4.3 Analysis of Economic Data

The economic data are divided into the categories of Primary and SecTer for the years 1810 and 1850, and into the categories of Primary, Secondary, and Tertiary for the years 1820, 1830, and 1840. Within each category, the data are further divided into the subcategories of dollar values and counts. As is discussed in below, however, the number of secondary firms in particular can be an unsatisfactory indicator of economic

activity. The characteristics of dollar values all the data sets are examined in much more detail because they will be used in the statistical modeling, and therefore their characteristics are important with respect to interpreting the results of that modeling.

4.3.1 Economic Data Analysis – Total Municipal Economies

The total dollar values of the various municipalities' economies are an important component of this study, and include the reported values of all three sectors. The basic descriptive statistics of this variable are reported in Table 4.5, in which the effect of the changes in tax valuation methodology are perceptible. The values reported in 1810 (except for the minimum) are much lower than in the succeeding years. The effect of the changes made between 1840 and 1850 are less clear, as it is possible that the increase in the maximum values was a result of economic changes rather than valuation changes. Within the panel years, the agreement between the mean and the median is variable from year to year, but still fairly close given the range of the data. In 1810, the standard deviation was larger than the median and the mean; in 1820, it fell to less than half of those measures, but over the following years it rose again to be close to the median once

Table 4.5. Descriptive Statistics of Total Municipal Economies, 1810-1850

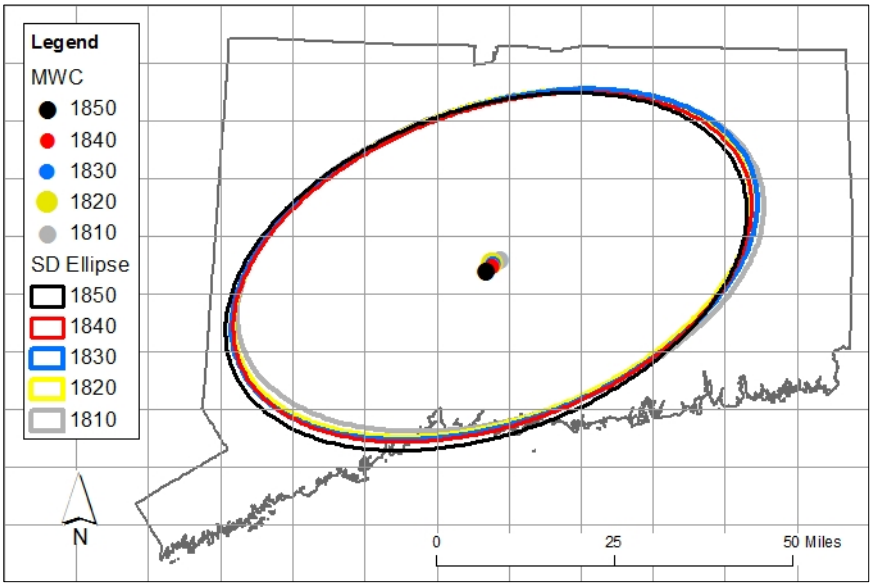
Statistic	1810	1820	1830	1840	1850
N	119	122	130	139	149
Minimum	9,472.39	4,617,822.01	5,047,150.66	3,988,355.00	3,073,666.70
Maximum	53,051.87	37,819,803.00	50,479,410.33	59,480,504.32	80,390,710.00
Mean	26,716.87	14,976,039.15	14,671,591.91	13,871,254.54	14,615,179.05
Median	24,518.64	14,044,415.00	12,858,665.34	11,708,245.67	12,790,837.00
SD	26,716.87	6,997,460.37	7,780,160.68	8,294,216.64	10,269,834.49
Sum	3,179,307.19	1,827,076,776.88	1,907,306,948.15	1,928,104,381.73	2,163,046,500.02

Source: Connecticut Department of Environmental Protection 1996.

more, reflecting the increasingly skewed distribution of these data (as shown in Figure 3.6). A map of the mean weighted centers and standard deviational ellipses of these data, given in Figure 4.6, shows that the center of the Total Municipal Economy values in each year is located a little southwest of the state's geographic center, and the long axes of the ellipses are oriented from southwest to northeast. This is broadly similar to the patterns for population, except that the centers are much more tightly clustered.

Statistics for the maximal cohort of municipal economies are reported in Table 4.6, below. These total dollar values reflect the strong influence of the Primary Sector (discussed below) throughout the period, such that the city-containing municipalities were not a major part of the cohort until 1850, when five of the ten largest municipal economies contained cities. Prior to 1840, in fact, the two city-containing municipalities

Figure 4.6. Map of Mean Weighted Centers and Standard Deviational Ellipses for Total Municipal Economies, 1810-1850.



that did appear in the cohort – Middletown and Hartford – each included large non-urban areas and were located in the fertile lands of the Connecticut River Valley. Since the physical context of the municipalities overall did not change, except in some cases to become physically smaller, the appearance of more of the city-containing ones in 1840 and especially 1850 may be attributed to economic trends other than agriculture – specifically the increase in secondary and tertiary sector activities within them. The

Table 4.6. Maximal Cohorts and Statistics for Total Value of Municipal Economy, 1810-1850

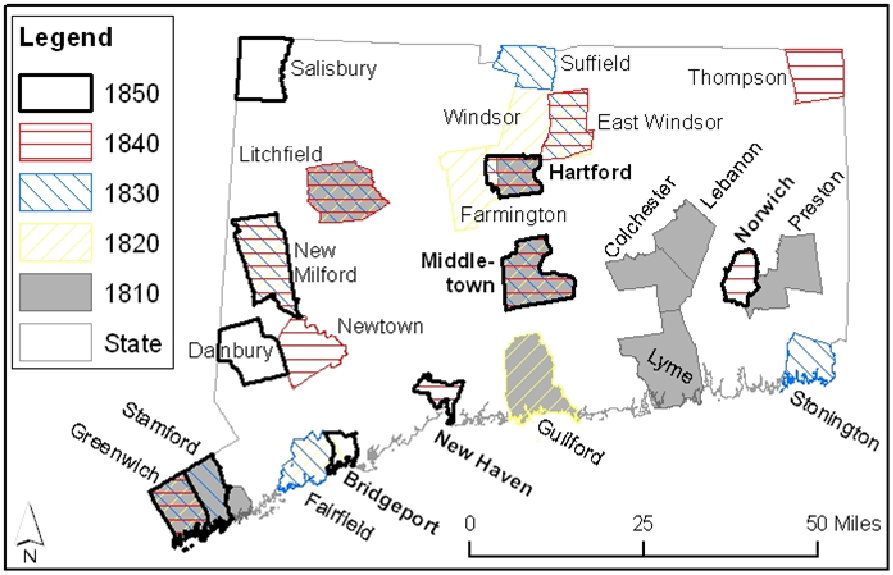
Year	1810	1820	1830	1840	1850
% of Total	15.53%	17.01%	17.94%	18.64%	20.21%
% if Even	8.40%	8.20%	7.69%	7.19%	6.76%
Min (of 10)	44,846.94	25,087,695.67	28,515,590.00	24,569,860.99	31,657,770.00
Max (all)	53,051.87	37,819,803.00	50,479,410.33	59,480,504.32	80,390,710.00
#1	**Middletown**	**Middletown**	**Hartford**	**Hartford**	**Hartford**
#2	Litchfield	*East Windsor*	**Middletown**	*New Haven*	New Haven
#3	Guilford	**Greenwich**	New Milford	**Middletown**	Norwich
#4	**Hartford**	**Hartford**	**Greenwich**	New Milford	New Milford
#5	Preston	*New Milford*	East Windsor	**Greenwich**	**Greenwich**
#6	Stamford	*Fairfield*	Fairfield	East Windsor	**Middletown**
#7	**Greenwich**	*Windsor*	*Suffield*	*Norwich*	*Stamford*
#8	Lyme	Litchfield	Litchfield	Litchfield	*Danbury*
#9	Lebanon	Guilford	*Stonington*	*Newtown*	*Bridgeport*
#10	Colchester	*Farmington*	*Stamford*	*Thompson*	*Salisbury*

Bold items persist across all years; italicized items were not present in the next preceding year; city-containing places are marked with dashed underlining.

locations of the maximal cohort municipalities were as variable across the study periods as the membership in the cohort, as Figure 4.7 shows. No particular locational pattern is seen, either within any given study year or across all of them.

The variations in the total values of the municipal economies in each study year are mapped by standard deviation in Figure 4.8, together with the maximal cohorts for

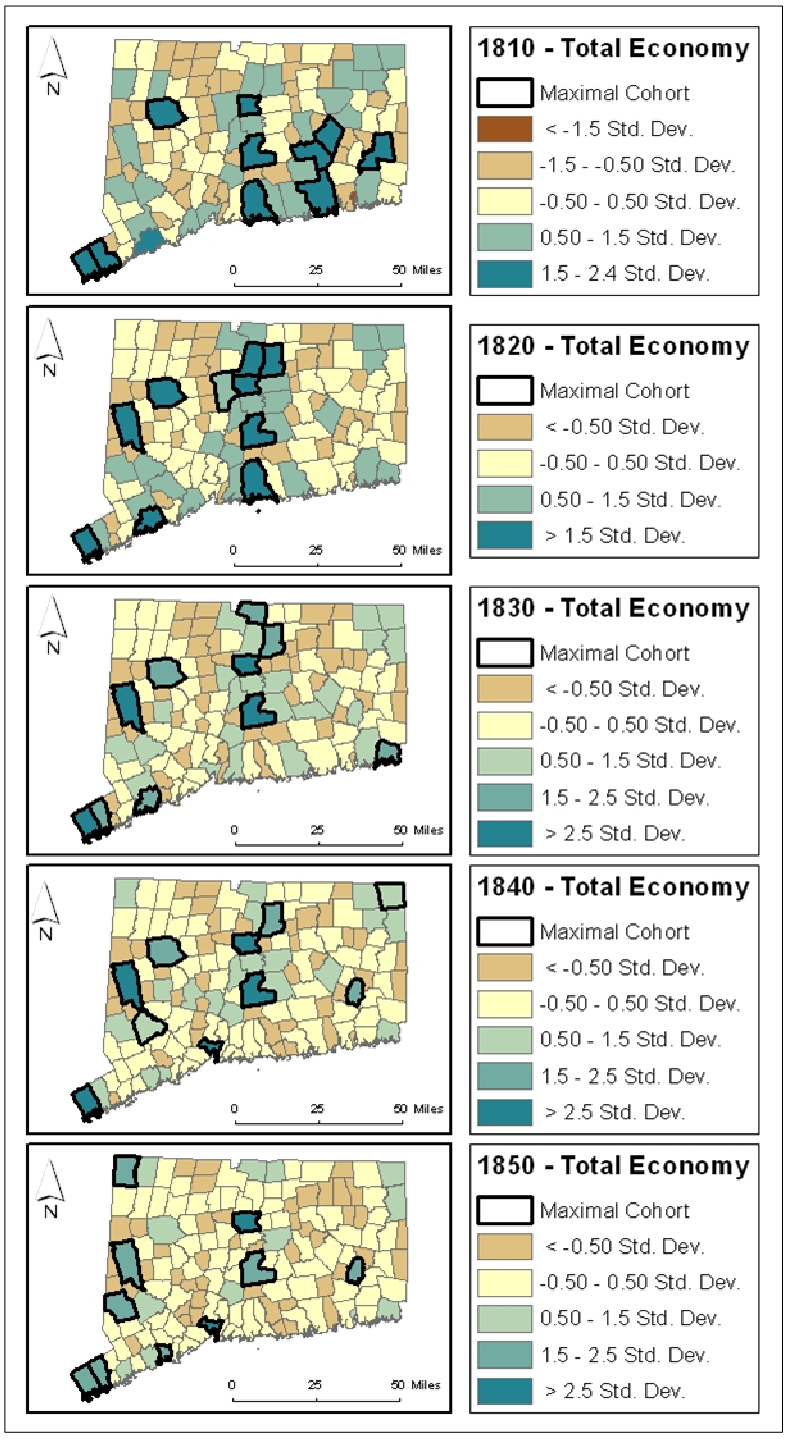
Figure 4.7. Map of Maximal Cohorts for Total Value of Municipal Economy, 1810-1850.



Boldface labels represent city-containing municipalities.

each year. Viewing the data in this manner also reveals the level of spatial variation in it, such that definite patterns cannot be found by visual study in these maps. What they do show, however, is that municipalities that appear in the maximal cohort in any given year are also very likely to register as above the mean standard deviation in other years, even if they do not appear among the ten largest. The exception is Guilford, which was divided in half after 1820, with neither resulting municipality having a larger than usual economy in succeeding years. New London, a city-containing municipality that had a very small physical area but the third-highest population in the state in 1850, registered as below the mean in each year *except* 1850. Like the divided Guilford, New London did

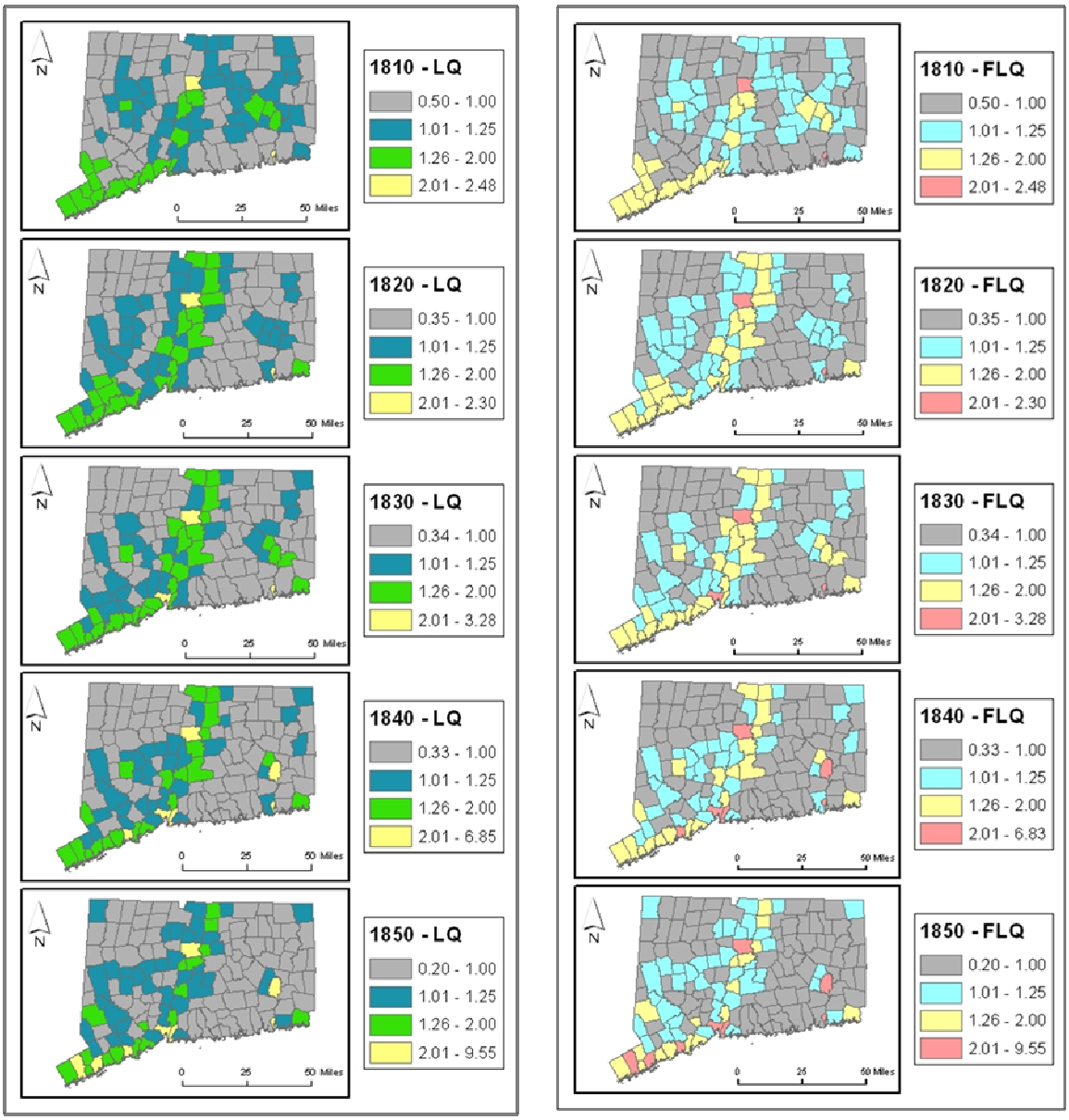
Figure 4.8. Maps of Total Municipal Economies with Maximal Cohorts, 1810-1850.



not have enough space for its primary sector to add very much to its secondary and tertiary sector. In contrast to the descriptive statistics, inferential analyses of the municipal economies' spatial patterns do show some patterns. The location quotient and focal location quotient analyses (Figure 4.9) each display a clear trend on visual inspection. The higher LQ and FLQ values form a rough corridor beginning at the northern boundary of the state, following the Connecticut River as far as Middletown and then swinging southwestward to New Haven, and thereafter trending westward along the coast. This is the same route that one of the state's earliest railroads followed, as was seen in Figure 3.8, but the pattern was already well established in 1820 and 1830, well before the construction of the railroad just before 1840. In this case, at least, the railroad clearly followed the existing road routes, including the Hartford and New Haven Turnpike, established in 1798.

Nonetheless, the general Getis-Ord *G** and Moran's *I* returned almost entirely random results, as Table 4.7 shows, except for the Moran's *I* results for 1820 and 1830; these showed a 99% probability of clustering in 1820, and a 90% probability of clustering in 1830. The local G* results showed somewhat weak clustering of high values toward the north-central part of the state, as shown in Figure 4.10; the tests using a twenty-mile zone of indifference (instead of the ten-mile zone used here) yielded even less clustering. As will be seen in the sectoral discussions below, these total dollar values are a composite of three groups of data with noticeably different spatial patterns, so the results of this measure reflect overall trends in the data. The local Moran's *I* results, also in Figure 4.10, mostly reflect the G_i* results, as expected. Of interest, however, is the fact that

Figure 4.9. LQ and FLQ Results for Total Municipal Economies, 1810-1850.



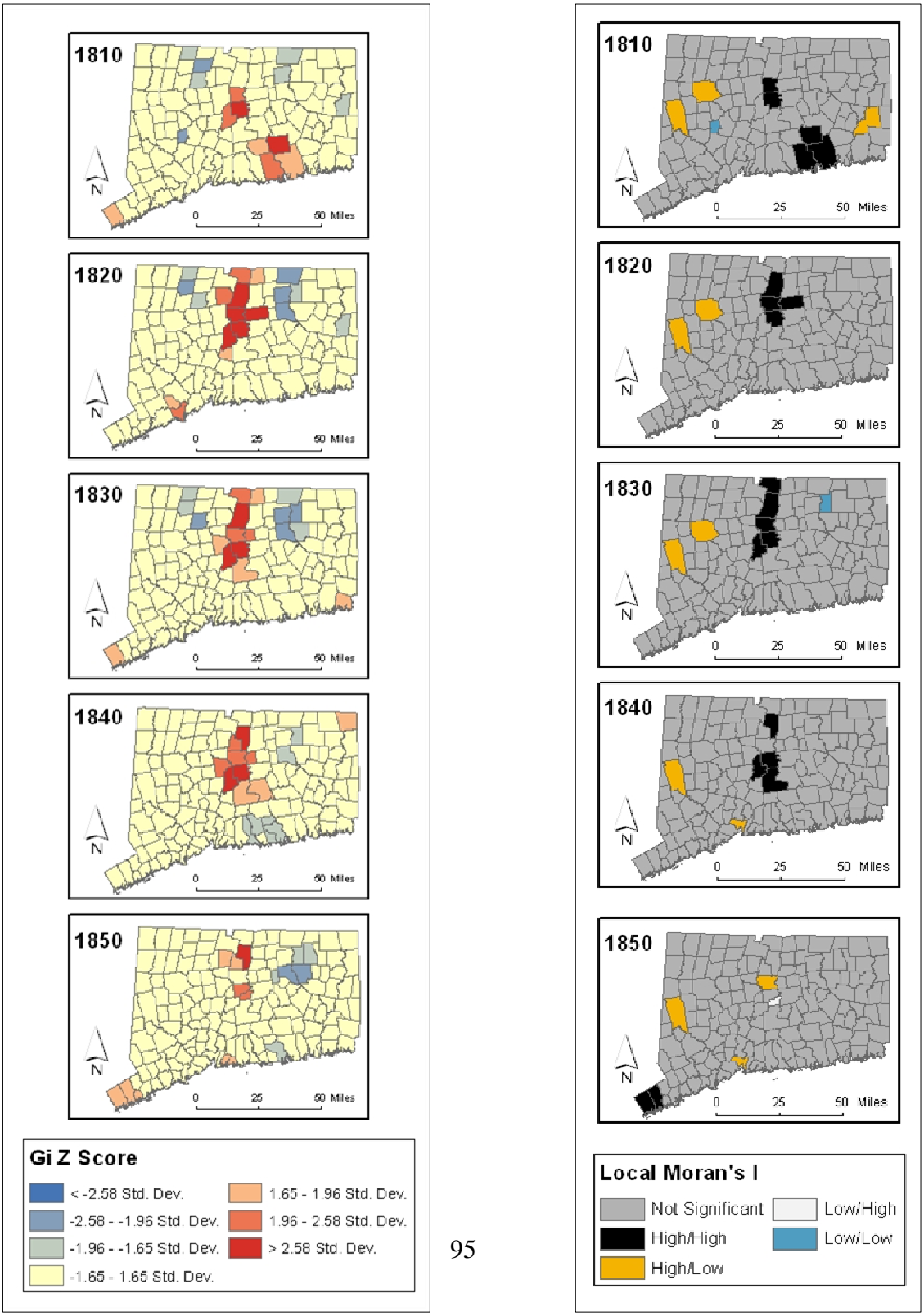
one municipality registered as having a statistically significant high/low relationship with neighboring municipalities across all five study years – New Milford.

Table 4.7. Results of Total Municipal Economies General Spatial Analyses, 1810-1850

	(ZI 10 miles)				
	1810	**1820**	**1830**	**1840**	**1850**
*General G**					
Obs. G*	0.047794	0.049850	0.048983	0.049432	0.050405
Z score	-0.730460	0.410670	-0.864874	-0.461416	-1.101728
p-value	0.465109	0.681314	0.387108	0.644500	0.270580
Moran's *I*					
I	0.058706	0.126033	0.075161	0.032160	0.004603
Z score	1.275334	2.648085	1.777568	0.920403	0.299026
p-value	0.202191	0.008095	0.075475	0.357362	0.764920

In summary, the LQ and FLQ analyses show a pattern of higher than expected total economy values running from north-central Connecticut to its southwestern coastline. None of the other measures, however, indicate that this is the result of any particular concentration or spatial autocorrelation patterns, except that there are more consistent significant "hot spots" in the north-central part of the state, around Hartford and the Connecticut River. The following sections analyze the economic data by sector, and examine how the spatial patterns in the different sectors may affect the patterns in the total economy.

Figure 4.10. Local G* and Local Moran's *I* Results for Total Municipal Economies, 1810-1850.



4.3.2 Economic Data Analyses – Primary Sector

Although the Primary Sector is not the true focus of this study, it is an essential component of Connecticut's historical economy. It is included in the total values of the municipal economies and the HH' index, and therefore its characteristics must be examined in order to understand their influence. First there is a comparison compare of the two components of the Primary Sector data (land and cattle) and their contributions to the sector, and then an examination of the total sectoral values. After that, the statistical and spatial patterns in the values per acre of the land will be examined in detail, and the value per head of the cattle more briefly. Strong spatial patterns are found in most of the data, but especially in the per acre and per head data sets.

Table 4.8 presents the basic descriptive statistics of the Primary Sector dollar value data, including both the totals and the Land and Cattle sub-categories. The problems with the utility of the valuations are clearest here, when the values from year to year are compared. First, the 1810 values are all much smaller than in the succeeding years. Second, it is clear from the 1840 and 1850 Cattle values that the method of valuing cattle, or perhaps the types of cattle that were included in the valuation, must have changed, given how much larger the 1850 values are. The ratios of total land values to total cattle values are also of interest. In 1810, the summed dollar values of the municipalities' land and cattle were quite close, as were the other statistics. This changed in the later years, due to the changes in valuation method for both categories, with the land values becoming many times larger than the cattle values. Thus, even though cattle were worth tens of millions of dollars, their influence on the total values of the Primary

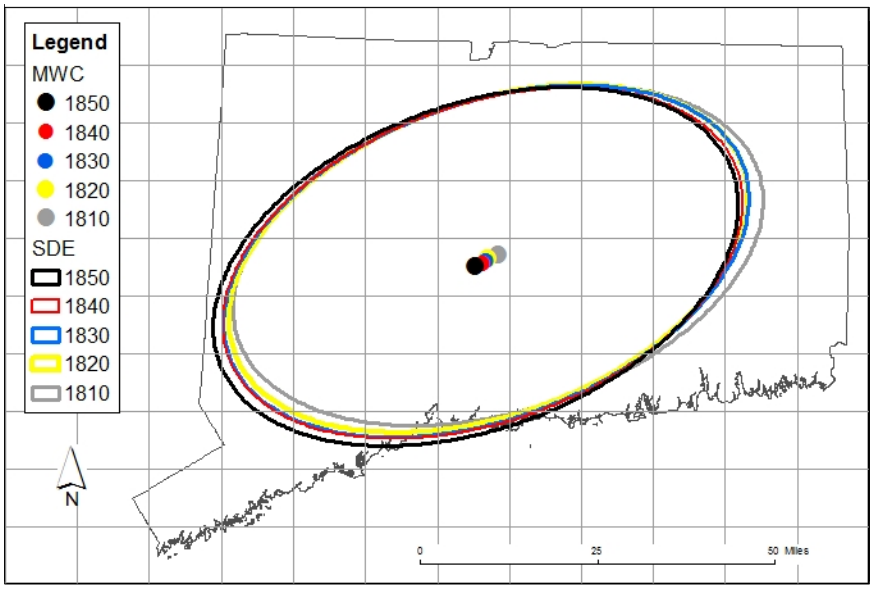
Sector was relatively small. Figure 4.11 shows the mean weighted centers and standard deviational ellipses of the total Primary Sector dollar values, which show that the clustering of the centers is located a little southwest of the state's center, and a long axis extending southwest to northeast, very similar to the pattern for the Total Municipal Economy data. This was the expected result, since most of the state's municipal economies were still dominated by the Primary Sector in this time period.

Table 4.9 presents the maximal cohorts and statistics for the total Primary Sector dollar values. These indicate that even in a sector that might be considered somewhat evenly spread across the state, the maximal cohorts usually held more than twice the amount of the Primary Sector dollar values than might have been expected if they were in fact so evenly spread. Still, the proportion held by the maximal cohorts never exceeded more than 17.37% of the total (in 1830), which as we will see is a different situation

Table 4.8. Descriptive Statistics of Total Primary Sector Dollar Values, 1810-1850

Statistic	**1810**	**1820**	**1830**	**1840**	**1850**
N	*119*	*122*	*130*	*139*	*148*
Total – Min	2,948.40	2,332,483.34	2,447,250.00	2,639,516.67	2,827,000.00
Total – Max	49,767.39	34,859,600.00	36,111,800.00	36,239,600.00	41,702,640.00
Total – Mean	24,475.56	14,428,533.78	13,662,970.87	12,422,712.54	12,586,382.85
Total - Median	22,807.76	13,414,516.67	12,258,600.00	11,105,358.34	11,598,534.00
Total – SD	9,922.34	6,656,681.03	6,942,027.45	6,272,074.77	6,721,132.93
Total – Sum	2,912,591.21	1,760,281,121.31	1,776,186,212.64	1,726,757,042.91	1,862,784,661.50
Land – Min	1,344.62	2,286,116.67	2,393,333.33	2,544,700.00	2,396,433.25
Land – Max	27,113.48	34,037,466.67	35,336,300.00	35,365,100.00	40,303,568.00
Land – Mean	13,202.91	13,999,776.49	13,247,382.77	12,019,335.58	11,691,916.18
Land - Median	12,284.44	13,006,066.67	11,831,966.67	10,679,216.67	10,758,067.00
Land – SD	5,476.30	6,510,798.65	6,797,501.31	6,127,124.23	6,395,407.70
Land – Sum	1,571,146.38	1,707,972,732.30	1,722,159,760.04	1,670,687,645.72	1,730,403,595.25
Cattle – Min	1,603.78	46,366.67	53,916.67	19,350.00	203,766.67
Cattle – Max	24,314.06	954,016.67	1,020,666.67	1,167,650.00	3,003,400.00
Cattle – Mean	11,272.65	428,757.29	415,588.10	403,376.96	894,466.67
Cattle - Median	10,774.11	411,033.33	407,733.33	386,450.00	841,533.31
Cattle – SD	4,668.07	174,064.94	175,357.91	185,721.45	431,567.72
Cattle – Sum	1,341,444.84	52,308,389.01	54,026,452.60	56,069,397.19	132,381,066.45

Figure 4.11. Map of Mean Weighted Centers and Standard Deviational Ellipses for Total Primary Sector Dollar Values, 1810-1850.



than with the Secondary Sector and Tertiary Sector data. Figure 4.12 shows the locations of the maximal cohorts in each year. Other than in 1810 and with a couple of exceptions in later years, these cohorts were in the north-central and western parts of the state. Again the patterns are similar, but not identical, to those found in the Total Municipal Economies data.

