Migration and change: the transformation of rural New York following the construction of the Erie Canal, 1825-1845

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Abstract

Large infrastructure projects usually induce two responses: agents directly affected by them change their behaviour; and new agents migrate to take advantage of the projects. This paper estimates how the construction of the Erie Canal led to the decline of home cloth production in New York between 1825 and 1845. It shows newly established households produced substantially less cloth at home than did established households, conditional on the size, age, and land-owning characteristics of the households. However, because long-established households eventually responded, albeit with a ten year delay, migration only caused a third of the overall decline of cloth production.

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1. Introduction.

Transport infrastructure projects have major effects on the development and transformation of isolated rural areas. A new road, railroad, waterway or harbour will cause transport costs to fall, improving the links to outside markets, and changing the prices of the goods and services bought and sold in the area. One effect of infrastructural projects is to induce those households already resident in the area to change what they produce, normally by increasing production of those items whose price has increased and reducing production of goods whose price has fallen. A second effect is to attract new households into the region to take advantage of the new opportunities. Ultimately the overall welfare effects, the distribution of the economic gains and losses, and even the political viability of an infrastructure project will depend on the relative importance of these two mechanisms, and the speed at which households respond to new prices.

While aggregate data can be used to calculate the overall effect of an infrastructure project, such data cannot be used to examine the responses of different households. Unfortunately, this means many questions concerning the overall effect of infrastructure investments have remained unanswered. For instance, it may be the case that an infrastructure investment has little effect on the production decisions of long established rural households, but simply induces large numbers of new households who behave differently to existing households to migrate to previously remote rural areas. If so, the transforming effects of low transport costs may be quite different than ordinarily imagined, relying on the relocation of households from one place to another rather than the transformation of productive activity within the household. Even if existing households do change their production activities, the overall welfare effects will depend on whether they do so quickly, or respond with a considerable delay.

This paper studies the home production activities of households living in New York state to ascertain how different households responded to the opening of the Erie Canal between 1825 and 1845. This question is of interest as it has long been argued that the decline in transport costs associated with the Erie Canal was instrumental in transforming New York from a region of self-sufficient frontier households into a region of market farmers. According to this argument, most families were largely self-sufficient prior to the construction of the canal, producing their own food, clothing, furniture and many other goods; but once transport costs fell low enough that farmers could sell their produce in distant markets, they specialized and sold farm products in order to purchase the items they formerly produced at home[1]. Historians have documented the change in rural New York that followed the opening of the canal. There was an influx of migrants into previously remote parts of the state, a big increase in wheat production, and a large decline in the production of other commodities such as home spun cloth. Nonetheless, there has been little detailed analysis of how transport cost reductions caused this transformation.

In the paper district-level and county-level data are used to estimate more precisely how distance and remoteness affected home cloth production across the state. The results confirm and extend the findings of Tryon (1917) and Cole (1926) that home cloth production declined substantially between 1825 and 1845, from 9.0 yards per capita in 1825 to 2.7 yards in 1845[2]. They also provide statistical support for their argument that access to water transport influenced home cloth production levels. For example, the paper shows that households located more than fifteen miles from the canal produced 30 percent more woolen cloth and twice as much linen cloth in 1835 than households located in the same county but within fifteen miles of the canal. It also shows that average home cloth production was positively correlated with the distance to New York for households living in counties that were less than 260 miles by water to New York. Beyond 260 miles, however, average home production levels were little affected by distance, although they were higher than the production levels of households living closer to New York.

Although the overall decline in home production indicates a significant transformation of rural household activity, the aggregate data do not reveal whether the decline was due to the changing behaviour of existing households or an influx of new households who eschewed home cloth production but grew wheat for market. To address this question, I have assembled a household level dataset from the 1825, 1835, and 1845 New York State censuses that enables me to analyse the home production activities of newly established and long established households separately. It was not possible to collect data from households distributed randomly across New York as most of the census records have been destroyed. Rather, I collected the household records of all households living in six districts in 1825 and 1835 and four districts in 1845, tracing as many households as possible through successive censuses to create a panel dataset. The data are used to investigate how individual production choices depended on their length of tenure in a location, conditioning on other factors such as the demographic composition of the household, their location and land holding. These estimates are then used to estimate how much of the overall response to the canal was due to the changing behaviour of established households, and how much was due to the different behaviour of new households.

The data confirm that households in remote regions were much more likely to produce cloth than households located near New York city. They also show that home production declined through time in households that were traced through all three censuses. However, they show there were important differences in the behaviour of newly established households and long established households. While both newly established and long established households produced more cloth in remote regions than in regions close to New York, in all regions home cloth production depended on the length of time a household had spent in a district. Conditional on the household's size, age, location, and land ownership, in both 1835 and 1845 newly established households produced 15 – 20 yards less cloth than their longer established counterparts, or 35 to

65 per cent less, depending on the year. The result is best demonstrated by comparing households that were in both the 1835 and 1845 censuses, but which differed by length of tenure. In 1835, the typical new household produced 17 yards less cloth (or a quarter less) than a household that had been in the district at least ten years, conditional on other factors such as age and household size. The average production of this household changed little by 1845, but it then produced only 5 yards less than a household that was first recorded in the 1825 census, as production had fallen in the latter. It appears that long established households followed the lead of their new neighbours, but with considerable inertia.

The paper uses these results to estimate how much of the decline in cloth production was due to the changing population distribution, and how much was due to the changing behaviour of existing households. In the four districts where data were available each census, average cloth production fell by 30 yards per household between 1825 and 1835, and a further 13 yards from 1835 to 1845. In both 1835 and 1845 the low production levels of new households caused average production to be 10 yards per household less than it otherwise would have been. It follows that 33 per cent of the average decline in home production between 1825 and 1835, and 23 per cent of the decline between 1825 and 1845 was due to the arrival of new households. The effect of population change on average production was largest in the most remote districts, but even there it was secondary to the production decline amongst established households.

The paper also provides evidence that changes in average production levels understate the welfare consequences of lower transport costs, as households also changed the type of cloth they were making. Between 1825 and 1845 many households stopped producing one type of cloth, normally linen, while continuing to produce other types. If households ceased making the type of cloth they found most onerous to produce, the changing composition of cloth production in the home may have been as significant to many households as the reduction in the average quantity produced.

While this paper is primarily a detailed study of New York production patterns, the fundamental issue of how transport infrastructure affects location and production choices is universal. Several papers have modeled the relationship between economic specialization, transactions costs, and the early stages of economic development. Some of these models focus on the individual household's choice between home production and production for market (for instance Locay (1990) and Yang and Ng (1993)); others examine the extent to which a village engages in specialized production and trade rather than self-sufficiency (Kelly (1997)); still others examine the extent to which specialization involves the production of intermediate producer services (Goodfriend and McDermott (1995); Rodriguez-Clare (1996)). Most of these models assume agents respond to price changes at the same speed in order to calculate the welfare effects of declining transactions costs. This paper raises questions about the validity of that assumption, as it shows that long established households were slow to adjust to big declines in transactions costs, and that a significant part of the aggregate adjustment occurred because new households replaced older ones. In terms of calculating the welfare benefits of transport infrastructure investments, a new class of models may be needed to better take into account this heterogeneity.

The paper begins with an overview of the effect of the Erie canal on the population distribution of the state. In section 3 aggregate district-level and county-level data are used to estimate how transport distances affected production choices. This followed in section 4 with an analysis of household level production choices in six districts. Lastly, conclusions are offered in section 5.

2. The Erie Canal: an overview of its effect on population.

The Erie canal, which runs across New York from near Albany on the Hudson River to Buffalo on Lake Erie, was built between 1817 and 1825. It is divided into the 110 mile eastern section, from the Hudson River to Utica along the Mohawk River, the 97 mile middle section, from Utica to the Seneca River, and the 157 mile western section from the Seneca River to Buffalo[3].

The geography of the canal makes it natural to classify counties according to their water access:

(1) The Hudson River and Eastern Seaboard (including Long Island);

(2) The Mohawk Valley;

(3) The Middle and Western Canal counties; and

(4) the "other" counties, everywhere else.

The first two groups had water transport access to New York City in 1814, while the third group gained it with the construction of the canal. After 1825, the transport technology was similar in these three groups of counties. The last group contains counties that were not directly contiguous to the Erie Canal, although some counties in this group had indirect water access to the Eastern Seaboard via rivers such as the Susquehanna, and others gained canal access from branch canals.

Transport costs fell in many parts of the state after the canal was opened, as land transport costs were up to thirty times as large as water transport costs during the early part of the nineteenth century[4]. Transport costs from Buffalo to New York fell to a tenth of their initial level once the canal was finished. In 1816, it cost $6.95 or 87 percent of the New York flour price to send a 200 lb barrel of flour from Buffalo to New York; in 1825, the transport cost was only 65 cents, or 13 percent of the lower New York flour price[5]. The response to the lower transport costs was dramatic. After the canal was opened, wheat prices in western New York increased four-fold, the rural population and wheat production expanded rapidly, and towns along the canal developed into large trading and manufacturing centres. The scale of the population influx and the growth of the market economy is epitomised by the rapid growth of Rochester. The town did not exist in 1814, but by 1840 it was the pre-eminent milling town in the world, with a population of 25000.

The influence of the canal on New York's population distribution was first analyzed by Winden (1900). He classified districts located along the Hudson River, the Mohawk River, and the entire western part of the state by their distance from a waterway and examined the population density of these districts. In 1820 the population density along the Mohawk and Hudson rivers was much higher than the density in the west, and within the Hudson-Mohawk region the densities of districts close to a river were much higher than the densities of districts more than twelve miles away. By 1840, however, population patterns in the west were very similar to those along the Mohawk and Hudson rivers[6]. Whitford (1906) conducted a very similar analysis. In part these authors capture the growth of towns and cities along the waterways as most major cities, including Buffalo, Rochester, Syracuse, and Albany are situated along the Hudson River or the canal, and thus in districts adjacent to water. Nonetheless, the rural population density patterns are qualitatively similar. Figure 1 shows the rural population density plotted against the distance to New York for each county in the state from 1814 to 1845[7]. The rural population density increased fastest in the canal counties, from 21 people per square mile in 1814 to 61 in 1845, compared to an increase from 44 to 63 people per square mile along the Hudson, 38 to 54 people per square mile in the Mohawk valley, and 9 to 33 people per square mile in the other counties.

The 1814 graph suggests a non-linear relationship between population density and the distance to New York in the pre-canal era; in particular, density declined with distance up to a point, beyond which it was independent of distance. Bairoch (1990) argued that such a pattern would occur if it were expensive to transport rural produce to urban markets. Beyond a critical threshold, the cost of transporting goods to market would exceed their worth, so households would be autarkic and population density would be independent of distance. Before this threshold, however, population density would decrease with the distance from the city, as increasing transport costs would make farming less profitable. This idea is, of course, the basis of Von Thunen's (1826) celebrated location model[8]. If correct, it suggests that areas with the highest transport costs should have low population density and high levels of home production. Moreover, a reduction in transport costs in an initially high transport cost area should simultaneously lead to an influx of migrants and a change in the production patterns of existing residents.

