Regional Resource Benefits Of Urban "UnSprawl"

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Abstract

This paper examines the development of New England for an effect of urbanization on forests. Forest area fell during early stages of the region's development, but later rebounded even as population and output were rising. Historical census data are consistent with these hypotheses: (1) spatial concentration of population can increase forest; (2) such concentration occurs when agriculture declines; and (3) industrial aspects of cities also facilitate spatial concentration. These points can explain why forests might first shrink and then grow as urbanization and concentration proceed. However, in New England the forest increase might not have occurred without food and timber from other regions. For land-use planning and policy, this suggests that such concentration can support but is not sufficient for forest conservation and/or regrowth.

Keywords: forest; urbanization; land use

1. Introduction

Urbanization is a longstanding and ongoing phenomenon. Both urban land use and the net benefits of city dwelling have been widely studied.[1] Given this attention to cities, it is surprising that the *environmental and resource impacts* of urbanization's implications for land use receive relatively little attention, notwithstanding possible environmentally negative impacts of suburban sprawl.[2]

Urbanization implies increased spatial concentration of population. This may have negative environmental and resource implications for cities themselves (e.g., air and water pollution). The exit of rural population corresponding to this urban concentration, however, may produce regional environmental and resource benefits. In short, when left alone, the countryside may re-generate.

This paper examines New England's development from 1790-1930 for evidence of such benefits, and of their causes. The main contribution is that, unlike many tropical cases, this case permits long-term analysis of regular, historical census measures. It also permits us to examine the effects of a shift away from agricultural/extractive production and toward both cities and industry:

1. <u>Does spatial concentration of population affect forest outcomes?</u> The reversals in both spatial concentration and deforestation, alongside the monotonic increase in regional population, suggest that spatial concentration of population can contribute to increased regional forest levels.[3]

2. <u>Does declining agriculture lead to spatial concentration?</u> The strong temporal correlation between the drop in transport costs from the Midwest and the start of concentration of population, and between decreasing farm area and ongoing rises in concentration, suggests the answer is yes.

3. <u>Do industrial aspects of cities also facilitate spatial concentration?</u> A small 'yes' is added to the large body of existing evidence by data on both relative spatial concentrations of agricultural and manufacturing and concentration of population along waterways useful for power and trade.

The paper proceeds as follows: Section 2 provides regional background on New England; Section 3 presents the data; Section 4 presents the evidence that can be derived, and the paper's suggestive inferences from the evidence regarding the questions above; and Section 5 concludes.

2. Regional Background

When the Pilgrims landed in the early 1600s, at least 90% of New England's area was in forest.[4] Native Americans had long burned to clear fields and fight insects, but at low population density. Colonists imposed small, fixed areas for individuals (Cronon 1983) and by the early 19th century, permanent colonization and greater population density in a European-style agricultural system put New England on a path of semi-permanent clearing. This continued until about 1830.[5]

During the first half of the nineteenth century, the United States' boundaries expanded greatly. However, for inter-regional economic linkages to arise, transport costs between regions had to be drastically reduced.[6] By the 1830s, both steamboats and railroads had started to proliferate, facilitating the transport of both people and cargo.[7] In addition, stimulated by the success of the Erie Canal, total canal mileage grew rapidly, nearly tripling in the two decades from 1830-1850.[8]

This engendered trade; evidence exists that wages and commodity prices converged across regions as smaller, differentiated regional economies were linked.[9] Agricultural output rose in the Midwest and fell in New England,[10] which was relatively well endowed with rivers and thus power, and appeared to find a niche in the trade system by moving towards factories and industry.[11] Thus a basic pattern emerged of agriculture in the Midwest and manufacturing in the northeast.[12]

Both households and industry created a growing demand for timber.[13] As a result, timber production shot up in the mid-1800s, at a rate more than double that of population (MacCleery 1992). This led to two types of substitution for New England timber: first, substitute timber was generated at an enormous rate from other regions of the country, such as the Lake States and the South;[14] and second, various materials were substituted for timber within a number of tasks.[15]

