The Varieties of Regional Change

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Abstract

Many metropolitan areas have experienced extreme boom-bust cycles over the past century. Some places, like Detroit, grew enormously as industrial powerhouses and then declined, while other older cities, like Boston, seem quite resilient. Education does a reasonable job of explaining urban resilience. In this paper, we present a simple model where education increases the level of entrepreneurship. In this model, human capital spillovers occur at the city level because skilled workers produce more product varieties and thereby increase labor demand. We decompose empirically the causes of the connection between skills and urban success and find that skills are associated with growth in productivity or entrepreneurship, not with growth in quality of life, at least outside of the West. We also find that skills seem to have depressed housing supply growth in the West, but not in other regions, which supports the view that educated residents in that region have fought for tougher land-use controls. We also present evidence that skills have had a disproportionately large impact on unemployment during the current recession.

1 Introduction

Are there universal laws of urban and regional population growth that hold over centuries, or do time-specific shifts in tastes and technology drive the shifts of population over space? Is urban change better understood with the tools of physics or a knowledge of history? In this paper, we investigate patterns of population and income change over the long run in the older regions of the U.S. Within this large land mass, there has been remarkable persistence in population levels across time. The logarithm of county population in 2000 rises almost perfectly one-for-one with the logarithm of population in 1860 and the correlation between the two variables is 66 percent.

Formal modeling of city growth has naturally tended to focus on patterns that are presumed to hold universally, such as Gibrat's law, which claims that population growth rates are independent of initial levels. Gibrat's law has received a great deal of recent interest because of its connection with Zipf's law, the claim that the size distribution of cities in most countries is well approximated by a Pareto distribution (Gabaix 1999, Gabaix and Ioannides 2004, Eeckhout, 2004).[1] Our paper is not concerned with static laws of urban size, such as Zipf's law, but rather with the permanence of dynamic relationships.

The long-run persistence of county level populations implies that Gibrat's law has very much held in the long run. But Gibrat's law doesn't hold reliably for county population changes at higher frequencies. Before 1860 and after 1970, less populous counties grew more quickly. During the intervening decades, when America industrialized and sectors concentrated to exploit returns to scale (Kim 2006), population growth was regularly faster in more populated areas. One interpretation is that Gibrat's law is universal, but only over sufficiently long time periods. An equally plausible interpretation is that Gibrat's law holds in the long run because of the accidental balancing of centripetal forces, which dominated during the industrial era, and centrifugal forces, which have become more powerful in the age of the car and the truck; and that—as a result—there is no reason to expect the law to hold in the future.

Geographic variables also wax and wane in importance. During recent decades, January temperature has been a reliable predictor of urban growth, and that was also true in the late 19th century; but it wasn't true either before 1860 or in the early decades of the 20th century. The Great Lakes seem to have attracted population both in the early years of the American Republic, and also during a second wave of growth in the first half of the 20th century, associated with the expansion of industrial cities that formed around earlier commercial hubs. Population has moved away from these waterways since 1970, even within the eastern areas of the U.S. To us, these patterns seem to suggest waves of broad regional change that are associated with tectonic shifts in the economy, rather than time-invariant laws.

Even schooling has its limits as a predictor of growth. Since 1940, in our sample of counties, the share of a county's population with college degrees at the start of a decade

[1] Another strand of the literature has expanded the standard theory of endogenous growth to incorporate urban dynamics and reconcile increasing returns at the local level with constant returns and a balanced growth path for the aggregate economy (Eaton and Eckstein 1997; Black and Henderson 1999; Duranton 2006, 2007; Rossi-Hansberg and Wright 2007).

predicts population growth in every subsequent decade except the 1970s. Even in the 1970s, schooling predicts growth among counties with more than 100,000 people. But this fact does not hold in the West even today, and it doesn't seem to hold during much of the 19th century. While Simon and Nardinelli (2002) document a connection between skilled occupations and area growth since 1880, we don't find much of a relationship between the share of the population with college degrees in 1940 and growth before 1900. Perhaps this just reflects the fact that we are forced to use an ex post measure of education that may well be poorly correlated with skills in 1860 or 1880; but it seems as likely that the industrializing forces of the late 19th century just didn't favor better educated areas.

The one persistent truth about population change in this group of counties is that growth strongly persists. With the exception of a single decade (the 1870s), the correlation between population growth in one decade and the lagged value of that variable is never less than .3 and typically closer to .5. Among counties with more than 50,000 people, the correlation between current and lagged population growth is never less than .4 in any decade. Over longer seventy-year time periods, however, faster growth in an early period is associated with lower subsequent growth. These facts are quite compatible with the view that growth is driven by epoch-specific forces, like large-scale industrialization and the move to car-based living, that eventually dissipate.