3. Transport costs and average cloth production.

In his study of home production in eighteen and nineteenth century North America, Tryon (1917) attributed the decline of home cloth production to two main causes: the improvements in manufacturing technology that caused the price of manufactured cloth to fall by three quarters between 1810 and 1845[9]; and the improvements in the transport network that increased farm-door prices for farm produce and enabled farmers to exchange farm produce for professionally woven cloth. Cole (1926) provided support for the latter thesis by documenting household production of wool cloth in the counties that bordered Lake Ontario. In 1820, before the canal was opened, these counties had the highest per capita cloth production in New York. In 1845, however, household cloth production had declined dramatically and the counties with the highest production were in the parts of the state most distant from the canal.

In this section the effect of transport costs — here proxied by distance — on average home cloth production quantities is analysed statistically. There are three aspects to this analysis. First, it is shown that the relationship between distance and home production was essentially a rural phenomenon. Secondly, it is demonstrated using district level data that the land distance to accessible water transport was an important determinant of cloth production among rural households, presumably because the high cost of transporting farm produce by land reduced farming returns and made home production more attractive. Lastly, it is shown using county level data that the water distance to New York city affected average cloth production across the state. The data come from the New York State censuses. These censuses collected information on the amount of three types of cloth produced at home: fulled woolen cloth, flannel and other woolen cloths that were not fulled, and linen, cotton, and other thin cloths.

Rural and Urban Cloth Production.

Tryon argued that household production levels were much lower in cities than in the rural countryside[10]. The data in Table 1, which shows aggregate production levels in fifteen towns (excluding New York) in 1825, 1835, and 1845, and aggregate production in the rural districts of the same counties, confirms his analysis. Urban production, which was low in all cities irrespective of their distance from New York, was only 20 per cent of rural production in 1825, 13 per cent in 1835, and 8 per cent in 1845.

Cloth Production by District

The effect of land distance on household production can be ascertained by comparing production in districts that differed in terms of the distance they were from the canal. In Table 2, the mean and standard deviation of per capita cloth production for districts located in eight central and western counties classified according to whether they were more than or less than 15 miles from the canal are presented[11]. These data clearly show that households close to the canal produced less cloth than households further away. In both 1825 and 1835, per capita production of each type of cloth was lower in the districts within 15 miles of the canal than in the districts more than 15 miles from the canal, and these differences were large and statistically significant at the 1 percent level. Per capita production of fulled cloth and woolen cloth in the more distant districts exceeded that in the districts close to the canal by between 25 and 35 percent in both census years, while in 1835 production of linen was twice as high.

Cloth Production by County

The effect of transport costs on home cloth production can be estimated by examining the relationship between average home cloth production in a county and the distance by waterway between that county and New York city. Figure 2 shows how average rural per capita production of flannel and other woolen cloth varied with the distance to New York in 1825, 1835, and 1845. The graphs of fulled cloth, and of linen are qualitatively similar. The graphs suggest the relationship between household production levels and distance is step-wise linear.

Table 3 presents regression estimates of the relationship between rural per capita output of cloth and distance for linen, woolen cloth (both fulled and not fulled) and the combined total for the years 1825, 1835, and 1845[12]:

$$cloth_i^{date} = \beta_0 + \beta_1 miles_i \, Dum_i^{1,2} + [\beta_2 + \beta_3 (miles_i - 260)]Dum_i^3 + [\beta_4 + \beta_5 miles_i \,]Dum_i^4 + e_i \quad (1)$$

where $cloth_i^{date}$ is the per capita production of cloth in a particular year;

Dum_i^j is equal to 1 if the county is a Hudson-Mohawk county (j=1,2), a canal county (j=3) or an "other" county (j=4), but zero otherwise; and

$miles_i$ is the number of miles by water to New York City for the Hudson, Mohawk, and Canal counties, and the direct distance to New York City for the other counties.

The "other" counties only include the counties in the hill country along the New Jersey and Pennsylvania border. The eight northern counties were omitted from the analysis as they were not directly affected by the canals. The factor of 260, or the number of miles by water to the head of the Mohawk Valley, is subtracted from the variable $miles_i^3$ in order to emphasize the effect of the canal on those counties that gained water access to New York for the first time.

The results of these regressions are considered for each region in turn. The quantity of cloth produced in the counties along the Hudson and Mohawk rivers increased linearly with the distance from New York in all years and for all cloth types. All of the distance coefficients β_1 in the regression were positive and all but one were significantly different from zero, with the coefficients for wool slightly larger than those for linen. Per capita production of cloth increased by nearly 2 yards per 100 miles distance from New York City in 1825 and 1835, and by 1.3 yards per 100 miles in 1845. Since the distance from New York city in this group ranged from 1 mile to 250 miles, and average production of cloth was 9 yards in 1825 and 3 yards in 1845, distance was a major factor in the decision of whether or not to produce cloth at home.

In contrast, there was little relationship between cloth production and distance in the western canal counties. The "canal distance" coefficients for all types of cloth in 1825 and 1835, and for linen in 1845 were small and insignificantly different from zero. Only in 1845 did wool cloth production increase with the distance from New York, and then by only 0.6 yards per 100 miles. While cloth production was little related to distance, the level of production in the canal counties was similar to that in the most distant Hudson and Mohawk counties.

There was also little relationship between cloth production in the "other" counties and distance. All distance coefficients were small and insignificantly different from zero, although the estimates of the dummy variable indicate that production was higher in these counties than in counties along the Hudson and Mohawk rivers.

The dominant feature of the results is the non-linearity of the relationship. Within a 250 mile radius of New York city, average household production increased steadily with distance; however it reached a plateau at that point, beyond which distance appears to have mattered little, at least in 1825 and 1835. The estimates for 1825 are consistent with Bairoch's argument that beyond a certain threshold agents were largely autarkic, and thus production was independent of distance, for transport costs had only just fallen and households may not have switched to producing grain for market. The coefficient estimates for 1835 are surprising, because households had ten years to respond to changed prices, and the overall decline in home production indicates there was some response. Nonetheless, it would appear that in parts of the state far from New York, the marginal effects of longer transport distances were not sufficiently important to have induced changes in home production choices.

4. Cloth production by individual households.

The New York state censuses potentially relevant to this paper were conducted in 1821, 1825, 1835, 1845, and 1855. Unfortunately, most of the original records were destroyed by fire in 1911, and there are only a handful of districts for which individual household returns are available. This study uses data from six censuses for which there are records from sequential censuses[13]. Each district had between 150 and 550 households per census, or roughly 2000 - 3000 people. Three districts were in the Hudson and Mohawk valleys (Argyle, Cornwall, and Salisbury), two were in central New York (Barrington and Scott) and one was in Western New York (Ellery). Census information from 1845 was only available for Barrington, Ellery, Salisbury and Scott. Ellery and Scott were always relatively isolated and had few settlers prior to 1814. The other districts were long settled in 1825, although Barrington only gained water access to the Erie canal when the Crooked Lake branch canal was completed in 1833. The dataset has 1906 households from 1825, 2414 households from 1835, and 1323 households from 1845. Basic geographic and demographic information about these districts are presented in Table 4. All linked households were carefully compared to ensure that age and family size were consistent across censuses.

Each census collected the full name of the head of the household, the number of males and females in the family, the number of females aged less than 16 and aged from 16-45, the amount of three types of household cloth production, the family's improved land acreage, and the number of animals they owned. They also collected other demographic information such as the numbers of births the preceding year, but not age information. The 1845 census had information about crops grown on the farm. One collector filled in the form for each district. If a household remained in the district with an unchanged household head, it could be linked across censuses. However, if a household moved out of the district, it could not be followed; similarly, it is not possible to determine whether new households were migrants or formed from the children of households already in the district. In total, 814 or 43 per cent of the 1905 households recorded in 1825 were traced through to 1835, of which 256 were linked through all three censuses. An additional 323 households new to the dataset in 1835 were traced through to 1845.

The state censuses have little age information. However, demographic data were collected in the 1830 and 1840 federal censuses, and these censuses were searched to find demographic data for Barrington, Ellery, Salisbury, and Scott households that appeared in at least two of the state censuses[14]. Approximately 90 percent of the names linked through two or more state censuses were found in the intervening federal census. However, in a trial sample of people who only appeared in one state census, 75 per cent of the people could not be found in the preceding federal census, and the attempt to find age data for this group was discontinued.

A few of the household records had no data other than the household name and household size. These households were ignored in the analysis, as were households that were obviously hostels[15]. Four observations with extremely large cloth production amounts were also dropped because they were assumed to be recording errors.

Household Matching Rates.

In Table 5, the matching rates — the fraction of households in one census that could be traced in the next — for each district are presented. The average matching rate between the 1825 and the

1835 censuses for Argyle, Barrington, Cornwall, and Salisbury was 38 per cent, but it was 58 per cent for Scott, and 61 per cent for Ellery, the two most isolated and most recently settled regions. Of the households in Barrington, Ellery, Salisbury and Scott that were in both the 1825 and the 1835 censuses, 56 percent were also in the 1845 census; but of the new households in these four districts in 1835, only 35 per cent were in the 1845 census.

These matching rates, while low, are similar to those in other studies that have matched households through time. Parkerson (1982) surveyed a range of studies that used New York census data from the middle of the nineteenth century to link households and calculated that the average matching rate was only 38 per cent[16]. Part of the reason for the low persistence rate of households is the high mortality rate during the period: Katz, Doucet, and Stern (1978) estimated that 8 per cent of male household heads aged 20-29, 11 per cent aged 40 – 49, and 17 per cent aged 50 – 59 died each decade. The main reason for the low persistence, however, was migration as families frequently moved as the mid-west was opened. The converse of these low persistence rates is that most households in each census were relatively new. In 1835, 66 per cent of households were not in the previous census; in 1845, by which time population had stabilized, 55 percent of households were not in the previous census.

Major Production Patterns

Tables 6 and 7 summarize the major production patterns across the six regions in the three census years. In table 6, the fraction of all households producing cloth and the mean per capita production are tabulated. Separate totals are presented for linen and woolen cloth, the latter defined as the total of fulled and non-fulled woolen cloth. Table 7 reports production statistics for households that were linked through the 1825 and 1835 censuses (Argyle and Cornwall) or through all three censuses (the other four districts).

There are several noteworthy patterns in the raw data. First, in each census year more cloth was produced in the more distant and remote districts than in the districts close to New York. Secondly, there was a significant decrease in cloth production through time, with the decline larger the closer the district was to New York[17]. Thirdly, the differences in average production levels between districts were driven by differences in the fraction of households producing nothing, rather than the average level of production of those that engaged in production. Conditional on producing anything at all, median production levels were similar in different districts, although the median production level did decline over time. Fourthly, linen cloth production declined more rapidly than woolen cloth production. In 1845, 56 per cent of households produced some woolen cloth, but only 36 per cent produced any linen. Lastly, in both 1835 and 1845 approximately 20 per cent more of the long established households produced cloth than did new households. Nonetheless, production patterns in different parts of the state by newly established and long established households were highly correlated. Household production was common amongst new households where it was common amongst established households and uncommon amongst new households where it was uncommon amongst established households[18].