Legislation is also a potentially significant factor in land use. In the U.S., from about 1850 on, debate over such legislation was inspired by both economic and ecological rationales for forest conservation.[16] However, much of the debate over national parks, the conditions for homesteads, and public versus private ownership was centered on lands west of the Mississippi.[17]

3. Data

The data are for all of New England, from decennial U.S. censuses for 1790 to 1930, at county and town levels. While they require some digging to produce, that each county total and some town data exist for all years is impressive. The measures used are of population and of land use on farms.[18] The latter is assumed to indicate deforestation. The categories of land use on farms that could consistently be found, though no land-use data exist before 1850, were 'improved' and 'unimproved' (an exhaustive breakdown). In 1870, 1910 and 1920, unimproved is broken down into woodland and other unimproved land. For 1930, three sub-categories of crop land, three of pasture land, plus woodland and other land were aggregated into improved and unimproved.[19]

While measures of farm areas are not direct measures of deforested area, they permit an estimate of deforestation. Harper (1918) suggests a method of calculating a measure of forested area. From total county area, subtract five percent (for originally treeless land), subtract one fifth of an acre per inhabitant (which he allows is too much for urban land use[20]), subtract total land in farms, and add back in the woodland area of unimproved land on farms. The latter two operations are almost the same as subtracting improved land on farms; they differ in that "other unimproved" land on farms is also subtracted. As I could find the breakdown of unimproved land into woodland and other unimproved only for a few censuses, a measure based on "improved" appears in Table 1.

Demographic variables in the Census include numerous breakdowns of the population by age, gender, ethnicity, and origin. Of these, other than perhaps some form of age-weighted index, the most natural measure of economic activity and land demand is the total population. Finally, the measure of manufacturing activity used below is total employment in manufacturing.

4. Tabular Evidence & Inferences

The data would ideally permit definitive tests of hypotheses that together yield a complete story linking urbanization to the evolution of forests in New England during 1790-1930. While the historical information available is not sufficient for that entire task, given the regional background and some basic theory even the simple tabular evidence presented does suggest effects of cities.

4.1 Spatial Concentration of Population Can Increase Forest

Table 1 aggregates county data to New England data, from 1850 to 1930, for population, estimated forest area, farm area and manufacturing employment. Total population grew steadily. Improved land on farms was fairly flat from 1850 to 1890, and shrank from 1890 to 1930. The shrinking farm area suggests potential for reforestation, and the estimated forest area turns upward after 1890, even though this estimate takes into account not only farm area but also population.

Thus, the oft-cited negative correlation between population density and forest does <u>not</u> hold for New England in this period at this spatial scale of analysis.[21] However, each person surely does create demand for food and shelter, and thus cleared land. Thus, Table 1's first column leads us to ask what factor might lower clearing *per person*, permitting a rise in forests in the second column.

Table 2's trends in the spatial concentration of population suggest an answer. Concentration was decreasing until about 1830, when the trend reversed (the timing of this crucial shift shows the value of the pre-1850 demographic data). The first measure is a Gini coefficient (this is a single aggregate measure of how skewed the distribution of the densities is away from being equal in all counties). Also, five-, fifteen-, and twenty-five-county concentration ratios are calculated for each year using the population densities of the sixty-seven counties in New England (these concentration ratios sum the 5 (or 15 or 25) highest population densities, and divide that by the sum of all 67). None of the concentration measures falls in any decade after 1830 (this is true in levels as well).