We only have county income data since 1950, and as a result we have little ability to observe large historic shifts in this variable. In every decade except the 1980s there is strong mean reversion in this variable; Barro and Sala-i-Martin (1991) established mean reversion for state incomes going back to 1840. The connection between income growth and education or manufacturing has, however, varied from decade to decade. In the 1960s and 1970s, income growth was positively correlated with income growth during the previous decade, but that trend reversed after 1980. With the exception of mean reversion, universal laws about income growth seem no more common than universal laws about population growth.

One interpretation of the collection of facts assembled in Section 2 is that the eastern United States has experienced three distinct epochs. In the first 60-odd years of the 19th century, the population spread out, especially towards colder areas with good soil quality and access to waterways. From the late 19th century until the 1950s, America industrialized and the population clustered more closely together, which set off a second growth spurt of the Great Lakes region. Over the past four decades, declining transport costs has led both to the spread of people across space, towards the Sun Belt, and the increasing success of skilled, entrepreneurial areas that thrive by producing new ideas. The early period of spatial concentration of U.S. manufacturing at the beginning of the 20th century and its dispersion in the last few decades are quite compatible with the work of Desmet and Rossi-Hansberg

(2009a, 2009b, 2010), who suggest that innovative new industries cluster to benefit from knowledge spillovers while mature sectors spread out following technology diffusion.

After discussing in Section 2 ten stylized facts that emphasize the changing varieties of regional growth, we present two brief vignettes about Detroit and Boston meant to examine the changing factors that contributed to regional growth. The growth of Detroit matches many of the stylized facts discussed in Section 2. In the early 19th century, Detroit grew along with many other colder, less populated counties near the Great Lakes. Detroit's geography left it bigger than most and well poised to succeed during the second burst of Great Lakes expansion, during the industrial era, when after 1880 there was a strong tendency for already well populated areas, like Detroit's Wayne County, to grow more quickly. Since 1970, Detroit has declined along with the other densely populated, colder areas in the U.S. that had relatively low levels of human capital. Average establishment size was larger in Wayne County than almost anywhere else, and places with smaller establishments have grown far more quickly since 1980.

Boston's early growth, like that of Detroit, reflected its harbor and strength in water-borne commerce. Like Detroit, Boston grew as an industrial city in the late 19th and early 20th centuries, and also like Detroit, the city declined after World War II. Education is the primary differentiating factor between Detroit and Boston, and since 1970 Boston has been able to reinvent itself around idea-intensive industries.

After reviewing these histories, in Section 4, we present a model of human capital, entrepreneurship and urban reinvention. The model is meant to help us understand the strong connection between human capital and urban reinvention in the post-war period. The model suggests that the impact of skills on growth will differ depending on local conditions, and skills will be particularly valuable in places that are hit with adverse shocks. The model also suggests a decomposition that enables us to understand the channels through which human capital impacts on growth.

The model suggests that skilled cities may grow because of faster productivity growth, perhaps due to greater entrepreneurship, of faster amenity growth, or of an expansion of housing supply. In Section 5, we use data on population growth, income growth and changes in housing values to estimate the extent of the power of these different forces. We find that the growth of skilled cities generally reflects growth in productivity rather than growth in amenities. The connection between growth and productivity seems strongest in the South and least strong in the West. The West is the only regions where skills are associated with increases in the quality of life. We also find that in the West, more skilled areas have had less housing supply growth, which may reflect that tendency of skilled people to organize to block new construction. These differences suggest the heterogeneity that exists across

America's regions.

Section 6 turns to the connection between skills and urban resilience during the current recession. We look at the strong negative connection between skills and unemployment and find that this connection is larger than would be predicted solely on the basis of the cross-sectional relationship between education levels and unemployment rates. This fact is additional evidence for human capital spillovers at the city level, which may reflect the entrepreneurial tendencies of the more skilled. Section 7 concludes.

2 Ten Stylized Facts about Regional Decline and Resilience

We begin this paper with a broad perspective on urban resilience and change in the older areas of the United States. Our approach is non-standard. We follow economic historians such as Kim and Margo (2004) and take a very long perspective, going back, in some cases, to 1790. This longer perspective then forces us to focus on counties rather than cities or metropolitan areas. County data is available for long time periods, and while it is possible to use modern metropolitan definitions to group those counties, we believe that such grouping introduces a considerable bias into our calculations. Since metropolitan area definitions are essentially modern, we would be using an outcome to define our sample, which introduces bias. Low-population areas in the 19th century would inevitably have to grow unusually quickly if they were to be populous enough to be counted as metropolitan areas in the 20th century.

We also include only counties in the eastern and central portions of the United States, to avoid having our results dominated by the continuing westward tilt of the U.S. population. The western limit of our data is 90th meridian (west), the location of Memphis, Tennessee: Mississippi can be thought of as the data's western border. We also exclude those areas that are south of 30th parallel, which exclude much of Florida and two counties in Louisiana, and those areas north of the 43rd parallel, which exclude some northern areas of New England and the Midwest. While we will present data going back to the 1790 Census, we think of this area as essentially the settled part of the United States at the start of the Civil War, which allows us to treat the post-1860 patterns as essentially reflecting changes within a settled area of territory.