The geographical production patterns are quite striking. There was practically no household production in Cornwall, the district closest to New York, in either 1825 or 1835. In contrast, over 85 per cent of households in each of the other districts produced cloth in 1825. By 1835, home production was on the decline in Argyle and Salisbury, but more than 80 percent of households in Ellery, Barrington and Scott still produced cloth. By 1845 fewer than the half of Salisbury households produced cloth at home, but it remained common in the most remote regions, with over 83 per cent of households in Ellery and 68 per cent of households in Scott producing some cloth that year. There was a big decline in home production in Barrington between 1835 and 1845 that appears to coincide with the completion of the Crooked Lake canal.

Determinants of household cloth production: evidence from tobit models

In order to isolate the effect of a household's length of tenure on its production choices, one needs to take into account other factors that are correlated with tenure length. According to table 8, which lists summary statistics for households in the dataset, households that were linked through all three censuses tended to be larger, and to own more land and livestock than other households; according to table 12, they were older as well, so such adjustments may be important. A series of tobit and ordinary least squares models were estimated to examine the importance of these factors. Table 9 reports the estimates of tobit models used to describe the home production activities of all households; these regressions do not take into account age effects as age data are not available for most households. Table 10 has estimates for those households in Barrington, Ellery, Salisbury and Scott that were in at least two censuses, for which age data were available. In addition, ordinary least squares estimates of the factors that caused output to change through time in the latter households are presented in Table 11.

The basic tobit models reported in tables 9 and 10 have the form:

$$cloth^*_{ijt} = \alpha_0 + X_{it}^{demography}\alpha_1 + X_{it}^{wealth}\alpha_2 + X_{it}^{region}\alpha_3 + X_{it}^{censusgroup}\alpha_4 + e_{ijt} \qquad (2a)$$

$$cloth_{ijt} = \min\left[0, cloth^*_{ijt}\right] \qquad (2b)$$

where

$cloth_{ijt}$ = the number of yards of cloth made by family *i* living in region *j* at *t*;

$X_{it}^{demography}$ is a vector of four demographic variables,

family $size_{it}$ = the number of people in family *i* at *t*;

adult $females_{it}$ = the number of women aged 16 years or more in family *i* at *t*;

young man_{it} = 1 if the oldest man in 1840 (1830 for 1825 data) is less than 40; and

old man_{it} = 1 if oldest man in 1840 (1830 for 1825 data) is over 60;

X_{it}^{wealth} is a vector of four variables measuring different aspects of wealth

$acres_{it}$ = number of acres owned by family *i* at *t*;

D_{it}^{acres} = 1 if family *i* had 1 acre or less of land at *t*, or 0 otherwise;

$cattle_{it}$ = number of cattle owned by family *i* at *t*;

$horses_{it}$ = number of horses owned by family *i* at *t*;

X_{it}^{region} is a vector of regional dummy variables,

$D_{it}^{region\ j}$ = 1 if family *i* lives in region *j* at *t*, and 0 otherwise; and

$X_{it}^{census\ group}$ is a vector of dummy variables indicating the censuses each household was in,

$D_{i}^{census\ group\ k}$ = 1 if family *i* was recorded in successive censuses and 0 otherwise,

where k = 1825-1835, 1835-1845 or 1825-1835-1845

Each tobit model was estimated separately for the 1825, 1835, and 1845 censuses. Separate models were estimated for linen, woolen cloth, and all cloth. Salisbury is the omitted region, so in table 9 the default group is a new household living on more than 1 acre in Salisbury. In table 10 the default group is a household that was in all three censuses living on more than 1 acre in Salisbury, whose head was aged between 40 and 59 either in 1840 (for the 1835 and 1845 regressions) or 1830 (for the 1825 regression.)

The difference regression models reported in table 11 have the form:

$$\Delta cloth_{ijt} = \beta_0 + \beta_1 \Delta family\ size_{it} + \beta_2 \Delta adult\ \ females_{it} + \beta_3 \Delta D_{it}^{acres*} + \beta_4 \Delta acres_{it} + \beta_5 \Delta cattle_{it}$$
$$+ \beta_6 \Delta horses_{it} + \beta_7\ young\ man_{it} + \beta_8\ old\ man_{it} + \sum_{k=1,2} \beta_{8+k} D_{it}^{census\ group\ k} + \sum_{j=1,3} \alpha_{10+j} D_{it}^{region\ j} + e_{ijt} \quad (3)$$

where

ΔX_t = X_t-X_{t-1}

ΔD_{it}^{acres*} =1 if household *i* had more than 1 acres at *t-1* but one or less acres at *t*.

The difference regressions were estimated over the periods 1825 to 1835, 1835 to 1845, and 1825 to 1845. Only households that had positive quantities of cloth in the initial year were included in the difference regressions.

The effect of each group of variables is discussed in turn.

Household composition and age

The results presented in table 9 (all households), table 10 (matched households with age data) and table 11 (difference regressions) are quite similar. Not unexpectedly, larger households produced more cloth than smaller households, with output increasing by between 3 and 5 yards for each extra person in the household[19]. Cloth output, especially linen output, was higher in households where there were more adult females, by 10 yards per female in 1825 and 7 yards per female in 1845. Since the coefficient estimates in the difference regressions and the tobit models are similar, it appears that these results are not just driven by differences between households; rather, as the demographic composition of a household changed, its output changed accordingly.

Age is not important in the regression results in tables 10 and 11. All the estimated coefficients for the young person dummy variable are small and statistically insignificantly different from zero; likewise, the coefficients on the old-age dummy variable for woolen cloth are small and statistically insignificantly different from zero. Age only seemed to be a factor in linen production. In 1825, the small number of households that had a male head over 60 years old produced more linen than average, while in 1845, their production was less than average. It is not clear why this change occurred[20].

Land and livestock ownership

The estimates in table 9 reveal a strong relationship between home cloth production and land ownership: households with less than an acre produced 20 -25 yards of cloth less than land-owning households each year[21]. Families that did not own land — most likely families with non-farming occupations, and thus market specialists — were much less likely to produce cloth than those that did. It is possible that the land owning dummy variable reflects household age, since fewer young households may have owned land than other households. In practice, this does not seem to have been the case because the coefficients on the land owning dummy variable were similar in both sets of tobit models, and the coefficients on the age variables in the second set were generally small and statistically insignificant. Consequently, it would appear that land-owning status was a major determinant of a household's propensity to produce cloth at home.

The coefficients on the land owning dummy variables are less precisely estimated in the difference regression. Most of the coefficients are small and none of them are significantly different from zero. Since changes in land ownership through time for a particular household had little effect on cloth production, it appears that the large and negative land-owning coefficients in the tobit regressions primarily reflect differences between households which always had less than an acre and those which always had more than an acre.

The coefficients on cattle and horses are typically positive and statistically significant. In 1825, cloth production increased by 5 yards per horse and 2 yards per cow that a household owned, so that the average household produced 20 yards more than a household with no livestock. These figures are robust to the inclusion of age variables. By 1845, the coefficients were smaller but still positive, at 0.5 yards per cow and 1 yard per horse.

These results are surprising, if livestock numbers are a measure of wealth. In 1825, a time when there was little specialization, the positive correlation between livestock numbers and cloth production might reflect overall differences in the total amount of economic activity performed by different households. Richer households may have simply produced more of everything than poorer households. Thereafter, however, models of specialization predict that specialized households should be richer and produce less cloth at home than those which do not specialize. This is not true in the cross-section. Moreover, since the livestock coefficients are of similar size in the difference regressions as the tobit regressions, there is evidence that households produced more cloth as they got more livestock. This result is curious, unless cattle and horse numbers are an indicator of a farm that is not specialized, rather than an indicator of wealth.

Geographical location

The coefficients on the regional dummy variables confirm that home production was decreasing in distance to New York city. The coefficients were smallest for Cornwall, the district closest to New York, and largest for Scott and Ellery, the most isolated districts. The changes in the regional dummy coefficients through time shows that home production declined faster in Salisbury and Cornwall than elsewhere, while the decline was slowest in Ellery. These results are consistent with the aggregate results presented in section 3.

Length of tenure

The estimated coefficients on the census group dummy variables in the all-household tobit regressions indicate that, conditional on all other factors, newly established households produced a lot less cloth than households that had been in the district for at least ten years. Households that were in just the 1835 census produced 21 yards less cloth than households that were in the district for all three censuses, and 13 yards less cloth than households that were in the 1825 and 1835 censuses. Households that were in just the 1845 census produced 21 yards less cloth than households that were in the district for all three censuses, and 15 yards less cloth than households that were in the 1835 and 1845 censuses. The comparison of single-census households with the households that were in both the 1835 and 1845 censuses is particularly interesting. In 1835, when both groups were new, households that were in both censuses produced only 3.6 yards more than households that were only in the 1835 census, and the difference is statistically insignificant. In 1845 households that were in both censuses produced 15.3 yards more than households that were only in the 1845 census, and the difference is statistically significant.

It is possible that the tenure dummy variables are picking up age effects. This hypothesis can be investigated by comparing the cloth production of the households that were in all three census with those that were only in the 1835 and 1845 censuses, as age data are available for both these groups[22]. This investigation suggests that age was not important. The evidence is two-fold. First, the coefficients on the census dummy variables in the "all household" regressions were compared to the coefficients on the tenure dummy variables in the "matched household" regressions that include age data. The inclusion of age information does not change the estimated effect of tenure. According to the 1835 "matched household" regressions, households that were not in the 1825 census produced 17.7 yards less cloth than those that were in all three censuses, an estimate extremely close to the estimate of 17 yards less from the "all households" regression. According to the 1845 "matched household" regression, households that were not in the 1825 census produced 5.2 yards less cloth than those that were in all three censuses, an estimate extremely close to the estimate of 5.9 yards less from the "all households" regression.

The second evidence comes from a comparison of cloth production by age for the two tenure groups. In 1835, for each age group households that were in all three censuses produced more cloth than those that were only in the 1835 and 1845 censuses (see table 12). The effect is most marked amongst households whose oldest male was aged 40 – 59 in 1840. While bivariate comparisons do not take into account other factors such as landownership that may vary with tenure, these data disprove the argument that differences in age structure are the main reason why new households produced less than established households in 1835. Of greater interest, however, is the comparison of cloth production by age and tenure in 1845. Except for a decline amongst the few households over 60, average production amongst the households who were only in the 1835 and 1845 censuses changed little between 1835 and 1845. For households who were in all three censuses, however, production dropped sharply towards the levels of the households who were only in two censuses. It appears that between 1835 and 1845 the longer established households became more like the newly established households, rather than the other way around. These data are indicative of habit persistence, with longer established households — especially middle-aged households — reducing home production much more slowly than newly arrived households.