Figure 4.13 depicts the total Primary Sector values in maps by standard deviation, with the maximal cohorts emphasized. Although some municipalities, in addition to a few members of the maximal cohorts, were consistently in the higher standard deviation categories, the only obvious spatial pattern is the way the maximal cohorts shift to the north-central and western areas of the state over time. The LQ and FLQ maps in Figure 4.14

Table 4.9. Maximal Cohorts and Statistics for Total Value of Primary Sector, 1810-1850

Year	1810	1820	1830	1840	1850
% of Total	15.48%	16.64%	17.37%	16.43%	16.86%
% if Even	8.40%	8.2%	7.69%	7.19%	6.76%
Min (of 10)	40,768.69	24,183,998.00	27,384,716.67	21,885,583.34	24,946,734.00
Max (all)	49,767.39	34,859,600.00	36,111,800.00	36,239,600.00	41,702,640.00
#1	Guilford	**Middletown**	**New Milford**	**New Milford**	Hartford
#2	**Litchfield**	**Greenwich**	**Greenwich**	**Greenwich**	**New Milford**
#3	Preston	*East Windsor*	**Middletown**	**Middletown**	**Greenwich**
#4	Lebanon	**New Milford**	Hartford	Hartford	*Stamford*
#5	**Middletown**	*Fairfield*	Fairfield	East Windsor	*Danbury*
#6	Lyme	Guilford	East Windsor	**Litchfield**	**Middletown**
#7	Stamford	*Windsor*	*Suffield*	*Newtown*	*Salisbury*
#8	**Greenwich**	**Litchfield**	**Litchfield**	*Wethersfield*	**Litchfield**
#9	Colchester	*Hartford*	*Stonington*	Fairfield	Fairfield
#10	**New Milford**	*Farmington*	*Stamford*	*New Haven*	*Newtown*

Bold items persist across all years; italicized items were not present in the next preceding year; city-containing places are marked with dashed underlining.

indicate that this reflects a noticeable pattern, in which from 1820 forward, the values greater than one are located from north-central Connecticut to New Haven and along the

Figure 4.12. Maximal Cohort Locations for Total Primary Sector Dollar Values, 1810-1850.

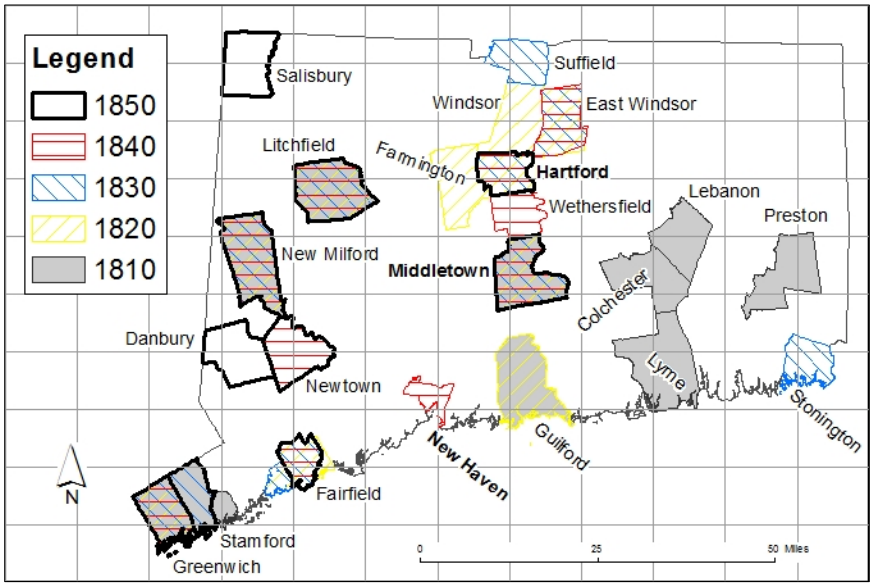


Figure 4.13. Maps of Total Value of Primary Sector by Standard Deviation, 1810-1850.

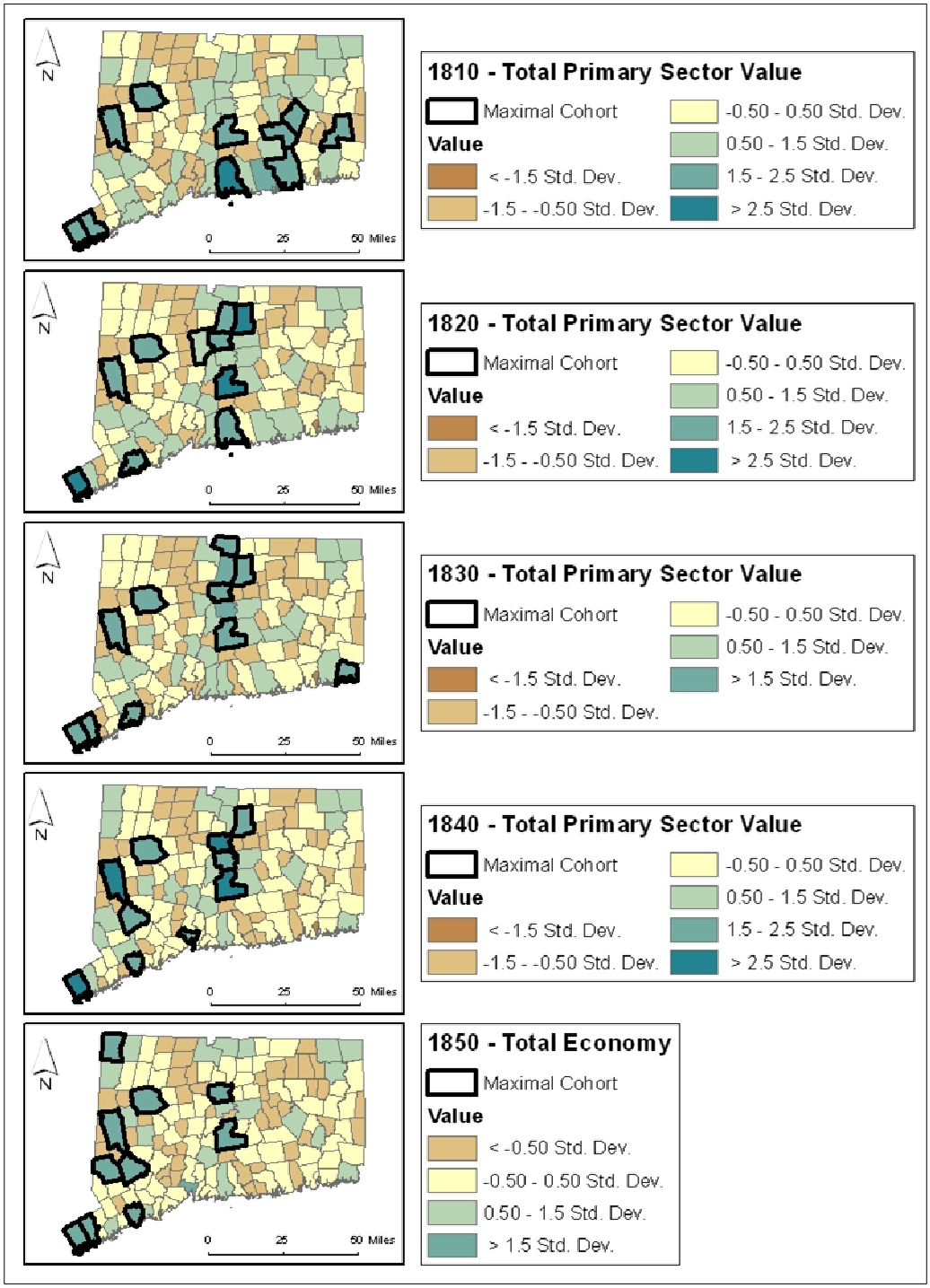
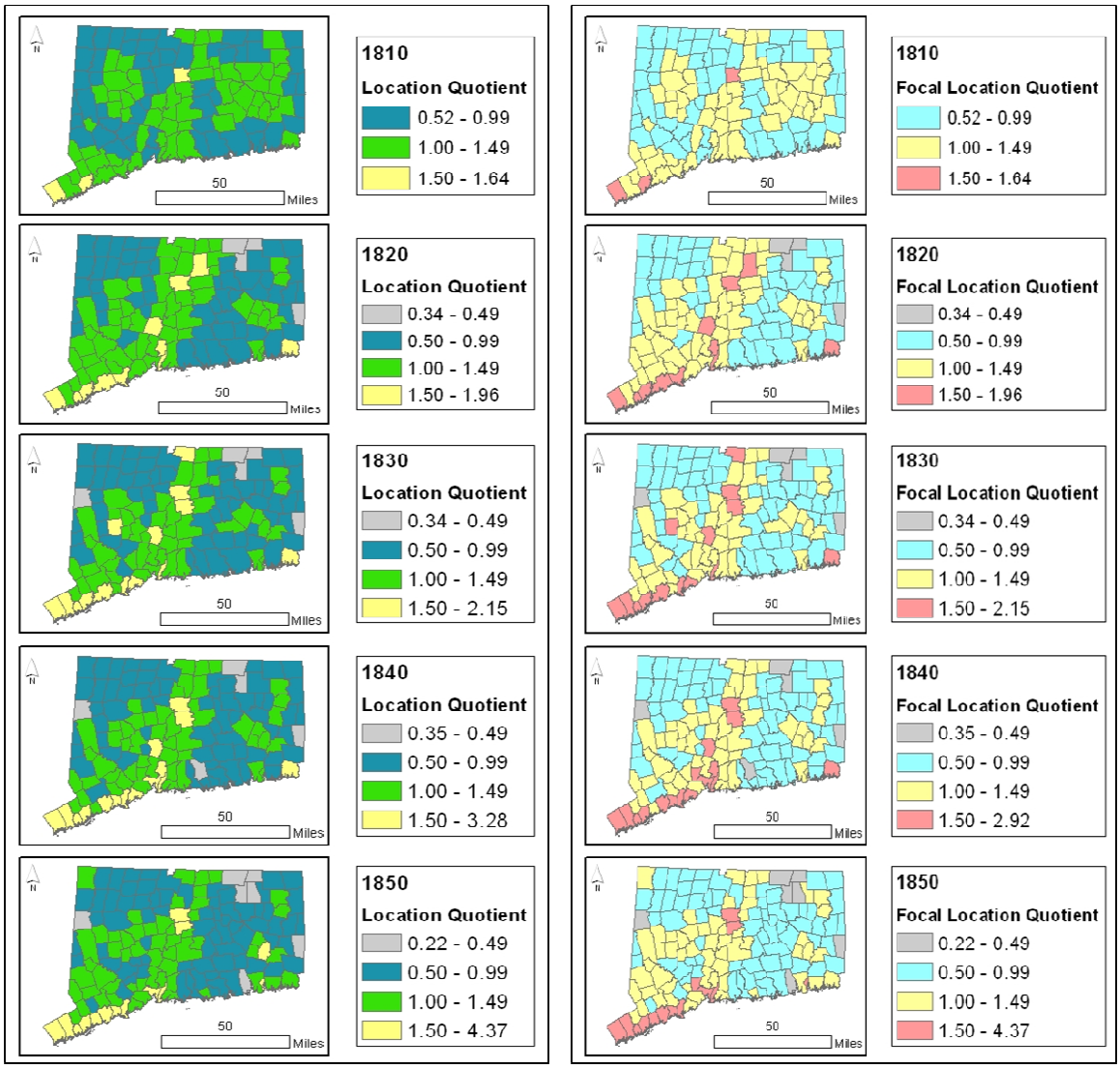


Figure 4.14. LQ and FLQ Results for Total Primary Sector Values, 1810-1850.



southwestern coastal region of the state. The southwestern part of the state also presents two other distinct areas of higher values, one of which follows the Housatonic River to its head of navigation at New Milford; the other is not so easily explained. In the southeast, higher LQ/FLQ values also cluster in a smaller area around Norwich and the coastal areas

around and including New London, extending northerly along the Quinebaug River (a source of water power, but not navigable).

The Getis-Ord and Moran's tests, however, indicate that these patterns are not based on statistically significant relationships among the municipalities' values. Table 4.10 presents the results of the global Getis-Ord *G** and Moran's *I* tests. As the table shows, the results for G* are random, except for 1850's clustering of low values (95% certainty). The results for *I* are also random, except for 1820, when some clustering is found (95% certainty). These tests used a zone of indifference of ten miles; a

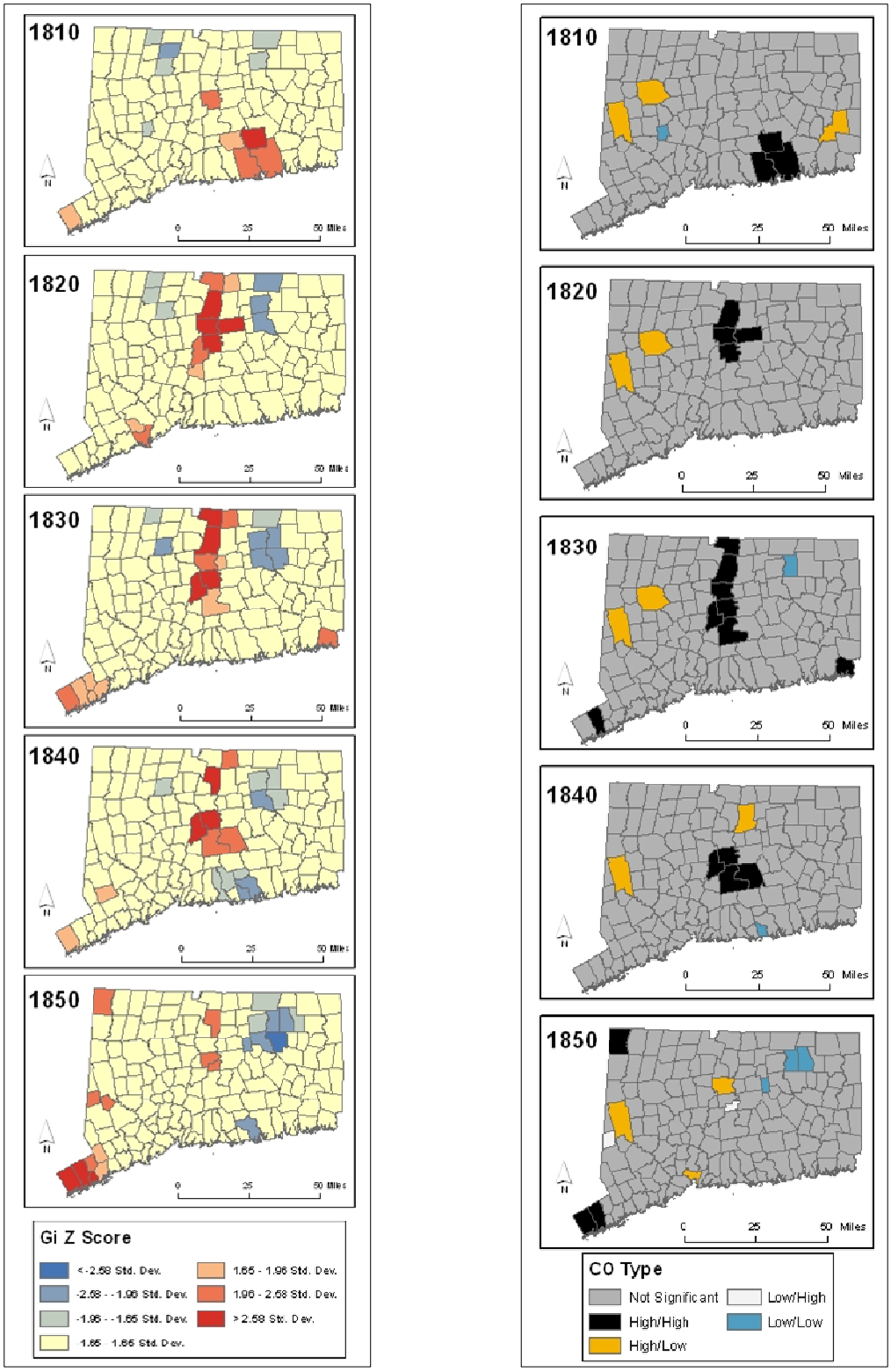
Table 4.10. Results of Total Primary Sector Value General Spatial Analyses, 1810-1850

	1810	1820	1830	1840	1850
*General G**					
Obs. G*	0.186787	0.188494	0.185911	0.188036	0.185755
Z score	-0.994245	-0.130606	-1.253367	-0.335104	-2.183315
p-value	0.320104	0.896087	0.210072	0.737614	*0.029013*
Moran's *I*					
I	0.013126	0.046777	0.001515	-0.001884	0.016673
Z score	0.896254	2.332269	0.424159	0.261306	1.251953
p-value	0.370117	*0.019687*	0.671450	0.793857	0.210587

Significant p-*values are given in italics.*

twenty-mile zone returned even less significant results. Figure 4.15 presents maps of the local versions of these tests, which indicate only limited areas of high-value clustering. In 1810, there is an area in south central Connecticut, but between 1820 and 1840 the

Figure 4.15. Maps of Local *G and Local Moran's *I* Results for Total Value of Primary Sector, 1810-1850.**



larger areas of high-value clustering are in north central Connecticut. In 1850, however, the largest area of high-value clustering was in the southwestern "toe" of the state. These maps also show some low-value clustering to the north and east in most years. The spatial autocorrelation results closely follow the patterns found by the high/low clustering test, but also picked out a few isolated municipalities that showed autocorrelation of the contrasting high/low variety. Other than the persistence of New Milford in this group, however, it shows no particular patterns.

Overall, the total Primary Sector dollar values data suggest that this sector was fundamentally stagnant during most of the study period. Setting aside the effects of changes in valuation methods, all of the key statistics of the Primary Sector rose only modestly or even fell between 1820 and 1840, and indicated only slightly greater growth in the 1850 data set. Similarly, the share of the maximal cohort and its minimums both rose and fell across the same period. The standard deviation maps of the total Primary Sector values in Figure 4.13 suggest that the range of variation among the municipalities was much less in 1850 than it had been in 1820, even with respect to the higher values. The LQ and FLQ result maps in Figure 4.14 show very consistent patterns in municipal shares of the economy by area, especially between 1820 and 1850, again suggesting stability. Thus, it is unlikely that the changes in the Total Municipal Economies discussed in Section 4.3.1 were caused by changes in the Total Primary Sector values of the municipalities.

Rather than examine the Land dollar values separately, which will yield patterns very similar to those for the total Primary Sector values, we will next consider the value

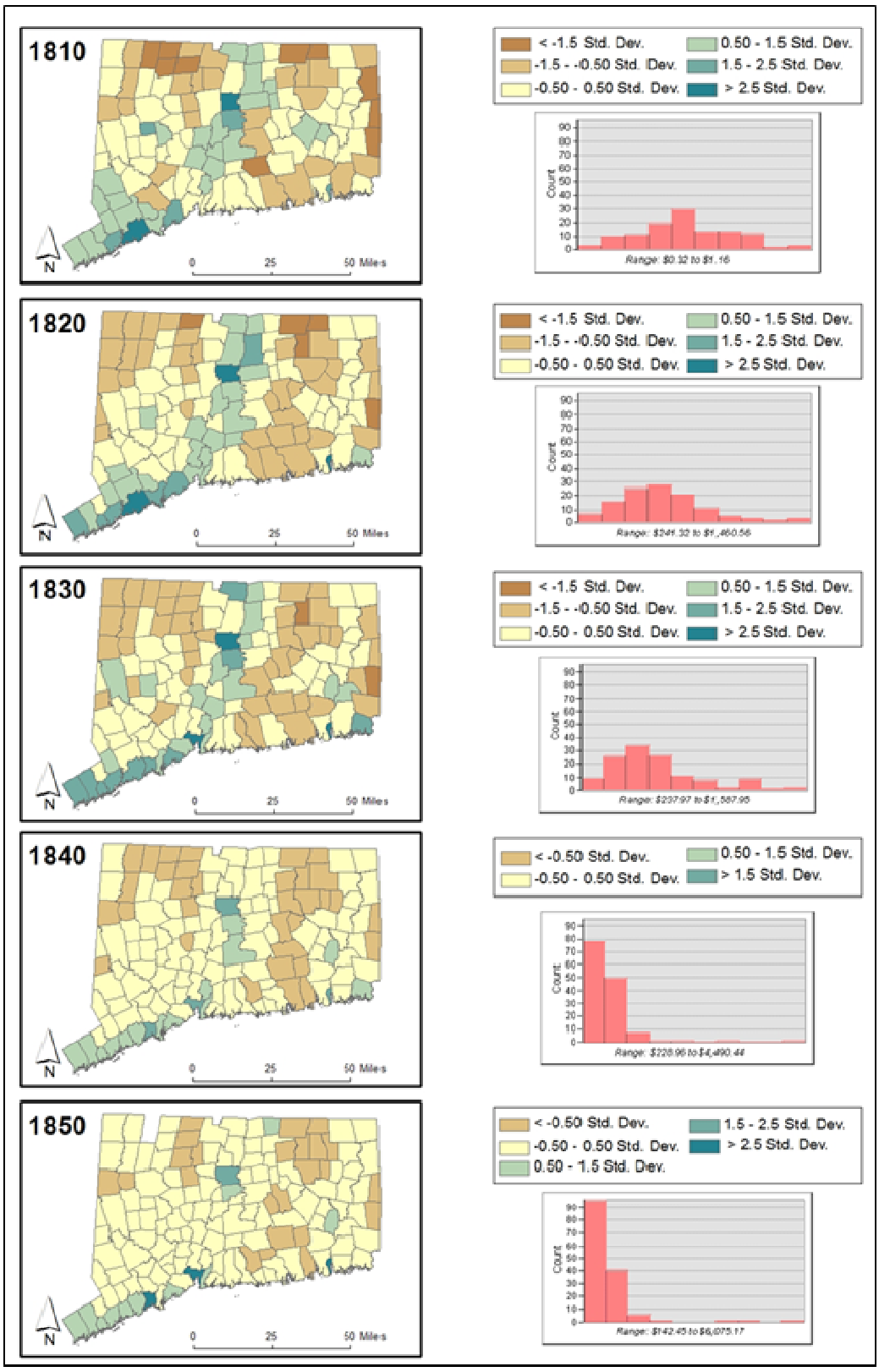
of the land per acre – a measure that inevitably is affected by the changes in how the land was valued, but which also shows some very interesting patterns that may be relevant to the interpretation of the changes in the economy overall. Table 4.11 reports the descriptive statistics for the value per acre for each study year. The very low 1810 figures reflect the category-based nature of the land valuations used in that year.

Table 4.11. Descriptive Statistics for Dollar Value Per Acre of Land, 1810-1850

Statistic	1810	1820	1830	1840	1850
Minimum	0.32	241.32	237.97	228.96	142.45
Maximum	1.16	1,460.56	1,587.95	4,490.44	6,075.17
Mean	0.71	684.84	683.74	691.69	749.60
Median	0.71	668.76	624.71	608.68	600.81
SD	0.17	235.49	271.09	455.03	676.54

Changing to a selling value approach produced much larger values from 1820 forward. Most of those values were also similar between 1820 and 1850, except that the maximum value rose precipitously in 1840 and 1850, reaching over $6,000 per acre for New London land in that year. Figure 4.16 contains maps of the per-acre values by year, classified by standard deviation, and also histograms of the values. The histograms indicate, consistent with the descriptive statistics, that the per-acre values have a roughly normal distribution in 1810, perhaps reflecting the valuation method. Over the succeeding years, however, the distributions became increasingly skewed toward the lower end of the range, much like most of the other data sets used in this research. These changes are roughly consistent with the changes in population documented in the

Figure 4.16. Maps and Histograms of Dollar Values per Acre of Land, 1810-1850.



previous section, and may be explained by either falling demand for land in many places that led to decreases in value per acre, or falling returns on investment in land that led to decreased population in many places – or, conceivably, both trends occurred and reinforced one another.

In addition, the maps and histograms in Figure 4.16 show that there are clear patterns in the dollar value per acre data, similar to the total value of the Primary Sector but much more distinct, especially in 1820 and 1830. The average values are classed by standard deviation in these maps, and for the first three study years (1810, 1820, and 1830) the maps required six classes to depict the diversity of values, ranging from less than –1.5 standard deviations to greater than 2.5 standard deviations. The higher values are plainly located, with some exceptions, near urban areas, along the Connecticut River, and along the southwestern coast and "toe" of the state. In 1840 and 1850, only four classes are required to depict the diversity of values, ranging from less than –0.5 standard deviations to greater than 1.5 standard deviations. The higher values are a small group, and with one exception they contain urban areas, are adjacent to municipalities containing urban areas, or are in the southwestern "toe" of the state – that is, quite close to New York City. Since the 1840 mean, median, and minimum were consistent with the 1820 and 1830 values, the data suggest that in some places the land rapidly became much more valuable. The 1850 values (which exclude Norfolk because it failed to report a number of acres) return to a five-category depiction, in which the highest-value places are the city-containing municipalities of New London, New Haven, Bridgeport, and Hartford. Overall, the spatial pattern is nearly identical to that of 1840, however.

General spatial analyses of the land value per acre yield the results shown in Table 4.12. Here, the Getis-Ord General *G** test only finds statistically significant clustering in the 1810 study year. The Moran's *I* test, however, reports highly significant spatial autocorrelation in every year. The contrast is explained by the local test results

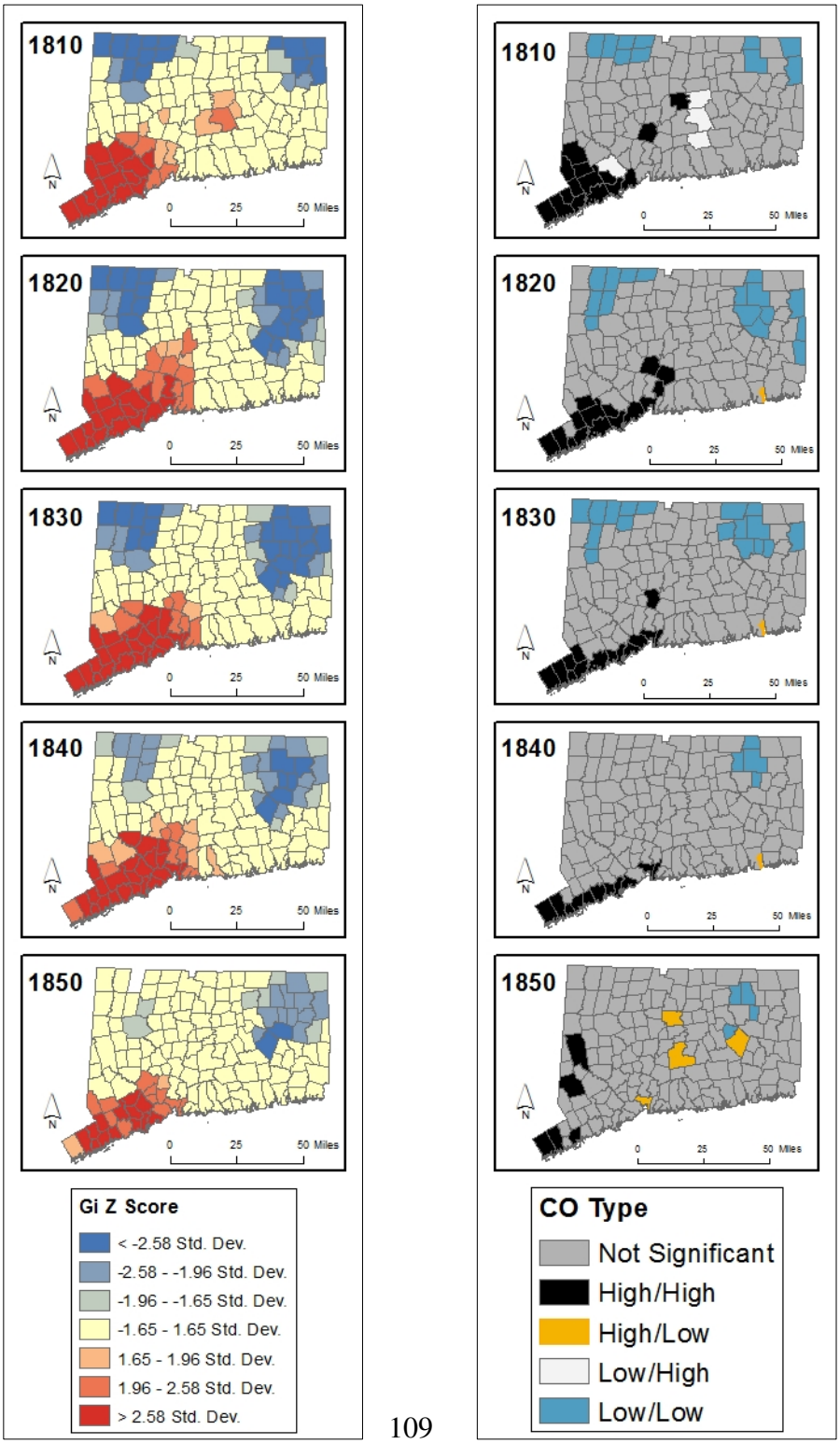
Table 4.12. Results of Land Value Per Acre General Spatial Analyses, 1810-1850

	1810	1820	1830	1840	1850
*General G**					
Obs. G*	0.196187	0.192580	0.196397	0.199354	0.198660
Z score	2.066119	1.038353	1.074569	1.625976	0.149728
p-value	*0.038817*	0.299106	0.282528	0.103955	0.880979
Moran's *I*					
I	0.161837	0.213407	0.199692	0.124163	0.059084
Z score	7.072177	9.415602	9.494914	7.372948	3.949697
p-value	*0.000000*	*0.000000*	*0.000000*	*0.000000*	*0.000078*

Significant p-*values are given in italics.*

provided in Figure 4.17, in which very strong patterns of both high and low value clustering were found: high values in the southwestern corner of the state in all years, and a small area in the central part of the state in 1810, while low values clustered in the northwestern and northeastern corners of the state. The size of the areas showing the clustering, and the intensity of the clustering, mostly declined over the years. By 1850, the high-value clustering includes a noticeably smaller area, the northwestern area had nearly disappeared, and the area in the northeastern corner was much smaller and less extreme. Similarly, the local autocorrelation results in Figure 4.17 also diminish in area. The High/High and Low/Low autocorrelation results match the Getis-Ord Local *G** results, but the analysis also found a number of outliers. New London is a contrasting

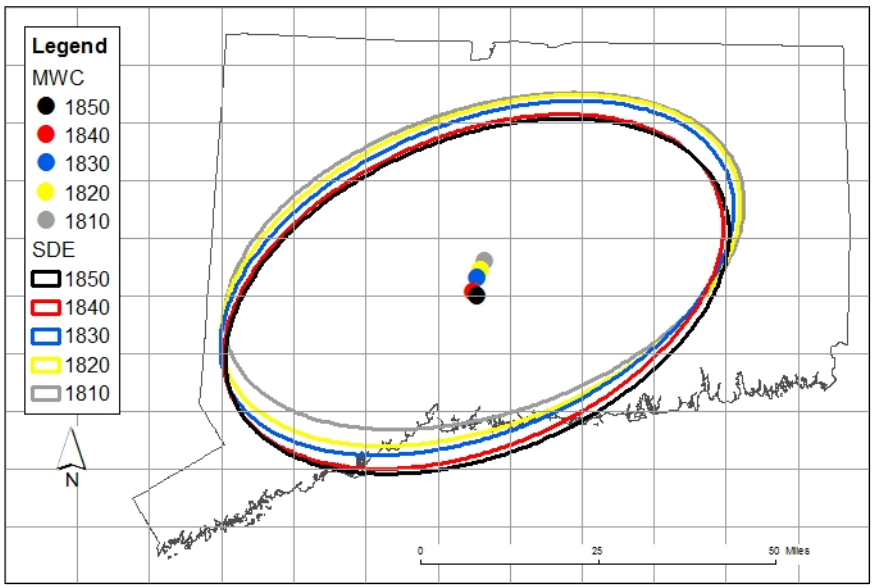
Figure 4.17. Maps of Local G* and Local Moran's *I* Results for Land Value Per Acre, 1810-1850.