In this section, we examine ten stylized facts about regional change using this sample of counties. These facts inform our later theoretical discussion and may be helpful in other discussions of urban change. In some cases, these facts are quite similar to facts established using cities and metropolitan areas, but in other cases the county-level data display their own idiosyncrasies.

Fact # 1: Population patterns have been remarkably persistent over long time periods

Perhaps the most striking fact about this sample of counties is the similarity of population patterns in 1860 and today. When we regress the logarithm of population in 2000 on the logarithm of population in 1860, we find:

$$\log(\text{Pop in } 2000) = \underset{(.32)}{1.268} + \underset{(.03)}{.996} \cdot \log(\text{Pop in } 1860). \tag{1}$$

The r-squared is .439 and there are 1124 observations. Figure 1 shows this 66 percent correlation between population across counties in the last census and population 140 years ago. There is plainly a great degree of durability, and population in 2000 rises essentially one-for-one with population in 1860. This fact implies that over this long time horizon, Gibrat's law operates and the change in population is essentially unrelated to the initial population level.

If we restrict ourselves to land even further east, using the 80th parallel as the boundary (about Erie, Pennsylvania), we estimate:

$$\log(\text{Pop in } 2000) = \underset{(.58)}{-.38} + \underset{(.06)}{.1.17} \cdot \log(\text{Pop in } 1860). \tag{1'}$$

In this case, there are only 306 observations, and the r-squared rises to .57, which represents a 75 percent correlation between population in 1860 and population in 2000 in this easternmost part of the U.S. While urban dynamics in America often seem quite volatile, there is a great deal of permanence in this older region. In this sample, there is a positive correlation between initial population levels and the rate of subsequent population growth, suggesting a tendency towards increased concentration.

Fact # 2: Population growth persists over short periods but not long periods

The permanence of population levels is accompanied by a remarkable permanence of population growth rates over shorter time periods. The first two columns of Table 1 show the correlation of population growth rates, measured with the change in the logarithm of population, and the lagged value of that variable. The first column shows results for our entire sample. The second column shows results when we restrict the sample to include only those counties that have 50,000 people at the start of the lagged decade.

Column 1 shows that in every decade, except for the 1870s, there is a strong positive correlation between current and lagged growth rates. Between the 1800s and the 1860s, the correlation coefficients range from .32 to .47. Then during in the aftermath of the Civil War there is a reversal, but starting in the 1880s, the pattern resumes again: between the 1880s and the 1940s, the correlation coefficients lie between .30 (the Great Depression decade) and .50 (the 1910s). During the post-war period, the correlations have been even higher, with correlation coefficients above .64 in all decades except for the somewhat unusual 1970s.

The pattern of persistence for more populous counties is even stronger. Over the entire period, the correlation coefficient never drops below .43. Except for the 1950s, the correlation coefficient is always higher for more populous counties than for smaller ones. The auto-correlation of growth rates for more populated counties was particularly high during the decades before the Civil War, when big cities were expanding rapidly in a more or less parallel path, and during more recent decades.

While short-term persistence is very much the norm for population growth rates, over longer periods growth rates can be negatively correlated. Figure 2 shows the relationship between population growth between 1860 and 1930 and population growth between 1930 and 2000 for those 54 counties that began with more than 50,000 people in 1860. An extra ten percent growth between 1860 and 1930 was associated with a lower 2.5 percent growth rate between 1930 and 2000. This negative correlation does not exist for the larger sample, but given that the persistence of decadal growth rates was even stronger among the counties with greater population levels the reversal is all the more striking.

This negative relationship is our first indication of the changes in growth patterns over the 1860-2000 period. It suggests that different counties were growing during different epochs, and perhaps that fundamentally different forces were at work. We now turn to the relationship between initial population and later population growth, which is commonly called Gibrat's law.

Fact # 3: Gibrat's law is often broken

In studies of the post-war growth of cities and metropolitan areas, population growth has typically been found to be essentially uncorrelated with initial population levels both in the U.S. and elsewhere (Glaeser, Scheinkman and Shleifer 1995; Eaton and Eckstein 1997; Glaeser and Shapiro 2003). Gabaix (1999), Eeckhout (2004), and Córdoba (2008) have used this regularity to explain the size distribution of cities. Our long-run population persistence fact has already shown that Gibrat's law also seems to hold in our sample over sufficiently long time periods. In our entire sample, the correlation between change in log population between 1860 and 2000 is -.0034 and the estimated coefficient in a regression where change in the logarithm of population is regressed on the initial logarithm of population is -.0038 with a standard error of .033. There is also no correlation between the logarithm of population in 1950 and population change over the 50 years since then.