New households and the decline of home production

It is apparent from the above analysis that newly established households tended to produce less cloth than long established households, irrespective of the age of the household. In 1835, 33 per cent of new households in Barrington, Ellery, Salisbury and Scott produced no cloth, compared to 13 per cent of households that had been in a district at least ten years; in 1845, the respective figures were 45 per cent and 25 percent. This raises the question: given that some 60 percent of households in each census were new, how much of the total decline in home production occurred because of an influx of new households who produced less than established households, and how much was because of a change in the production patterns of established households?

An approximate answer can be calculated using the tobit model estimates of the production difference between new and established households in table 9. By multiplying the tenure dummy variables by the fraction of population in each tenure classification, it is apparent that average household production for new households was 15 yards lower in 1835 and 18 yards lower in 1845 than average household production of households that were established for at least ten years. Given that 67 per cent of households were new in 1835 and 57 per cent of households were new in 1845, it follows that average household production was 10 yards less in both 1835 and 1845 than it would have been if all households had been long established. Average household cloth production amongst all households in Barrington, Ellery, Salisbury and Scott declined from 76 yards to 46 yards to 33 yards between 1825 and 1835 and 1835 (see table 8). It follows that 33 per cent of the decline between 1825 and 1835, and 23 per cent of the decline between 1825 and 1845 can be attributed to the effect of new households, while the rest can be attributed to the changing production patterns of established households. In regions such as Ellery and Scott where the decline amongst established households was less rapid, the effect is larger, but even there the introduction of new households only accounted for a third of the overall decline in home production between 1825 and 1845.

The selective decline of linen and woolen cloth production.

Even though most established households continued to produce some cloth, the opening of the canal had a major effect on the type of cloth they produced. In particular, linen production — but not wool production — fell quite sharply amongst the matched households, with only 20 per cent of households in Salisbury and 29 per cent of households in Barrington producing linen in 1845. The more rapid decline of linen than wool production suggests that many families were quite sensitive to changes in relative prices. As transport costs fell, and the relative price of farm produce to cloth improved, many households appear to have curtailed production of the type of cloth in which they had the least comparative advantage. In 1825, only 12 per cent of the linked households in Salisbury, Scott and Ellery produced one type of cloth, but not both, whereas in 1845 this fraction had increased to 40 per cent in Salisbury, 35 per cent in Scott, and 19 per cent in Ellery.

The selective production of different types of cloth was in fact quite general, and not just limited to the households that appeared in all three censuses. As the data in table 13 indicate, the fraction of households choosing not to produce at least one type of cloth increased much faster than the fraction choosing to produce no cloth. In Barrington, for instance, the fraction of households producing no cloth increased from only 11 per cent to 18 per cent between 1825 and 1835, but the fraction choosing not to produce at least one type of cloth increased from 29 per cent to 62 per cent. The effect is even more marked when woolen cloth is divided into fulled and non-fulled varieties. It strongly suggests that even when households chose to continue making some types of cloth, they stopped making the cloth they found most onerous to produce.

5. Conclusions.

This paper has estimated how different households changed their home production activities following the construction of the Erie Canal, one of the most important transport infrastructure projects in the United States during the nineteenth century. It has shown that, conditional on variables such as age, household size, and land ownership, long established households were much slower to respond than newly established households to the huge decline in transport costs that occurred following the completion of the canal. The raw data show that about twenty percent more long established households produced cloth at home than did newly established households in both 1835 and 1845; the tobit models suggest this means the typical new household wished to produce 20 yards less cloth than an established household. Moreover, a comparison of the home production activities of households that were in just the 1835 and 1845 censuses with those that were in all three reveals that households that were in all three censuses reduced their production over time to levels similar to their newer neighbours. This evidence suggests the longer established households responded to the canal with a delay of ten years or more compared to more recently established households. If this delay is typical of the speed of response to infrastructure development in other times or places, it indicates that the impact of infrastructure development may take a while to be visible.

The data suggest that average cloth production in both 1835 and 1845 was 10 yards per household less than it would have been if the newly established households behaved in the same way as the long-established households. In turn, this means 33 per cent of the decline in cloth production that occurred between 1825 and 1835, and 23 per cent of the decline that occurred between 1825 and 1845, was due to the replacement of established households by new households. The effect of migration was more important in the more remote regions, where established households were slower to curtail cloth production, but even there migration was only responsible for a third of the decline between 1825 and 1845. Migration accelerated the decline in home cloth production, but the evidence suggests the decline would have occurred anyway as long established households slowly changed their ways.

It is difficult to compare this estimate of the relative importance of “migration and change” over a twenty year period following a large infrastructure project, as such estimates are rarely made. The relatively small effect of inward migration is surprising, given the large population turnover rate at the time. It stems from the high correlation across districts of the behaviour of new and established households: new households establishing themselves in remote regions chose to produce cloth at home, although not to the same extent as established households. Since new households were choosing to produce cloth in remote regions twenty years after the canal was opened, it would appear that home cloth production remained profitable this late. Of course, cloth production could have been less trouble than other types of home production, particularly as much of the labor could be performed in winter. If so, it may be necessary to examine other indicators of the extent to which households specialized in their productive activities to gauge the full effect of the canal on the rural economy.

The results of the paper raise further questions. First, while the focus of the paper has been the decline of home production activity, it is of interest to know how quickly households engaged in other activities. The data to investigate how household specialization depended on tenure are less suitable for analysis than the cloth production statistics, but further research should be able to determine whether newly established households also took the lead in the transformation of market production in rural New York.

Secondly, the data suggest that urbanization was an important part of the means by which the rural economy was transformed. As is well known, the canal sparked the growth of large cities along its length. These cities were important locations for trade and manufacturing, and as such represent important locations for specialized economic activity. The data are clear that home cloth production ceased in these cities far sooner than in their surrounding hinterlands. At the same time, most districts had small but growing urban villages, which provided local specialized services. It is unfortunate the census records do not identify which households were part of these villages, for it may be the case that economic specialization increased and home cloth production declined first in these villages. The large and negative coefficient on the land-ownership dummy variable is certainly consistent with this story, as is the growing fraction of households within rural districts that owned less than an acre of land. If so, it may be the case that the development of small urban centres was an important component of the way in which rural areas were transformed by the Erie Canal.

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Appendix 1.

The population census data for the period are available by district and county. Rural population densities are calculated by deflating the county population by the county area, using the 1835 boundaries, where the latter data are sourced from Gordon (1836). It is necessary to adjust the population figures from the censuses before 1835 to take into account boundary changes, as the county boundaries were evolving over the period. This was done in two ways. The 1865 New York Census has a table of the population of each county from 1790 to 1865 using the 1865 boundaries. There were four more counties in 1865 than in 1835, and the populations of these new counties were added back into the counties from which they came to create the population along 1835 boundary lines. The population densities are based on this procedure. The second method is to rearrange the individual districts in the early censuses into the 1835 county boundaries. This process was used to calculate the per capita cloth production data by county. The population figures from this process were very similar although not identical to the population figures from the first process. The difference can be attributed to the manner in which some county boundaries cut across district boundaries when new counties were formed.

The rural population is defined to be the population of the county minus that of any urban areas that were sufficiently large that they exceeded 3000 people in 1835. The list of such towns was constructed using Gordons "Gazetteer of New York" (1836), which was also used to obtain geographical information such as the distance of the county from Albany or New York.

The County categories are as follows.

Group 1: The Hudson and Eastern Seaboard.

Albany; Columbia; Duchess; Greene; Kings; Orange; Putnam; Queens; Rensselaer; Richmond; Rockland; Saratoga; Suffolk; Ulster; Warren; Washington; West Chester.

Group 2: The Mohawk Valley.

Fulton; Herkimer; Montgomery; Oneida; Otsego; Schenectady; Schoharie.

Group 3: The Canal Counties.

Cayuga; Chautauqe; Clinton; Erie; Essex; Livingston; Madison; Monroe; Niagara; Onondaga; Ontario; Orleans; Wayne; Yates.

Group 4: Other Counties.

Allegany; Broome; Cattaraugus; Chemung; Chenango; Cortland; Delaware; Franklin; Genesee; Hamilton; Jefferson; Lewis; Oswego; St Lawrence; Schuyler; Seneca; Steuben; Sullivan;Tioga; Tompkins; Wyoming.

Chemung, Fulton, Hamilton, Schuyler, and Wyoming did not exist as legal entities in 1835.

Urban Areas (County and 1835 population are in parenthesis):

Albany (Albany; 28109); Auburn (Cayuga; 5368); Hudson (Columbia; 5531); Poughkeepsie (Duchess; 8520); Buffalo (Erie; 19715); Brooklyn (Kings; 32057); Rochester (Monroe; 18734); New York (New York; 270089); Lockport (Niagara; 6092); Utica (Oneida; 10183); Syracuse (Onondaga; 7793); Geneva (Ontario; 6608); Newburg (Orange; 7683); Oswego (Oswego; 4802); Troy (Rensselaer; 16957); Schenectady (Schenectady; 6272); Seneca Falls (Seneca; 3786); Ithaca (Tompkins; 5556)

The population figures for the urban areas are from Gordon (1836).