The shift in trend in spatial concentration coincides well with the data in Table 1 and our knowledge that, before shifting trends, New England was deforested as its population grew from the mid-1700s. (Unfortunately, land data is not in censuses before 1850.) Decreasing concentration until 1830 matches that forest clearing. Increasing concentration since 1830 matches the eventual increase in forest in Table 1. Thus, the explicit concentration measure in Table 2 could explain how the rising estimated forest in Table 1 could occur, despite the rising population in Table 1. Further, an effect of concentration makes sense from a land-markets perspective. With spatial concentration, a greater share of the population lives in dense areas, where all will use reduced land per person at a higher land price. If the people left in lower-price areas don't greatly expand, cleared land can fall.[22]

4.2 Spatial Concentration Occurs When Agriculture Declines

If concentration mattered, we'd like to explain why it occurred.[23] Economic theory suggests that land will be allocated between uses to obtain the greatest expected total return. Thus, factors which affect relative returns should affect land allocation. This implies that trade should affect land use, as trade affects returns, given comparative advantage based on regional factor endowments.

Of relevance to New England forests, the Midwest has an absolute advantage over New England in agriculture (given high soil quality in the Midwest, and hills and rocky soils in New England). The Midwest also has absolute disadvantages in both ocean products and, at this time, also manufacturing (rivers' water power was an input to manufacturing production).[24] In sum, the Midwest had a clear comparative advantage in agriculture. Given that, if Midwest transport costs were to drop we would predict an increase in agricultural imports by New England, where high costs would imply low returns and thus little agricultural land use (even if forest's return is zero).[25]

In light of this basic theory, and that we know that transport costs to and from the Midwest dropped in the early 1800s, Tables 1 and 2 suggest that agricultural decline did contribute to spatial concentration. The perfect correlation of the timing of the transport cost shock and the reverse in Table 2 in the trend in spatial concentration in New England suggests that the transport shock drove the reversal in concentration. The obvious mechanism is a reduction in agriculture and a migration to New England's cities, given the drop in regional agricultural profitability. This idea is supported by Table 1 -- the third column's direct measure of the land in agriculture drops over time, while the fourth column's measure of manufacturing employment rises steadily over time.[26] Thus, a decline in agriculture occurred alongside and could have caused spatial concentration in New England.

However, another piece of evidence is needed for this simple potential causality argument: support for the assumption that agriculture is less concentrated than manufacturing. If it is not, then a reduction in agriculture and migration to manufacturing would not explain spatial concentration.[27] Table 3 presents more spatial concentration data over time, this time for the agricultural and the manufacturing sectors, using the same measures used in Table 1's third and fourth columns. The salient fact is not trends over time for either sector but, as seen in comparing the sector averages, that the manufacturing employment is very clearly more concentrated than is the agricultural land. Thus, the decline in agriculture would appear to have contributed to the spatial concentration.[28]

4.3 Industrial Aspects Of Cities Also Facilitate Spatial Concentration

While replacement of agriculture with manufacturing helps to explain spatial concentration, households will demand land for daily life, such as for shelter, whatever the exact nature of their employment. Thus, we must fully consider the effect on land use of the post-agricultural regime.[29]

Many have shown that industry facilitates concentration; here we consider land-use/forest impacts. Consider the claim that for an equivalent level of population or output, manufacturing implies less cleared land than agriculture. One obvious argument for this is that manufacturing production features lower ratios of land to labor and capital; this directly lowers cleared land per unit output. Another argument is that manufacturing production has "agglomerative" features that lead to spatial concentration, including increasing returns to scale, cross-firm externalities, and the idiosyncratic location of important factors of production or distribution.[30] The link to cleared land here is less direct than for land ratios, as for a given output, fewer sites need not imply less total land use. However, concentration may reduce manufacturing-related but non-production land use, such as for shelter (see endnote 22, e.g.), and thus reduce cleared land per unit output or per unit employment (e.g., urban apartments house manufacturing factory workers on little land).