But Gibrat's law doesn't hold for many decades within our sample. Column 3 of Table 1 shows the correlation between the initial logarithm of population and the subsequent change in the logarithm of population over the subsequent decade. Column 4 shows the correlation only for more populous counties, those with at least 50,000 people at the start of the decade. The table shows that Gibrat's law holds during some time periods, but certainly not uniformly.

During the early decades of the 19th century, population growth is strongly negatively associated with initial population levels, especially in places that began with less people. For example, between the 1790s and the 1840s, the correlation between initial population and later growth for all counties in our sample is never less than -.46. There are also sizable negative correlations in the 1850s and 1870s (-.32 and -.36) respectively. This period is not marked by Gibrat's law at all—it is marked by mean reversion, as Americans spread out towards less populated counties. This process reflects improvements in transportation over this time period, and the great demand for newly accessible agricultural land.

The second column shows that there is no mean reversion for more populated counties during this time period. Indeed, during the same periods where the entire sample is showing strong mean reversion, there is a positive, but usually insignificant, correlation between initial population levels and later growth in more populous counties. The pattern in this period is perhaps best understood as two separate processes that are going on simultaneously. Cities are getting bigger, as America grows, but empty farm areas are also gaining population.

This early period reflects the settlement of the region, and it can be considered anomalous and unrelated to patterns that should be expected to hold in a more mature area. We therefore focus more on the post-1870 period, when the eastern U.S. is more mature; but even in those years, Gibrat's law often fails to hold. The post 1870 period can be divided into three different epochs. From 1880 to 1900, the correlation between initial population and subsequent growth is weak across the entire sample of counties, and something like Gibrat's law seems to apply. Among the more populous counties, there is still a strong correlation between initial population levels and later growth. This can be interpreted as suggesting that big cities were still expanding rapidly during this epoch, but the basic process of filling in empty space had petered out by the late 19th century.

From the 1910s through 1960s, there was a long period where Gibrat's law, more or less, applies for more populated counties, but the larger sample shows faster population growth in places with higher initial levels of population. The process of centralized big city growth had become far weaker, but there was more growth in middle-population counties. The strong positive correlation between initial population levels and later population growth between 1900 and 1930 also reflects the relative decline of agriculture during those years and the fact that agriculture was overrepresented in the least dense counties. Between 1900 and 1930, America's rural population increased by 17 percent while the urban population increased by 128 percent. It surely is not a surprise, then, that growth was relatively slower in the most rural, least populated counties.

Finally, from 1970 to 2000, the correlations between initial population and later growth are generally negative, especially in the most populous counties. This presumably reflects some of the impact of sprawl and the role that the automobile played in dispersing the American population. While Gibrat's law holds over the very long time horizon, and during some periods, there are also many time periods when population growth is faster in either more or less populated areas.

Fact # 4: The 19th century moved west; the 20th century moved east

Just as Gibrat's law is hardly universal, there is also no universal pattern of horizontal movement within the region we consider. During the 19th century, the norm was to move west, but that reversed itself during much of the 20th century, within our restricted sample of counties. We focused on the eastern, central parts of the United States to reduce the impact of the enormous changes associated with the move to California and later to Florida. But that doesn't mean that there wasn't a westward push during much of 19th century. Table 2 shows the correlation between longitude and population growth by decade across our sample.

During every decade in the 19th century, growth was faster in the more western counties in our sample. This connection is strongest before the Civil War, when America is moving towards the Mississippi, but even as late as the 1890s, there is a weak negative relationship between longitude and population growth. The fact that longitude is less strongly correlated with growth after 1860 isn't accidental. We defined our sample with geographic boundaries that were meant to capture the settled regions of America when Lincoln was elected.

To us, the more interesting fact is that since 1900, there is a move back east, at least in this sample. In every decade, except for the 1930s, longitude positively predicts growth. Over the entire period from 1900 to 1970, the correlation coefficient is .25. Ten degrees of longitude are associated with .38 log points of faster population growth. This positive correlation does not hold for the more populous cities with more than 50,000 people in 1900. One interpretation of this fact was that the gains from populating the Midwest declined substantially after 1900, perhaps because America had become a less agricultural nation. According to this hypothesis, the eastern counties grew more quickly because they were better connected with each other and more suitable for services and manufacturing, and the agricultural communities declined.

Since the 1970s, the connection between population growth and longitude has essentially disappeared. Over the entire time period, the correlation between population growth and longitude is .05 for the entire sample and -.05 for counties with more than 50,000 people in 1970. Neither relationship is significant at the 95 percent level. The changes in the correlation of longitude and population growth again emphasize that urban change depends on changes in historical trends rather than permanent laws.