County	Miles	Area	Population				Total cloth production		
			1814	1825	1835	1845	1825	1835	1845
Hudson Valley									
Kings	1	76	3850	3888	4203	5922	2.77	0.07	0.01
Queens	1	208	19269	20331	25130	31849	4.87	0.53	2.52
Richmond	12	70	5502	5932	7691	13673	1.10	0.02	0.00
Westchester	22	554	26367	33131	38790	47394	5.12	0.94	0.31
Rockland	30	151	7817	8016	9696	13741	6.15	0.92	0.18
Suffolk	60	594	21368	23695	28274	34579	7.01	1.90	0.71
Putnam	65	216	9353	11866	11551	13258	8.41	2.61	0.96
Orange	65	760	29801	35564	37413	43226	7.83	2.05	1.36
Dutchess	76	765	38034	40763	42175	43333	9.31	2.71	0.87
Ulster	110	1008	26428	32015	39960	48907	8.60	3.43	1.93
Columbia	125	626	30315	33245	35742	36319	9.49	4.12	1.70
Greene	130	583	20210	26229	30173	31957	8.89	3.52	2.02
Albany	160	464	22205	26850	31653	35129	8.44	4.50	2.31
Rensselaer	156	631	31992	36206	38556	40629	11.14	5.93	2.36
Saratoga	181	787	31139	36295	38012	41477	9.33	4.32	2.04
Washington	210	759	36359	39280	39326	40554	10.26	4.96	2.04
Mohawk Valley									
Schenectady	163	163	4069	8808	9958	10075	6.95	4.37	2.78
Schoharie	199	150	19323	25926	28508	32488	9.20	6.97	4.55
Fulton									
Montgomery	199	190	37196	40902	48359	43222	9.06	4.83	3.26
Herkimer	246	260	23725	33040	36201	37424	10.59	4.53	2.75
Oneida	255	252	45627	52807	67335	72586	9.02	3.49	5.42
Otsego	260	200	41587	47898	50428	50509	12.03	6.88	4.18
Canal Counties									
Madison	291	590	26276	35646	41741	40987	10.68	5.07	3.14
Onondaga	316	826	28779	44602	53115	54371	8.65	4.17	2.88
Cayuga	341	647	33609	39761	43834	43492	10.13	5.40	3.92
Seneca	350	309	13935	20169	18841	20975	7.59	4.11	1.75
Ontario	370	653	19131	31575	34262	34681	10.48	4.77	2.35
Yates	370	320	5434	13214	19796	20777	8.77	4.86	2.31
Wayne	370	586	11220	26761	37788	42515	7.97	4.32	3.47
Monroe	414	614	9867	30542	39351	39822	8.77	2.97	2.21
Orleans	439	430	1524	14460	22893	25845	6.12	3.70	2.88
Livingston	445	494	13181	23860	31092	38389	8.73	4.33	2.99
Genesee	460	974	14846	40905	58588	59536	9.10	5.24	3.80
Niagara	478	485	1276	11062	20398	25236	5.00	2.85	2.77
Erie	509	851	5141	19175	37879	48862	9.99	4.63	3.69
Chautauqua	545	1016	4259	20640	44869	46548	10.28	6.39	6.04

County	Miles	Area	Population				Total cloth production		
			1814	1825	1835	1845	1825	1835	1845
Other Counties									
Sullivan	100		6233	10373	13755	18727	8.21	3.51	2.17
Delaware	166	1362	21290	29565	34192	36990	11.09	6.44	4.47
Tioga	200	976	10154	19951	33999	45974	9.37	4.67	3.37
Cortland	200	500	10893	20271	24168	25081	12.52	7.61	4.65
Chemung									
Tompkins	212	580	11667	29287	32452	31985	9.51	5.92	3.79
Schuyler									
Steuben	220	1400	10834	29245	41435	51979	8.57	5.60	4.09
Warren	240	802	7938	10906	12034	14908	8.15	5.09	3.31
Chenango	250	804	24221	34215	40762	39900	12.23	7.02	4.67
Hamilton									
Broome	252	627	7423	13893	20190	25808	9.57	5.48	4.30
Essex	271	1162	9949	15993	20699	25102	7.87	4.36	2.27
Lewis	275	1122	6848	11669	16093	20218	8.30	4.90	3.53
Franklin	287	1527	2568	7978	12501	18692	6.07	4.79	4.46
Oswego	295	907	5382	16693	33343	42393	8.22	4.38	3.75
Clinton	305	933	7764	14486	20742	31278	6.97	3.07	1.83
Jefferson	305	1125	18564	41650	53088	64999	7.38	5.08	4.05
Wyoming									
Allegany	349	1185	2207	18164	35214	31402	9.38	6.25	5.34
St Lawrence	350	2717	8252	27595	42047	62354	6.24	5.13	4.61
Cattaraugus	384	1270	537	8643	24986	30169	8.57	5.62	5.44

Table 1: Urban and rural cloth production 1825 – 1845.

	Population	Fulled cloth	Woolen Cloth	Linen	Total
			1825*		
Urban	68984	0.46	0.74	0.69	1.89
Rural	399492	2.02	2.73	4.48	9.23
			1835		
Urban	160620	0.17	0.24	0.11	0.52
Rural	576980	1.16	1.48	1.49	4.13
			1845		
Urban	218580	0.07	0.09	0.08	0.24
Rural	609855	0.69	1.19	1.08	2.96

An urban centre had at least 3000 people in 1835. For a list of cities and counties, see the Appendix.
* Hudson, Newburgh, and Schnectady and their respective counties are excluded as the data for these towns suggested cloth production exceeded 50 yards per capita.

Table 2: District level cloth production 1825 – 1835.

			Fulled Cloth		
Year	district	N	Mean	std	F(canal)
1825	Canal< 15	78	1.88	0.48	
	Canal> 15	21	2.35	0.43	16.6**
1835	Canal< 15	81	1.31	0.36	
	Canal> 15	23	1.61	0.31	12.4**
1825 - 1835	Canal< 15	73	-0.51	0.51	
	Canal> 15	19	-0.81	0.42	5.7*
			Woolen Cloth		
1825	Canal< 15	78	2.72	0.83	
	Canal> 15	21	3.68	0.89	21.1**
1835	Canal< 15	81	1.70	0.52	
	Canal> 15	23	2.25	0.62	18.1**
1825 - 1835	Canal< 15	73	-0.98	0.79	
	Canal> 15	19	-1.44	0.60	5.4*
			Linen and Cotton		
1825	Canal< 15	78	3.49	1.27	
	Canal> 15	21	5.77	1.39	51.3**
1835	Canal< 15	81	1.09	0.73	
	Canal> 15	23	2.25	1.22	32.8**
1825 - 1835	Canal< 15	73	-2.23	1.14	
	Canal> 15	19	-3.54	1.14	20.0**

Source: 1825 and 1835 New York State censuses. "Canal < 15"" are districts within 15 miles of the canal in Madison, Onondaga, Cayuga, Seneca, Wayne, Ontario, Monroe, and Niagara. "Canal > 15" are districts over 15 miles from the canal in these same counties. The comparison between 1825 and 1835 is only for districts listed in both censuses. F(canal)is the F-test that
the mean of each of the groups is equal, with ** and * indicating significance at the 1% and 5% levels respectively.

Table 3: County–level home cloth production regressions, 1825-1845.

	Linen 1825	**Wool 1825**	**All Cloth 1825**	**Linen 1835**	**Wool 1835**	**All Cloth 1835**	**Linen 1845**	**Wool 1845**	**All Cloth 1845**
Constant	3.28 (0.64)*	1.77 (0.55)*	5.04 (1.13)*	0.31 (0.34)	0.47 (0.36)	0.77 (0.66)	-0.20 (0.22)	0.46 (0.30)	0.26 (0.45)
Hudson distance	0.80 (0.43)	1.20 (0.37)*	2.01 (0.77)*	0.84 (0.23)*	1.03 (0.24)*	1.87 (0.45)*	0.71 (0.15)*	0.62 (0.20)*	1.34 (0.31)*
Canal dummy	0.99 (1.22)	3.38 (1.04)*	4.37 (2.17)*	1.07 (0.65)	2.54 (0.68)*	3.61 (1.26)*	0.88 (0.42)*	0.92 (0.58)	1.80 (0.86)*
Canal distance	-0.25 (0.62)	-0.17 (0.53)	-0.42 (1.10)	-0.09 (0.33)	0.17 (0.35)	0.08 (0.64)	0.12 (0.21)	0.63 (0.29)*	0.75 (0.44)
"other" dummy	0.19 (2.27)	2.11 (1.95)	2.30 (4.04)	1.37 (1.22)	1.55 (1.26)	2.93 (2.35)	0.63 (0.77)	0.58 (1.07)	1.21 (1.61)
"Other" Distance	0.16 (.79)	-0.03 (0.68)	0.14 (1.40)	0.05 (0.42)	0.30 (0.44)	0.03 (0.82)	0.21 (0.27)	0.63 (0.37)	0.84 (0.56)
R^2	0.09	0.34	0.17	0.29	0.52	0.40	0.40	0.56	0.53
N	47	47	47	47	47	47	47	47	47

See equation 3. A * indicates coefficient is different from zero at the 5% statistical significance level. The coefficient on the distance variables is the increase in cloth output per 100 miles.

Table 4: Six census districts – geographic and demographic information.

District	Cornwall, Orange	Argyle, Washington	Salisbury, Herkimer	Scott, Cortland	Barrington, Yates	Ellery, Chautauqua
Location	Hudson river valley	Hudson river valley	Mohawk river valley	Central New York	Western New York	Lake Erie
Miles to NY City	65	210	246	316*	370	545
1820 population	3020	2811	1438	775	1639**	787**
1825 population	3020	3025	1779	1006	2099	1207
1835 population	3289	3013	1974	1504	1937	2002
1845 population	3854	3241	1860	1368	1783	2395

Source: Census of the State of New York, 1865; Gordon (1836).

*Scott is 200 miles by land to New York. It is 20 miles south of Syracuse, which is 316 miles from New York by canal and river.

**Neither Barrington nor Ellery existed as independent districts in 1820. The population of Barrington is estimated as 45 % of the 1820 population of Wayne district, as in 1825 Barrington had 45% of the population of the combined region that had been Wayne in 1820. Similarly, the population of Ellery is estimated as 31 % of the 1820 population of the Chautauqua district.

Table5: Number of households by tenure in the six census districts

	Cornwall	**Argyle**	**Salisbury**	**Scott**	**Barrington**	**Ellery**
All Households						
1825	451	484	303	167	276	224
1835	534	507	370	267	333	403
1845			355	253	323	392
Matched households						
1825-35	160	198	57	41	46	54
1825-35-45			65	56	52	83
New 1835-45			80	64	78	101
% matched households						
1825- 1835	36%	41%	40%	58%	36%	61%
Old 1835-45			53%	58%	53%	61%
New 1835-45			32%	38%	33%	38%
% households that are new						
1835	70%	61%	67%	64%	71%	66%
1845			59%	53%	60%	53%

The table presents the number of households categorized by the number of times they appear in a census. For instance, 57 of the 303 Salisbury households that were in the 1825 census are in the 1835 census and a further 65 are in all three. This means 40% were linked from 1825 to 1835, and 53% of "old" households in 1835 were linked to 1845. In contrast, only 32% of the "new" households that were in the 1835 but not the 1825 census were in the 1845 census. 76% of households were new in 1835.

Table 6: Per capita production of cloth by district.

	Cornwall	Argyle	Salisbury	Scott	Barrington	Ellery
Water miles from NY	65	210	246	316[1]	370	545
Fraction of households producing zero cloth						
1825	73%	11%	7%	7%	11%	5%
1835	94%	33%	46%	19%	18%	21%
1845			58%	32%	42%	17%
Mean production per capita - yards of all types cloth						
1825	2.28	11.18	14.11	14.57	9.99	15.97
1835	0.34*	5.44*	5.60*	13.88*	7.01*	8.66*
1845			3.47*	7.20*	3.65*	9.98
Fraction of households producing zero linen						
1825	84%	26%	18%	17%	23%	11%
1835	99%	66%	70%	32%	56%	40%
1845			85%	47%	77%	45%
Mean production per capita - yards of linen						
1825	1.15	6.00	7.95	7.78	5.36	9.58
1835	0.06*	2.09*	2.13*	9.33	2.45*	4.10*
1845			0.79*	4.38*	1.04*	4.20
Fraction of households producing zero woolen cloths						
1825	77%	18%	15%	12%	16%	11%
1835	95%	38%	52%	36%	24%	29%
1845			60%	49%	48%	21%
Mean production per capita - woolen cloths						
1825	1.13	5.18	6.16	6.79	4.62	6.39
1835	0.28*	3.35*	3.48*	4.55*	4.56	4.56*
1845			2.68*	2.82*	2.60*	5.78*

[1]Cortland is 20 miles south of the Erie Canal, and thus the only county not linked by water to New York
A * indicates that the hypothesis that the distribution of per capita output is the same as in the previous census is rejected at the five per cent critical level. The Wilcoxon Mann Whitney test statistic is calculated; those with a * exceed 1.96, the five per cent critical value for a standard normal distribution.