High/Low outlier in all the study years except 1810 and 1850; as of 1850, New Haven, Middletown, Hartford, and Lebanon all had high land values that contrasted significantly with those of their neighbors. All of these but Lebanon were city-containing municipalities, as was New London. Only the 1810 study year showed Low/High outliers.

The apparent flattening of the agricultural land values in most municipalities is an important factor to consider when evaluating the patterns of secondary and tertiary activity, the results of the diversity indices, and the modeling conducted as part of this research. Notwithstanding this trend, however, the mean weighted center and standard deviational ellipses in Figure 4.18 indicate that the southwestward shift of the value per acre did continue through at least 1850, although that year's spatial characteristics were

Figure 4.18. Map of Mean Weighted Centers and Standard Deviational Ellipses for Land Value Per Acre, 1810-1850.



quite similar to those of 1840, those two years having spatial trends that were slightly but noticeably different from those of the preceding years.

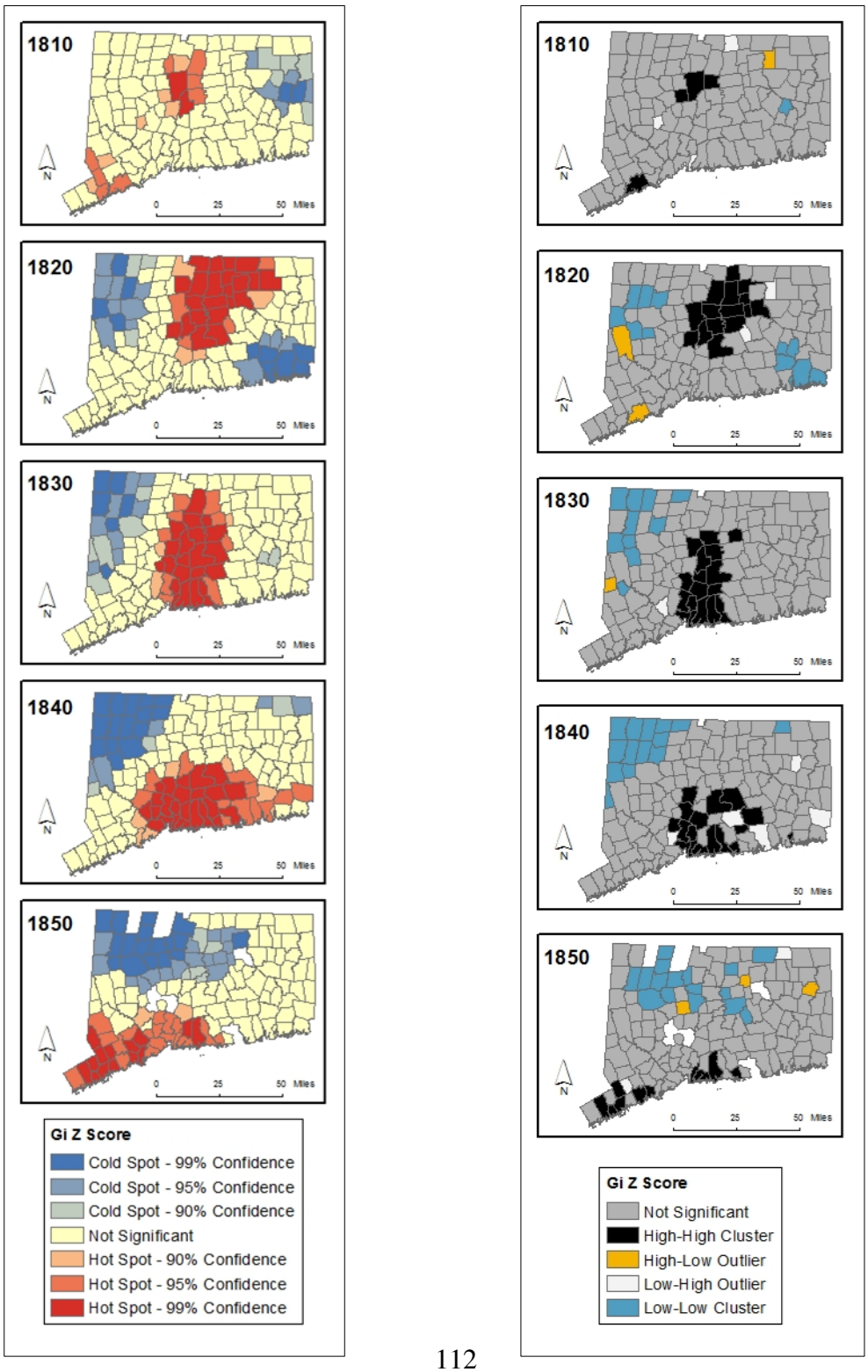
Like the base value of land, the base value of cattle shows little in the way of spatial patterns; but as with the value per acre of land, the value per head of cattle does show distinct spatial patterns. The general spatial analysis results in Table 4.13 indicate that while the 1810 study year did not show any significant clustering or autocorrelation, in the subsequent years both were features of the data, except in 1850 when the Getis-Ord General *G** statistic was not significant. It must be noted that in 1850, eight municipalities (Barkhamsted, Cheshire, Coventry, Hartland, Naugatuck, Norfolk, Saybrook, and Waterbury) failed to report their number of cattle, so the value per head could not be calculated and they are excluded from the calculations. As the maps of the local Getis-Ord *G** and Moran's *I* in Figure 4.19 show, however, the patterns are much more variable than those for value per acre of land, with the areas of highest value clustering moving around the state in each study year, although the northwestern corner's

Table 4.13. Results of Cattle Value Per Head General Spatial Analyses, 1810-1850

	1810	1820	1830	1840	1850
*General G**					
Obs. G*	0.191192	0.191110	0.195211	0.196137	0.193931
Z score	0.830919	2.088571	2.269553	4.241341	-0.343786
p-value	0.406020	*0.036746*	*0.023235*	*0.000022*	0.731007
Moran's *I*					
I	0.028259	0.182288	0.145471	0.167678	0.104695
Z score	1.553611	8.056942	7.342877	8.609665	5.675714
p-value	0.120277	*0.000000*	*0.000000*	*0.000000*	*0.000000*

Significant p-*values are given in italics.*

Figure 4.19. Maps of Local *G and Local Moran's *I* Results for Cattle Value Per Head, 1810-1850.**



data resulted in low-value clustering from 1820 to 1810. This locational volatility suggests that the predictive value of the value per head, and perhaps of the underlying total values, would not be very high.

Overall, despite consistent pattern in the high value of land per acre, the Primary Sector trends suggest considerable variability in the total value of agricultural markets in any given year. The municipalities with the highest total Primary Sector values show some consistency, but also some variation from year to year, and the overall trends in the totals and in both subcategories is toward the south and west. There is also the trend toward more skewed total Primary Sector values over time, as seen in the histograms in Chapter 3, with increasing numbers of municipalities in the low end of the range, a small number of places in the high end of the range, and as a result a lower range of variation overall. The influence of land quality and proximity to urban markets can be seen in the LQ/FLQ analyses of the total Primary Sector Values, and again in the clustering and autocorrelation analyses of the land values per acre.

4.3.3 Combined Secondary and Tertiary Sector Analyses, 1810-1850

The combined Secondary and Tertiary ("SecTer") data will be analyzed first, because they are comparable (with certain caveats as discussed above) across the whole study period. Table 4.14 provides the basic descriptive statistics of these combined dollar values. From these figures, which show mean values that are much higher than the medians, and standard deviations that are higher than the means, it is clear that this is a very skewed set of data. All of these figures also rise across all the study years, including

Table 4.14. Statistics of SecTer Dollar Values, 1810-1850

Statistic	1810	1820	1830	1840	1850
N	119	122	130	139	148
Minimum	160.00	23,431.33	34,276.67	29,860.34	10,000.00
Maximum	25,593.00	8,600,382.00	19,611,428.00	29,131,732.00	47,632,768.00
Mean	2,241.31	547,505.38	1,008,621.06	1,448,542.00	2,028,795.96
Median	1,696.50	281,390.70	460,906.70	470,135.17	551,033.30
SD	3,038.07	1,048,259.42	2,188,514.42	3,631,795.06	5,587,907.20
Sum	266,715.98	66,795,656.17	131,120,737.20	201,347,337.52	300,261,801.84

All values are in dollars as originally recorded.

the 1820-1850 period, which are the most reliably comparable. The maximum values also rise steeply in the same way, while the minimum values are much more variable. As with the Primary Sector dollar values, we cannot directly compare the values of all the years by municipality, due to the changes in valuation criteria and the tax categories. Instead, the maximal cohorts of the each of the five study years are analyzed. Table 4.15 gives this information, showing that the proportion of the combined values held by the ten municipalities with the largest values – ten out of over 100 municipalities in each case – held 33.5% of the total value in 1810, and by 1850 held 56.7% of the total. As with the state's population, this pattern strongly suggests increasing concentration, primarily but not exclusively in the cities, with a small number of places providing the largest share of the total values. In fact, by 1850 one municipality (New Haven) held nearly 16% of the total of SecTer dollar values, while in 1810 the one with the largest percentage (also New Haven) had only 9.6%.

In Figure 4.20 we find that the histograms of the combined SecTer values are indeed extremely skewed, with the vast majority of municipalities' values located in the lowest category; this is consistent with the individual study years' distributions, as

Table 4.15. Data for Maximal Cohorts of SecTer Dollar Values, 1810-1850

Year	1810	1820	1830	1840	1850
Percentage	33.5%	47.2%	50.5%	54.4%	56.7%
% if Even	8.4%	8.2%	7.7%	7.2%	6.8%
Minimum	4,424.00	1,266,218.40	2,143,182.00	3,810,515.00	4,950,667.00
Maximum	25,593.00	8,600,382.00	19,611,428.00	29,131,732.00	47,632,768.00
#1	**New Haven**	**Hartford**	**Hartford**	**New Haven**	**New Haven**
#2	**Hartford**	**New Haven**	**New Haven**	**Hartford**	**Hartford**
#3	**Middletown**	**Middletown**	**Norwich**	**Norwich**	**Norwich**
#4	**New London**	**Norwich**	**Middletown**	**Bridgeport**	**New London**
#5	Stamford	**New London**	*Thompson*	Thompson	**Bridgeport**
#6	**Norwich**	**Stratford**	*Windham*	**Middletown**	Thompson
#7	**Stratford**	East Windsor	*Killingly*	Killingly	**Middletown**
#8	East Windsor	*Canaan*	**New London**	Windham	*Norwalk*
#9	Fairfield	*East Hartford*	**(Bridgeport)**	**New London**	*Enfield*
#10	Greenwich	*Chatham*	*Pomfret*	*Plainfield*	*Simsbury*

Bold items persist across all years; italicized items were not present in the next preceding year, and city-containing places are underlined. Bridgeport appears in bold from 1830 forward because its center was formerly in Stratford.

discussed in Chapter 3. This figure also provides maps of the total values classified by geometrical interval to illustrate the patterns contained in these data. The increasingly skewed nature of the data sets is clearly illustrated in the way, through the application of a geometrical interval classification, the number of municipalities falling into the highest category falls dramatically between 1820 and 1830; by 1850, half of the maximal cohort places are not even in the highest category. Other than the persistence of the city-containing municipalities in the maximal cohorts, however, no particular spatial patterns seem to be present here. As Figure 4.21's depiction of the mean weighted centers and standard deviational ellipses of the total SecTer dollar values shows, there was noticeable variation in the overall spatial arrangement of these values, with a significant shift of the MWC eastward in 1830, followed by a drift westward. The SDE patterns follow the

Figure 4.20. Maps and Histograms of SecTer Dollar Values, with Maximal Cohorts, 1810-1850.

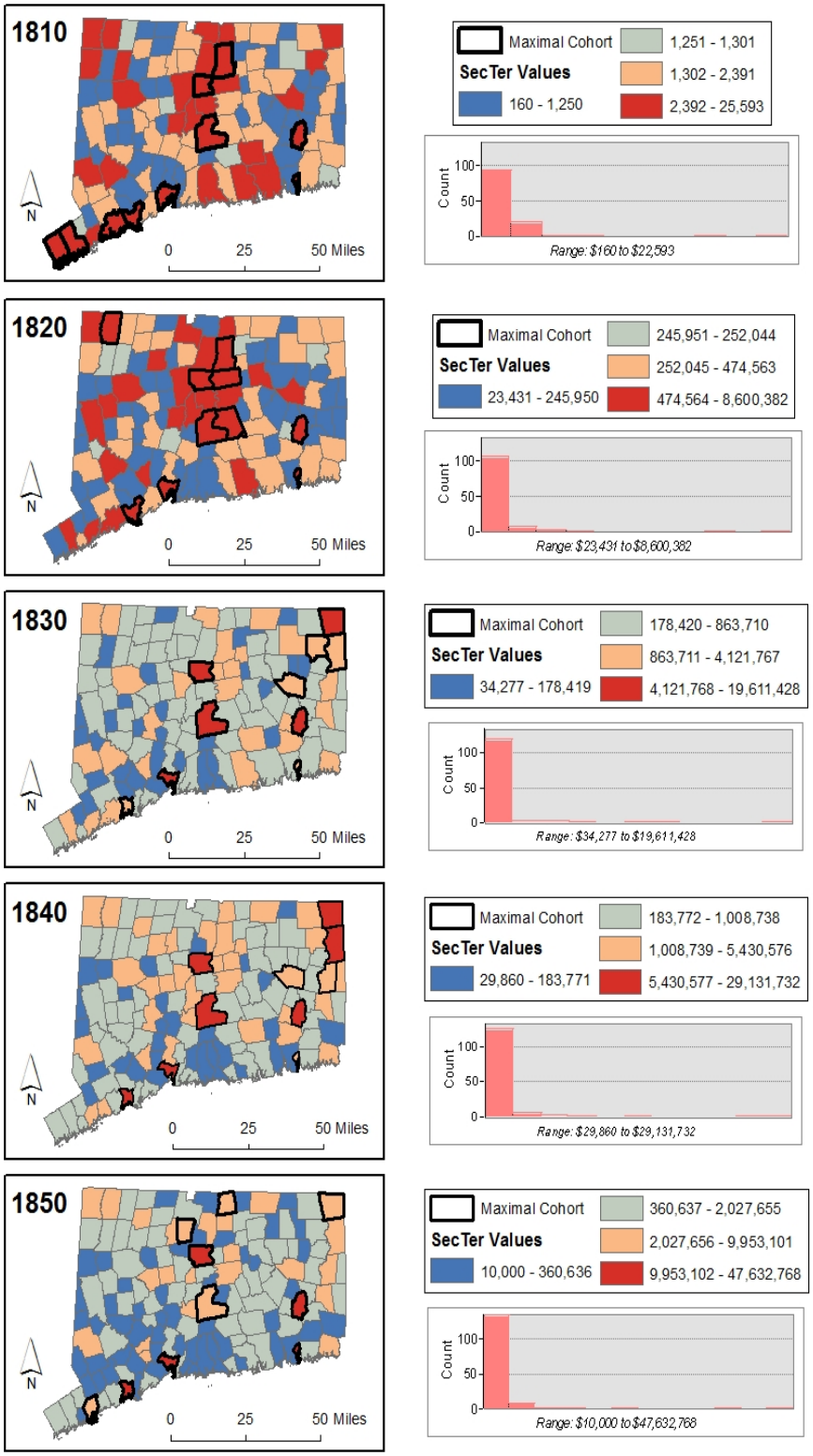
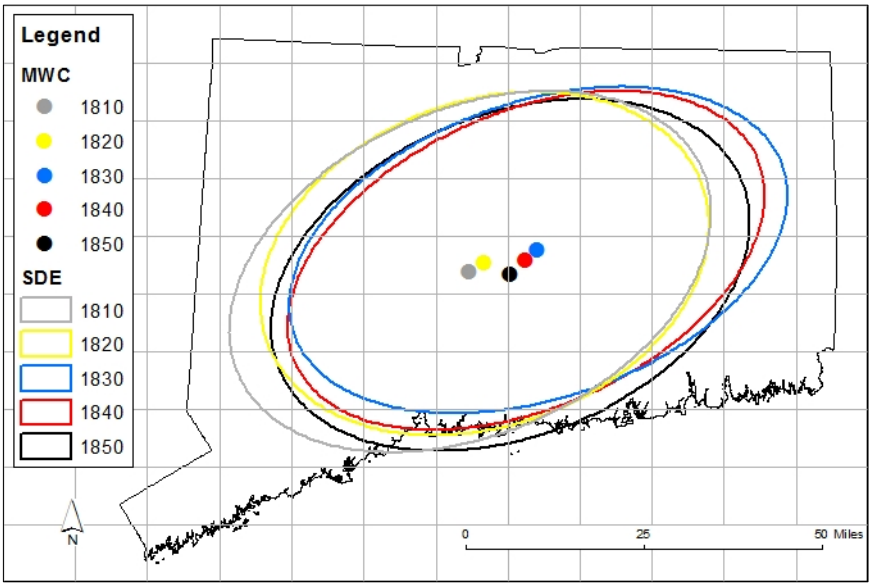


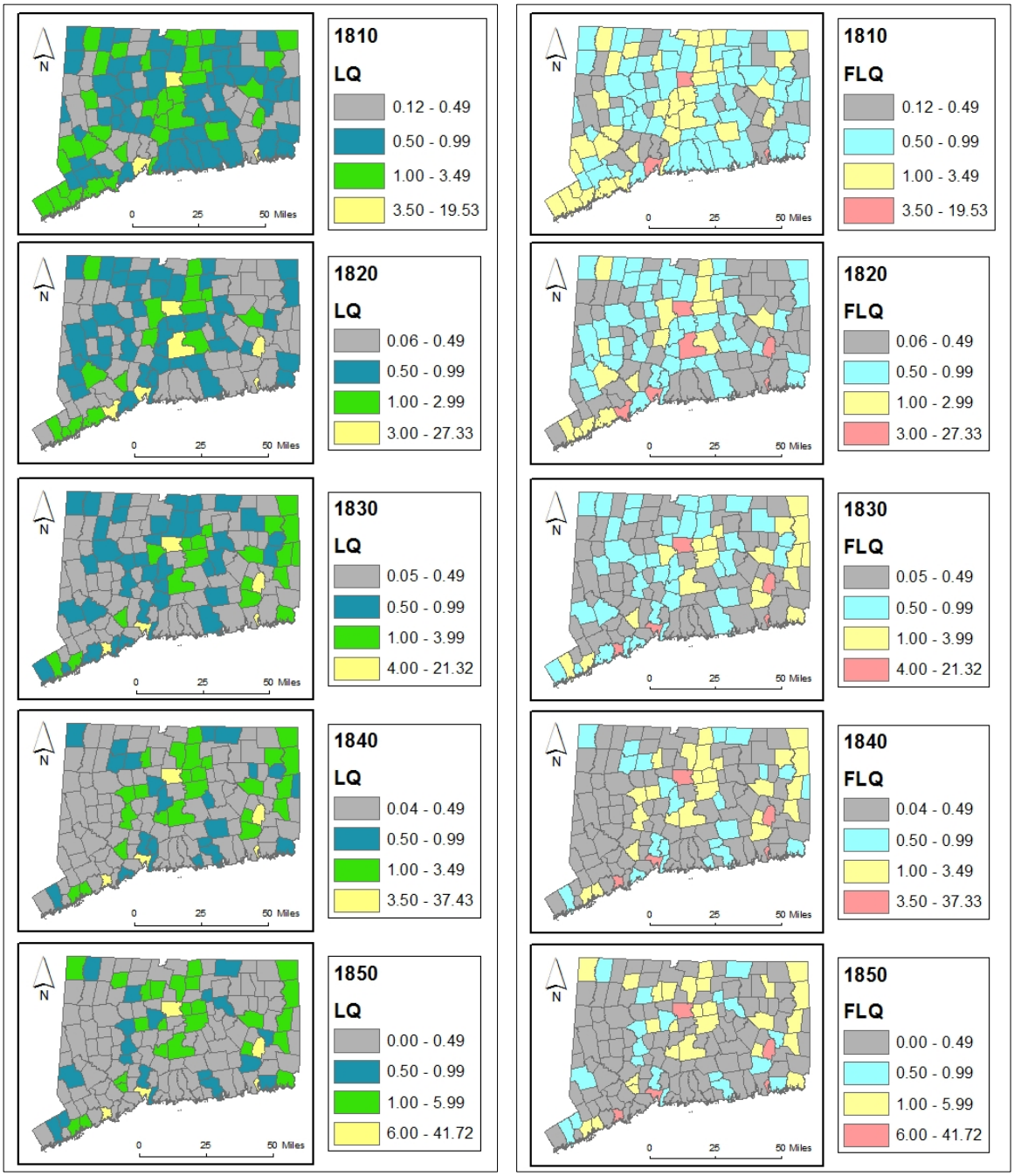
Figure 4.21. Mean Weighted Centers and Standard Deviational Ellipses for Total SecTer Dollar Values, 1810-1850.



MWCs, but each year has somewhat different axial distances, although the general southwest to southeast orientation seen in the data sets remains consistent.

The spatial analyses of the SectTer total value data find a similar lack of significant patterns, unlike the Primary Sector data. For these data, a ten-mile boundary distance continued to be used. Figure 4.22 shows that the LQ/FLQ results picked out most of the city-containing municipalities as having the dollar values most inconsistent with their areas, except that Middletown fell into the second tier year except 1820, in 1810 Norwich also fell into the second tier, and in 1820 Stratford (a parent municipality of Bridgeport) fell into the highest tier. The second tier was a much more variable group. The FLQ results are identical to the LQ results in most years. The exceptions are that

Figure 4.22. LQ and FLQ Results for SecTer Dollar Values, 1810-1850.



in 1820, the municipality of Roxbury (in the southwest quarter of the state) is shifted into the 1.00 – 2.99 class of municipalities, and second in 1850 the municipality of Ashford in the northwest region is also moved into the 1.00 -5.99 class.

There are three notable features of these results. First, after 1810 there is no particular concentration of higher values in the southwest part of the state (unlike with the Primary Sector dollar values). Second, there are more high-value municipalities in the north-central part of the state, around Hartford, than in most other regions. Third, from 1830 a group of municipalities in the northeast corner of the state appear in the second tier of LQ values, probably reflecting the textile-industry investments that were ongoing in this time period (as has previously been mentioned, in 1820 these firms were tax-exempt and thus left out of these values).

The global formulations of the Getis-Ord *G** and Moran's *I* statistics found random results for the total dollar values, as Table 4.16 shows. The results of the local formulations of the statistics contrast with these results, however. The local *G** analysis found (at a ten-mile zone of indifference) consistent statistically significant

Table 4.16. Results of SecTer Dollar Value
General Spatial Analyses, 1810-1850 (ZI 10 miles)

	1810	1820	1830	1840	1850
*General G**					
Obs. G*	0.048813	0.053741	0.048362	0.046626	0.046079
Z score	0.042812	0.489234	-0.175533	-0.261991	-0.416416
p-value	0.965821	0.624676	0.860661	0.793328	0.677106
Moran's *I*					
I	-0.007990	0.014016	-0.014349	-0.037147	-0.037242
Z score	0.011215	0.525116	-0.171023	-0.799109	-0.890529
p-value	0.991052	0.599503	0.864206	0.424227	0.373182

clustering of high SecTer dollar values in two regions, as shown in Figure 4.23. One was in the north-central part of the state (around Hartford) in every study year, and the other was in the southwest part of the state (around New Haven) in every year but 1830. In the latter year, one additional statistically significant result appeared in the municipality in the northeast corner of the state (Thompson). The local Moran's *I* analysis, in the same figure, found a small number of municipalities (between two and four) with statistically significant spatial autocorrelation in each year – with Hartford and New Haven appearing in all five study years, Norwich in three, places adjacent to Hartford in 1810 and 1820, and the municipality of Bridgeport in 1850. These results are generally consistent with the raw dollar values as mapped in Figure 4.19, above, and also with the skewed nature of these data.