Fact #5: The Great Lakes region grew during two distinct periods

In the early 19th century, waterways were the lifeline of America's transportation network, and the Great Lakes were the key arteries for the network. We measure proximity to the Great Lakes by calculating the distance between the county center and the center of the nearest Great Lake.[2] We then define proximity to the Great Lakes as the maximum of 200 minus the distance to the Great Lake centroid or zero. As such, places that are 250 miles from a Great Lake or 500 miles from a Great Lake are both rated as having no proximity to these bodies of water. There are two advantages to this adjustment. First, we think that it is reasonable to believe that the pull of the Great Lakes would peter out after two hundred miles. Second, the unadjusted distance to the Great Lakes is extremely highly correlated with latitude and negatively correlated with warmth (-.89). By adjusting the measure, we are better able to distinguish proximity to the Great Lakes from coldness.

The second column of Table 2 shows the correlation between population growth and this measure of proximity to these large central bodies of water. Between 1790 and 1870, the correlation is uniformly positive, ranging from .07 during the 1850s to .44 during the 1810s. The early 19th century was the period when the Great Lakes had the strongest impact on population growth, which is not surprising since there were few other workable forms of internal transportation in the pre-rail era

Between 1870 and 1910, the correlation between proximity to the Great Lakes and growth is generally negative and quite weak. It turns out that this negative correlation is explained by the positive relationship between proximity to the great lakes and population levels in 1870 (.28 correlation coefficient). Since the post-1870 period was marked by continuing population growth in low population areas, and since the areas close to the Great Lakes had more population in 1870, proximity to the Great Lakes negatively predicts growth during

[2] We use ESRI Data & Maps 9.3 for the calculation.

this time period. When we control for population in 1870, there is no negative correlation between proximity to the Great Lakes and population growth between 1870 and 1900. Still, the absence of a positive relationship can be seen as an indication that the growing rail network had made access to waterways far less critical during the latter years of the 19th century.

After 1910, there is again a positive correlation between proximity to the Great Lakes and subsequent growth. Figure 3 shows the .33 correlation between proximity to the Great Lakes and population growth between 1910 and 1960 among those counties that were within 200 miles of the Great Lakes. During this era of industrial growth and declining agricultural populations, factories grew in cities, like Detroit, that had once been centers of water-borne commerce. In some cases, the waterways were still important conduits for inputs and outputs. In other cases, industry located along the Great Lakes because this is where population masses were already located—about 44 percent of the positive correlation between proximity to the great lakes and population growth between 1910 and 1960 disappears when we control for the population level in 1910.

After this second surge of Great Lakes population growth, the region declined after 1970. Many explanations have been given for the decline of the Rust Belt, such as high union wages and an anti-business political environment (Holmes 1998), a lack of innovation in places with large plants and little industrial diversity, and the increasing desire to locate in sunnier climates. All of these explanations surely have some truth to them, and they help explain why proximity to these great waterways, which positively predicted growth in the early decades of both the 19th and the 20th centuries, then predicted decline at the end of the 20th century.

Fact # 6: The Sun Belt rose both after 1870 and after 1970

The third column in Table 2 shows the correlation between population growth and January temperature between 1790 and today. Colder places grew more quickly during every decade between the 1790s and the 1860s. This was the period during which the North was gaining population relative to the South and there are many explanations for this fact. Many Northern areas had better farmland and they had a denser network of waterways. Industrialization came first to the North. While all cities faced the scourge of urban disease during the 19th century, some illnesses, like malaria, were more prevalent in the South. For every extra degree of January temperature, population growth fell by .038 log points between 1810 and 1860, and by 1860, the correlation between county population levels and January temperature was -.41.

After the Civil War, the relationship between temperature and population growth reversed itself. During every decade between the 1870s and the 1900s, population growth was positively associated with January temperature. Every extra degree of January temperature was associated with .01 log points of growth between 1880 and 1910.[3] The effect of January temperature is particularly pronounced in less dense areas and the effect disappears in more populous counties. One explanation for this phenomenon is higher fertility rates among the poorer and less well education Southern population (Steckel 1978). It is also possible that increasing rail densities in the South during this time period made farming in more remote areas more attractive.

The positive relationship between January temperature and population growth then disappears between 1910 and 1970. If anything the relationship is negative, but the correlation coefficients of population growth between 1910 and 1970 and January temperature are generally weak. Moreover, this relationship seems explained largely by the positive correlation between initial population levels and later growth that we have already discussed. Once we control for initial population, an extra ten degrees of January population is associated with a statistically insignificant .003 log points of extra growth during the entire 1910-1970 time period. The coefficient become significantly positive once we restrict ourselves to counties with more than 50,000 people in 1910, which is line with previous work documenting the positive effect of sun on city growth (e.g., Glaeser and Tobio 2008). Before 1970, people were moving to warmer cities, but not warmer rural areas, and since there were fewer dense counties in the South to begin with, the overall effect of warmth on population growth is negative.