Table 7: Per capita production of all types of cloth for continuing households

	Cornwall	Argyle	Salisbury	Scott	Barrington	Ellery
Water miles from NY	65	210	246	316[1]	370	545
#households	159	196	65	56	52	83
Fraction of households producing zero cloth						
1825	63%	9%	3%	4%	2%	2%
1835	89%	22%	22%	5%	2%	6%
1845			43%	11%	35%	12%
Mean production per capita - yards of all types cloth						
1825	3.21	12.60	14.70	15.26	12.10	16.58
1835	0.61*	6.66*	7.88*	17.28	10.04	12.55*
1845			5.00*	9.96*	4.21*	12.68
Fraction of households producing zero linen						
1825	79%	21%	14%	11%	11%	5%
1835	99%	58%	48%	16%	36%	21%
1845			80%	30%	71%	31%
Mean production per capita - yards of linen						
1825	1.45	6.76	7.69	7.81	6.79	9.98
1835	0.06*	2.61*	2.74*	9.98	3.61*	6.14*
1845			1.16*	5.83*	1.28*	5.44
Fraction of households producing zero woolen cloth						
1825	66%	14%	6%	5%	8%	10%
1835	89%	28%	28%	14%	12%	8%
1845			46%	27%	40%	12%
Mean production per capita - yards of woolen cloth						
1825	1.76	5.85	7.01	7.46	5.31	6.60
1835	0.55*	4.05*	5.13	7.30	6.42	6.40
1845			3.84*	4.13*	2.93*	7.24

[1]Cortland is 20 miles south of the Erie Canal, and thus the only county not linked by water to New York
A * indicates that the hypothesis that the distribution of per capita output is the same as in the previous census is rejected at the five per cent critical level. The Wilcoxon Mann Whitney test statistic is calculated; those with a * exceed 1.96, the five per cent critical value for a standard normal distribution.

Table 8: Summary Statistics of Census information

	All Households					
	Argyle, Cornwall			Barrington, Ellery, Salisbury, Scott		
	1825	**1835**	**1845**	**1825**	**1835**	**1845**
N	930	1030		969	1369	1322
Family size	6.1 (3.0)	5.9 (2.9)		5.9 (2.5)	5.7 (2.6)	5.4 (2.5)
Adult females	1.7 (1.1)	1.7 (1.1)		1.7 (1.1)	1.7 (1.1)	1.8 (1.2)
Acres	35.5 (41.4)	31.5 (45.0)		27.6 (36.0)	33.4 (43.8)	39.8 (51.8)
Dummy (acres ≤1)	0.24 (0.49)	0.49 (0.50)		0.21 (0.40)	0.28 (0.45)	0.32 (0.46)
Cattle	6.4 (6.9)	6.9 (9.2)		7.7 (9.4)	7.2 (10.1)	7.7 (9.6)
Horses	1.4 (1.8)	1.8 (1.9)		1.1 (1.6)	1.6 (1.9)	1.7 (1.8)
Cloth	43.2 (57.8)	17.7 (32.9)		75.7 (60.4)	46.0 (56.3)	32.6 (43.6)
Linen	22.5 (35.3)	6.4 (17.5)		42.2 (40.2)	22.5 (41.9)	13.3 (27.3)
Woolen cloth	20.9 (27.6)	11.3 (20.0)		33.5 (29.2)	23.6 (25.7)	19.3 (24.7)
	Households in 1825, 1835 and 1845 censuses					
				Barrington, Ellery, Salisbury, Scott		
N				255	252	252
Family size				6.4 (2.6)	7.0 (3.0)	6.0 (2.6)
Adult females				1.8 (1.1)	2.1 (1.3)	2.2 (1.3)
Acres				35.6 (37.5)	57.5 (53.8)	63.1 (64.8)
Dummy (acres ≤1)				0.12 (0.32)	0.09 (0.29)	0.17 (0.37)
Cattle				10.4 (11.3)	13.5 (13.2)	12.1 (11.0)
Horses				1.5 (2.0)	2.7 (2.3)	2.5 (2.1)
Cloth				90.0 (59.5)	76.4 (62.6)	51.9 (57.5)
Linen				49.6 (38.8)	36.8 (48.2)	22.5 (39.4)
Woolen cloth				40.5 (29.8)	39.7 (27.1)	29.4 (30.4)

Table 9: Tobit model regression results, all households.

	Cloth			Linen			Wool		
	1825	**1835**	**1845**	**1825**	**1835**	**1845**	**1825**	**1835**	**1845**
Constant	8.41 (4.60)	-31.25 (5.17)*	-44.9 (5.18)*	0.89 (3.83)	-55.97 (6.19)*	-72.58 (6.43)	-0.87 (2.39)*	-18.26 (2.72)*	-25.76 (3.28)*
Family size	4.62 (0.58)*	3.35 (0.62)*	3.47 (0.76)*	2.46 (0.49)*	2.03 (0.73)*	1.05 (0.85)	2.53 (0.30)*	1.98 (0.32)*	2.77 (0.48)*
Adult females	10.09 (1.51)*	4.66 (1.49)*	7.23 (1.62)*	8.43 (1.26)*	5.06 (1.72)*	8.48 (1.79)*	2.35 (0.79)*	0.79 (0.78)	2.13 (1.03)*
D(acres≤1)	-7.71 (3.62)*	-19.61 (3.77)*	-16.45 (4.10)*	-9.76 (3.05)*	-20.18 (4.48)*	-8.85 (4.60)*	-3.34 (1.88)	-8.25 (1.99)*	-12.39 (2.63)*
Acres	0.02 (0.06)	0.03 (0.05)	-0.015 (0.05)	-0.00 (0.05)	-0.06 (0.06)	-0.06 (0.06)	-0.00 (0.03)	0.072 (.025)*	-0.01 (0.03)
Cattle	2.31 (0.25)*	0.96 (0.20)*	0.48 (0.24)*	1.18 (0.20)*	0.81 (0.24)*	0.38 (0.28)	1.29 (0.13)*	0.48 (0.10)*	0.42 (0.15)*
Horses	5.36 (1.00)*	4.19 (0.89)*	1.06 (1.04)	2.68 (0.82)*	1.28 (1.02)	-0.50 (1.18)	3.15 (0.51)*	3.30 (0.46)*	1.44 (0.65)*
D(25-35)	7.27 (3.06)*	12.97 (3.51)*		3.98 (2.55)	10.27 (4.16)*		4.39 (1.58)*	7.70 (1.82)*	
D(35-45)		3.56 (4.08)	15.31 (3.68)*		3.56 (4.63)	9.62 (4.14)*		3.56 (2.14)	8.91 (2.32)*
D(25-35-45)	2.03 (3.82)	20.60 (4.49)*	21.20 (4.10)*	1.36 (3.15)	16.79 (5.01)*	17.09 (4.52)*	1.62 (1.98)	11.53 (2.34)*	10.92 (2.60)*
Cornwall	-86.66 (7.78)*	-88.34 (6.72)*		-73.88 (7.40)	-92.78 (10.7)*		-34.05 (4.00)*	-45.90 (3.50)*	
Argyle	-17.39 (3.90)*	4.34 (4.57)		-13.53 (3.24)*	2.82 (5.44)		-5.31 (2.02)*	2.48 (2.39)	
Scott	-10.50 (5.27)*	53.33 (5.29)*	28.3 (4.97)*	-11.60 (4.36)*	62.80 (6.03)*	46.75 (5.74)*	0.75 (2.72)	10.58 (2.79)*	3.21 (3.19)
Barrington	-15.01 (4.17)*	22.47 (4.70)*	12.09 (4.59)*	-10.98 (3.46)*	15.03 (5.56)*	14.51 (5.64)*	-4.49 (2.16)*	14.08 (2.45)*	4.82 (2.89)
Ellery	13.01 (4.44)*	31.97 (4.51)*	53.80 (4.20)*	12.02 (3.66)*	35.04 (5.23)*	55.21 (5.08)*	3.64 (2.30)	13.38 (2.36)*	26.97 (2.63)*
N	1491	2147	1271	1498	2147	1271	1492	2147	1271
σ^2	48.7	55.4	49.6	39.7	57.8	48.6	25.0	28.6	30.9
L-R $\chi^2(n)$	913*	1150*	445*	591*	712*	300*	840*	1147*	414*
Censored	145	779	436	332	1290	797	242	927	521
% censored	10%	36%	34%	22%	60%	63%	16%	43%	41%

See Equation 2 for a full description of terms. The dependent variable is the yards of cloth produced by the household. All households in the sample for whom data were available are included in the regression.

Table 10: Tobit model regression results, continuing households.