Similar to the Primary Sector, analysis of the SecTer per capita dollar values was done. The per capita values are influenced by smaller numbers, of course, but the relationship between municipal population, which reflects potential and actual employment to some degree, and the dollar values of the combined Secondary and Tertiary Sectors are of greater general relevance to the growth and development of the state than the size (averaged or otherwise) of individual firms. Table 4.17 identifies the maximal cohorts in SecTer per capita dollar values, together with the municipal populations and descriptive statistics about the data. Several patterns emerge from these statistics. First, several of the highest-population municipalities appear consistently in the maximal cohorts, but not all of them – Middletown in particular, despite falling among the five highest-population places through 1850, drops from the maximal cohorts

Figure 4.23. Local *G and Moran's *I* Results for SecTer Dollar Values, 1810-1850.**

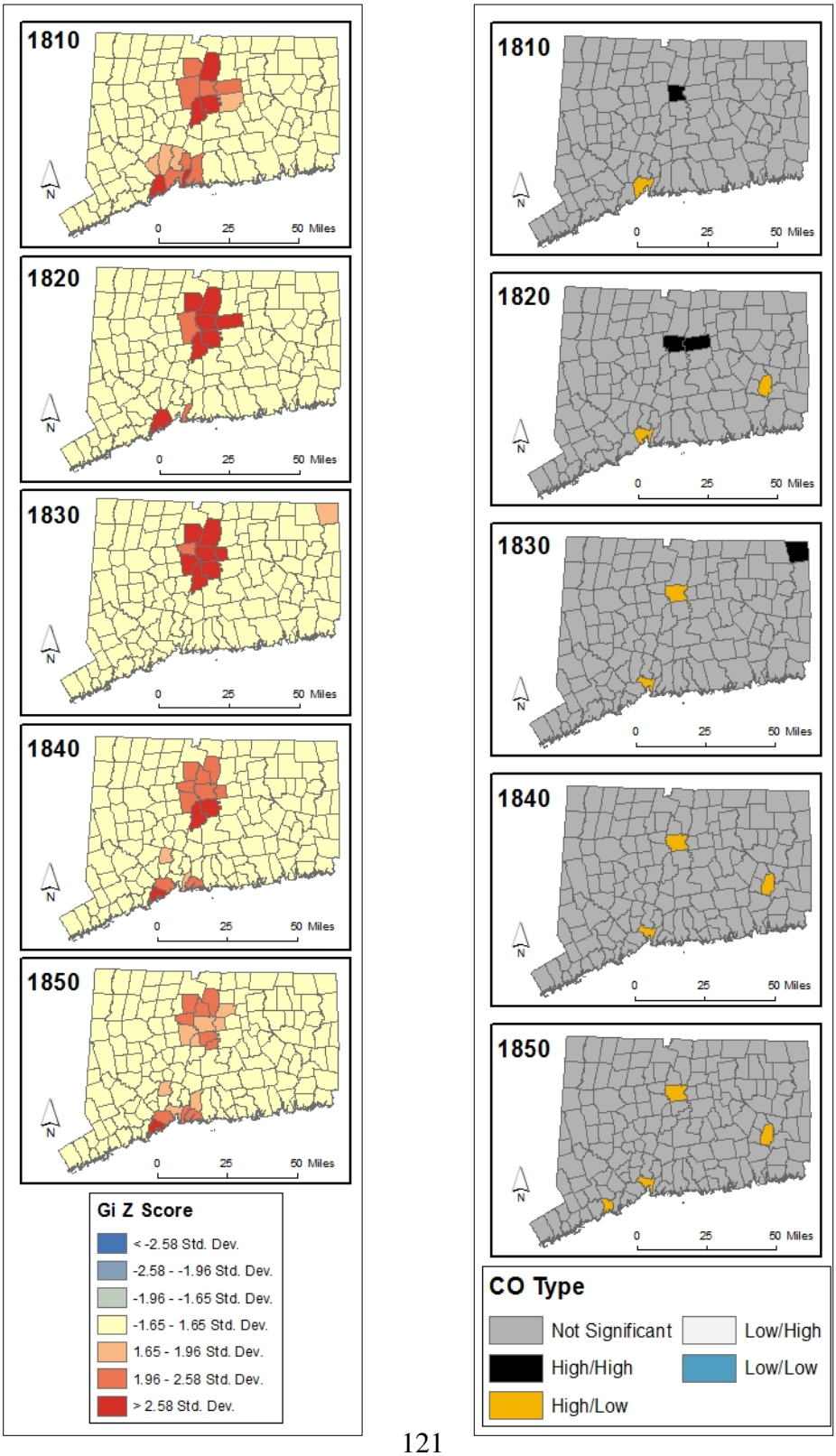


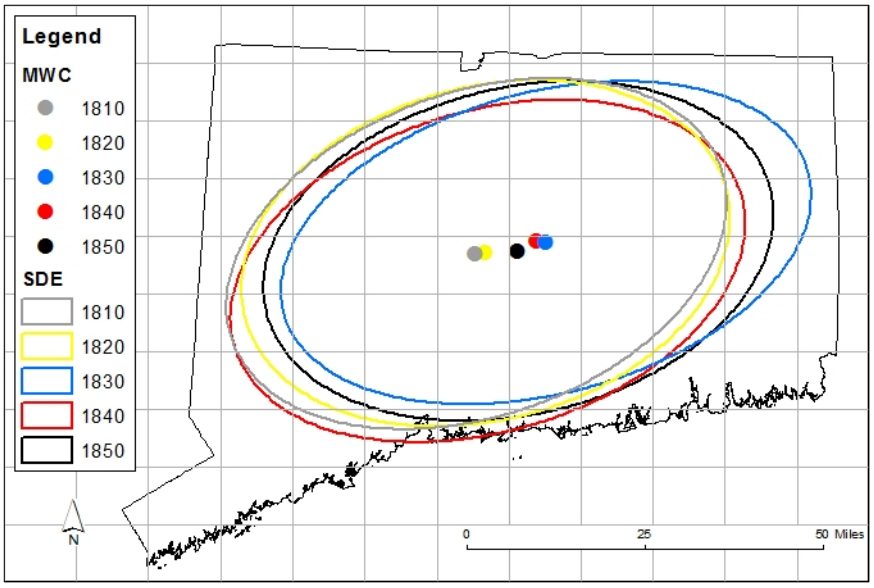
Table 4.17. Descriptive Statistics of Per Capita SecTer Dollar Values, with Maximal Cohorts and Municipal Populations, 1810-1850

1810		1820		1830		1840		1850	
Statistic									
Minimum (All)	$ 0.14		$ 26.78		$ 34.24		$ 33.05		$ 5.41
Minimum (10)	1.60		454.62		929.92		1,344.57		1,627.14
Maximum	3.67		1,246.25		2,003.41		2,056.79		2,854.15
Mean (All)	0.91		194.36		336.71		446.54		513.53
Median (All)	0.82		140.76		217.01		260.82		292.45
SD (All)	0.52		172.98		342.54		463.94		524.12
Municipality	**Population**	**Municipality**	**Population**	**Municipality**	**Population**	**Municipality**	**Population**	**Municipality**	**Population**
New Haven	6,987	**Hartford**	6,901	**Hartford**	9,789	Norwich	7,239	**Hartford**	13,555
Hartford	6,003	**New Haven**	8,327	Norwich	5,179	**Hartford**	12,793	**New Haven**	20,345
Vernon	827	*Norwich*	3,634	*Windham*	2,812	**New Haven**	14,390	Norwich	10,265
New London	3,238	Canaan	2,332	*Thompson*	3,380	Thompson	3,535	Bridgeport	7,560
Canaan	2,203	New London	3,330	*Killingly*	3,257	Bridgeport	4,570	Canton	1,986
Goshen	1,641	*Stratford*	3,438	*Pomfret*	1,978	*Vernon*	1,430	Thompson	4,638
Somers	1,210	*East Windsor*	3,400	*Bozrah*	1,079	*Canton*	1,736	*Simsbury*	2,727
Canton	1,374	*Enfield*	2,065	Bridgeport	2,800	*Plainfield*	2,383	*New London*	8,991
Middletown	5,382	Middletown	6,479	**New Haven**	10,678	Killingly	3,685	Bozrah	867
Southbury	1,413	*East Hartford*	3,373	*Griswold*	2,212	Bozrah	1,067	Plainfield	2,732
Mean Population: 2,201		*Mean Population: 2,251*		*Mean Population: 2,290*		*Mean Population: 2,231*		*Mean Population: 2,442*	
Median: 1,951		*Median: 1,984*		*Median: 1,935*		*Median: 1,790*		*Median: 1,848*	

Bold items persist across all years, italicized items were not present in the next preceding year, and city-containing places are underlined.

after 1820. Second, the population of the other municipalities varies widely, and in the cases of Vernon (1810) and Bozrah (1850) including some of the smaller municipalities in the state. The statistics show again that 1810's valuation method makes useless any numerical comparisons between that and other years. From 1820, however, we can see a consistent increase in the minimum and maximum values of the maximal cohorts. The mean weighted centers and standard deviational ellipses for these data, in Figure 4.24, are broadly similar to those for the total values, but also have a somewhat different variations in their ellipses' radial axes. the overall minimum, however, is inconsistent, and the 1850 minimum unexpectedly low. Two municipalities in that year reported values resulting in per capita values under $10.00, but the next smallest value was $49.55; further, the 1850 reported values for those two municipalities (Kent and Suffield) were much smaller than they reported in both 1840 and 1851. Examination of the data also indicates that in each

Figure 4.24. Mean Weighted Centers and Standard Deviational Ellipses for Per Capita SecTer Dollar Values, 1810-1850.



year except 1810, between eleven and thirteen of the largest values were statistical outliers – which is consistent with most of the data in this study.

The map in Figure 4.25 shows that, notwithstanding the differences in municipal rankings between the total SecTer dollar values and the per capita values, the spatial patterns of the two are roughly similar. High numbers concentrate, upon visual inspection, in the center-north and northeast parts of the state, with some strong activity in the southwestern and northwestern corners. The general statistical tests found statistically significant spatial autocorrelation in 1830, 1840, and 1850, but nothing significant in the Getis-Ord *G** test, as Table 4.18 shows. It is interesting that it is the per capita results that, like the per acre results for the Primary Sector, shows some minimal statistical bias in the global statistics. In the local statistics, with a twenty-mile Zone of Indifference (but not a ten-mile zone) there was substantial high/low clustering as shown in Figure 4.26. Specifically, the local G_i* statistic found statistically significant high-value clustering was found in the north-central part of the state in 1810

Table 4.18. Results of SecTer Dollar Value Per Capita General Spatial Analyses, 1810-1850 (ZI 20 miles)

	1810	1820	1830	1840	1850
*General G**					
Obs. G*	0.190132	0.197201	0.209135	0.204724	0.199873
Z score	-0.138028	0.889717	1.588726	1.476914	0.349616
p-value	0.890218	0.373618	0.112122	0.139699	0.726627
Moran's *I*					
I	0.025458	0.023716	0.085084	0.067655	0.032454
Z score	1.467025	1.425256	4.342247	3.658341	2.094549
p-value	0.142369	0.154083	*0.000014*	*0.000254*	*0.036211*

Significant p-*values are given in italics.*

Figure 4.25. SecTer Dollar Values Per Capita, 1810-1850.

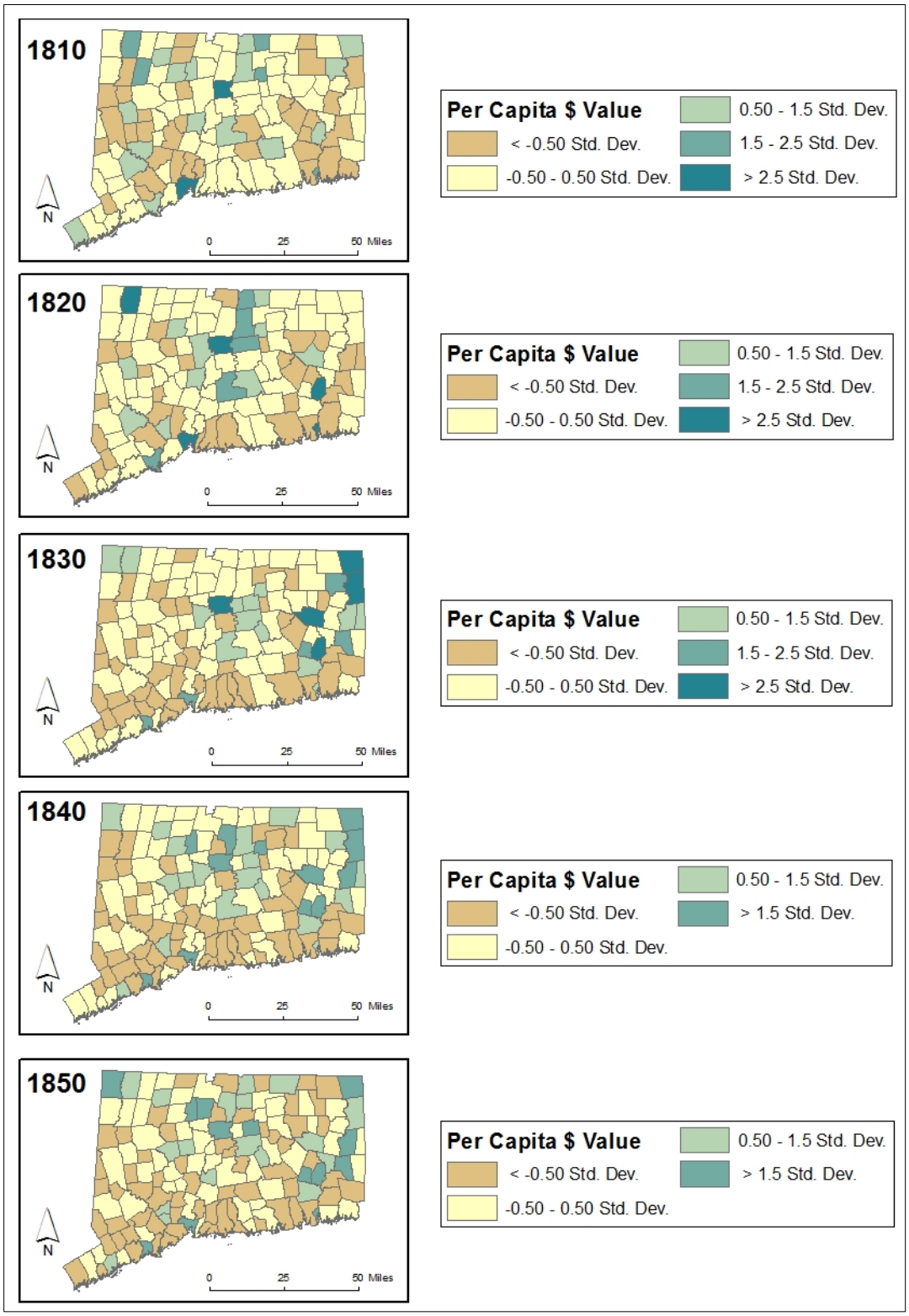
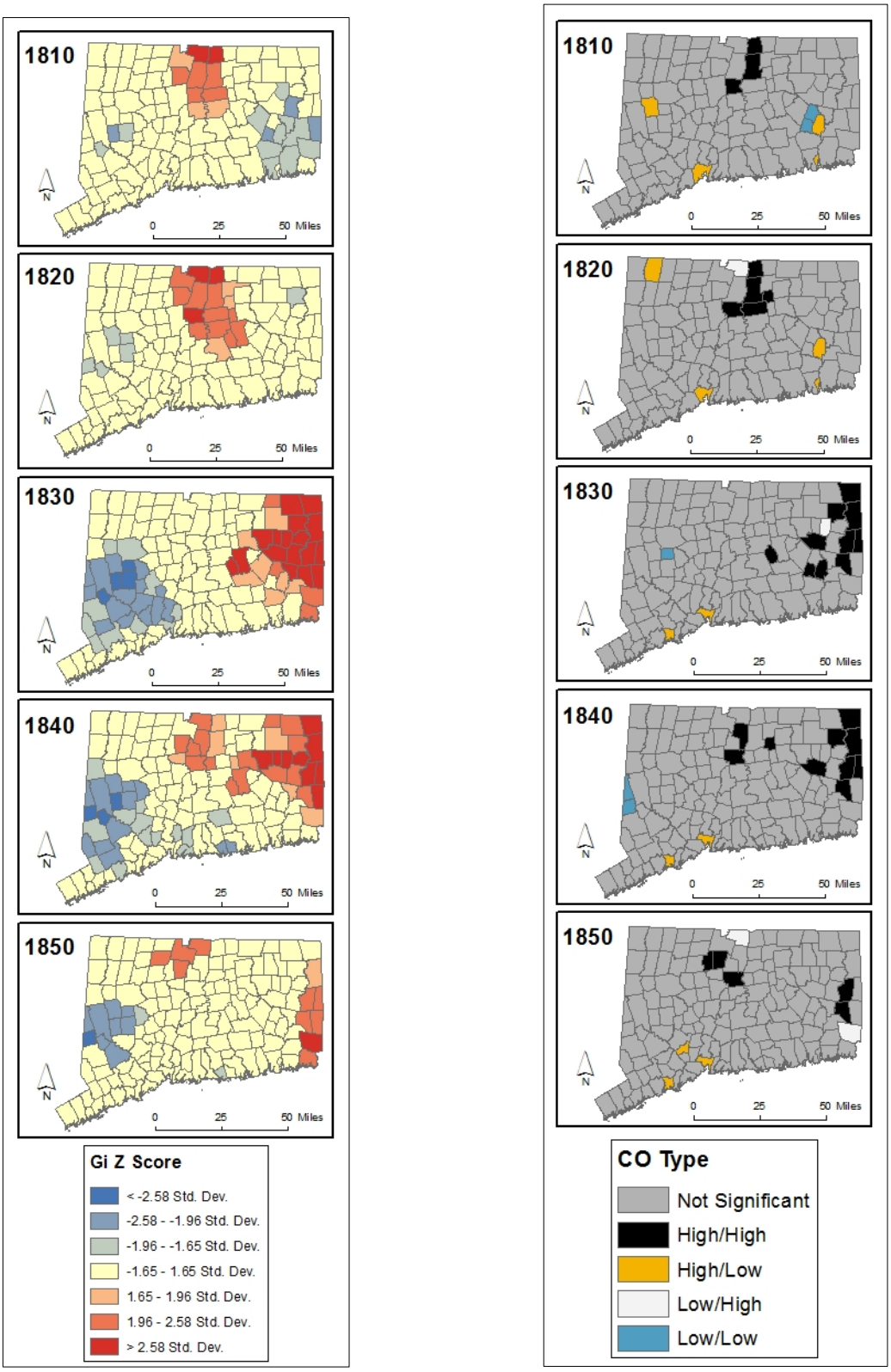


Figure 4.26. Local G_i* and Moran's *I* Results for Per Capita SecTer Dollar Values, 1810-1850.



and 1820, with smaller areas in 1840 and 1850. In 1830 and 1840, extreme high-value clustering was found in the northeastern part of the state, the historical location of the capital-intensive textile industry. Low-value clustering was less pronounced than the high-value clustering in 1810 and 1820, but there was a substantial area in the southeastern part of the state in 1810 and a smaller one toward the west; in 1820, two patches of low-value clustering occurred in slightly different areas. The pattern changed substantially in 1830, with the appearance of a large area of low-value clustering in southwestern Connecticut, per capita investment in the Secondary and Tertiary Sectors was unusually low in that region. This pattern persisted, albeit in increasingly smaller areas, in the 1840 and 1850 data sets. The local test for spatial autocorrelation, also mapped in Figure 4.25, found high/high value spatial autocorrelation in the areas with clustering of high values, as expected. The spatial autocorrelation involving low/low and high/low values was less pronounced, with only a scattered few municipalities showing statistically significant autocorrelation of this type, though their locations were generally consistent with the clustering of low values shown by the local Getis-Ord G_i^* test. The fact that per capita values show such distinct patterns may indicate differing levels of capital investment in different industries, as is discussed below.

Counts of SecTer firms can also provide valuable information, but the fact is that they do not distinguish between very large firms and very small ones, and the mean count values are particularly subject to the influence of extreme values. In addition, since the Assessments category of 1810 is only given in dollar values, it must be omitted from an analysis of SecTer counts. Nonetheless, these counts are important data and also have the

advantage that they can be compared across the study years from 1820 to 1850. The 1820 counts data also include a separate count of forty-one textile factories incorporated before that date, as these firms were exempt from taxation in that year and were not included in the Grand List.

As the figures in Table 4.19 show, the number of firms involved in the Secondary Sector and the Tertiary Sector had a very wide range in each year – the minimum counts were 3, 4, 2, and 2, while the maximum counts more than doubled, from 242 in 1820 to 528 in 1850. The mean number remained below 50, though it rose slightly across the period, and the standard deviation increased, being nearly doubled by 1850. The total counts rose substantially from 3,910 in 1820 to 5,766 in 1840; in 1850, however, because of the failure of thirty-five municipalities to report counts, the total fell to 4,752. The 1851 total of twenty-seven of these missing counts is 1,149, which yields the total of 5,901 given in the table. In all probability the real number was over 6,000, since Hartford (which had 304 firms in 1840) was one of the places that failed to report counts, as was Middletown (which had 168 in 1840).

Table 4.19. Count Statistics for SecTer Firms, 1820-1850

Statistic	1820	1830	1840	1850*
N	122	130	139	148
Minimum	3	4	2	2
Maximum	242	321	375	528
Mean	32	29	41	42
Median	23	28	28.5	21
SD	32	44	50	61
Sum	3,920	5,126	5,766	5,901

**The 1850 sum includes 1,149 firms substituted from the 1851 returns, resolving 27 of 35 missing counts from 1850.*

Table 4.20 conveys descriptive statistics of the maximal cohorts, with the percentage of the firms that they hold. This shows that as with the dollar values for these firms, the ten largest of the over 100 municipalities in each year held at least 30% of the total number of firms. That total percentage rises over the study period, but not as drastically as the dollar values – to only 32.10% in 1840. The 1850 total percentage for the group is very misleading because of the absence of the Hartford and Middletown counts from the data set; both should also appear as persisting across all four years, but are not because of the missing data. Thus, the number of SecTer firms, as well as their dollar value, displayed concentration in a relatively small set of municipalities, though the counts appear to show a less extreme concentration.

Table 4.20. Maximal Cohorts for SecTer Counts and Their Percentage of the Total Number of Firms, 1820-1850

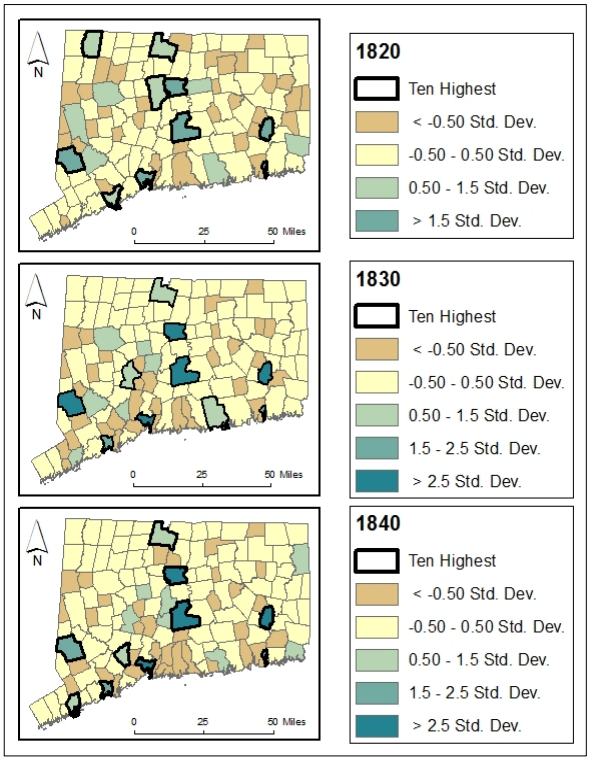
Year	1820	1830	1840	1850*
Percentage	29.90%	31.19%	32.10%	38.57%
Minimum	64	72	88	81
Maximum	242	321	375	528
Mean (All)	32	29	41	42
#1	**New Haven**	**New Haven**	**New Haven**	**New Haven**
#2	Hartford	Hartford	Hartford	**Norwich**
#3	**Norwich**	**Norwich**	**Norwich**	**Bridgeport**
#4	Middletown	Middletown	Middletown	**Danbury**
#5	**New London**	**Danbury**	**New London**	**New London**
#6	**Danbury**	**New London**	**Bridgeport**	Norwalk
#7	Granby	**(Bridgeport)**	**Danbury**	*New Milford*
#8	**Stratford**	Granby	*Derby*	*Stonington*
#9	Canaan	*Saybrook*	Granby	*Windham* (tie)
#10	Farmington	*Waterbury*	*Norwalk*	*Salisbury* (tie)

**The 1850 data are misleading because thirty-five municipalities, including Hartford, failed to report a count of firms in 1850 and 1851.*

Bold items persist across all years; italicized items were not present in the next preceding year. Bridgeport appears in bold from 1830 forward because its center was formerly in Stratford.

Mapping of the SecTer firm numbers for 1820-1840 (excluding 1850 because of the large number of missing counts) as in Figure 4.27, also emphasizes the city-containing municipalities, especially with maximal cohorts picked out. The cities, again, are all located on coasts or waterways; the two non-city places that appear in the group of ten highest in all three years are (1) Danbury, which is located in the southwest corner of the state but not on the shoreline, and (2) Granby, which is at the northern border of the state. Granby's persistence is best explained by the number of distilleries located there, as is discussed below in the section on separate secondary counts. Danbury, in contrast, had the largest number of manufactories in 1820 and 1830, and the second-largest in

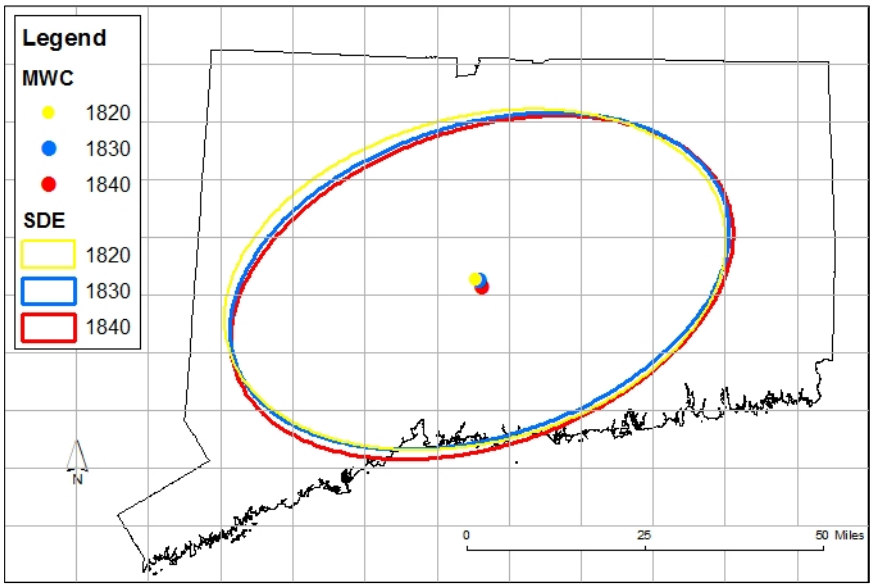
Figure 4.27. Counts of Combined SecTer Firms, 1820-1840, with Maximal Cohorts.



1840. Yet as will also be seen below, neither of these municipalities is positioned in the upper end of the dollar value based statistics, a fact that suggests that there was low capitalization involved in early nineteenth century industries like distilling and, in Danbury, hat-making (the industry for which the municipality is best known). Mapping the mean weighted centers and standard deviational ellipses, as in Figure 4.28, indicates that – unlike the total values and per capita values – there was little variation in the overall locations of the firms: both the dots and the ellipses in these maps are very similar. 1850 is excluded here because of the large number of missing values, but the 1820-1840 pattern was stable, even as the underlying numbers increased.

Analysis of the average value of these firms, although it would be valuable, is inherently problematic, since the presence of one or two very valuable firms among a

Figure 4.28. Mean Weighted Centers and Standard Deviational Ellipses for Counts of SecTer Firms, 1820-1840.



small number in a municipality would yield a highly skewed average. Further, in the present circumstances, comparisons across years are inadvisable for several reasons. First, in the 1810 data there are no counts for Secondary Sector firms, only for Tertiary Sector stores. Second, in 1820 the Secondary Sector counts excluded tax-exempt textile mills, so any average values for that year would be incomplete and misleading. Third, in 1850 thirty-five of the 148 municipalities (including most of Hartford County) failed to report counts of their mills and stores. The only complete data we have are for the years 1830 and 1840, and Table 4.21 shows, by looking at the statistical outliers of the average firm values, how strongly high individual firm values can affect the average value. In 1830, there were seven municipalities with over 100 Secondary and Tertiary firms, only two of which appear in this list of municipalities with average values that are statistical outliers; in 1840, there were eight such firms, and again only two of them appear in this

Table 4.21. Average Dollar Value of Secondary + Tertiary Firms: Statistical Outliers and Number of Firms, 1830 and 1840

1830			1840		
Municipality	Avg. Value (in thousands)	Firms	Municipality	Avg. Value (in thousands)	Firms
Thompson	102.97	45	Thompson	142	48
Killingly	85.52	46	Plainfield	115	33
Griswold	76.18	27	Montville	103	20
Montville	72.93	20	Vernon	90.8	28
Hartford	72.90	269	Windsor	87.2	35
Windham	68.05	60	Hartford	86.3	304
Plainfield	66.16	22	Killingly	80.7	68
Manchester	52.73	25	Canton	79	39
Pomfret	51.03	42	New Haven	77.7	375
Norwich	50.10	186	Enfield	76.9	23
			Windham	75.8	58
			Glastonbury	67.6	43
			Griswold	65.2	30
			Hamden	64	17
			East Hartford	63.7	21

list. For a little more perspective on these numbers, in 1830, the overall mean of these average values was $21,074.84, and in 1840 it was $26,043.21. Thus, the value of at least some of the firms in these statistical outlier municipalities was extraordinary. Notice, for example, that in 1830 Montville and Hartford had nearly the same average firm value, but Montville had only twenty firms, while Hartford had 269; similar disparities exist for other pairs. Thus, average SecTer firm values are less useful category of analysis than the SecTer values and per capita values.

The SecTer data are highly skewed, with increasing concentration in a small but somewhat variable set of municipalities over time. Spatially, the total dollar values suggest a pattern of northwestern and central emphasis, but the counts' locations are far more variable, with no northwestern emphasis. The per capita figures follow much the same trends as the total dollar values. These dollar values and counts seem to vary based on the capitalization required for types of industries, so that high values and high per capital values have different spatial patterns from the simple counts. Since the original data do not specify the specific industries of the reported firms, however, we can only speculate about the identity of the different industries based on historical knowledge of the municipalities. This discussion is reserved, however, for the discussion of the separate Secondary Sector analyses, in which the Tertiary Sector firms do not complicate matters.

4.3.4 Separate Secondary Sector Analyses, 1820-1840

The available data permit some analysis of the Secondary Sector alone, but only for the 1820, 1830, and 1840 years. Table 4.22 reports the total values of the whole sector, and also the totals of the three types reported in the Grand List (mills, distilleries, and manufactories), as discussed in Chapter 3. As can be seen there as well as here, the minimums and medians of the total values varied slightly over this twenty-year period, while the maximums, means, standard deviations, and totals rose substantially. Looking at the types shows that this growth rested almost entirely on the increase in the value of

Table 4.22. Descriptive Statistics of Secondary Sector Dollar Values, 1820-1840

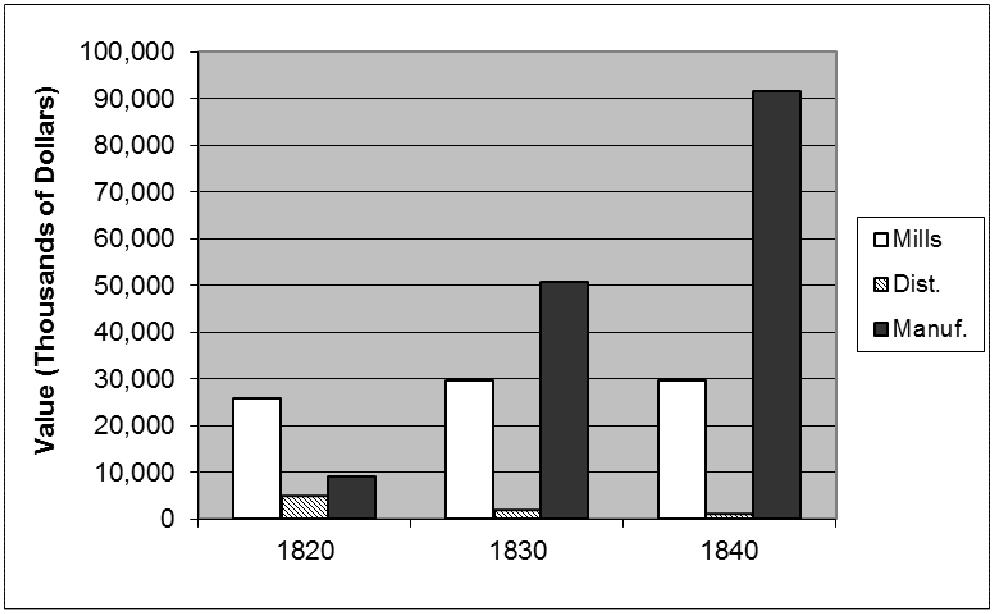
Statistic	1820	1830	1840
N	122	130	139
Total – Min	23,333.33	28,800.00	25,000.00
Total – Max	1,571,666.67	4,350,766.67	8,040,000.00
Total – Mean	326,309.38	632,784.19	879,099.64
Total – Median	221,666.66	429,333.33	372,350.00
Total – SD	301,163.19	792,198.21	1,287,473.73
Total – Sum	39,809,744.60	82,261,944.32	122,194,850.03
Mills – Min	23,333.33	0.00	0.00
Mills – Max	1,203,668.67	1,154,800.00	1,406,666.67
Mills – Mean	212,340.65	227,981.37	214,012.79
Mills – Median	159,166.67	156,666.67	139,566.67
Mills – SD	170,979.24	205,899.81	238,282.72
Mills – Sum	25,905,559.61	29,637,577.66	29,747,777.71
Distilleries – Min	0.00	0.00	0.00
Distilleries – Max	816,666.67	183,333.33	416,666.67
Distilleries – Mean	39,158.20	14,338.20	6,853.72
Distilleries – Median	1,000.00	0.00	0.00
Distilleries – SD	102,448.82	32,819.98	36,576.77
Distilleries – Sum	4,777,299.97	1,863,966.64	952,666.64
Manufactories – Min	0.00	0.00	0.00
Manufactories – Max	942,033.33	4,188,333.33	8,040,000.00
Manufactories – Mean	74,535.52	390,464.62	658,233.13
Manufactories – Median	15,166.67	106,166.67	159,000.00
Manufactories – SD	159,168.39	731,937.23	1,239,249.36
Manufactories – Sum	9,093,333.35	50,760,400.02	91,494,405.68

All values are in dollars as originally reported.

manufactories, as the value of mills barely rose, and those of distilleries fell substantially. Figure 4.29 illustrates this in a bar chart, showing how the total value of manufactories shifted from less than half that of mills in 1820, to much more than mills in 1830, to three times as much in 1840, all while the value of mills remained roughly constant and that of distilleries, never very large, grew smaller. This indicates that the growth in the secondary sector over this period came mainly from investments in manufacturing. The steady value of the mills is consistent with the value of the Primary Sector over this period, which remained roughly stable; though it was still vastly larger than the Secondary and Tertiary Sectors, at least in value for tax purposes, there was no apparent call for expansion of primary processing facilities.