After 1970, January temperature becomes a strong positive predictor of population growth, in both more or less populous counties. On average, an extra ten degrees of population growth is associated with an extra .1 log points of population growth from 1970 to 2000. The last three decades have seen a remarkable rise of the Sun Belt.

In Table 3, we show the impact of initial population, January temperature, proximity to the Great Lakes and longitude in a multiple regression framework during six different thirty-year periods. We skip the 1860s, which are unusual because of the Civil War, and the 1930s, which are unusual because of the Great Depression. The results in these regressions essentially mirror the univariate results that we have already discussed.

The first two columns show results for the two antebellum periods: 1800-1830 and 1830-1860. During these periods, initial population, longitude and January temperature all have a negative impact on growth, and proximity to the Great Lakes has a positive impact on growth. The impact of the Great Lakes and longitude are strongest during the 1800-1830 period; the impact of initial population becomes enormous during the second thirty year

[3] The 1870 Census is potentially problematic because of an undercount in the South (Farley 2008).

period. Those years were truly an era of spreading out.

The third regression shows results for the last thirty years of the 19th century. The sign on January temperature switches, and as we have just discussed, warmer areas grow more quickly, although the undercounting of Southern population in the 1870 Census means that this coefficient should be cautiously interpreted. The impact of proximity to the Great Lakes has become much weaker, as has the tendency of population to mean revert. There is no longer any tendency of the population to move west within this region. Overall, the explanatory power of these variables has dropped significantly relative to the years before the Civil War.

The fourth regression shows results for the 1900-1930 period. January temperature has a positive effect on population growth during this time period, but so do proximity to the East Coast and proximity to the Great Lakes. Places with more initial population grew more quickly, reflecting the growth of big cities during those decades. The results on the 1940-1970 are quite similar to the results for 1900-1930, except that January temperature is no longer significant. Counties that were close to the East Coast, close to the Great Lakes and had more initial population added population at a greater speed.

After 1970, however, January temperature becomes the most powerful predictor of county-level growth. Population moves east rather than west. Initial population is negatively associated with growth, which presumably reflects the growth of sprawl. Proximity to the Great Lakes has a slight negative impact on county-level population growth. Looking across the columns in Table 3 reminds us that all of our variables had different impacts during different epochs, and that regional growth can only be understood by bringing in outside information about changing features of the U.S. economy.

During the post-war period, we also have income data that can help us make more sense of the growth of the South during this time period. Table 4 shows the correlation of county level median incomes and other variables. The first column shows the connection with January temperature. This median income data does nothing to control for the human capital composition of the population. Interestingly, the correlation between income growth and January temperature is highest in the 1950s and 1960s, when the connection between January temperature and population growth is weakest. During this era, the Sun Belt was getting much more prosperous but it wasn't attracting a disproportionate number of migrants.

After 1970, the connection between January temperature and income drops considerably, even though the correlation between population growth and January temperature rises. One explanation for this phenomenon, given by Glaeser and Tobio (2008) is that over the last 30 years, sunshine and housing supply have gone together. The South seems to be considerably more permissive towards new construction, which may well explain why three of the fastest growing American metropolitan areas since 2000 are in states of the old Confederacy (Atlanta, Dallas and Houston).

Fact # 7: Income mean reverts

One explanation for Gibrat's law is that areas receive productivity shocks that are proportional to current productivity (Eeckhout 2004). But that interpretation is difficult to square with the well-known convergence of regional income levels found by Barro and Sala-i-Martin (1991) and others. In our data sample, median incomes also mean revert. We have data on median income levels starting in 1950, and the second column of Table 4 shows the correlation between the decadal change in the logarithm of this variable and the logarithm of the variable.

The table shows that during every decade except the 1980s, income growth was substantially lower in places that started with higher income levels. As Figure 4 shows, for every .1 log points that median income was higher in 1950, income grew by .066 log points less over the entire 1950 to 2000 time period. Income in 1950 can explain 72 percent of the variation in income since then. While population levels persist, income levels generally do not.

There does seem to have been a weakening in income convergence after 1980, shown most notably during the 1980s and most strongly among larger cities. As incomes increase by .1 log points in 1980, income growth between 1980 and 2000 falls by .0049 log point in the whole sample. Among those counties that began with more than 50,000 people, however, the relationship between initial income and income growth is actually positive. These facts suggest that convergence has fallen off, perhaps because of an increase in the returns to skill.