	Cloth			Linen			Wool		
	1825	**1835**	**1845**	**1825**	**1835**	**1845**	**1825**	**1835**	**1845**
Constant	**-5.45** (11.43)	-4.86 (10.7)	-24.4 (9.52)*	-10.54 (9.15)	-24.48 (11.6)*	-61.13 (11.4)*	-0.83 (5.43)	- 5.38 (4.79)	-13.32 (5.69)*
Family size	5.36 (1.29)*	3.02 (1.24)*	2.71 (1.26)*	3.58 (1.02)*	1.50 (1.32)	0.66 (1.42)	2.25 (0.61)*	2.09 (0.55)*	2.39 (0.75)*
Adult females	11.86 (3.98)*	6.25 (2.91)*	12.08 (2.53)*	8.48 (2.37)*	6.60 (3.05)*	14.58 (2.77)*	3.21 (1.41)*	0.48 (1.30)	2.79 (1.52)
D(acres≤1)	-8.56 (8.61)	-20.66 (8.63)*	-21.81 (7.68)*	-11.01 (6.92)	-9.26 (9.11)	-11.34 (8.67)	-1.37 (4.14)	-14.06 (3.97)*	-15.68 (4.65)*
Acres	0.12 (0.15)	0.12 (0.08)	-0.04 (0.067)	-0.02 (0.12)	0.06 (0.09)	-0.10 (0.08)	0.15 (0.07)*	0.12 (.036)*	-0.01 (0.04)
Cattle	1.94 (0.45)*	0.73 (0.31)*	0.65 (0.36)	1.01 (0.36)*	0.26 (0.35)	0.53 (0.41)	0.98 (0.21)*	0.43 (0.14)*	0.56 (2.63)*
Horses	5.18 (1.67)*	2.14 (1.53)	0.19 (0.36)	2.35 (1.32)	-0.79 (1.62)	-1.80 (1.81)	2.76 (0.79)*	2.35 (0.68)*	1.00 (0.93)
Young man	2.15 (6.19)	-2.62 (6.55)	-2.47 (6.08)	4.04 (4.94)	1.18 (6.96)	-5.26 (6.80)	-2.20 (2.94)	-1.88 (2.92)	-0.20 (3.63)
Old man	22.96 (9.13)*	-8.75 (7.69)	-13.60 (7.71)	21.99 (7.23)*	-12.33 (8.21)	-23.47 (9.04)*	2.66 (4.32)	-0.15 (3.43)	-2.35 (4.61)
D(25-35)	8.15 (5.17)*			5.16 (4.11)			3.51 (2.45)		
D(35-45)		-17.72 (6.16)*	-5.22 (5.79)		-19.19 (6.53)*	-6.58 (6.48)		-6.14 (2.74)*	-2.60 (3.45)
Scott	-2.78 (8.60)	44.46 (8.64)*	23.6 (8.08)*	- 5.81 (6.85)*	43.89 (9.20)*	42.42 (9.30)*	4.07 (4.07)	13.06 (3.87)*	2.73 (4.88)
Barrington	-8.92 (7.57)	18.30 (7.87)*	8.48 (7.86)	-4.87 (6.04)	11.29 (8.57)	6.94 (9.78)	-4.18 (3.60)	10.00 (3.51)*	4.47 (4.68)
Ellery	23.81 (6.97)*	34.79 (7.31)*	59.69 (6.98)*	20.89 (5.55)*	34.54 (7.86)*	63.24 (8.35)*	4.14 (3.31)	13.38 (3.26)*	29.07 (4.15)*
N	413	523	533	413	523	533	413	523	533
σ^2	50.5	56.1	54.5	39.8	56.2	53.7	23.8	24.7	32.2
L-R $\chi^2(n)$	235*	171*	187*	138*	93*	174*	260*	268*	160*
Censored	12	85	125	39	204	291	31	128	158
% censored	3%	16%	23%	9%	39%	55%	8%	24%	30%

See Equation 2 for a full description of terms. The dependent variable is the number of yards of cloth produced by the household. All continuing households in the sample in Barrington, Ellery, Salisbury and Scott for whom data were available are included in the regression.

Table 11: Difference regressions, continuing households.

	Cloth			Linen				Wool	
	1825-1835	**1835-1845**	**1825-1845**	**1825-1835**	**1835-1845**	**1825-1845**	**1825-1835**	**1835-1845**	**1825-1845**
Constant	-35.0 (8.1)*	-50.7 (8.9)*	-53.5 (11.2)*	-38.9 (7.5)*	-27.7 (8.0)*	-42.9 (8.42)*	-16.6 (4.14)*	1.62 (0.75)*	-19.0 (6.0)
ΔFamily size	3.29 (1.41)*	3.81 (1.48)*	4.10 (1.60)*	0.82 (1.27)	1.64 (1.38)	1.19 (1.21)	2.43 (1.07)*	3.18 (1.42)*	2.12 (0.84)*
ΔAdult females	9.69 (2.64)*	6.33 (3.06)*	10.67 (3.39)*	6.49 (2.57)*	9.34 (2.50)*	8.15 (2.55)*	1.07 (1.45)	-2.06 (5.81)	4.71 (1.79)*
ΔD(acres≤1)*	-2.30 (10.5)	17.12 (14.5)	5.99 (14.9)	20.1 (12.0)	-5.28 (10.3)	8.62 (11.29)	1.26 (6.79)	-2.06 (5.81)	-1.35 (7.94)
ΔAcres	0.01 (0.07)	-0.12 (0.10)	-0.10 (0.09)	-0.18 (0.08)*	-0.06 (0.07)	0.01 (0.07)	0.07 (0.05)	0.02 (0.03)	-0.09 (0.05)
ΔCattle	0.57 (0.31)	0.96 (0.37)	0.70 (0.51)	0.68 (0.30)*	0.60 (0.35)	-0.28 (0.39)	0.34 (0.17)*	0.27 (0.16)	0.89 (0.27)*
ΔHorses	0.79 (1.57)	5.06 (1.66)	6.15 (2.09)*	3.35 (1.38)	-0.13 (1.51)	3.09 (1.55)*	1.77 (0.78)*	0.21 (0.82)	2.83 (1.09)
Young man	-3.01 (7.83)	4.32 (8.20)	8.21 (14.6)	-1.42 (6.89)	-4.51 (7.51)	4.94 (10.9)	4.21 (3.83)	1.02 (4.15)	1.41 (8.49)
Old man	-1.51 (8.58)	-9.68 (12.1)	-29.8 (11.3)*	-12.0 (9.85)	-4.28 (8.44)	-28.6 (8.44)	4.51 (5.63)	-0.76 (4.58)	-1.93 (5.86)
D(25-35)	13.43 (6.93)			-2.46 (5.87)			-6.84 (3.33)*		
D(35-45)		-8.75 (7.07)			4.61 (6.62)			6.43 (3.66)	
Scott	-2.38 (9.21)	52.5 (10.3)*	20.9 (13.1)	51.8 (8.66)*	0.29 (8.93)	29.0 (9.8)*	4.68 (4.81)	0.71 (5.02)	-2.34 (6.89)
Barrington	0.48 (8.90)	26.1 (10.3)	-6.49 (13.5)	14.7 (8.73)	3.84 (9.20)	-5.01 (10.07)	12.85 (4.89)	-1.91 (4.75)	-0.40 (7.17)
Ellery	30.3 (8.4)*	16.5 (9.6)*	23.7 (12.0)*	10.4 (8.06)	17.6 (8.23)*	13.0 (8.83)	7.92 (4.53)	18.9 (4.44)	15.1 (6.36)*
N	438	393	229	368	319	214	374	396	217
σ^2	60.4	66.8	63.6	53.7	49.1	45.7	30.7	30.6	32.9
R^2	0.17	0.19	0.28	0.16	0.13	0.26	0.21	0.17	0.25

See Equation 3. The dependent variable is the change in the number of yards of cloth produced by the household. All continuing households in the sample in Barrington, Ellery, Salisbury and Scott for whom data were available and who produced positive quantities of cloth (or linen, or wool) in the initial year are included in the regression.

Table 12: Cloth production by age, continuing households 1835-1845.

Age in 1840	Number households	Fraction Output=0	Mean output	Number households	Fraction Output=0	Mean output
	1825-1835-1845 households			1835-1845 households		
	1835					
< 29	2	0	41	30	0.27	35
30 – 39	28	0.18	47	138	0.23	40
40 –49	87	0.09	73	63	0.27	41
50 – 59	71	0.04	103	31	0.23	45
60 – 69	40	0.13	66	19	0.37	41
70 – 79	8	0	66	7	0.00	46
80 – 89	3	0	60	3	0.00	65
Unknown	12	0	66	29	0.42	38
Total	252	0.08	76	324	0.26	41
Mean Age	56			45		
	1845					
< 29	2	0.50	9	30	0.17	39
30 – 39	27	0.15	55	138	0.24	45
40 –49	88	0.22	54	63	0.27	51
50 – 59	73	0.16	62	31	0.26	38
60 – 69	40	0.28	36	19	0.47	26
70 – 79	8	0.38	48	8	0.50	18
80 – 89	2	0.00	82	3	0.67	10
Unknown	11	0.64	16	29	0.34	30
Total	252	0.23	52	325	0.27	41
	Change, 1835 to 1845					
< 29	2			30	-0.10	4
30 – 39	27	-0.03	8	138	0.01	5
40 –49	88	0.13	-19	63	0.00	10
50 – 59	73	0.12	-41	31	0.03	-7
60 – 69	40	0.15	-30	19	0.10	-15
70 – 79	8	0.38	-18	8	0.50	-28
80 – 89	2			3		
Unknown	11			29		
Total	252	0.15	-24	325	0.01	0

Table 13: Fraction of households producing cloth by year.

	Cornwall	**Argyle**	**Salisbury**	**Scott**	**Barrington**	**Ellery**
Water miles from NY	65	210	246	316[1]	370	545
Fraction of households producing cloth in 1825						
Produce nothing	73	11	7	7	11	5
Produce only wool	11	15	11	10	13	6
Produce only linen	4	7	8	5	5	6
Produce linen and wool	12	67	74	78	71	83
Fraction of households producing cloth in 1835						
Produce nothing	94	33	46	19	18	21
Produce only wool	5	33	24	13	38	19
Produce only linen	1	5	6	17	6	8
Produce linen and wool	0	29	24	51	38	52
Fraction of households producing cloth in 1845						
Produce nothing			58	32	42	17
Produce only wool			27	15	35	28
Produce only linen			2	4	6	4
Produce linen and wool			13	49	17	51

Figure 1: Population density versus the distance from New York, 1814-1845.