Histograms of the Secondary Sector data were presented in Figure 3.3. There, it can be seen that the Secondary Sector values were much less skewed than those of the

Figure 4.29. Total Dollar Value of Secondary Firms by Type, 1820-1840.



Tertiary Sector. This probably results from the fact that small agricultural processing facilities (grist mills, saw mills, etc.) tended to be located close to the materials. Overall, the implication is that the patterns seen in the combined SecTer dollar values was mainly a result of the Secondary Sector values, with the Tertiary Sector values adding large amounts to only a few municipalities (as is discussed in more detail in the following section). The three Secondary Sector histograms do, however, show increasing skewness toward the smaller end of the scale over time, while the raw numbers in Table 4.22 showed increasing values in each category except for the minimums and medians (which fell in 1840). These patterns strongly suggest increasing concentration of total Secondary Sector activity over time, much as occurred with the population. In Table 4.23, the maximal cohorts and statistics for the total Secondary Sector dollar values are reported. In each year, if these dollars were evenly distributed among the municipalities, the

Table 4.23. Maximal Cohorts and Statistics for Total Secondary Sector Dollar Values, 1820-1840

	1820	1830	1840
Cohort %	28.82%	35.42%	38.44%
% if Even	8.20%	7.69%	7.19%
Min (10)	813,966.66	1,578,000.00	2,983,083.34
Max	1,571,666.67	4,350,766.67	8,040,000.00
#1	East Windsor	*Thompson*	**New Haven**
#2	Canaan	**Norwich**	Thompson
#3	East Hartford	*Killingly*	**Norwich**
#4	Chatham	*Windham*	Killingly
#5	**Middletown**	**Hartford**	Windham
#6	**New Haven**	**Middletown**	**Hartford**
#7	**Hartford**	*Pomfret*	*Plainfield*
#8	**Norwich**	*Griswold*	**Middletown**
#9	Enfield	**New Haven**	*Canton*
#10	Newtown	*Glastonbury*	*Windsor*

Bold items persist across all years; italicized items were not present in the next preceding year; city-containing places are underlined.

maximal cohorts should have included between 7.19% and 8.20% of the total. Instead, they included between 28.82% and 38.44%, indicating that the municipalities with the ten highest total dollar values held a disproportionate amount of the total. The city-containing municipalities of Hartford, Middletown, New Haven, and Norwich appeared in every maximal cohort; otherwise the membership was variable, with multiple textile-manufacturing places appearing in 1830 and 1840, but not to the exclusion of all other places.

The Secondary Sector total dollar values are mapped in Figure 4.30 by standard deviation, with the maximal cohort municipalities noted. Places in the north-central part of the state are consistently included in these cohorts, and in 1830 and 1840 the northeastern textile-manufacturing municipalities are strongly represented. The mean weighted centers and standard deviational ellipses in Figure 4.31 reflect the spatial biases seen in the maps of the values, with only the 1820 point and ellipse approximating those of the total economy or SecTer data sets; the 1830 and 1840 points and ellipses clearly are shifted toward the northeast, although all three retain the northwest to northeast orientation of most of the data sets.

The level of concentration of the Secondary Sector dollar values is also very different from type to type, as can be seen in Table 4.24. If investments in these types had been evenly distributed, the maximal cohort would have included less than 9% of the total in each year. In fact, however, the percentage of the total value of distilleries held by the municipalities with the ten largest totals is 63.92% in 1820, 59.72% in 1830, and 80.30% in 1840. The mills type produced maximal cohort percentages of 24.94% in

1820, 25.67% in 1830, and 31.13% in 1840. The manufactories' percentages were 56.49%, 49.86%, and 47.34%. The maximal cohort percentages for SecTer dollar values, discussed in the prior section, are clearly the product of interaction among the three types' varying percentages, as well as the influence of the tertiary values. The Mills type pushes the combined figures down somewhat, though less effectively over time, as the statewide type totals become more skewed toward manufactories. Also, the identity of the maximal cohort members in each type shows considerable variation from decade to

Figure 4.30. Maps of Secondary Sector Total Dollar Values, with Maximal Cohorts, 1820-1840.

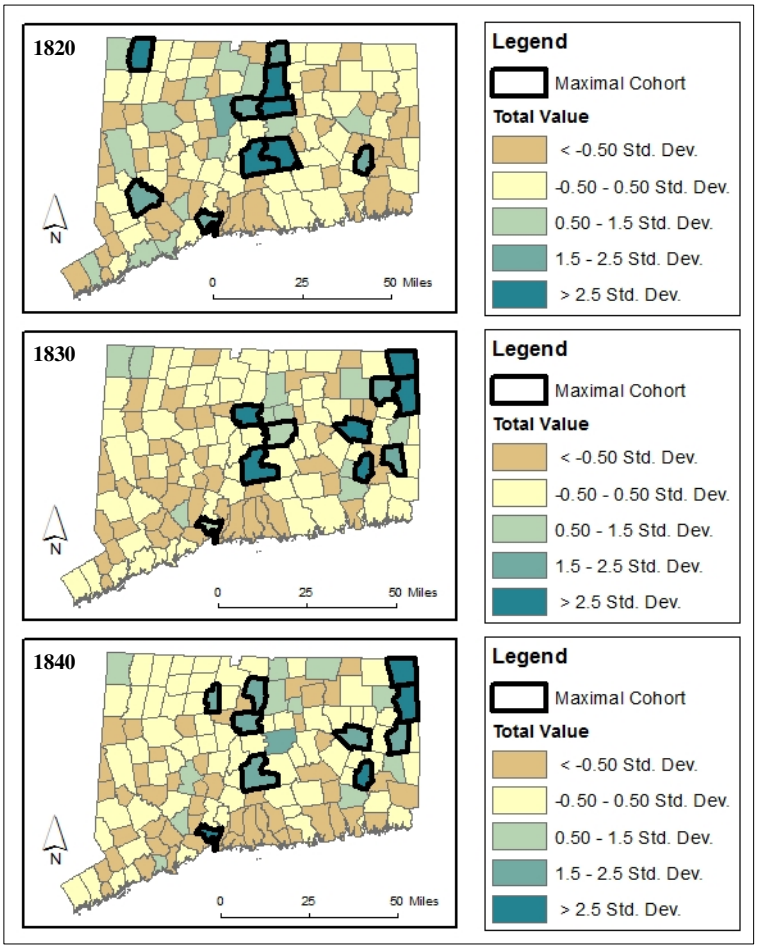
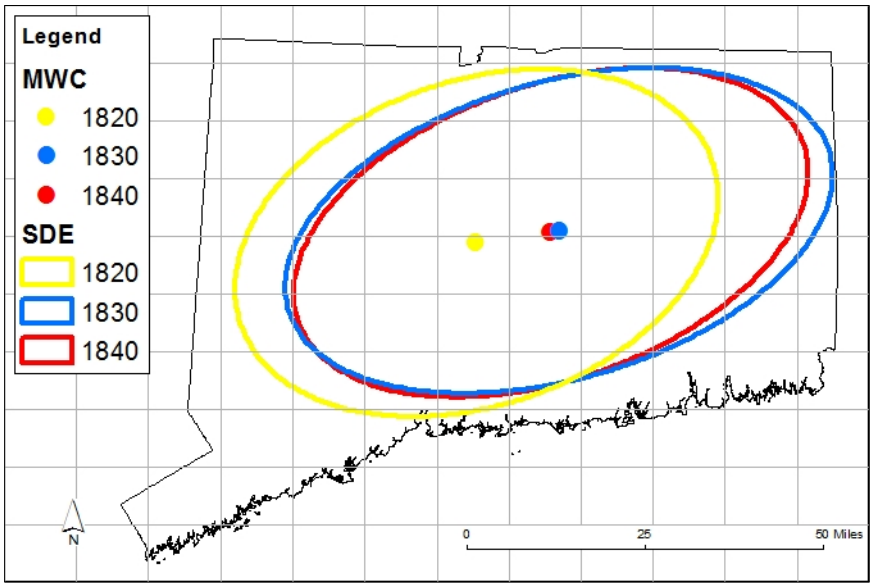


Figure 4.31. Map of Mean Weighted Centers and Standard Deviational Ellipses for Secondary Sector Total Dollar Values, , 1820-1840.



decade (see Table 4.24 again). In fact, the smallest amount of change was in the Manufactories category, and only four municipalities appeared in all three lists: New Haven, Norwich, Middletown, and Hartford, all of which were high-population cities. A further three of these were the same in 1840 as they had been in 1830, while three more were new entrants in that year. Geographically, as we will see in later sections, the newer entrants in 1830 and 1840 were mainly in the northeastern part of the state, where the textile industry was taking root in previously rural municipalities.

Spatially, Figure 4.32 shows the categories' patterns in maps classified by standard deviation. Mills show considerable variation, with some emphasis on the north-central part of the state in 1830 and 1840. The Distilleries maps, of course, show the limited number of such facilities, and also indicate considerable concentration in the

Table 4.24. Maximal Cohorts and Statistics of Secondary Sector Total Dollar Values By Type, 1820-1840

Year	1820			1830			1840		
Type	**Distill.**	**Mills**	**Manuf.**	**Distill.**	**Mills**	**Manuf.**	**Distill.**	**Mills**	**Manuf.**
% of Total	63.92%	24.94%	56.49%	59.72%	25.67%	49.86%	80.30%	31.13%	47.34%
% if Even	8.20%	8.20%	8.20%	7.69%	7.69%	7.69%	7.19%	7.19%	7.19%
Min (of 10)	123,333.33	503,333.33	211,366.67	54,433.33	609,233.33	1,449,200.00	25,333.33	560,000.00	2,619,000.00
Maximum	816,666.67	1,203,668.67	942,033.33	183,333.33	1,154,800.00	4,188,333.33	416,666.67	1,406,666.67	8,040,000.00
#1	East Windsor	**East Hartford**	Canaan	New Haven	**East Hartford**	**Norwich**	*East Windsor*	Windsor	**New Haven**
#2	**Enfield**	East Windsor	**New Haven**	*Hartford*	*Suffield*	*Thompson*	**Granby**	**East Hartford**	Thompson
#3	Hartford	Fairfield	Chatham	**Granby**	*Hartford*	*Killingly*	**Enfield**	Sterling	**Norwich**
#4	Windsor	Newtown	**Middletown**	Windsor	Newtown	*Windham*	*Burlington*	Hartford	Killingly
#5	**Farmington**	Norwich	Stratford	**Enfield**	*Sterling*	**Middletown**	*New London*	Woodstock	*Plainfield*
#6	Killingly	Stamford	Salisbury	*Simsbury*	*Woodstock*	**Hartford**	*Cheshire*	**Windham**	**Middletown**
#7	New Haven	New Milford	**Hartford**	*Berlin*	*Greenwich*	*Griswold*	**Farmington**	Greenwich	Windham
#8	Chatham	Canaan	**Norwich**	**Farmington**	*Windsor*	**New Haven**	*Avon*	Suffield	**Hartford**
#9	**Granby**	**Windham**	New London	*New Milford*	East Windsor	*Pomfret*	*Derby*	*Montville*	*Canton*
#10	Southington	Derby	Danbury	Southington	**Windham**	Salisbury	*Bristol*/Simsbury	*Farmington*	*Glastonbury*

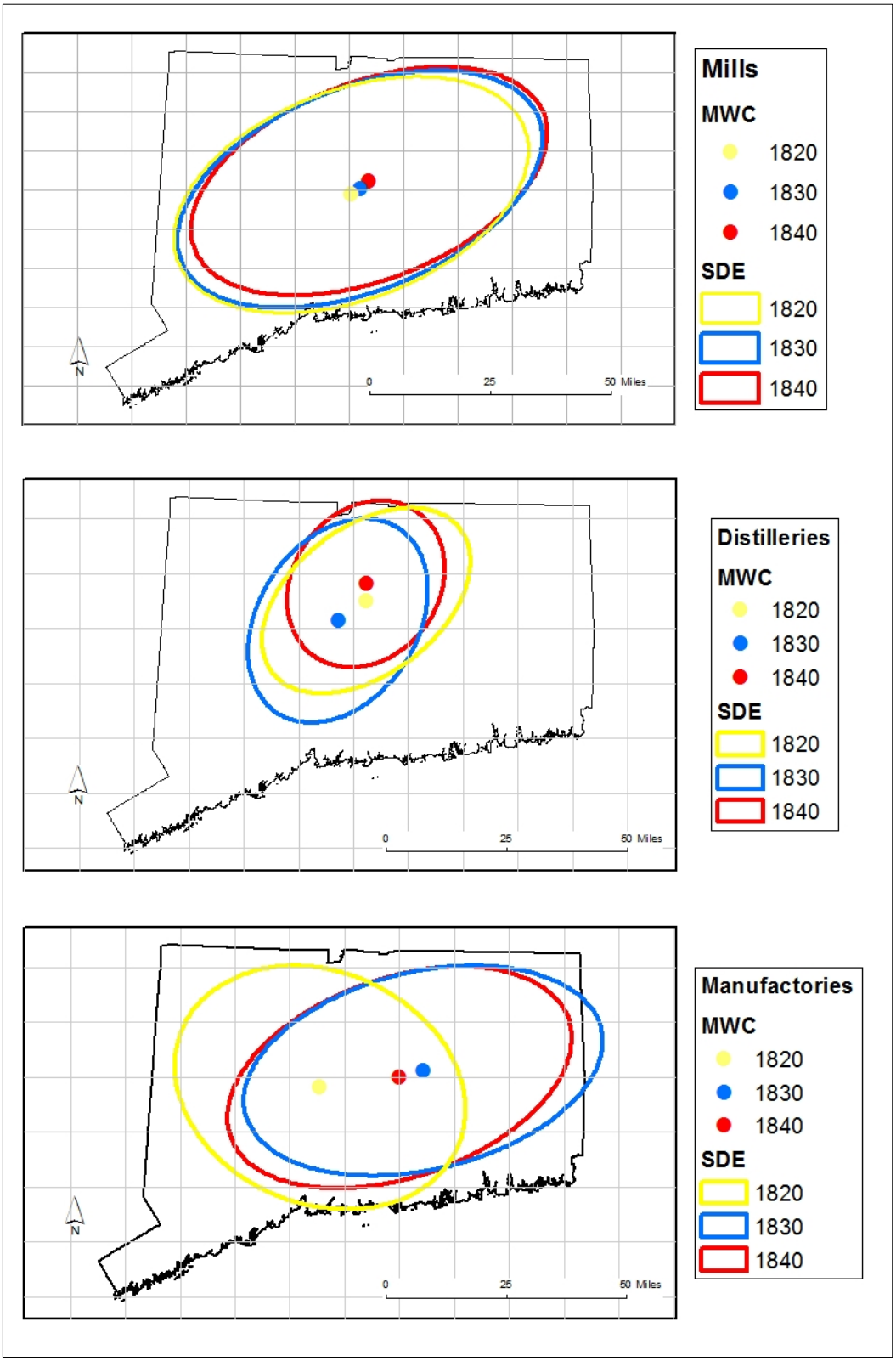
For each category, italicized entries are new compared with the prior year; bolded entries appear in all three years; city-containing places are underlined.

Figure 4.32. Maps of Secondary Sector Dollar Values by Type, Classified by Standard Deviation, 1820-1840.

north central part of the state. Manufactories, like Mills, show considerable variation across space, but in 1830 and 1840 (when textile mills were included in the valuations) show most of the highest values in the north central and northeastern parts of the state. The spatial arrangements of these three types are also expressed in Figure 4.33, which shows the mean weighted centers and standard deviational ellipses for each Secondary Sector type and study year. These points and ellipses illustrate how relatively consistent the other data sets are by the way those for the Distilleries have very different point locations, axial distances, and also directions – these all focused more toward the north-central part of the state than any other data. The 1820 Manufactories point and ellipse are also of interest, as they reflect, most likely, the absence of the textile manufacturing firms (concentrated in the northeast) from the dollar value data set.

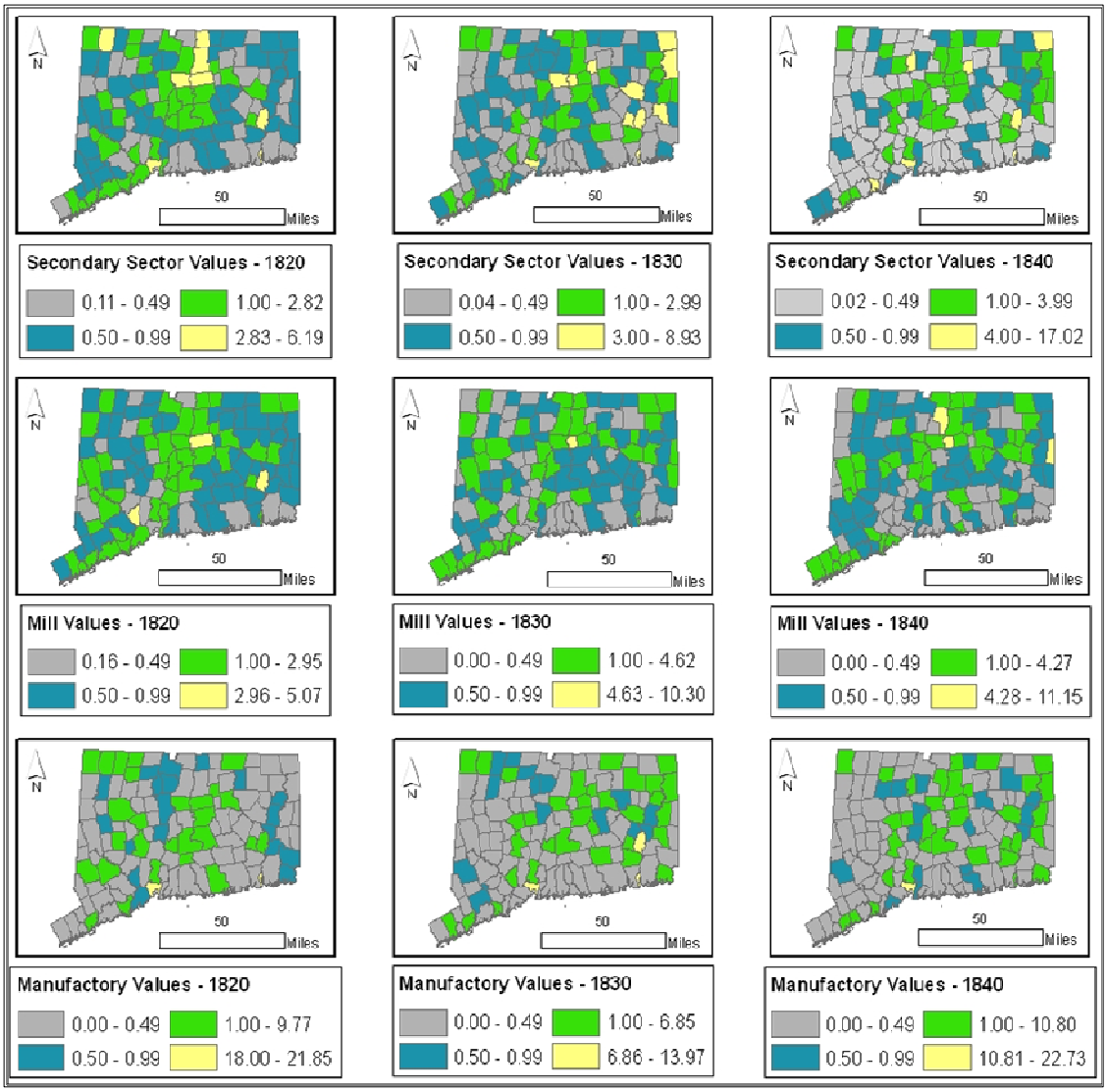
Moving into the inferential statistical analyses, distilleries will be omitted because so many municipalities had none at all (by 1840, 106 out of 139 had none) and, in addition, their locational patterns are already clear from the descriptive mapping. Beginning with the location quotient and focal location quotient calculations for the Secondary Sector total dollar values, the Mills values, and the Manufactories values, we find that the vast majority of the municipalities return values of less than one, which is consistent with the above-mentioned concentration of Secondary Sector activity in a small number of municipalities. These analytical results are mapped in Figure 4.34 for the location quotient and Figure 4.35 for the focal location quotient. As with the previous sets of results, there are few differences between the LQ and FLQ for these data. Although the values defining the mapped categories are sometimes slightly different, the

Figure 4.33. Maps of Mean Weighted Centers and Standard Deviational Ellipses by Secondary Sector Type, 1820-1840.



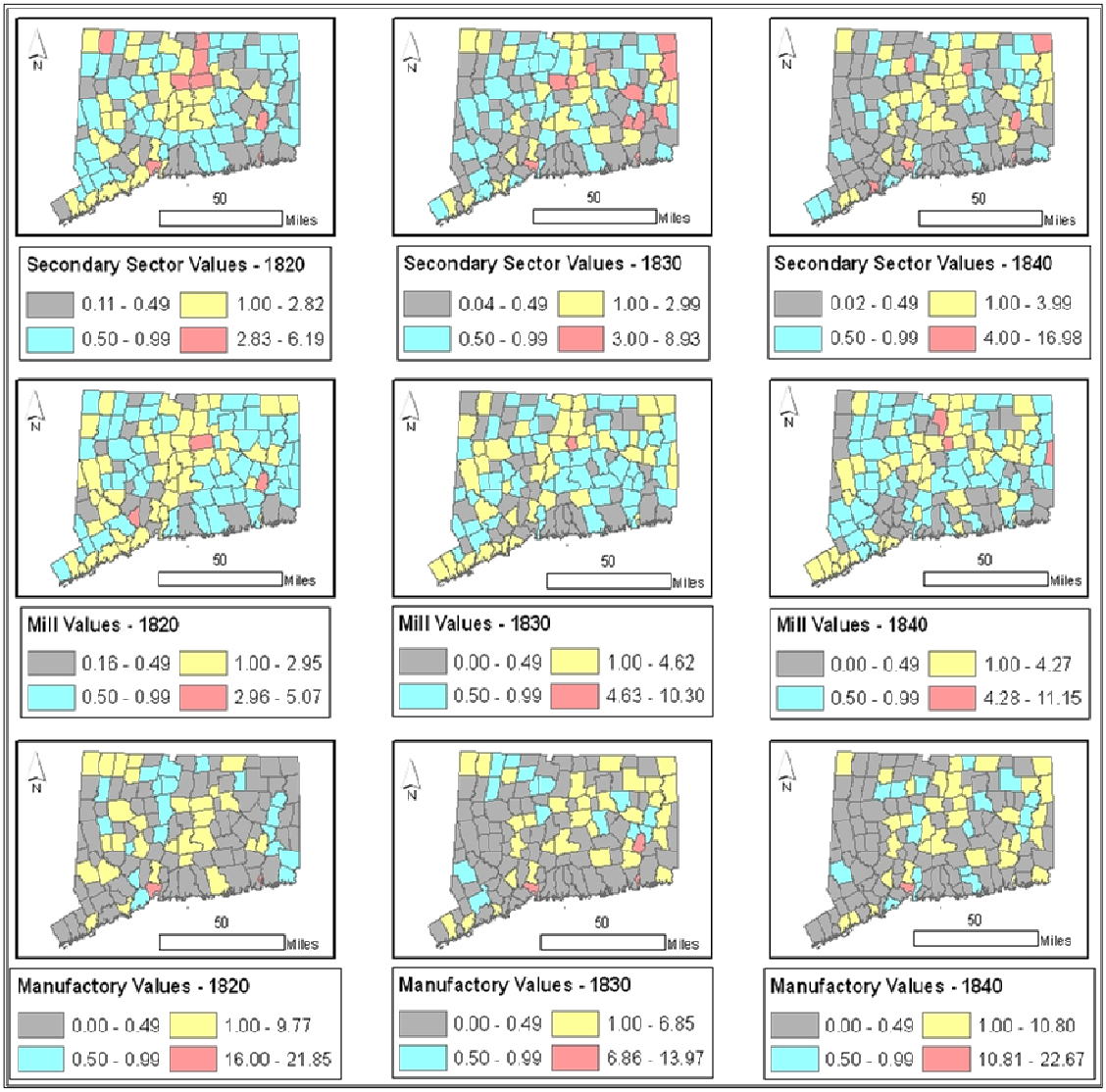
membership of the categories remains the same except in two cases: in 1820, the Manufactory FLQ for Roxbury rises above 1, while in 1840, the Mill FLQ for Roxbury drops below 1. Consistent patterns are difficult to discern in these maps, even though only a relatively small number of municipalities have LQ or FLQ values greater than 1 – no more than forty-seven for both in the Mills category in 1820, with minimums of

Figure 4.34. Location Quotient Results for Secondary Sector Total Dollar Values, Mill Values, and Manufactory Values, 1820-1840.



twenty-nine (LQ) and thirty (FLQ) for Manufactories in 1820. As was previously noted, outside of a handful of consistently-present municipalities, the identity of the municipalities with the largest dollar values of Secondary Sector activity showed great volatility from year to year, so this lack of obvious patterns in these measures is consistent with that trend.

Figure 4.35. Focal Location Quotient Results for Secondary Sector Total Dollar Values, Mill Values, and Manufactory Values, 1820-1840.



The general analyses of spatial trends for the total Secondary Sector dollar values, Mill dollar values, and Manufactory dollar values are reported in Table 4.25 (distilleries once more being omitted because there are too many zero values). At a Zone of Indifference of 20 miles, the Getis-Ord General *G** statistic shows no statistically

Table 4.25. Results of Separate Secondary Sector General Spatial Analyses, 1820-1840

(a) Total Secondary Sector Dollar Values (ZI 20 miles)

	1820	1830	1840
*General G**			
Obs. G*	0.203452	0.203238	0.199940
Z score	1.494148	0.812939	0.671565
p-value	0.135137	0.416253	0.501861
Moran's *I*			
I	0.065050	0.073940	0.031544
Z score	3.158279	3.865363	1.945884
p-value	*0.001587*	*0.000111*	*0.051669*

(b) Mill Dollar Values (ZI 20 miles)

	1820	1830	1840
*General G**			
Obs. G*	0.192999	0.190814	0.208455
Z score	0.476776	-0.149928	1.711429
p-value	0.633521	0.880821	*0.087002*
Moran's *I*			
I	0.017284	0.046952	0.095518
Z score	1.120338	2.523905	5.112153
p-value	0.262570	*0.011606*	*0.000000*

(c) Manufactory Dollar Values (ZI 20 miles)

	1820	1830	1840
*General G**			
Obs. G*	0.201948	0.228156	0.196492
Z score	0.457247	1.565914	0.320683
p-value	0.647493	0.117369	0.748451
Moran's *I*			
I	0.013268	0.070819	0.011715
Z score	0.974609	3.752250	0.961289
p-value	0.329754	*0.000175*	0.336407

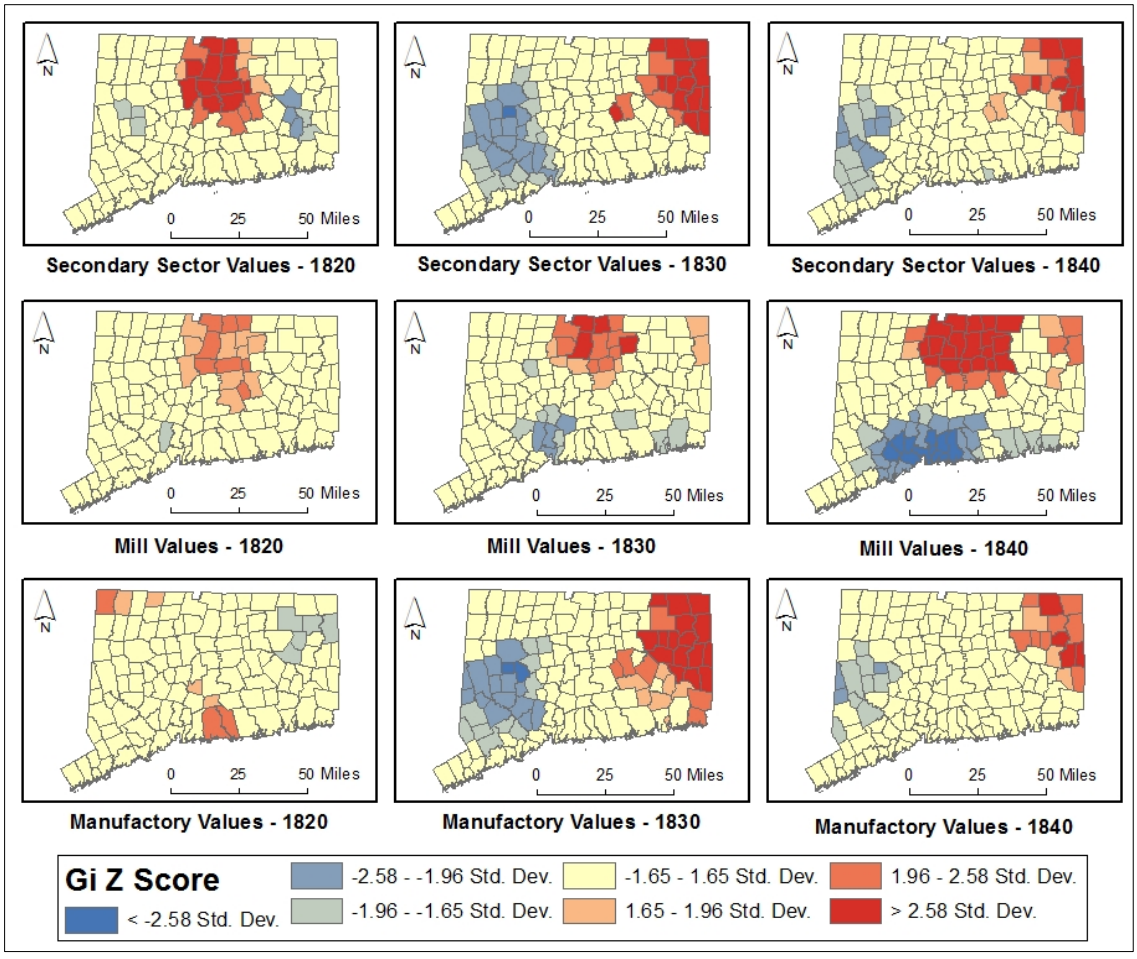
Significant p-*values are presented in italics.*

significant clustering of values in any category except in Mills in 1840, when clustering of high values was found with 90% confidence. In contrast, most of the global Moran's *I* tests for spatial autocorrelation found clustering of values; only the Mill and Manufactory data in 1820 indicated random spatial distributions, and in 1830 only the Manufactory data did. As we have seen in previous analyses in this study, the general statistics tend to mask patterns that appear in the local statistics, especially where the Getis-Ord G* measure is concerned.