There is a positive correlation between population growth and initial income levels which may explain some of the income convergence. Between 1950 and 1980, an extra .1 log points of initial income was associated with a reduction in income growth of .06 log points and an increase in population growth of .03 log points. But given conventional estimates of labor demand elasticity (Borjas 2003), this population growth can only explain about a fifth of income convergence. Other explanations for income convergence are that technology has spread over space, and capital mobility and changing composition of the labor force. The last explanation, however, is troubled by the fact that the share of the population with college degrees has increased more quickly in places that had higher incomes in 1950; on average a .1 log point increase in 1950 incomes is associated with a .007 percent increase in the share of the adult population with college degrees.

While income levels do generally mean revert, there is a positive correlation between income growth in one decade and income growth in the next decade before 1980. Since 1980, higher income growth in one decade predicts lower income growth over the next ten years. These facts can be reconciled with the strong positive persistence of population growth if a steady flow of new people is pushing wages down in some areas.

Fact # 8: Manufacturing predicts the decline of cities but not the decline of counties

Many papers have noted the negative correlation between concentration in manufacturing and subsequent urban growth (Glaeser, Scheinkman and Shleifer 1995). This correlation does not appear in our county data. We use the share of the county's employment that is in manufacturing in 1950 as our measure of the concentration of the county in manufacturing at the start of the post-war era.

Figure 5 shows the positive .17 correlation coefficient between the share of a county's workers in manufacturing in 1950 and subsequent population growth. As the share in manufacturing rises by 10 percent, subsequent growth rises by .07 log points. This effect only grows stronger if we control for initial population, January temperature and distance to the Great Lakes. The effect gets slightly weaker if we control for initial income, because manufacturing counties did have higher wages.

This fact does not hold for the more populous counties, which presumably explains why city and metropolitan-area data show a negative connection between manufacturing and growth. If we restrict our sample to include only those counties with more than 100,000 people in 1950, the correlation becomes negative. Manufacturing did leave cities and those cities that were highly concentrated in manufacturing did decline. However, concentration in manufacturing does not seem to have been so negative for county growth, at least measured by population levels.

Manufacturing was, however, negatively correlated with income growth at the county level, as shown by the last column in Table 4. In every decade except for the 1980s, manufacturing in 1950 predicts income decline. A 10 percent increase in the share of manufacturing in 1950 is associated with a .114 log point decline in median incomes between 1950 and 2000. Counties with more manufacturing didn't lose population, but their incomes did fall.

The income decline in manufacturing counties was not, however, unusual given their high initial incomes. Indeed, once we control for income in 1950, manufacturing is positively associated with income growth between 1950 and 2000. There is also a difference between big and small counties. In more populous areas, the impact of manufacturing on income growth is more strongly negative, which reinforces the view that manufacturing has proven to be far worse for densely populated areas than for counties with fewer people. Big factories seem a better match with moderate density levels (Glaeser and Kohlhase 2004).

Fact # 9: Education predicts post-war growth

A series of papers have also shown the connection between education and the success of cities (Rauch 1993; Glaeser, Scheinkman and Shleifer 1995; Simon and Nardinelli 2002; Glaeser and Saiz 2004; Shapiro 2006). We now ask whether this correlation also holds at the county level in our sample. Table 5 shows the correlation between the share of the adult population with college degrees and subsequent income and population growth. We have this during every decade except 1960, and for that year, we use the college attainment rates in 1950 instead.

The first column in Table 5 shows the positive correlation between college attainment and population growth that holds in every decade except the 1970s, when there is a negative relationship that becomes insignificant when we control for the logarithm of 1970 population. The relationship was strongest in the 1950s and 1960s. Despite the 1970s, there is an impressive connection over the long haul between college education and population growth in this sample. On average, as the share of the population with college degrees increase by 10 percent in 1940, population growth between 1940 and 2000 increases by .13 log points.

The second column in Table 5 shows results for income growth. Across the entire sample, there is a regular, negative relationship between initial education and subsequent income growth. This fact certainly is not true across cities or metropolitan areas, but it does seem that median income rose more quickly in those counties that began with lower levels of education. But this effect is primarily a reflection of the mean reversion already discussed. In a bivariate regression, where income growth is regressed on initial log of income and initial share of the population with college degrees, we estimate significant coefficients of .89 (in the 1950s), .55 (in the 1960s, using education share in 1950), and .9 (in the 1990s). The coefficients on education share in the 1970s and the 1990s are also positive but statistically insignificant. It does appear that more educated places are growing both in population and income, once we account for the tendency of income levels to mean revert.

Glaeser and Resseger (2010) present evidence suggesting that skills have more impact in larger cities. The basic theoretical argument is that urban density becomes more valuable when proximity is connecting people who have more to teach one another. The third column of Table 5 shows the population growth correlations with initial education for those counties that begin the decade with at least 100,000 people. The correlations are uniformly positive, but they are not always larger than the correlations with population growth across the entire sample. In the first three decades, the correlation is actually stronger for the entire sample. During the last three decades the correlation is stronger in the sample of counties with more people.