The rest of the tabular evidence then provides a small addition to the substantial existing evidence that the industrial nature of employment in cities facilitated spatial concentration of the population. First, not shown here is that of the population of the five largest towns in each county, summed over counties, about 40% was on the coast, and of the non-coastal about 40% was on large rivers[31], and 75% was on some river. This suggests an importance of fixed, idiosyncratically located manufacturing inputs, since rivers were used for power and coasts and rivers provided transport.[32]

Finally, Table 4 shows high and increasing concentration even within the set of such relatively advantageous locations, i.e. concentration in a few sites along major rivers. Facts on spatial heterogeneity of river services, such as locations of waterfalls that provide useful power, might simply take the idiosyncratic-inputs argument one step further. However, this table may suggest that not only these fixed, idiosyncratically located river services but also other features of manufacturing, such as increasing returns to scale or externalities, affected spatial concentration.

Conclusion

This paper's strength is long-term analysis of census data. Evidence for New England suggests that forests can be a regional benefit of urbanization. Linked to theory, the tabular evidence supports these hypotheses: (1) spatial concentration of population can increase forest; (2) such concentration occurs when agriculture declines; and (3) industrial aspects of cities facilitate spatial concentration.

Two additional points regarding urbanization and forests are worth mentioning. First, as urbanization may involve significant changes in economic returns over time (including through sharp shifts between equilibria), it may alter the effects of policies on the forest; a given policy's effects on returns may be rendered insufficient to affect land-use choices. For example, a new road raising agricultural returns might have spurred clearing pre-1830, when agriculture made money, but have had little impact post-1870, when even with higher returns crops would have lost money.

Second, the hypotheses above could explain why forest area might first drop and then rise as development and urbanization proceed; this is what occurred in New England, as the increased spatial concentration enhanced forest outcomes driven by land use. However, the abandonment of agricultural land and the increase in forests in New England might not have occurred without the supply of food and timber from other regions.[33] This highlights the potential importance of the spatial scale or spatial bounds of any such analysis. It also suggests that while agglomeration can support enhancement of such environmental and resource outcomes, it may well not be sufficient.

It would be ideal if these points were relevant everywhere, but historical New England differs from other contexts, including in property rights regime or environmental impacts of forest clearing (e.g., possible irreversible loss of species). Further theoretical modeling and/or data might help to increase generality, for instance by helping to isolate the sign and significance of the effect of population, or by providing evidence of particular "agglomerative" processes. Though it seems unlikely that more land-use data of the type used here will become available for these analyses, other locations may offer the opportunity for a more in-depth empirical analysis of these points.

Nevertheless, this case may provide some relevant evidence for land-use policy in other countries that will continue to urbanize and face pressure to protect their environment and natural resources. Pfaff (1999) found that the marginal person's impact on Brazilian Amazon forests falls as more people are already present. This too suggests that increased spatial concentration of population increases forest. Since roads also mattered, to minimize deforestation per unit output Brazil might build good roads to existing cities, and focus on urban employment. However, even such policy speculation should include a vision of how broad-scale processes such as rural-urban migration and industrialization will affect land use over time. While New England's past and the current Brazilian Amazon clearly differ, it is hoped that the former offers policy-relevant facts.

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Table 1

TRENDS OVER TIME IN NEW ENGLAND, FROM 1850-1930

Year	**Density of Total Regional Population** (people / acre)	**Density of Estimated[b] Forest Area** (acre / acre)	**Density of Improved (i.e., cleared) Land on Farms[a]** (acre / acre)	**Density of Manufacturing Employment** (people / acre)
1850	.07	.66	.28	.008
1860	.08	.63	.31	.010
1870	.09	.63	.30	.013
1880	.10	.60	.33	.016
1890	.12	.66	.27	---
1900	.14	.72	.21	.024
1910	.17	.73	.18	---
1920	.19	.76	.15	.034
1930	.21	.78	.13	.028

[a]: The Census divides total land on farms into improved and unimproved. The latter includes both woodland and other unimproved land. At least roughly, improved land would appear to include all crop land plus plowable pasture land.

[b]: This version of Harper's (1918) estimate is: (county area * .95) - (population * .2 acres) - (improved land on farms).