Figure 4.36 presents maps of the local Getis-Ord G_i* results, which show some interesting contrasts to the spatial patterns found in the combined Secondary + Tertiary Sector data discussed above. First, unlike the combined-sector dollar value data, there are statistically significant value clusters found with a twenty-mile Zone of Indifference, rather than the ten-mile one. Second, the total Secondary Sector dollar values' patterns closely resemble those found in the *per capita* analysis of the SecTer dollar values. In addition, the Mill values and Manufactory values show interesting spatial patterns. The Manufactory values for 1830 and 1840 closely resemble the total Secondary Sector patterns for those years; 1820 does not match, but it must be recalled that this data set omits the tax-exempt textile factories, which is likely to affect each of these analyses. The Mill values show very different patterns, with high values clustering in the north central part of the state in all three years; a secondary cluster of high values in the northeast corner of the state in 1830 and 1840; and clustering of low values along the coastline in 1830 and 1840, especially in 1840 in a region centered on New Haven.

Consistent with the changes in the relative total values of the Mill and Manufactory types discussed above, the Mill value clustering seems to influence the total Secondary Sector clustering in 1820, undoubtedly with assistance from the Distillery type, which even in raw dollar values was plainly clustered in the north-central part of the state. The local Getis-Ord G_i* patterns are echoed in the local Moran's *I* analyses, shown in Figure 4.37. Most of the statistically significant local results reflect adjacent high/high values, focused

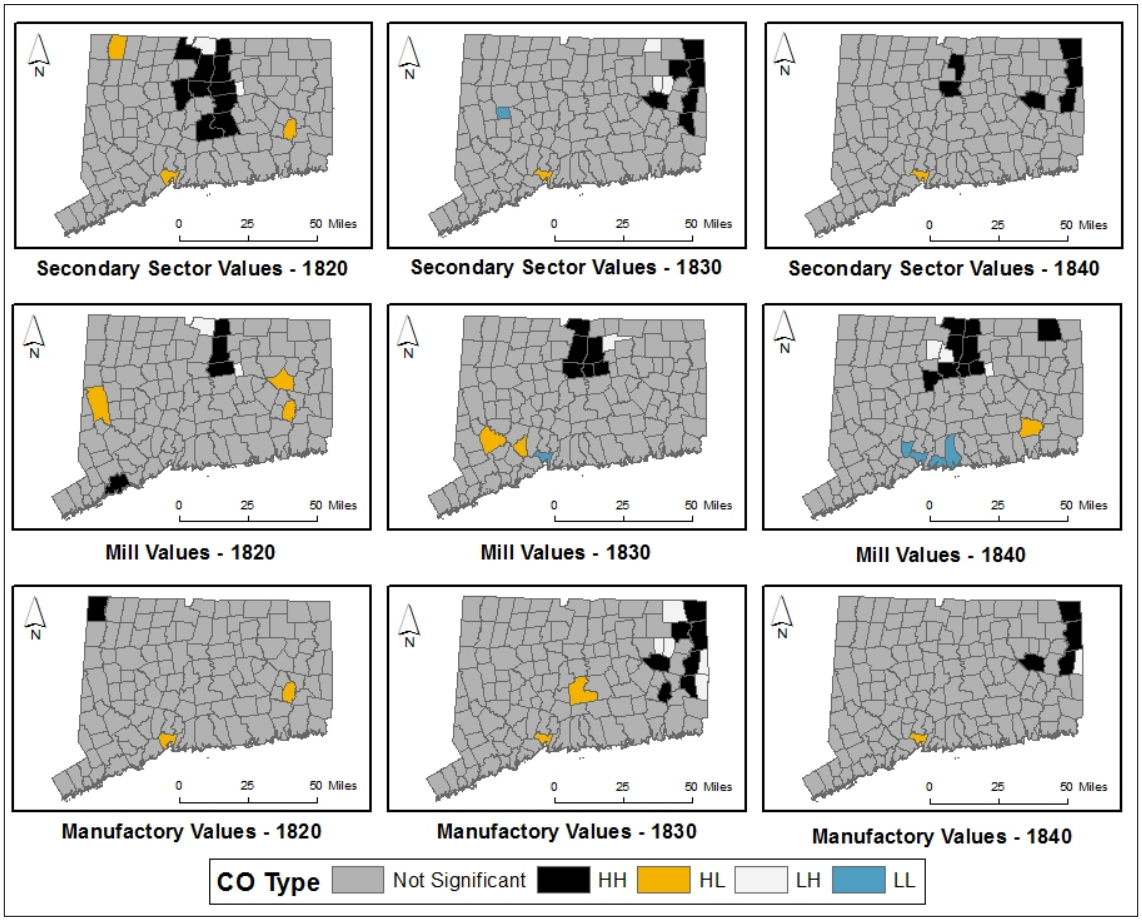
Figure 4.36. Maps of Local G* Results for Secondary Sector Total Dollar Values, Mill Values, and Manufactory Values 1820-1840.



around the high-value cluster areas found with the local G_i* statistics. The results involving adjacent low values, however, only follow the low-value clustering patterns in a few cases, most notably the 1830 and 1840 Mill values.

As has already been noted, separate Secondary Sector firm counts are also available for 1820, 1830, and 1840 only, and represent mills (minimum of 1), distilleries (minimum of zero), and manufactories (minimum of zero). Table 4.26 provides the

Figure 4.37. Maps of Local Moran's *I* Results for Secondary Sector Total Dollar Values, Mill Values, and Manufactory Values 1820-1840.



descriptive statistics for the total number of Secondary Sector firms reported in each year by sector, and Figure 4.38 illustrates their locational characteristics. There were more Secondary Sector firms in Connecticut than there were Tertiary Sector firms, but the similar skew toward the more numerous low numbers that was seen in the SecTer values is also seen here. The maps show how the Distilleries' locations were quite volatile across this time period, while the Mills and Manufactories were somewhat volatile in comparison. It should be noted that the absence of high values in the northeastern corner of the state in 1820 may be a result of missing information, as textile mills were exempt from taxation in that year, and their number and values are believed to have gone unrecorded. Also notable is the fact that in these maximal cohorts, city-containing municipalities appear only in the Manufactories category, which was not the case with the total dollar values for the Secondary Sector. This suggests a quite different economic emphasis than in the municipalities with high numbers of Mills or Distilleries, in which a few very valuable Distilleries or Mills might be present but not a large number of less valuable (presumably smaller) such firms.

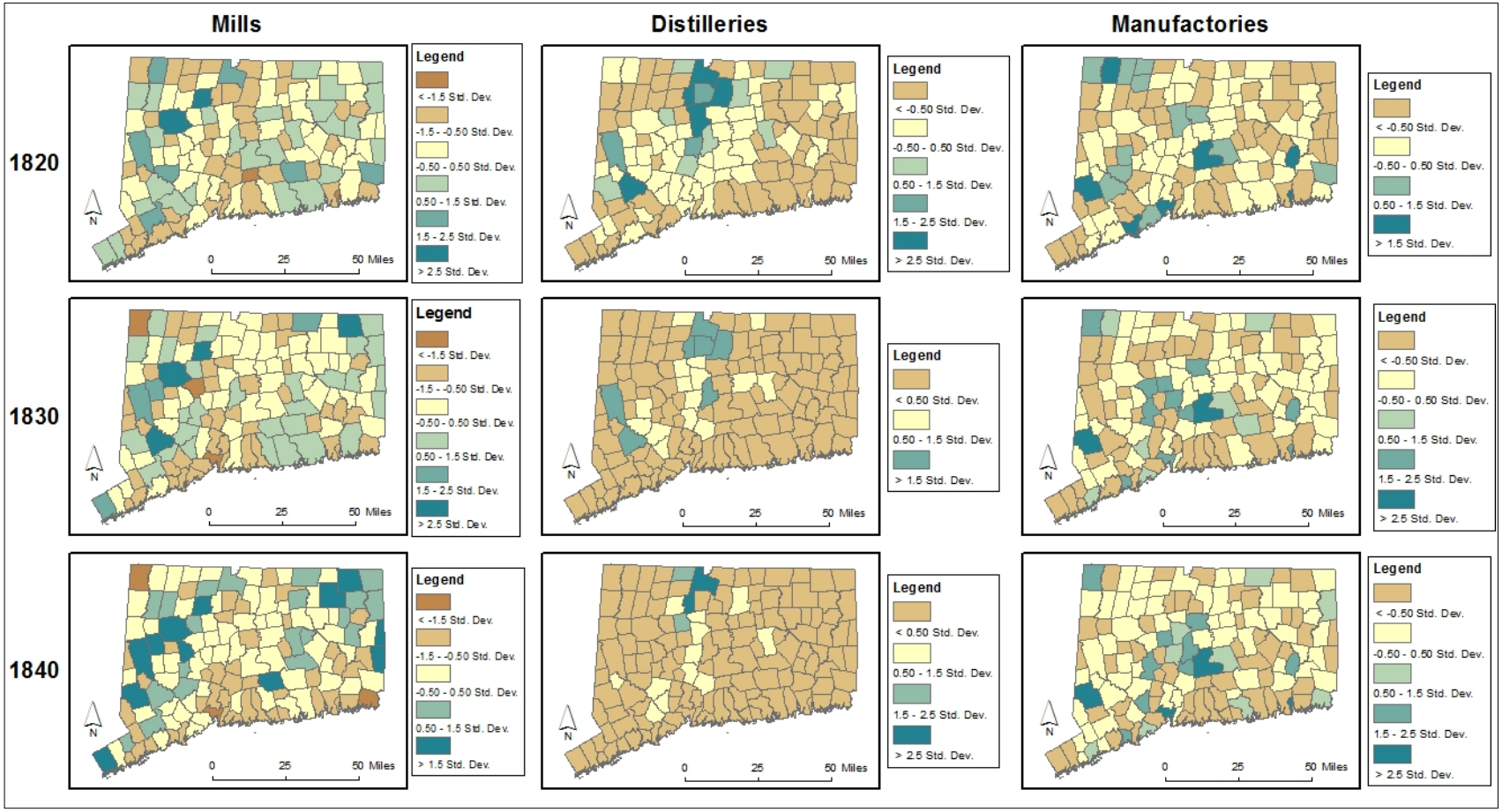
The relative proportions of the counts of these types are also of interest with respect to the industrialization of Connecticut, and are shown in Figure 4.39**.** In 1820, Mills outnumbered Manufactories by more than half; in 1830, their numbers were roughly equal (unlike the values, discussed above, in which manufactories overtook Mills by that year); and in 1840 the number of Manufactories was noticeably larger (by 495) – all while the number of Mills varied only slightly, and the relatively small number of

Table 4.26. Secondary Sector Maximal Cohorts Of Counts of Firms By Type, 1820-1840

Year	1820			1830			1840		
Type	**Distill.**	**Mills**	**Manuf.**	**Distill.**	**Mills**	**Manuf.**	**Distill.**	**Mills**	**Manuf.**
Minimum	12	23	17	9	23	41	5	23	55
Maximum	41	41	62	49	42	115	42	39	119
Sum (All)	384	1,548	673	336	1,597	1,466	168	1,510	2,005
Mean (All)	3	12.8	5.6	2.6	12.3	11.3	1.2	10.9	14.4
Percentage	52%	17.8%	47%	55.96%	18.5%	37.96%	68.70%	18.48%	35.58%
#1	**Granby**	**New Hartford**	Danbury	**Granby**	**New Hartford**	Danbury	**Granby**	Woodstock	**New Haven**
#2	**Canton**	**Litchfield**	**New Haven**	**Canton**	*Newtown*	**Middletown**	**Canton**	**New Hartford**	*Danbury*
#3	Farmington	**New Milford**	**Middletown**	Newtown	**Litchfield**	**New Haven**	Hartland	**Litchfield**	**Middletown**
#4	Windsor	Weston	**New London**	Simsbury	*Woodstock*	Norwich	Burlington	**New Milford**	**New London**
#5	Newtown	Canaan	**Stratford**	New Milford	*Greenwich*	**Hartford**	*Avon*	Washington	**Hartford**
#6	New Milford	Southbury	Norwich	Windsor	**New Milford**	*Bristol*	*New Hartford*	Greenwich	**Bridgeport**
#7	Simsbury	East Haddam	Canaan	Berlin	*Washington*	**Bridgeport** (= Stratford)	**Hebron**	*Danbury*	Waterbury
#8	Southington	North Stonington	Norfolk	**Hebron**	*Stafford*	*Waterbury*	*Derby*	*Haddam*	*Meriden*
#9	**Hebron**	Granby	**Hartford**	*Hartland*	*Pomfret / Windham /* Hebron	**New London**	*Oxford/ Cheshire/* **Southington**	*Sterling*	*Derby*
#10	Berlin	Hebron/Ashford	Salisbury	Farmington / Southington / *Burlington*		Salisbury		*Voluntown/ Watertown*	**Norwich**

Notes: The municipality lists include multiple places (or none) when two or more places in the 9th or 10th position have the same number of firms. For each category, italicized place names are "new" entries, which did not appear in the maximal cohort for that type in the immediately preceding study year; bold place names appeared in the maximal cohort for that category in all three study years; and city-containing places are underlined.

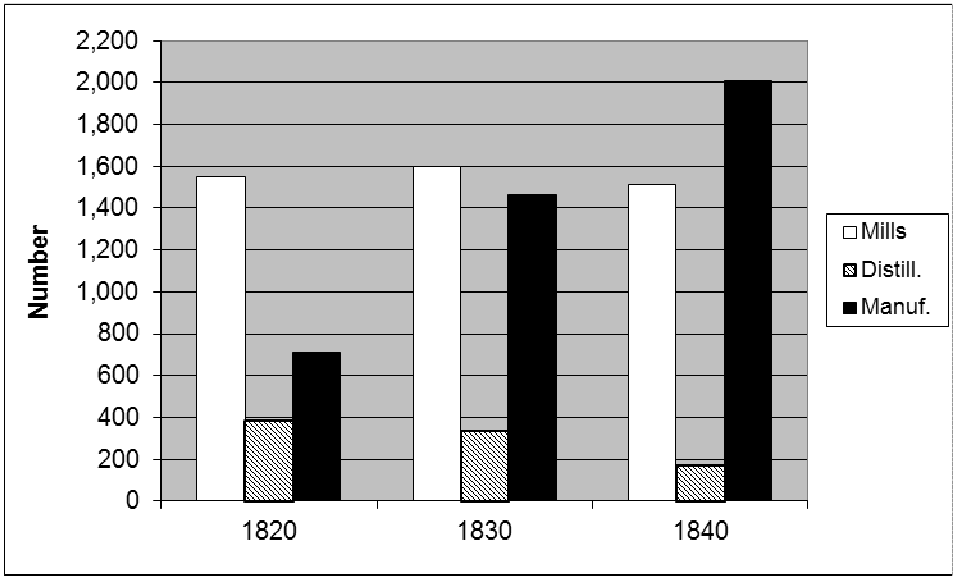
Figure 4.38. Maps of Secondary Sector Counts by Type, 1820-1840.



Distilleries shrank. As the values also showed, the Secondary Sector growth in number of firms clearly came from the Manufactory type, but the ultimate difference between Mills and Manufactories was smaller, proportionately, than was the case with the values. Distilleries shrank in number across the study period, and in each year were heavily concentrated in a relatively small number of municipalities. Indeed, many municipalities had no distilleries at all: 60 out of 122 in 1820, 80 out of 130 in 1830, and 106 out of 139 in 1840.

Between 1820 and 1840, the values and counts of Distilleries fell, those of mills held roughly steady, and those of manufactories increased. The scale of the change was much larger in dollar value than in counts, however, suggesting that numerous smaller, less valuable firms contributed to the changes. These data confirm that economic growth during this period came primarily from growth in manufacturing, and not from agricultural processing (mills) or from the shrinking distilling industry. Presumably,

Figure 4.39. Counts of Secondary Firms by Type, 1820-1840.



these trends continued into 1850, although separate Grand List data for these subcategories are not available for that year.

4.3.5 Tertiary Sector Analyses, 1810-1850

The Tertiary Sector data can be separated out for the years 1810 through 1840, with the caveat that the 1820-1840 data sets include assessments, while the 1810 set includes only stores. The descriptive statistics of these data sets are reported in Table 4.27, below. Again, direct comparison between 1810 and the other study years is untenable because of the different valuation method used, but the table shows that like the other years, it had a standard deviation much larger than its mean, and a median much lower than the mean, confirming the skewed distribution shown in Figure 3.1. The

Table 4.27. Statistics of Tertiary Sector Dollar Values, 1810-1840

Statistic	1810	1820	1830	1840
N	119	122	130	139
Total – Minimum	0.00	0.00	55.00	0.00
Total – Maximum	2,890.00	7,562,048.33	16,783,093.67	22,361,904.33
Total – Mean	131.68	221,195.99	375,836.86	569,442.37
Total – Median	50.00	37,221.67	41,134.67	66,080.84
Total – SD	349.32	888,048.02	1,739,066.11	2,729,957.05
Total – Sum	15,670.00	26,985,910.97	48,858,791.19	79,152,488.79
Stores – Minimum	0.00	0.00	0.00	0.00
Stores – Maximum	2,890.00	7,553,333.33	16,756,666.67	22,328,333.33
Stores – Mean	131.68	220,528.78	374,745.30	568,458.27
Stores – Median	50.00	35,166.67	40,666.67	65,833.34
Stores – SD	349.32	886,960.93	1,736,573.49	2,727,229.88
Stores – Sum	15,670.00	26,904,511.31	48,716,888.69	79,015,700.04
Assessments – Min	--	0.00	47.00	0.00
Assessments – Max	--	8,715.00	26,427.00	33,571.00
Assessments – Mean	--	942.22	1,091.56	984.09
Assessments – Median	--	624.00	574.00	339.50
Assessments – SD	--	1,184.36	2,567.19	3,068.71
Assessments – Sum	--	114,951.33	141,902.50	136,788.75

All values are in dollars as originally recorded.

relatively small size of the Assessments category in 1820-1840 is also highlighted here, along with the vastly increasing amounts of the Stores type over time.

As with the other data sets, we will look at the crude measure of concentration provided by the proportion of the total Tertiary Sector dollar values held by the maximal cohort (the municipalities with the ten largest values). These figures are provided in Table 4.28. There are few surprises here: the places with the largest values contain cities and/or ports, the ten largest hold very large percentages of the totals (rising from 60% to over 80%), and there was very little change in the identity of the ten municipalities from decade to decade. What change there was, occurred toward the bottom of the ten. The range represented by the minimum and maximum values of the maximal cohorts is also informative, as the distance between them is very large, reflecting the highly skewed nature of the distribution of these values.

The spatial patterns of the totals, Stores, and Assessments are shown in Figure 4.40, below. In most years for most categories, there are fewer than ten values that

Table 4.28. Maximal Cohorts for Tertiary Sector Total Dollar Values, 1810-1840

Year	1810	1820	1830	1840
Percentage	60.18%	79.27%	83.61%	84.44%
Minimum	245.00	305,090.33	518,954.00	572,590.00
Maximum	2,890.00	7,562,048.33	16,783,093.67	22,361,904.33
#1	**New Haven**	**Hartford**	**Hartford**	**Hartford**
#2	**Hartford**	**New Haven**	**New Haven**	**New Haven**
#3	**Norwich**	**New London**	**Norwich**	**Norwich**
#4	**New London**	**Middletown**	**Middletown**	**Bridgeport**
#5	**Middletown**	**Norwich**	**New London**	**Middletown**
#6	**Stratford**	**Stratford**	**Bridgeport**	**New London**
#7	**Norwalk**	Fairfield	*Farmington*	**Norwalk**
#8	Fairfield	**Norwalk**	**Norwalk**	Stonington
#9	Wethersfield	*Saybrook*	*Stonington*	*Westport*
#10	Guilford	*Litchfield*	Litchfield	*Waterbury*

Bold items persist across all years; italicized items were not present in the next preceding year; and city-containing places are underlined. Bridgeport and Stratford are considered identical for continuity purposes.

registered as significant higher than the mean, or even close to the mean. At the same time, the lower values do not show notable significant extremes; only the "less than 0.5 standard deviation" category is necessary to classify them. This illustrates how unusual it was for a municipality to have a high level of tertiary activity – even more unusual than high levels of secondary activity. The exception is the 1820 Assessments type, which had a much greater mix of values; why this changed in the succeeding years is uncertain. In terms of mean weighted centers and standard deviational ellipses, shown in Figure 4.41, the points are somewhat further south than is the case with the other economic data (probably reflecting a coastal bias), and the ellipses have shorter axial distances. Otherwise, the differences between the Totals and the Stores is negligible, because the Assessments amounts are so much lower; the Assessments' points and ellipses are slightly different from those of the Totals and Stores.

In analyzing the separate Tertiary Sector data for 1820, 1830, and 1840, it proved necessary to change the Zone of Indifference distance to ten miles, instead of the twenty miles used for the separate Secondary Sector data – but like that needed for the SecTer data sets. (The 1810 year is omitted because it presents only one category, Stores.) The location quotient results for the total Tertiary Sector dollar values, the Stores dollar values, and the Assessments dollar values are mapped in Figure 4.42. The total Tertiary Sector and Stores dollar value maps are identical for each year, while the Assessments dollar value maps are noticeably different. This is explained by the fact that the Stores dollar values are much larger than the Assessments dollar values; the Stores range from $0.00 (each year) to $22,328,333.00 (1840), while the Assessments range from $0.00 (1820 and 1840) to $33,571.00 (1840). In terms of dollar values, the Stores values

Figure 4.40. Maps of Total Tertiary, Stores, and Assessments Dollar Values, by Standard Deviation, 1810-1840.

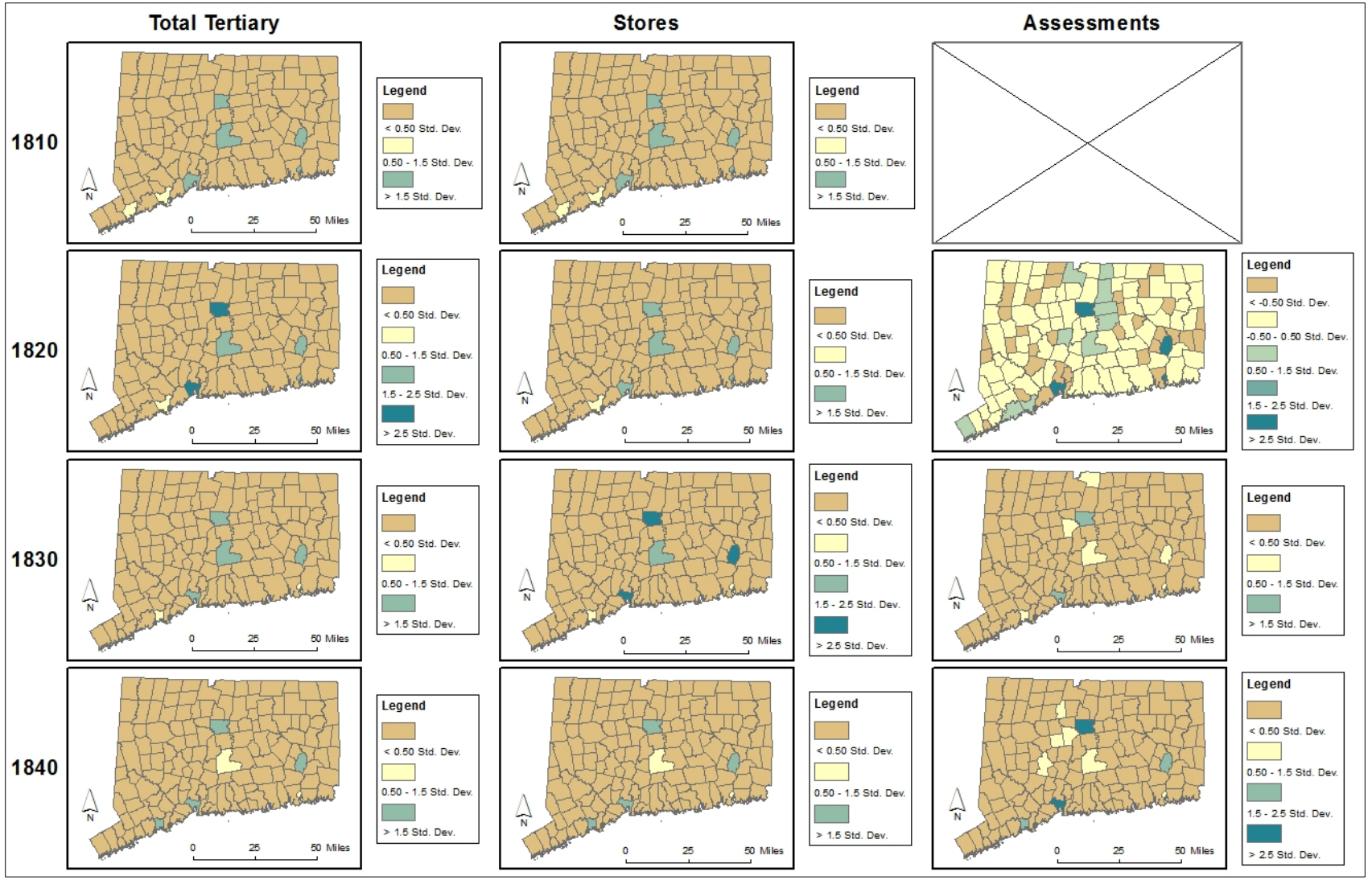


Figure 4.41. Maps of Mean Weighted Centers and Standard Deviational Ellipses for Total Tertiary, Stores, and Assessments Dollar Values, 1810-1840.