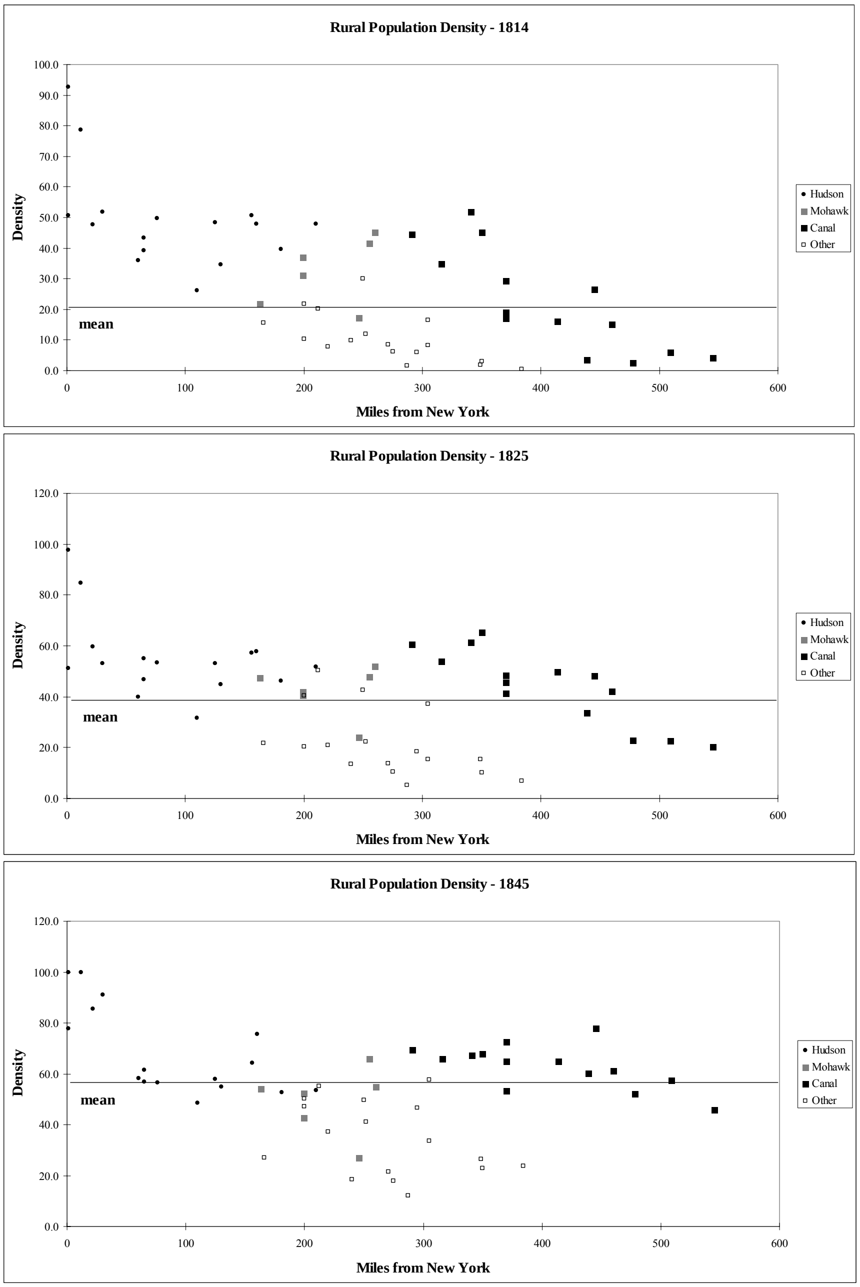
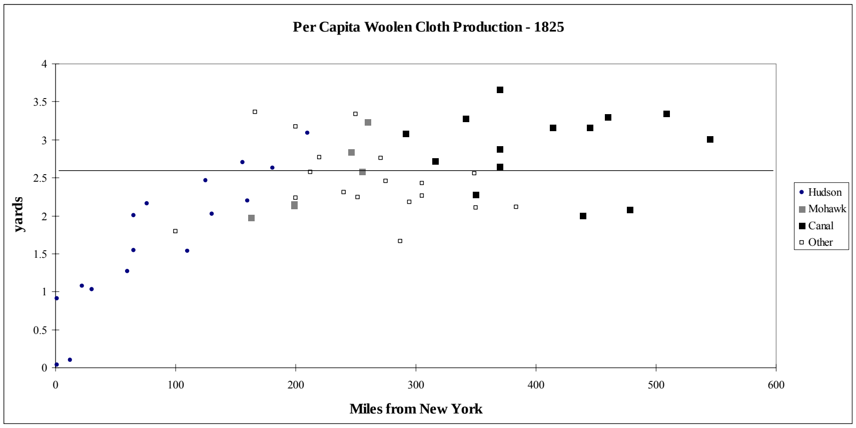
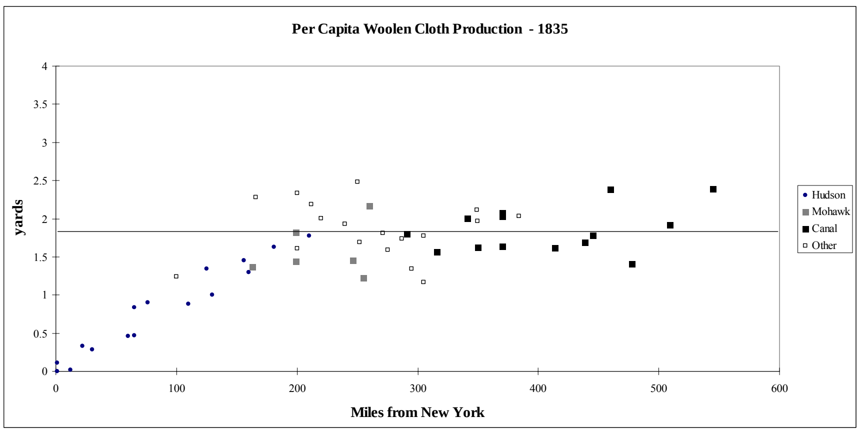
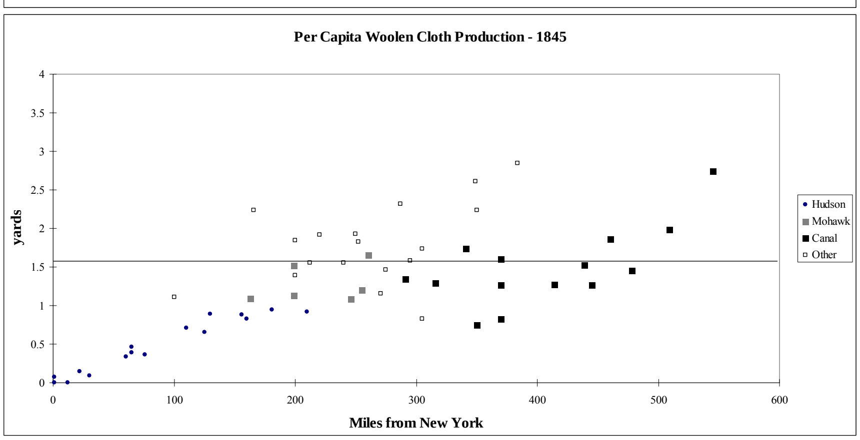


Figure 2: Per capita woolen cloth production by distance to New York, 1825-1845.







[1] The argument is made about the transformation of the northern United States, as well as about New York. See amongst others Hamilton (1791); Clark (1916); Tryon (1917); Bidwell and Falconer (1925); Cole (1926); Hedrick (1933); Ellis (1946); M^cNall (1952); or Parkerson (1995) for statements of the argument.
[2] Tryon (1917) pages 288, 305, quoting state census records. According to the 1810 national census per capita cloth production in New York was 9.4 yards, but the data were considered unreliable.
[3] Several branch canals were also constructed: the Cayuga and Seneca in 1826; the Oswego in 1828; the Chemung in 1834; and the Crooked Lake, Chenango, Genesee Valley, and Oneida Lake between 1835 and 1841. Rand McNally and Company (1895) shows the path of the canal. For more information about the canal, see US Bureau of Statistics [Nimmo] (1885), Whitford (1906) or Rubin (1961).
[4] Taylor (1951; p 132) estimated it cost 30 cents per ton mile to freight overland between 1810 and 1819, a figure supported by Hazard (Samuel Hazard, ``The Register of Philadelphia'', Vol 15 No 16 April 18 1835, p252). In contrast, transport along the Hudson River was only 0.9 cents per ton mile (H Niles, Niles Weekly Register, Vol 26, July 31 1824, p368). Berry (1943) has similar estimates.
[5] See Cole (1938) for prices.
[6] In 1840 population density in districts within six miles of a waterway along the Hudson, the Mohawk, and the Western counties were 112, 120, and 100 people per square mile respectively, compared to 77, 68, and 33 in 1820. Population density continued to be low in districts more than twelve miles from a waterway, only 39, 30, and 44 people per square mile respectively.
[7] The rural population of a county is calculated as the total population minus the population of any town that had at least 3000 people in 1835. The data for these calculations, including the manner that the rural populations were calculated, is in the Appendix. For the Hudson, Mohawk, and Canal counties the distance is calculated as the distance by water to New York, as calculated by Gordon (1836). For the remaining counties, the distance is the overland distance, also given by Gordon.
[8] Nerlove and Sadka (1991) and Coleman (1998) provide formal spatial models of this process that are based on Von Thunen's original model.
[9] In New York, the price of a yard of brown sheeting fell progressively from 27 cents between 1810 - 1815 to 21 cents in 1820, 14 cents in 1825, 10.5 cents in 1835, and 7.5 cents in 1845 (Cole, 1938). Tryon (p276) gives figures for New England that suggest a sharper price decrease between 1815 and 1830.
[10] However, neither his nor Cole's analysis of county level data separated out rural and urban households.
[11] Madison, Onondaga, Cayuga, Seneca, Wayne, Ontario, Monroe, Niagara. The identification was made using Williams (1833) and Rand McNally and Company(1895)to identify the census towns and districts.
[12] New counties were continually created in New York. In this paper, the 1835 county definitions are used, and counties that were created after 1835 are reallocated into the counties from which they came. In 1835 there were 56 counties. New York City was omitted as it had zero rural population. The eight most northern counties were also admitted as they were not directly influenced by the canal. Population figures for counties prior to 1835 come from the 1865 census, which has a table of population of the counties according to their original boundaries and according to the 1865 boundaries.
[13] See Douglas and Yates (1981) for information on these records. Many of the records are available on microfiche from the library of the Church of the Latter Day Saints. The six districts were not randomly chosen, but selected to provide maximum geographical diversity. Where there were two or more districts in a county, the district with the most legible handwriting was chosen.
[14] The federal census was searched using the search platform provided by Ancestry.com. Given knowledge that a person lived in Salisbury in 1825, 1835, and 1845, the federal census files for Salisbury in 1830 and 1840 were searched to find his record and thus to obtained the age profile of his family.
[15] These households were mainly located in Cornwall, where West Point Military Academy is located.
[16] However, he also showed that persistence rates were lower in rural and recently settled areas than in urban areas, in contrast to the relatively high persistence rates in Scott and Ellery.
[17] In each district the hypothesis that the distribution of per capita output did not change between successive censuses was tested using the Wilcoxon-Mann-Whitney test. The hypothesis was rejected in 9 out of 10 cases for all households, and 7 out of ten cases for continuing households.
[18] This statement has a formal statistical basis. Using the six 1835 census observations, and the four 1845 census observations, the fraction of all households (excluding those linked through all censuses) in a

district that produced no cloth was regressed against the fraction of linked households in that district that produced no cloth. The correlation coefficient for the regression was 0.95.

[19] The phrase " produced 3 yards more cloth" is not a strictly correct interpretation of the meaning of a tobit model coefficient that is 3, since cloth output is censored at zero. When average output is low, the coefficient must be compared to the standard deviation of the error process to calculate the additional likelihood of producing zero cloth.

[20] Note that the age dummy variable is picking up effects additional to those caused by older households producing less because they were smaller, and because they had fewer adult women. They have fewer women because of an important selection bias in the way I have collected age data. I have only collected age data for households that were matched through different censuses. Since the household is identified only by its head, who was ordinarily a male, age data is primarily available for households whose male head did not die. Many of these men were widowers.

[21] The 20-25 yard figure is the total of the coefficient on the dummy variable D(acres <1) minus the cattle coefficient times the average number of cows, since people without land typically owned at most one cow.

[22] The age profiles of those in all three censuses and those only in the 1825 and 1835 censuses can also be compared. However, there was practically no difference between these two groups. In 1830 the mean age of the oldest male of those in the 1825 and 1835 censuses was 48.8 (σ=14); the mean age of the oldest male of those in all three censuses was 47.1 (σ=12). The main difference was that 13 per cent of the former group were over 60, compared to only 6 percent of the latter group.