Table 2

DISTRIBUTION OF COUNTY POPULATION DENSITIES IN NEW ENGLAND
Gini Coefficient and Decennial Concentration Ratios

Year	**Gini**[a]	**CR-5**[b]	**CR-15**[b]	**CR-25**[b]
1790	0.24	0.18	0.45	0.73
1800	0.21	0.15	0.38	0.64
1810	0.18	0.09	0.39	0.61
1820	0.16	0.09	0.37	0.58
1830	***0.13***	***0.12***	***0.34***	***0.57***
1840	0.13	0.12	0.37	0.58
1850	0.14	0.20	0.40	0.59
1860	0.15	0.22	0.46	0.60
1870	0.18	0.26	0.52	0.63
1880	0.20	0.29	0.56	0.69
1890	0.23	0.32	0.60	0.73
1900	0.26	0.34	0.65	0.77
1910	0.27	0.35	0.68	0.79
1920	0.28	0.35	0.71	0.81
1930	0.29	0.35	0.72	0.82

[a]: This measures the difference between the actual distribution of densities over counties and a hypothetical distribution in which all counties have equal densities. It is an aggregate inequality measure that considers the entire distribution.

[b]: The "CR-*x*" variables are the sum of the *x* highest county population densities over the sum of all county densities. The set of counties that made up the *x* with highest densities changed over time, as the shifts discussed were occurring.

Table 3

DISTRIBUTION OF IMPROVED LAND AND MANUFACTURING EMPLOYMENT
Decennial Concentration Ratios of Densities

	Year	CR-1[a]	CR-5[a]	CR-15[a]	CR-25[a]
Improved Land	***Sector Average***	***0.04***	***0.14***	***0.37***	***0.55***
	1850	0.03	0.13	0.36	0.56
	1860	0.03	0.12	0.34	0.53
	1870	0.03	0.12	0.35	0.55
	1880	0.03	0.12	0.33	0.52
	1890	0.03	0.13	0.34	0.53
	1900	0.04	0.15	0.37	0.55
	1910	0.04	0.15	0.37	0.55
	1920	0.05	0.17	0.41	0.58
	1930	0.05	0.18	0.42	0.59
Manufac. Employ.	***Sector Average***	***0.47***	***0.68***	***0.87***	***0.94***
	1850	0.50	0.70	0.86	0.94
	1860	0.36	0.59	0.82	0.91
	1870	0.49	0.69	0.86	0.94
	1880	0.53	0.72	0.88	0.95
	1890	---	---	---	---
	1900	0.49	0.69	0.88	0.94
	1910	---	---	---	---
	1920	0.45	0.69	0.90	0.96
	1930	0.46	0.69	0.90	0.96

[a]: The "CR-*x*" variables are the sum of the *x* highest county improved land (or manufacturing employment) densities divided by the sum of the improved land (or manufacturing employment) densities for all New England counties.

Table 4

CONCENTRATION OF POPULATION ALONG THE MERRIMACK & CONNECTICUT

	CR-1[a]	**CR-3**[a]	**CR-5**[a]
Merrimack[b]			
1850	0.03	0.13	0.36
1860	0.03	0.12	0.34
1870	0.03	0.12	0.35
1880	0.03	0.12	0.33
1890	0.03	0.13	0.34
Connecticut[c]			
1850	0.50	0.70	0.86
1860	0.36	0.59	0.82
1870	0.49	0.69	0.86
1880	0.53	0.72	0.88
1890	---	---	---

[a]: The "CR-*x*" variables are the sums of the populations of the *x* largest towns on the Merrimack (Connecticut) divided by the sums of the populations of all the towns (see footnotes below) on the Merrimack (Connecticut).

[b]: The total number of towns counted as on the Merrimack for this table is 26.

[c]: The total number of towns counted as on the Connecticut for this table is 111.

[1] Mieszkowski and Mills 1993 note that the share of U.S. population in MSAs (not necessarily in the central city) was 69% in 1970 and 77% in 1990. Certainly von Thunen 1826 and the monocentric urban model of Alonso 1964, Mills 1967 and Muth 1969 focused attention on urban land use. On urban benefits and costs, see, e.g., Glaeser 1998.