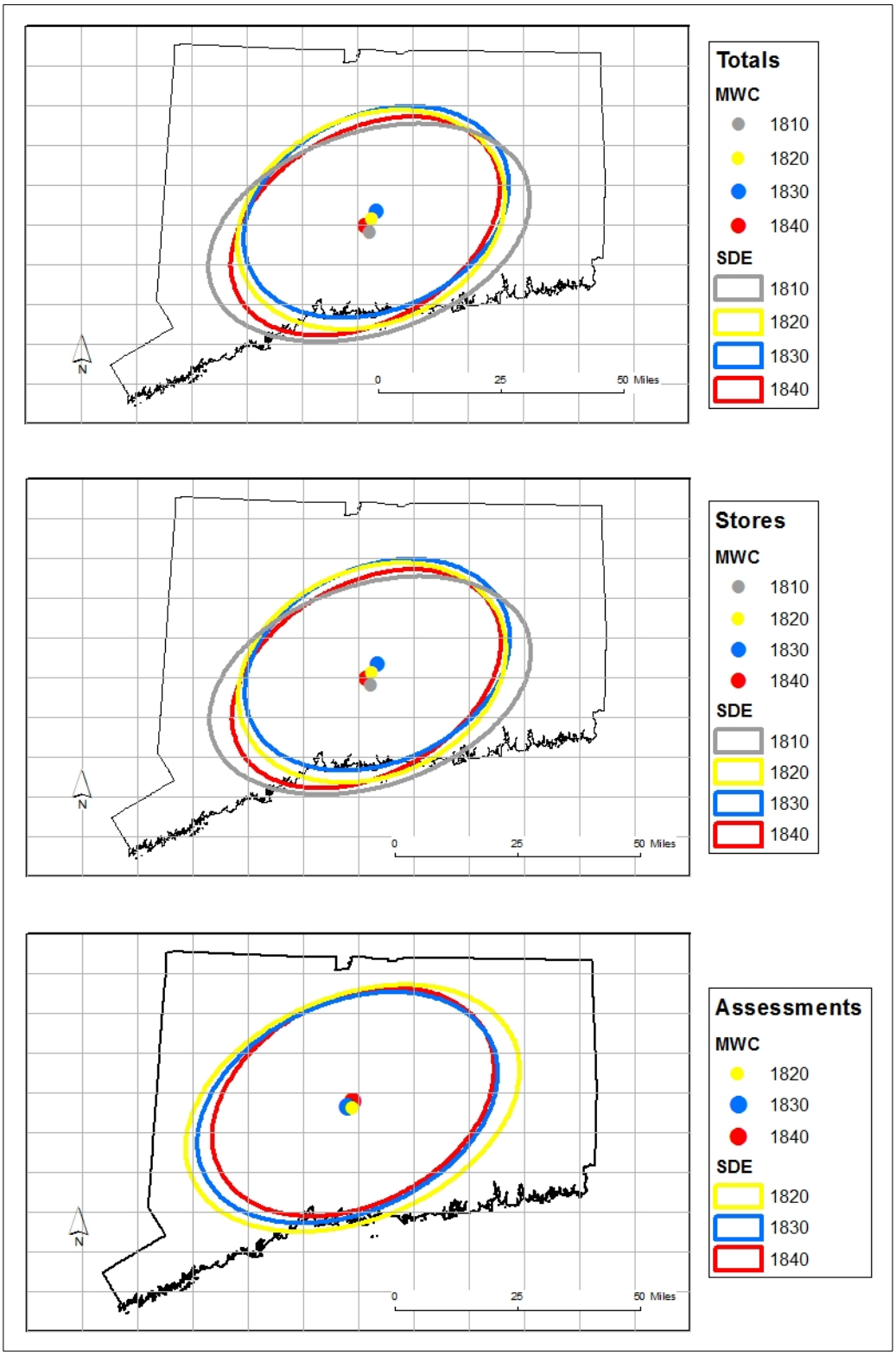
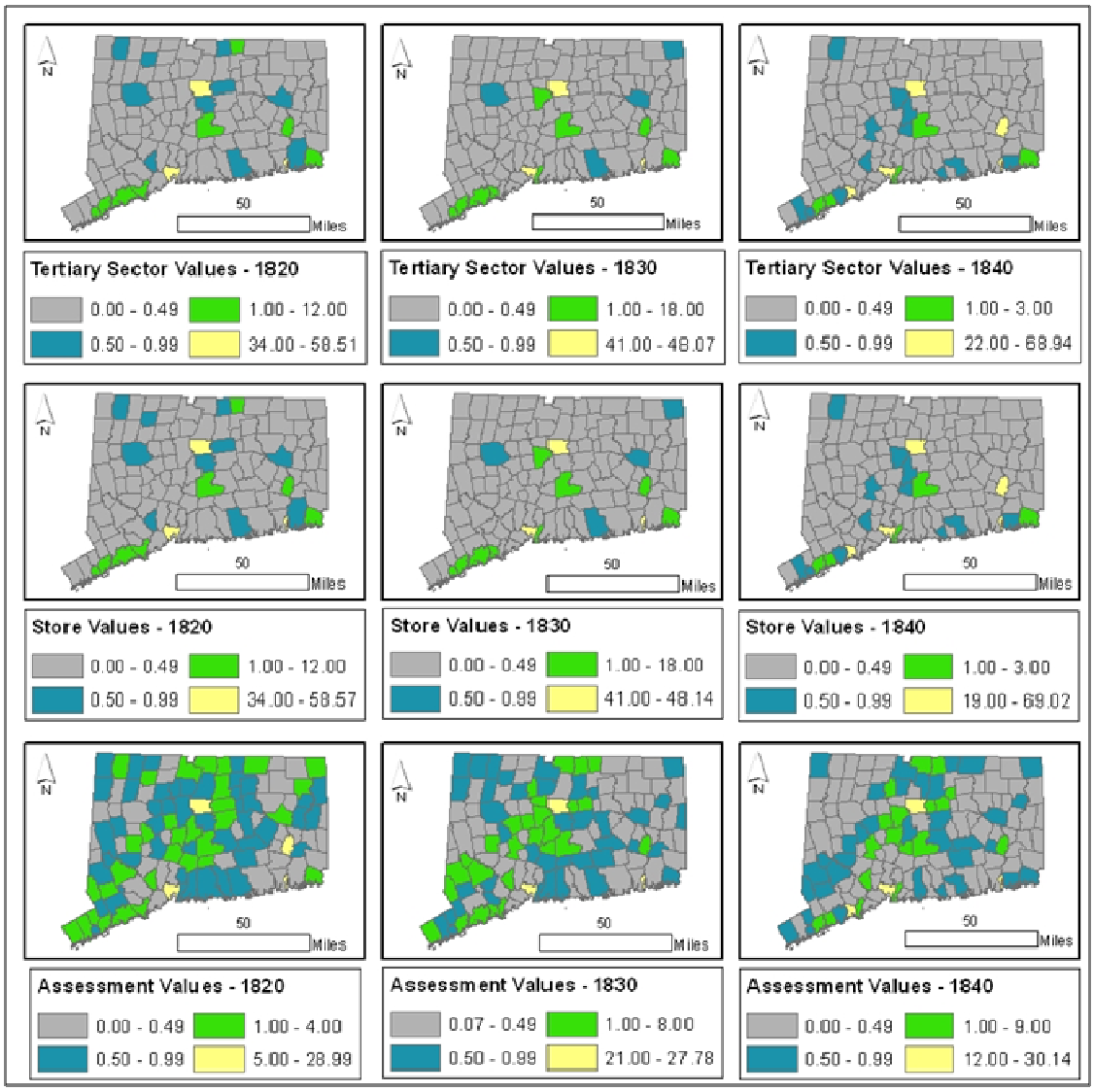


Figure 4.42. Location Quotient Results for Tertiary Sector Total, Store, and Assessment Dollar Values, 1820-1840.



dominate all the statistics when the two subcategories are combined. At the same time, the maps show that more municipalities have Assessments LQ values at or above the 1.00 mark than have Tertiary Sector or Stores LQ values in that range. Overall, the city-containing municipalities of Hartford, New Haven, New London, Bridgeport, and

Norwich have the highest LQ values, which is to be expected since, as we have seen, they had the largest total values. As with the previous data sets, the use of the focal location quotient statistic does not yield any significant changes; the only changes, in fact, are again in the classification of Roxbury, which in the 1820 Tertiary Sector and Assessments analyses shifted from less than one to the lower tier of the equal to or greater than one category, as shown in the maps in Figure 4.43. Both measures appear to show stronger Tertiary Sector activity in the southeast and north-central portions of the state, similar to other patterns seen in these economic data sets.

The analyses of clustering and spatial autocorrelation that were run on the Tertiary Sector data and its subcategories starkly revealed the influence of the Tertiary Sector on the SecTer data sets. As with the combined data, the Getis-Ord General *G** and general Moran's *I* analyses found no difference from a random distribution in any of the Tertiary categories, as can be seen in Table 4.29. In contrast, the separate Secondary Sector analyses did find a few instances of clustering and autocorrelation at the global level, as is discussed below. The local statistical analyses, however, do show some clustering according to the Getis-Ord Local G* statistic (using a ten-mile Zone of Indifference), and in patterns nearly identical to those shown in the SecTer analyses – and generally quite different from those in the separate Secondary Sector analyses. Figure 4.44 provides maps of the local G_i* results, showing the clustering of high values in the north-central part of the state, near Hartford, and the southwest part of the state, near New Haven, just as with the SecTer data. This pattern holds for the two sub-categories and for the full Tertiary Sector data. But the local Moran's *I* analyses, in

Figure 4.43. Focal Location Quotient Results for Tertiary Sector Total, Store, and Assessment Dollar Values, 1820-1840.

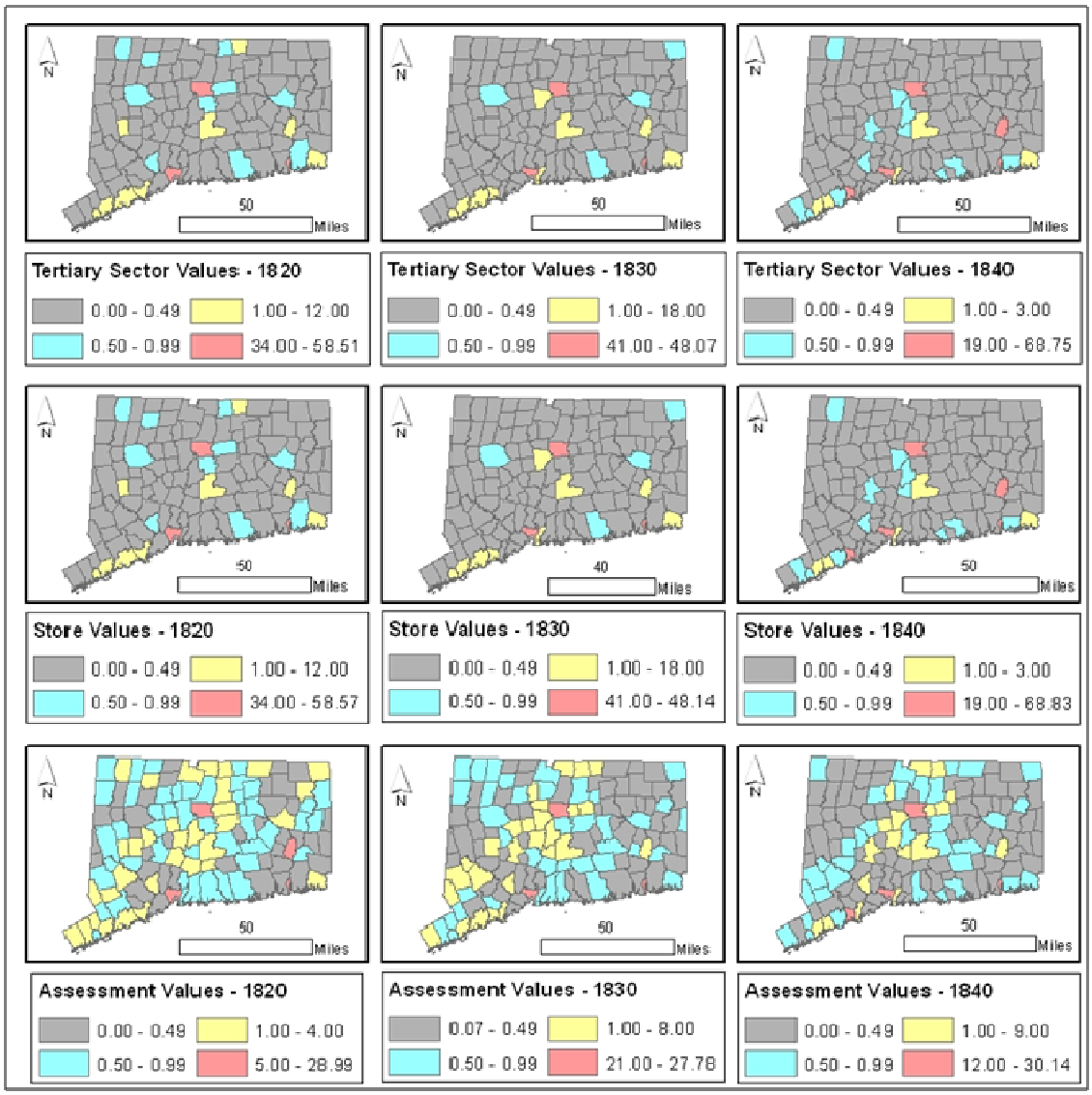


Figure 4.45, offer very little support for these statistical patterns. It finds autocorrelation of the high/low variety in only two or three municipalities for both the Tertiary Sector and the Stores data, one of which (Norwich) was not an area identified as having significant clustering by the G_i^* measure. In the Assessments analyses, the patterns are similar – a handful of municipalities, some registering high/high

Table 4.29. Results of Separate Tertiary Sector General Spatial Analyses, 1820-1840

(a) Total Tertiary Sector Dollar Values (ZI 10 miles)

	1820	1830	1840
*General G**			
Obs. G*	0.030037	0.034986	0.023506
Z score	-0.519962	-0.346629	-0.538062
p-value	0.603090	0.728870	0.590534
Moran's *I*			
I	-0.031742	-0.023993	-0.040367
Z score	-0.595156	-0.486571	-0.942978
p-value	0.551739	0.626563	0.345692

(b) Stores Dollar Values (ZI 10 miles)

	1820	1830	1840
*General G**			
Obs. G*	0.029867	0.034877	0.023455
Z score	-0.522478	-0.347850	-0.538125
p-value	0.601337	0.727953	0.590491
Moran's *I*			
I	-0.031823	-0.024035	-0.040365
Z score	-0.597268	-0.487740	-0.942870
p-value	0.550328	0.625734	0.345748

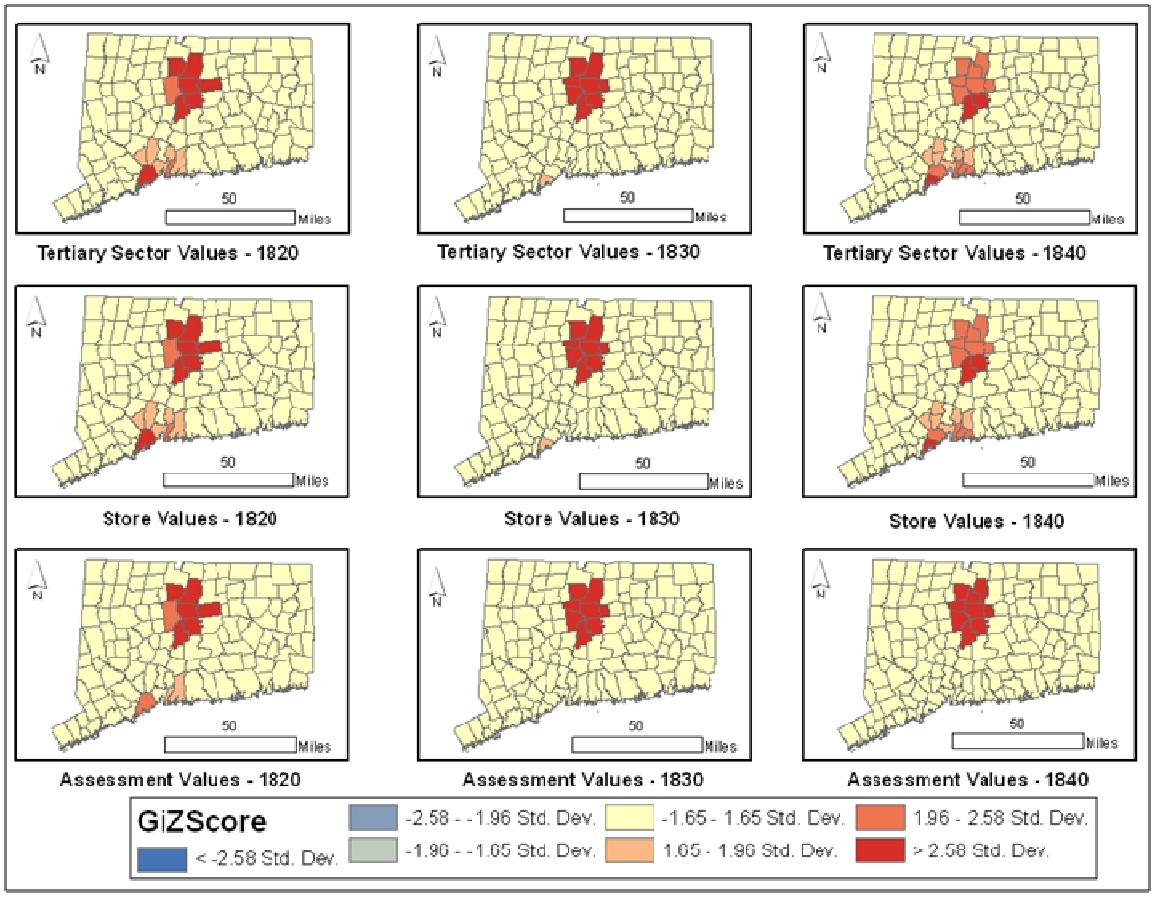
(c) Assessments Dollar Values (ZI 10 miles)

	1820	1830	1840
*General G**			
Obs. G*	0.046940	0.057527	0.049378
Z score	-0.517442	0.710327	-0.053522
p-value	0.604848	0.477501	0.957316
Moran's *I*			
I	-0.014026	0.016757	-0.019869
Z score	-0.126090	0.794176	-0.490864
p-value	0.899660	0.427093	0.623523

autocorrelation, others high/low, and in one case low/high (near New Haven). All of these results are very similar to those for the SecTer data.

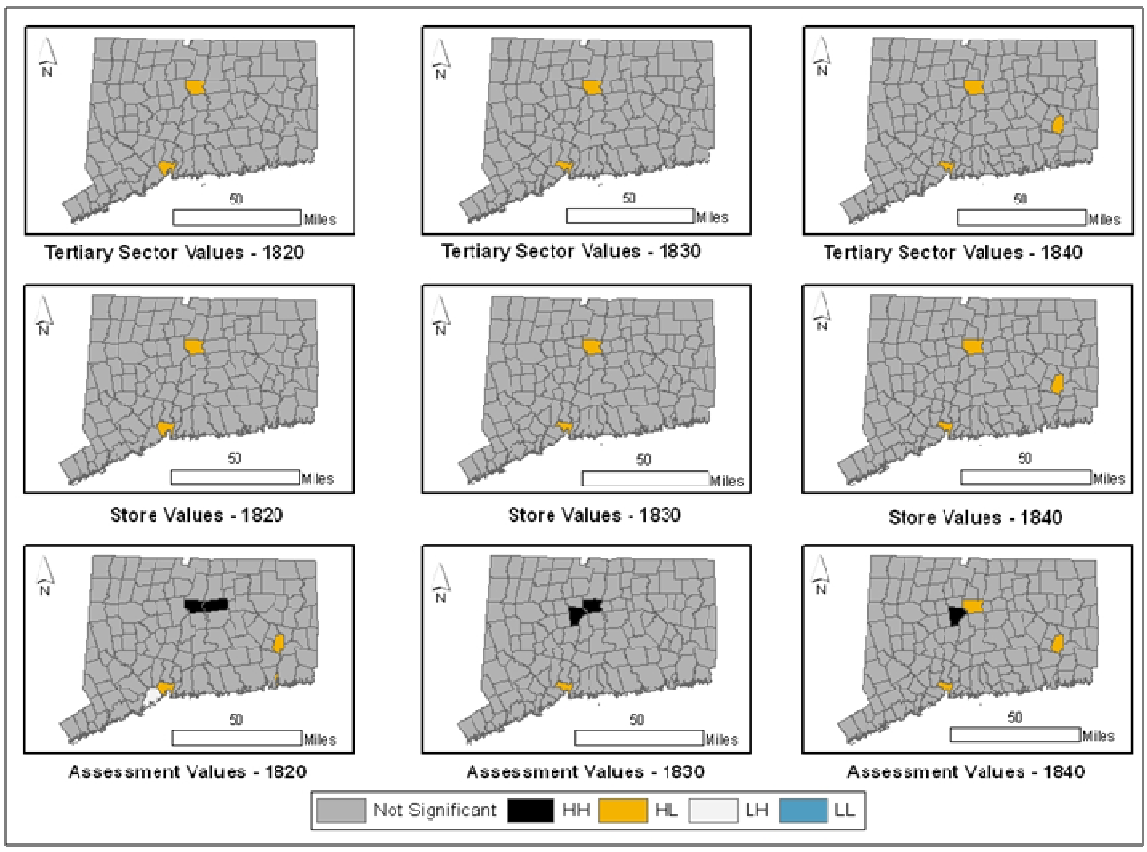
This indicates that the Tertiary Sector data have a very strong influence on the outcome when they are combined with the Secondary Sector. If, as appears to be the case, inclusion of the Tertiary Sector eliminates the statistically significant spatial patterns seen in the separate Secondary Sector data in favor of those seen in the Tertiary

Figure 4.44. Local *G Results for Tertiary Sector Total, Store, and Assessment Dollar Values, 1820-1840.**



Sector only, this has significant implications for using the SecTer data for further analyses. Thus, for the purpose of modeling the development of the Secondary and Tertiary sectors, the best data sets to use might be the Tertiary and Manufactories categories alone. Further model testing could include all the Secondary Sector categories to determine whether they have any effect on the model outcomes. The relative absence of spatial patterns in some of these data does not, of course, overcome the fact that the data are highly skewed in the non-spatial sense, but it does mean that there is less potential distortion of results than there could be.

Figure 4.45. Local Moran's *I* Results for Tertiary Sector Total, Store, and Assessment Dollar Values, 1820-1840.



Next we will consider the Stores counts alone, because the Assessments report only dollar values. The relevant descriptive statistics are provided in Table 4.30. The mean and median numbers show how thinly-spread this commercial activity was: the median counts ranged from four to six, and the mean values from ten to fifteen, with a large standard deviation, even as the total and maximum numbers rose substantially – from over 1,187 to just over 2,000 in total, and from 182 to well over 200 in maximum.

Table 4.30. Tertiary Sector Count Statistics, 1810-1840

Statistic	1810	1820	1830	1840
N	119	122	130	139
Stores – Minimum	0	0	0	0
Stores – Maximum	182	185	270	256
Stores – Mean	10	11	13	15
Stores – Median	4.5	4	5	6
Stores – SD	22	24	33	35
Stores – Sum	1,187	1,310	1,727	2,084

The influence of larger values is shown by examining the maximal cohorts of these counts of stores, as in Table 4.31. In each of the four years, the percentage of the statewide total number of stores held by the maximal cohorts ranged between 52.15% and 53.05%. This contrasts with the dollar values of the Tertiary Sector (dominated by the Stores values), which had a maximal cohort minimal percentage of 60.18%. As the maps above suggested, there were many stores with low individual values, a factor that substantially affected the total dollar values for the various municipalities. The

Table 4.31. Maximal Cohorts and Statistics for Store Counts, 1810-1840

Year	1810	1820	1830	1840
Percentage	52.15%	55.11%	58.23%	53.05%
Minimum	20	27	32	35
Maximum	181.5	185	270	256
#1	**New Haven**	**New Haven**	**New Haven**	**New Haven**
#2	**Hartford**	**Hartford**	**Hartford**	**Hartford**
#3	**Norwich**	**Norwich**	**Norwich**	**Norwich**
#4	**New London**	**New London**	**New London**	**Bridgeport**
#5	**Middletown**	**Middletown**	**Middletown**	**New London**
#6	**Stratford**	**Stratford**	**Bridgeport**	**Middletown**
#7	**Fairfield**	*Somers*	Saybrook	**Norwalk**
#8	**Norwalk**	*Saybrook*	**Fairfield**	Stonington
#9	Guilford	**Norwalk**	**Norwalk**	**Fairfield**
#10	Wethersfield	**Fairfield**	*Stonington*	*Derby*

Bold items persist across all years; italicized items were not present in the next preceding year; and city-containing places are underlined. Bridgeport and Stratford are considered identical for continuity purposes.

difference between the minimum and maximum counts of the maximal cohorts is likewise instructive: in 1810, the counts ranged from 20 to 181.5, and in 1840 from 35 to 256. This means that the other N – 10 municipalities in the state had fewer than 20 stores in 1810, and so forth. Even with the maximal cohort, there were sometimes substantial differences. In 1840, for example, only Hartford, New Haven, and Norwich had over 200 stores, and also all the rest of the cohort had fewer than 100. Finally, the locations of these maximal cohort municipalities are significant. While the maximal cohort for total dollar value included some inland places (specifically Litchfield, Farmington, and Waterbury), the counts cohorts are exclusively coastal or riverine places. In both categories, however, the city-containing municipalities occupy the highest ranks.

4.4 Economic Structure and Diversity

The HH′ index calculations for 1810 and 1850 can have only two components, the Primary Sector and the SecTer dollar values, while those for 1820, 1830, and 1840 can also be calculated both (a) with the three sectors separate, and (b) with the Secondary and Tertiary Sectors combined (the latter to enable equivalent comparisons across the entire time period). The HH′ results for the SecTer and Primary Sector will be addressed first, across all five study years, and then the separated Secondary Sector, Tertiary Sector, and Primary Sector data analyzed for the applicable years only, and the two sets of results compared.

For the purpose of additional comparison, index calculations for the whole state's economy are presented in Table 4.32 below. The results indicate that over the forty-year

period of this study, the overall economy's diversity increased noticeably, such that by 1850 the HH′ measure was "only" 76% above the theoretical minimum – the minimum value representing, in this measure, the maximum possible diversity. The statewide economy continued to be dominated by the Primary Sector, which (according to the underlying data) represented at least 90% of the total economy from 1810 to 1840 and 86% of the total economy in 1850. According to these measures, then, individual municipalities' economies differed not only from each other but from the statewide economy. These statewide data also show that the differences between the two-sector and three-sector HH′ index values were very minor, though they did increase over time: from 0.07 lower in 1820 to 0.23 lower in 1830 to 0.52 lower in 1840. For statistical purposes, however, the two versions are probably interchangeable at the state level.

A summary of the calculation results for the Primary Sector and SecTer dollar values are presented in Table 4.33, together with the identity of, and summary statistics related to, the ten municipalities with the smallest HH′ values (that is, the most diverse municipalities, or the "minimal cohort") in each study year. The city-containing municipalities of Hartford, New Haven, New London, Norwich, and Bridgeport

Table 4.32. Statewide Herfindahl-Hirschmann Calculations

	Two-Sector Version		Three-Sector Version	
	HH	**HH'**	**HH**	**HH'**
1810	0.846293	84.63	---	---
1820	0.929556	92.96	0.928912	92.89
1830	0.871959	87.20	0.869749	86.97
1840	0.812955	81.30	0.807752	80.78
1850	0.760910	76.09	---	---

(substituting its parent municipality of Stratford before 1840) make up five of the ten in every study year, while Middletown drops out of the cohort after 1830. The other five of the ten, however, tend to change from year to year, a volatility that was also seen in the underlying sectoral and population data. As was noted in Chapter 3, a lower index value means a higher level of diversity. Thus, the HH′ values reported in the table indicate that in each year except 1810, at least one municipality's economy had achieved a value quite close to the potential minimum HH′ (representing the maximum possible diversity), and far below the statewide measure previously discussed.

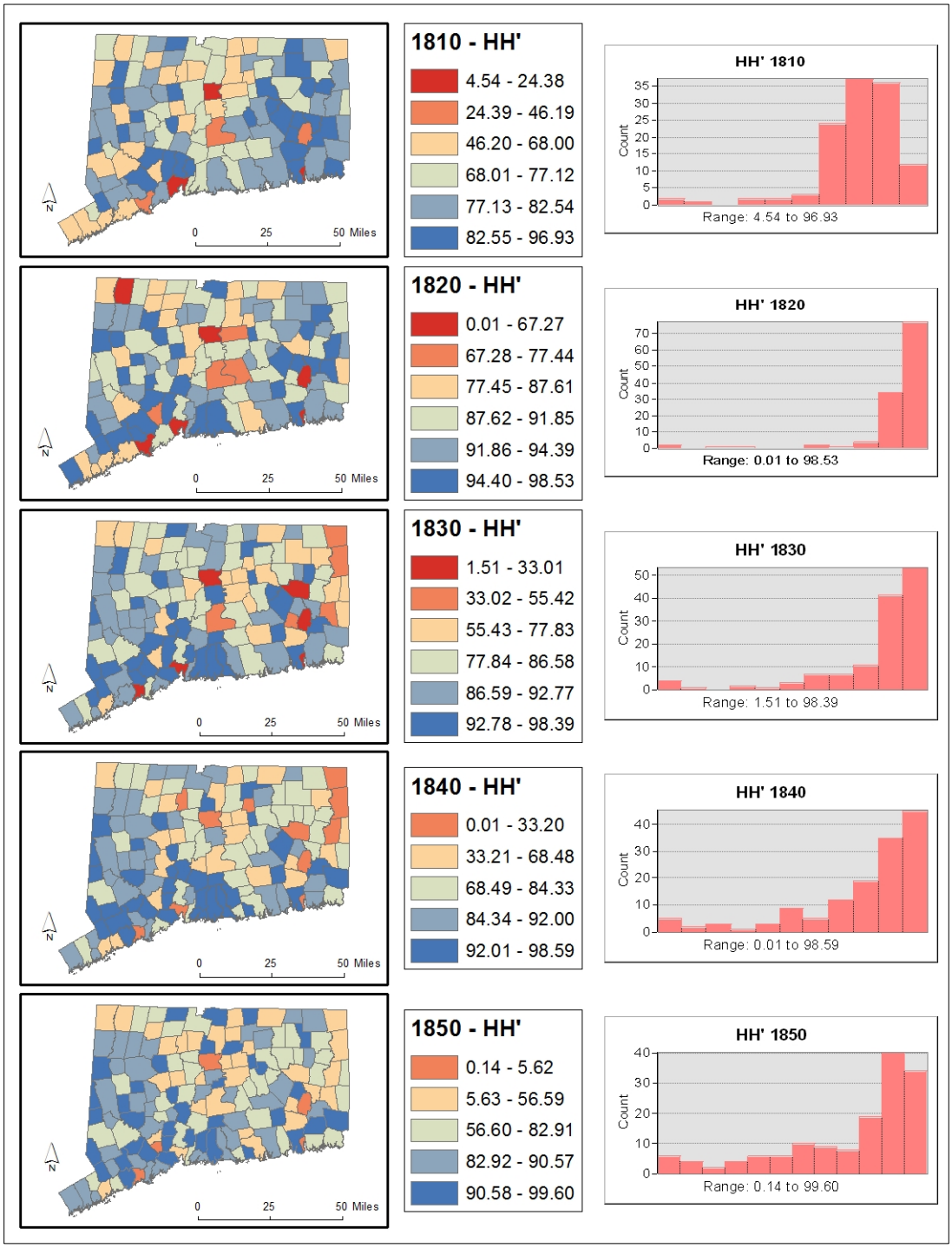
Mapping the HH′ values by min/max, quantiles, and fences, as in Figure 4.46, shows an increasing number of more-diverse municipalities over time, as do the histographs in the same figure. It is not clear whether the difference in the histograph

Table 4.33. Data for Minimal Cohorts of HH′ Values (Two Sectors)

Year	1810	1820	1830	1840	1850
Min	4.54	0.01	1.51	0.01	0.14
Max (of 10)	55.85	76.81	50.14	25.17	15.04
Max (All)	96.93	98.53	98.39	98.59	99.60
Mean (All)	73.67	87.98	80.39	75.50	71.52
#1	**Hartford**	**New London**	**New London**	**Norwich**	**Hartford**
#2	**New Haven**	**New Haven**	**Norwich**	**Hartford**	**Bridgeport**
#3	**New London**	**Hartford**	**New Haven**	**New Haven**	*Derby*
#4	**Norwich**	**Norwich**	**Hartford**	**Bridgeport**	**Norwich**
#5	**Stratford**	Canaan	**Bridgeport**	**New London**	**New London**
#6	Middletown	**Stratford**	*Windham*	*Canton*	Canton
#7	Canaan	Middletown	*Killingly*	*Vernon*	*Seymour*
#8	Canton	*East Hartford*	*Thompson*	Thompson	**New Haven**
#9	Derby	*Chatham*	*Griswold*	Killingly	Thompson
#10	Vernon	Derby	Middletown	Windham	*Simsbury*

Bold items persist across all years; italicized items were not present in the next preceding year; city-containing municipalities are underlined.