[2] See, e.g., Clawson 1962, Brown *et al.* 1981, Fischel 1982, and Kahn 2000. However, most work on sprawl has focused on sprawl's impacts on agricultural land uses, not on forest, as here. In terms of policy, since the relatively early 1900s, northeastern cities have acted in order to preserve forests' watershed services (see, e.g., Stroud 1997).

[3] This claim can be related to at least the migration-prevention version of claims seen in the environment-and-development literature about the benefits of intensification of land use in terms of the slowing of deforestation.

[4] Harper 1918, citing a U.S. Forest Service circular by Kellogg 1909.

[5] Raup 1966 discusses late 1700s clearing in Petersham, MA (from 10% to 15% during 1770-1790l). On one 600 acre farm, e.g., clearing was 11% in 1770, 77% in 1830, and 90% in 1850, indicating faster clearing in the early 1800s.

[6] Improvements in communication, such as in the telegraph, also matter. See, e.g., Duboff 1982 and Field 1992. In addition, the development of a system of property rights may play a crucial role. See, e.g., Alston *et al.* 1995.

[7] Steamboats sailed the rivers and coasts, while railroads offered east-west transport. As north-south transport along the coasts had long existed, railroads probably had greater effect on trade (see Williams 1989).

[8] Taylor 1951.

[9] See Slaughter 1997 on commodity prices. Rosenbloom 1996 finds a well-integrated labor market by the late 1800s in the Northeast and North Central regions, but large and persistent north-south differences into the 1900s.

[10] See, e.g., the discussion of the expansion and commercialization of Midwestern agriculture in Gregson 1993.

[11] Raup 1966 tells of living in the Midwest and receiving fish products from the northeast in the early 1900s within wooden barrels and buckets that were crafted in factories, from forests grown up on formerly agricultural lands.

[12] From 1820 to 1850, total employment in New England per thousand people in the national population grew; agricultural employment fell, while manufacturing employment rose (Census (1850), including the Compendium).

[13] Household demand for wood for heating tailed off only after 1900 (MacCleery 1992, Cronon 1983). Industries used wood for fuel, charcoal, railroad ties, shipbuilding, and eventually pulp. Pitch was also used, for making ships.

[14] While in 1840 the northeast accounted for over two thirds of timber production, by 1860 this share was about one third and still falling, although regional output was more or less constant (Williams 1989, including Figure 7.5).

[15] E.g., coal and oil in generation of energy, and cement and steel in construction. Although the absolute peak for wood harvested occurred in about 1930, the fraction of total U.S. energy produced by wood fell from 90% in 1850 to about 10% in 1930. In contrast, coal's share rose from about 10% in 1850 to 70% in 1910, but fell 50% by 1930 as oil increased in popularity (Williams1989, Figure 10.2, p.333 (based on Schurr and Netschert 1960, pp.36-7)).

[16] See Starr 1865, Pinchot 1919, Marsh 1864 and Muir 1876, all cited in Williams 1989.

[17] See, for instance, Libecap 1981 and Libecap and Johnson 1979.

[18] Unfortunately the land use is only from 1850 onward. Other data such as forest inventories may exist, but if so they will be even harder to collect, in particular for anything like this complete coverage at regular time intervals.

[19] It would appear that improved land can be thought of as all crop land plus plowable pasture land.

[20] This produces negative estimates for Suffolk County, MA, which contains Boston (not a problem for an index).

[21] Some examples of this correlation, in particular within cross-country empirical analyses, can be found in Lugo *et al.* 1981, Allen and Barnes 1985, Palo *et al.* 1987, Rudel 1989, Cropper and Griffiths 1994, and Deacon 1994.

[22] Imagine 36 one-land-unit subregions, of which 6 are cities. Cities have 30 residents and other subregions have 10. All land is cleared, i.e.residents use 1/10 or 1/30 of a land unit (at different land prices). Then, half the residents of each non-city subregion move to a city, such that cities end up with 55 residents and other subregions with only 5. Surely all land in the cities will still be cleared, with each resident using 1/55 of a unit, at a higher price than before. In the other subregions, unless the land per person doubles (as the land price falls), forests have room to regrow.

[23] Others have considered migration and urbanization at length: Kuznets *et al.* 1957 on population and growth in the U.S., Harris and Todaro 1970, and several papers in van der Woude *et al.* 1990. Also, De Vries' 1984 analysis of migration processes, city growth and the evolution of a European urban system depicts a period of de-urbanization of smaller cities as metropolises expanded, followed by a period in which smaller cities grew disproportionately.

[24] While steam became important, in 1870 water power was still common in Maine, New York, and Pennsylvania. In 1900, 25% of power for New England manufacturing was water power, versus less than 7% elsewhere (Harper 1918).

[25] Note that the comparative advantage in livestock may not equal that in crops, and that livestock could also be detrimental to forest. Still, farm area encompasses both activities to large extent, so when it falls it likely represents a fall in livestock area as well. To the extent that livestock co-exist with forest but perhaps degrade the forest over time, we face the issue of our crude, 1/0 measure of the dependent forest variable, one lacking quality gradations.

[26] While it would be better to have direct evidence regarding profitability, that is suggested by the fall in area.

[27] Note that de Vries 1984 and van der Woude *et al.* 1990 stress the existence of rural, non-agricultural populations.

[28] Note that agriculture did become somewhat more concentrated over time as it shrank. An interesting suggestion I've received concerning this result is that is may be due to spatial autocorrelation in the topography of the region.

[29] As to why it was industry, there exists extensive discussion of development and industrialization including links both to and from agriculture and urbanization. A broad discussion is beyond the scope of this paper's simple sketch of relevant theory, but work relevant for considering land use includes Boserup 1966, Hymer and Resnick 1969 on agriculture, and historical analyses of urbanization and cities' relationships to society, such as de Vries 1984.

[30] Regarding increasing returns to scale, for any firm this will push toward fewer locations of production.

Regarding externalities, in Krugman 1991 locational externalities between firms arise from transport costs and the fact that one firm's employees are another firm's customers. Another possible interaction between firms is informational spillovers, usually assumed to decrease with distance (see Marshall 1961, Henderson 1974, Rivera-Batiz 1988, Fujita 1993, and Krugman 1994, as well as Ellison & Glaeser 1997 and Hanson 1997 for empirics).

Regarding the fixed, idiosyncratic location of important factors, these may be important for explaining any given example. Ellison and Glaeser 1997, e.g., offer the wine industry's concentration in California as an effect of a site-specific climate effect. Also, along New England's lengthy coast, the non-uniformity of population density is striking, with big cities found in natural harbors. River location is also important, as rivers provide not only transport but also water power, at least during the period considered here. There exist analogous agricultural features, including the idiosyncratic location of agriculturally relatively productive areas, such as areas of good soil (regarding the Northeast, Hutchinson 1985 ascribes some industries' location to regional resource advantages). Finally, pre-existing railways could be determinants of location. However, historical accounts suggest that the causality was more likely to run from town location to railroad location (see, for example, Tanner 1840, or Harlow 1946, chapters 3 and 5).

[31] The "large" rivers are defined for these purposes as the Connecticut and the Merrimack rivers in particular, in addition to the Housatonic and, Maine, the Androscoggin, Kennebec, Penobscot, and Saco rivers.

[32] Also of interest is the Erie Canal, along whose path across relatively empty land Rochester and Syracuse boomed because of their sudden access to transport. The development of those urban centers was distinct from the persistent

lower population density along much of the canal. As Harlow 1925 points out, most of New York State was so thinly settled that it was quite a gamble to spend what was at that time the huge sum of 8 million dollars on this canal.

[33] A number of people have made related observations on trade, including Saint Paul in Goldin and Winters 1995.