Figure 4.46. HH′ Results for Two Sectors, 1810-1850.



Maps are classified by minimum, upper fence (1820-1830), inner fence, quantiles, outliers, and maximum.

pattern between the 1810 data set and the others results from differences in the data collection, or meaningful differences in the municipal economies. Overall, the city-containing municipalities register as statistical outliers for diversity, and extreme outliers in the 1810, 1820, and 1830 data sets. In 1830 and 1840, the outliers were mild rather than extreme, but still included the city-containing places. Some other municipalities also had outlying HH′ values, particularly the northwest corner of the state in 1830, 1840, and 1850 – a result of the relatively high secondary-sector activity found there, as was discussed in Section 4.3.4 above. The values up to the first quantile are more scattered across the state, but tend to be toward the north and west, especially in the last three study years.

Calculating HH′ with three sectors results in noticeably higher minimum numbers and slightly higher maximum numbers, as is shown in Table 4.34. The more diversity that was present in a municipality, in fact, the more substantial was the difference in its two HH′ values, as will be seen in more detail below. These changes did not have any effect on the rank order of the municipalities in 1820 and 1830, but as Table 4.35 shows (when compared with Table 4.33 above), there were differences in 1840. Although the membership of the "ten smallest" group did not change, the rank order of several of the city-containing municipality entries did, such as New London becoming the smallest and Hartford falling to fifth smallest. As Figure 4.47 shows, the class into which each municipality falls for mapping purposes is the same for the three-sector HH′ index values as for the two-sector index values, except that in 1840 the lowest three-sector index values registered as extreme outliers, which was not the case in the two-sector version.

Table 4.34. Minimal Cohorts and Statistics of HH′ Values (Three Sectors)

Year	1820	1830	1840
Min	16.42	11.14	6.56
Max (of 10)	82.44	61.01	45.52
Max (All)	98.90	98.79	98.94
Mean (All)	90.79	84.79	80.91
#1	**New London**	**New London**	**New London**
#2	**New Haven**	**Norwich**	**Norwich**
#3	**Hartford**	**New Haven**	**New Haven**
#4	**Norwich**	**Hartford**	**Bridgeport**
#5	Canaan	**Bridgeport**	**Hartford**
#6	**Stratford**	*Windham*	*Canton*
#7	Middletown	*Killingly*	*Vernon*
#8	East Hartford	*Thompson*	Thompson
#9	Chatham	*Griswold*	Killingly
#10	Derby	Middletown	Windham

Bold items persist across all years; italicized items were not present in the next preceding year; and city-containing places are underlined.

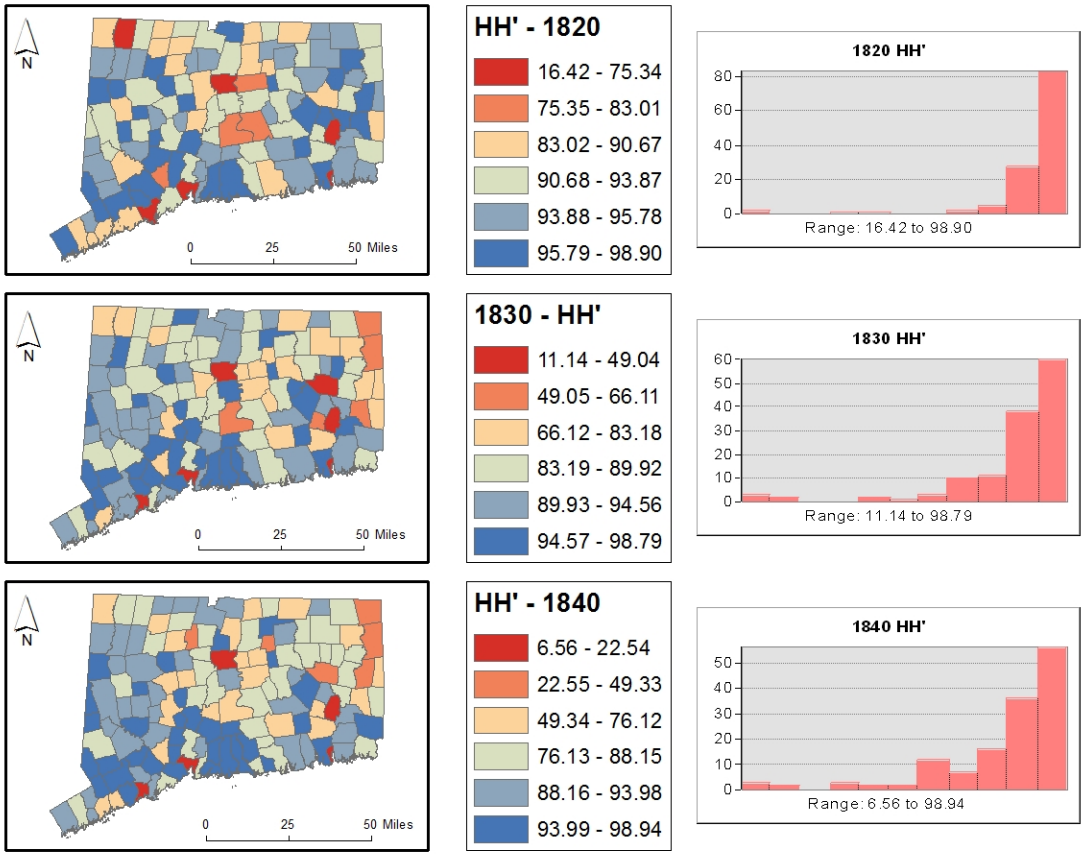
Using a twenty-mile zone of indifference, the general spatial analyses reported in Table 4.35 found no clustering of high or low values, but did find significant clustering-type autocorrelation in every year except 1820. In contrast, the maps of the local spatial analyses in Figure 4.48 (also calculated with a twenty-mile zone of indifference) show a mix of high and low-value clustering and spatial autocorrelation for each year except, again, 1820. The overall locations of these areas within the state are broadly consistent with the economic data on which the index is based: north-central region, north west, and center-southwest. The fact that 1820 is so different is another indication that the lack of data on the textile mills is an important flaw in the data sets.

Table 4.35. Results of HH□ (2-Sector)
General Spatial Analyses, 1810-1850 (ZI 20 miles)

	1810	1820	1830	1840	1850
*General G**					
Obs. G*	0.193522	0.189827	0.194758	0.191770	0.197167
Z score	1.225028	0.448245	1.022141	0.759392	0.270450
p-value	0.220565	0.653976	0.306714	0.447618	0.786814
Moran's *I*					
I	0.043395	-0.010685	0.051548	0.061377	0.027965
Z score	2.222770	-0.111476	2.761325	3.337364	1.834959
p-value	*0.026231*	0.911239	*0.005757*	*0.000846*	*0.066512*

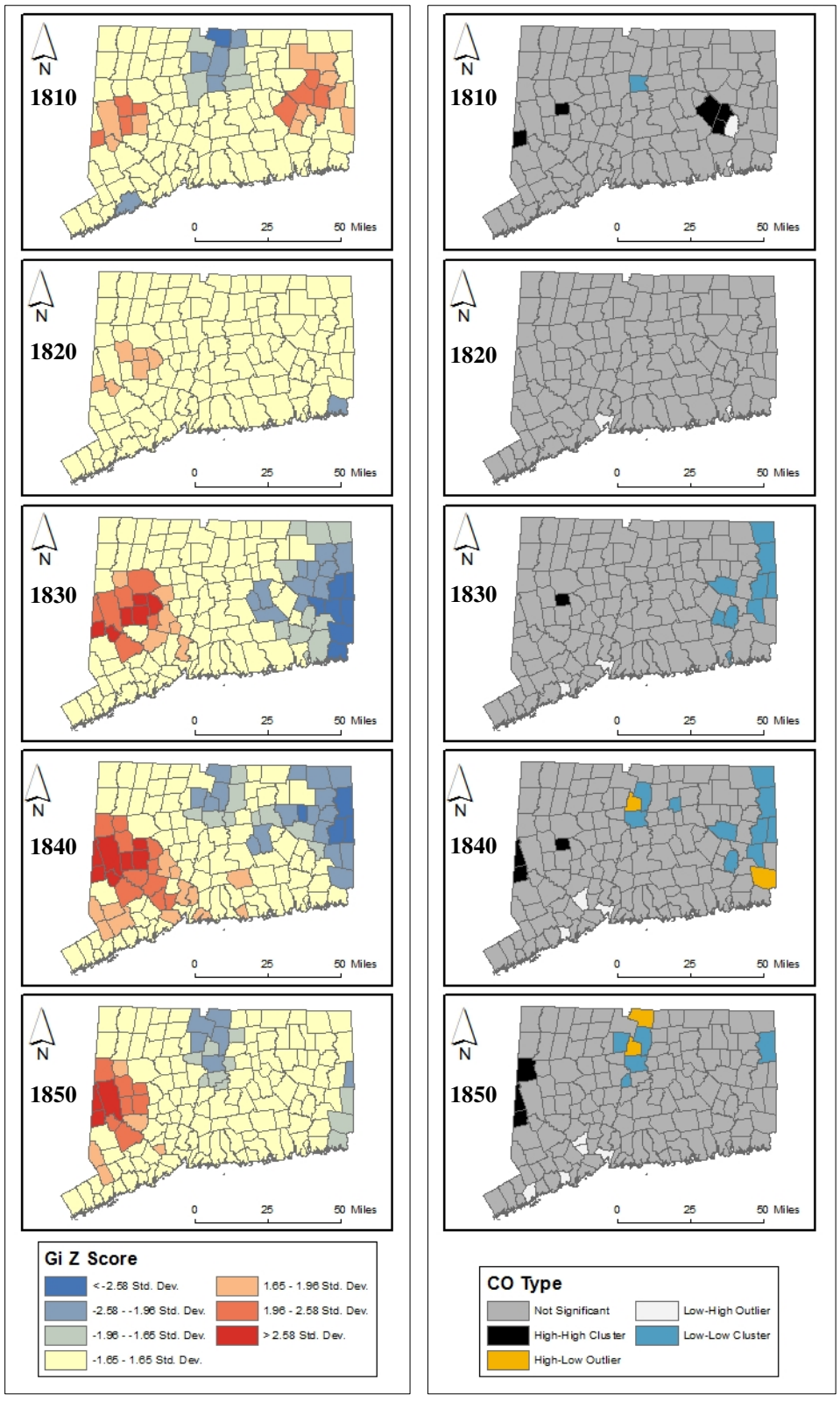
Statistically significant p-*values are given in italics.*

Figure 4.47. HH′ Results for Three Sectors, 1820-1840.



Maps are classified by minimum, upper fence, inner fence, quantiles, outliers, and maximum.

Figure 4.48. Local *G and Moran's *I* Results for HH□ (2-Sector), 1810-1850.**



In summary, then, the HH′ index calculations find increasing diversity both globally and locally over the study period, although not enough to undermine the dominance of the Primary Sector except in a few municipalities. The individual municipal HH′ index results are quite different depending on whether the two sectors or three sectors are used; therefore, the two-sector version will be used for the modeling, in order to ensure that the data used are as similarly constructed as possible from year to year. It was also found that the city-containing municipalities (except Middletown) dominate the minimal cohorts in each study year in both the two-sector and three-sector measures of diversity, with a variety of other municipalities filling in the rest of the ten. In addition, the local inferential statistical measures find patterns of spatial value clustering and autocorrelation in the two-sector HH′ index results, which largely echo the patterns found in the economic data.

4.5 Summary and Conclusions

During the study period, the state's population became increasingly concentrated in a small group of municipalities, with the ten largest places holding nearly 25% of the total population by 1850. In fact, between the several census years, this maximal cohort of places captured between 24.26% and 68.12% of the state's overall population increase over this period. Global statistical measures of population concentration, such as the Hoover Index, do not capture this aspect of the state's population growth patterns. These large places were dominated by the city-containing places, but also included more rural places, mainly along the shoreline and in the southwestern part of the state. Analysis of

spatial statistics found little evidence of significant clustering or autocorrelation, and a decreasing amount over time. Although there is convincing evidence of concentration in Connecticut's municipal populations, the individual municipalities were still too spatially isolated for there to be detectable spillover effects from the rapid growth of even the city-containing municipalities.

The value of the municipal economies also showed concentration, although the scale of the concentration and the identity of the municipalities involved varied by sector. The concentration of the total values of the economies in the maximal cohorts for each census year increased slightly, with the cohorts' share rising from 15.53% to 20.21% (well above the less than 9% that they would have if the values were equal across all the municipalities). The locations of the maximal cohorts varied widely, with only three places appearing in all five study years. Statistically, the LQ/FLQ analyses found a corridor of higher than expected values running from the Hartford area to New Haven and then westward along the coast, while the clustering and autocorrelation tests could only find a little apparent clustering in part of that area. These results proved to be most influenced by the Primary Sector component of the total values, which displayed very similar LQ/FLQ patterns. Looking for clustering and autocorrelation in dollar value per acre of land revealed very distinct spatial patterns: clustering of high values in the southwestern part of the state, and clustering of low values in the northeastern and northwestern corners. These patterns became less distinct from 1810 to 1850, but were still reasonably persistent.

The secondary and tertiary sector data were first analyzed as combined "SecTer" values in order to provide a consistent data set from 1810 through 1850. The dominance of a small group of municipalities, consisting of the six city-containing places with four, variable others, is confirmed by both their identity and by the fact that in 1810 they held 33.5% of the total value of the state's economy, and in 1850, 56.7%. Spatial statistics found only a little clustering of these values in the north-central part of the state. The same analyses of per capita SecTer values, however, found some notable areas of statistically significant clustering, with high values in the north-central or northeastern sections, or both, and an area of low-value clustering in the southwest. Analysis of separate Secondary Sector data was possible for the 1820, 1830, and 1840 study years, in which a review of the raw numbers shows that manufacturing was responsible for nearly all the growth in the total value of this sector. Four city-containing municipalities appeared consistently in the maximal cohorts for these years, with the cohort holding a rising share of 28.82% to 38.44% of the total value in these years. Mill values, tracking with the agricultural values, showed some spatial concentration along the Hartford-New Haven-Greenwich corridor in the LQ/FLQ statistics, although the spatial clustering measures do not support this interpretation (with high-value clustering in the north-central region in all three years, and an area of low-value clustering centering on the New Haven area). Separate Tertiary Sector data were available for 1810 through 1840, and they showed an even greater level of concentration than the separate Secondary Sector: In 1810, the maximal cohort held 60.18% of the statewide total, and by 1840 it held 84.44%. This cohort included the six city-containing places in every year, plus one additional one

(leaving only three varying additional places in the top ten). The spatial statistics found a substantial area of high-value clustering in the north-central part of the state, with a subsidiary area of high-value clustering around New Haven in some sub-categories. Overall, it is clear that although the several components of the total economic values have some strong patterns and display considerable clustering, in the totals these patterns either cancel each other out, or are overwhelmed by the still much-larger value of the Primary Sector portion of the economy.

The diversity calculations were carried out with both two-sector and three-sector versions, and it was decided to use the two-sector version for the modeling. Although municipal HH′ values varied considerably at the individual level depending on which version was used, the patterns were roughly the same. Increasing diversity was found across the study period, at both the state level and the municipal level. Five of the six city-containing municipalities appeared in the minimal cohort (lower numbers representing greater diversity with this statistic) consistently across the five study years. The minimum HH′ values were extremely close to zero in the 1820-1850 study years, and somewhat less close in 1810; the maximum HH′ values of the minimal cohort were also variable, beginning with at 55.85 in 1810 and then rising to 76.81 in 1820, but then falling in each year until 1850, when it reached 15.04. Spatially, the two-sector HH′ values displayed somewhat variable patterns of clustering across the study period, but in 1830to 1850 settled into a distinct pattern of low-value clustering in the eastern and north-central parts of the state, with high-value clustering in the west-central area. Overall, the diversity results confirm that most of the municipalities were still

predominantly agricultural during the study period, and that there was considerable volatility in diversity at the municipal levels between the five out of six city-containing municipalities and the more wholly agricultural places.

These results do not support the hypothesis that high levels of economic diversity lead to long-term economic and population growth. All but one of the city-containing municipalities, whose mix of primary and tertiary sector activities predated the study period and the industrialization process, did attract substantial industrial and population growth, and saw increasing economic diversity. These places, however, must be considered special cases: they had a substantial initial advantage, being colonial-era port cities (and in the cases of Hartford and New Haven, also being the co-capitals of the state). The hypothesis of this study was not that being a port city and/or state capital leads to long-term economic and population growth. Furthermore, not all of these advantaged places saw continuous growth during the study period. Middletown, in particular, showed declines in economic status across most categories, while other city-containing places returned variable results or increases. With respect to the non-city places, the volatility in status in the various categories is consistent with Leblanc's (1969) description of a "sorting process," but not with a direct relationship between diversity and economic and population growth. Nor are these trends consistent with the hypothesis of a stable urban system based on that relationship.

Finally, the transportation system does not appear to have had any decisive impact on development. The turnpikes reached most of the state's municipalities at an early date, providing roughly equal access for them. The rivers and coastline, of course,

remained constant, and as already noted were the site of most of the city-containing places before 1810. Of the two railroad lines that were built by 1839, one was part of a connection between New London, Providence, and Boston that was not extended further westward until after 1850; until then, the westward connections were handled by steamboats plying Long Island Sound (Turner and Jacobus 1989; see Figure 3.9). The other was a connection between Hartford and New Haven, along the pre-existing corridor of high land values noted in this study. Clearly, in such circumstances, this line was built in response to existing economic conditions, not as a cause of those conditions. In fact, the map shows that the rail lines that had been built as of 1849 formed a relatively complete system linking northwestern municipalities to the coast, which again is more likely to be a response to economic conditions than a cause of them. These railroads can be presumed to have reinforced the pre-existing patterns but were not their origin. Thus, all three of this study's hypotheses are not proven.

Chapter 5

Conclusions

5.1 Introduction

The economic success of a place can be measured by the size of its population, the size of its economy, or a combination of both. These factors historically reflect the place's level of economic development, itself normally measured by sectoral employment but in the case of this study, by business property classed by economic sector. The period under study saw the beginnings of significant secondary sector development in some places, accompanied by further tertiary sector development (in addition to what already existed at the beginning of the period). It was found that the total economy in the state of Connecticut between 1810 and 1850, and in most municipalities of the state, was still dominated by the primary sector, making analyses of the spatially limited secondary and tertiary sectors problematic. Notwithstanding this problem, it was found that the value of

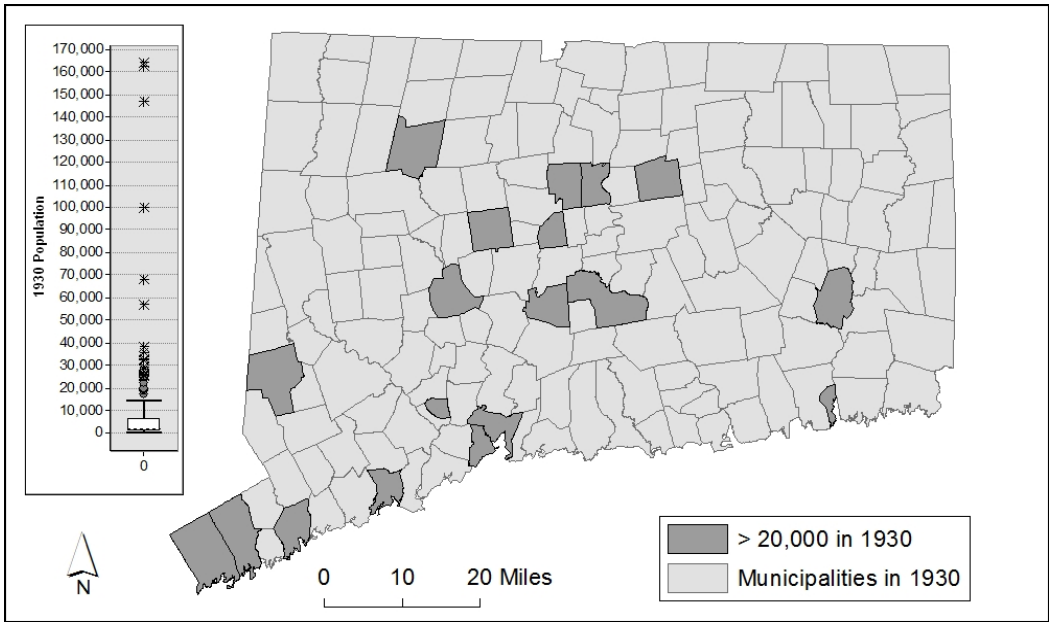
economic diversity as a predictor of either total economy size or population is very limited, as was discussed in Section 4.5. Nor did access to transportation have any apparent causative effect on economic development. More important, in the long term, was the location of a given municipality in the broad sense of its proximity to major urban areas.

5.2 Factors in Long-Term Population Outcomes

The municipal populations of 1930 have as non-normal a distribution as those of any of the earlier years, if not more so. There were four places with populations of 100,000 or greater (including one with a reported 99,902 residents); two with populations between 50,000 and 70,000; four with populations between 30,000 and 40,000; and nine with populations between 20,000 and 30,000 (including one with a reported 19,898 residents). The map in Figure 5.1 shows the locations of these nineteen places, together with a boxplot illustrating the overall distribution. Only three of these places (New London, Norwich, and Manchester) were located east of the Connecticut River. Comparison of these locations with the LQ/FLQ maps for the Total Economy (Figure 4.9), LQ/FLQ maps for the Total Primary Sector (Figure 4.14), and the maps of the value of land per acre (Figures 4.16 and 4.17) suggests that the spatial pattern of the long-term population outcomes, as of 1930, has more in common with the spatial patterns of the Primary Sector (and the Total Economy patterns that are strongly influenced by them) than with any other data set.

Eastern Connecticut has much the same physical geography as western Connecticut, with a number of important streams that could and did support industrial activity and two old port cities (Norwich and New London) to provide transshipment foci for the region. Western Connecticut had a long-standing land route between Hartford and New Haven, and from New Haven along the coast to New York City – in addition to multiple ports that were closer to New York than were those at the eastern end of Connecticut's shoreline. The higher per-acre land values and total economy values roughly follow that land route previously discussed. In fact, these patterns even suggest that western Connecticut developed an early peripheral relationship with the core of New York City, as was described by Lindstrom (1978) in her study of the Philadelphia region.

Figure 5.1. Map and Boxplot of Municipal Populations in 1930



Clearly, proximity to New York City was a more important factor in long-term population outcomes than economic diversity alone.

5.3 Summary

The economic data and modeling indicate that at the municipality level and during the first half of the nineteenth century, and despite this southern New England state's status as an important industrial region, only a very limited number of municipalities actually participated in industrialization – and many of those that did, never made the transition from small and isolated industrial villages within the municipalities to spatially extensive, high-population, industrialized cities. Finally, the geographic fact of western Connecticut's proximity to New York City seems to have given it an insurmountable advantage over eastern Connecticut, despite the latter's early and well-known commitment to textile manufacturing. The obvious conclusion is that geographic advantage is a stronger potential predictor of long-term municipal success in economic development than initial advantage (i.e., being a commercial port), early investment in industrial facilities, or even the size of investments of industrial development. In other words, the industrial villages of eastern Connecticut were never in a position to have more than a temporary and limited impact on the long-term population and economic development trends of the municipalities in which they were located.

The further implication is that significant economic development in locationally disadvantaged regions is still unlikely. Since the southern relocation of much of the textile industry beginning in the 1920s, industrial villages in northeastern Connecticut (in

Tolland and Windham counties) have struggled to maintain their economic bases. Although their populations have grown since 1930, only one (Vernon) has passed the 30,000 mark as of 2010, and that is a municipality that is close to Hartford. Similarly, New London County in southeastern Connecticut, which has twenty-one municipalities, has only two with populations over 30,000: the old industrial city of Norwich (which had a population of over 40,000 in 1970) and the town of Groton, where a submarine base and associated industries are located. All but one of the rest (New London) have populations under 20,000. Meanwhile, Fairfield County in southwestern Connecticut has twenty-three municipalities, of which two have populations over 100,000, four have populations over 50,000, and three have populations over 30,000. New Haven County (on Fairfield County's eastern boundary) has similar proportions (Keegan 2012). In terms of public policy, this suggests that governmental efforts to encourage business development and location in eastern Connecticut will, in most cases, need to be perpetual, rather than the temporary measures they are usually considered to be.

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Appendix A

Categories in Each Study Year Grand List

Category	1850	1840	1830	1820	1810
Dwelling houses	X	X	X	X	X*
Land *or* Acres of Land	X	X	X	X	X*
Mills, Stores, &c	X				
Mills		X	X	X	
Stores		X	X	X	X*
Distilleries		X	X	X	
Manufactories		X	X	X	
Horses Asses &c *or* Horse Kind	X	X	X	X	X*
Stallions & Mules		X			
Mules					X*
Stallions				X	X
Neat Cattle	X	X	X	X	X*
Sheep & Swine	X				
Sheep		X	X		
Deduction for Sheep					X
Silver Plate & Plated Ware		X	X	X	X
Coaches, Carriages *or* Riding Carriages and Waggons	X	X	X	X*	X*
Farming Utensils	X				
Time Pieces *or* Clocks, Watches & Time Pieces	X	X	X	X	X*
Pianofortes & other musical instruments	X				
Furniture & Libraries	X				
Quarries & Fisheries	X				
Quarries		X			
Fisheries		X	X	X	
Ferries		X			
Steam Boat Stock	X				
State Stocks	X				
Bank, Insurance & Manufacturing Stocks	X				
Bank Stock		X	X	X	X
Nonresident Bank Stock			X	X	
Insurance Stock		X	X	X	
Nonresident Insurance Stock			X		
Turnpike Stock		X	X	X	
Bridge Stock		X			
Canal &c Stocks	X				
United States Stock				X	
Rail Road & Other Cm Bonds	X				
Investments in Trade &c	X				
Investments in Mechanics & Manufacturing	X				
Investments in Vessels &c	X				
Money at Interest	X	X	X	X	X
Assessments		X	X	X	X
All Other Taxable Property	X				
Three Folds				X	
Deductions	X			X	X
Additions				X	
Polls	X	X	X	X	X

* Multiple sub-categories exist in this year.

Appendix B

Selected Sub-Categories of Data in the 1810 Grand List

Category	Sub-category	Count?	Value
Neat Cattle	Oxen 4 years old and upwards	Yes	$10.00 per head
	Cows, Steers, Heifers 3 years old	Yes	$7.00 per head
	Steers Heifers 2 years old	Yes	$3.34 per head
Acres of Land	Plowing	Yes	$1.67 per acre
	Upland mowing and pasture	Yes	$1.34 per acre
	Boggy meadow mowed	Yes	$0.84 per acre
	Boggy meadow not mowed	Yes	$0.34 per acre
	Meadow in Hartford or Middlesex county	Yes	$2.50 per acre
	Other Meadow	Yes	$1.25 per acre
	Bush Pasture	Yes	$0.34 per acre
	Uninclosed land 1st rate	Yes	$0.34 per acre
	Uninclosed land 2nd rate	Yes	$0.17 per acre
	Uninclosed land 3rd rate	Yes	$0.09 per acre
Stores	1 Story high	Yes	$10.00 each
	2 Stories high	Yes	$20.00 each
	3 Stories high	Yes	$30.00 each
Assessments	Assessments	No	Total

In C.G.S. (1808), Title CII, Ch. I, § 9, various details about how these categories were to be defined were given. The less obvious ones included:

Bush Pasture: "[S]uch lands as are overgrown with woods, bushes, briars and the like, whereby the lands become unserviceable for pasture, whether the same have been cleared or not …" (a definition dating to 1715);

Uninclosed land 1st rate: "All timber lands which if cleared would be fit for mowing or plowing" (a definition dating to 1779);

Uninclosed land 2nd rate: "All other timber lands except on mountains inaccessible to teams" (a definition dating to 1779); and

Uninclosed land 3rd rate: "[A]ll other uninclosed lands" (a definition dating to 1779).

§ 15 defined stores as "Each store or ware-house, whether part of or connected with any part of a dwelling-house or not" (a definition dating to 1804). Finally, § 16 provided that

> Attornies in actual practice shall be assessed according to the profits of their profession, at a sum not less than *seventy-five*, nor more than *three hundred dollars*.
>
> Physicians and surgeons in actual practice shall be assessed according to their profits at a sum not less than *thirty-four*, nor more than *two hundred dollars*.
>
> Traders of all kinds shall be assessed according to their profits, at a sum not less than *forty* nor more than *three hundred dollars*.
>
> Persons carrying on mechanical business of any kind, shall be assessed according to their profits at a sum not less than *ten*, nor more than *two hundred dollars*.
>
> Tavern keepers shall be assessed at a sum according to their profits at a sum not less than *twenty*, nor more than *two hundred dollars*.