Column 4 shows the correlation between income growth and education for more populous counties. In the 1950s and 1960s when skills were negatively associated with income growth in the entire sample, skills were positively associated with income growth in more populous counties. In the 1970s and 1990s, education is less negatively associated with income growth in the more populous counties than in the entire sample. In the 1980s, education was more positively associated with income growth in the initially more populous counties. These results support the view that there is a complementarity between skills and density.

In Table 6, we present two regressions looking at the entire 1950-2000 period. In the first regression, income growth is the dependent variable. In the second regression, population growth is the dependent variable. We include as controls January temperature, longitude and distance to the Great Lakes. We control for the logarithms of initial education and population. We also include the share of employment in manufacturing, the share of the population with college degrees and an interaction between the logarithm of 1950 population and the share of the population with college degrees. We have normalized the initial population by subtracting the mean of that variable in this sample; this enables us to glean the impact of education for the mean city with the coefficient in the regression.

These regressions capture many of the patterns that we have already discussed. Initial income strongly predicts subsequent income declines and significant population increases. Initial population is negatively associated with both income and population growth. Proximity to the East Coast, longitude and manufacturing are both positively correlated with both income and population growth. Proximity to the Great Lakes has no impact on population growth, but a negative correlation with income growth.

Education has a positive effect on both income and population growth. At the average initial population level, as the share of adults with college degrees in 1950 increases by 3 percent (about one standard deviation), subsequent population growth increases by slightly more than .12 log points (about 12 percent) and income growth rises by around 7 percent. These effects are statistically significant and economically meaningful.

The effects of education on income and population growth are stronger for counties with higher initial levels of population. As the level of population increases by one log point (slightly less than one standard deviation), the impact of education on population growth increases by 54 percent and the impact of education on income growth increases by 36 percent. Skills do seem, over the fifty year period, to have had a particularly strong positive effect on income and population growth for areas that initially had higher levels of population.

While it is clear that skills matter during the post-war period, it is less clear whether skills were as important before World War II. We are limited by an absence of good education data during this earlier period, which is why Simon and Nardinelli (2002) focus on the presence of skilled occupations in 1900. Yet because it seems worthwhile to know whether skilled places also increased in the 19th century, Table 7 shows the correlation between the share of the population with college degrees in 1940 and growth over the entire 1790-2000 period. There are at least two major problems with this procedure. First, skill levels do change and a place that is skilled in 1940 may well not have been skilled in 1840. We are only moderately reassured by the .75 correlation between the share of the population with college degrees in 1940 and the share of the adult population with college degrees in 2000. Second, it is possible that skilled people came disproportionately to quickly growing areas. Indeed, there is a strong positive correlation (.61) in our sample between population growth between 1940 and 2000 and the growth in the share of the population with college degrees over the same time period.

Despite these caveats, Table 7 shows the correlations over the long time period. The first column includes all of our counties; the second column shows results only for those counties with more than 50,000 people at the start of the decade. The table shows a strong positive correlation between skills in 1940 and growth in population for most of the twentieth century, except for the 1970s and 1990s, which we have already discussed. In the 19th century, education was largely uncorrelated with growth across the entire sample. Among more populous counties, the correlation is generally positive after 1820. One interpretation of these differences is that there was a complementarity between cities and skills even in the 19th century. A second interpretation is that skills in 1940 are a reasonable proxy for skills in the 19th century among more populous counties, but not for sparsely populated areas that presumably changed more over the century.

Those different interpretations yield different conclusions about the long run correlation between skills and population growth. If the latter interpretation is correct, and the correlation disappears because skills in 1940 don't correlate with 19th century skills, then the skills-growth correlation may be the one relationship that holds virtually over our entire sample. If, however, the former interpretation is correct, then the relationship between skills and growth is, like everything else we've looked at, a phenomenon that holds only during certain eras.

Moretti (2004) and Berry and Glaeser (2005) report a positive correlation between initial levels of education and education growth over the post-war period. We also confirm this fact with our cross-county data. We look at the relationship between change in the share of population with college degrees between 1940 and 2000 and the share of the population with college degrees in 1940. Over the entire sample, we estimate the relationship:

$$\text{Change in share with BAs 1940–2000} = \underset{(.003)}{.048} + \underset{(.088)}{2.66} \cdot \text{Share with BAs in 1940.} \tag{2}$$

Standard errors are in parentheses. There are 1326 observations and the r-squared is .4. As the share with college degrees in 1940 increases by 2 percent, growth in the share of college degrees increases by 5.32 percent. Figure 6 illustrates this relationship for those counties with 50,000 or more people in 1940. We show the figure only for more populous counties purely to make the graph less cluttered. It is certainly quite possible that one of the reasons why initially skilled places have done so well is that they have attracted more skilled people over time.

We have also examined the correlations during the sub-periods. The one decade in which there is no positive correlation between initial schooling and subsequent growth in schooling is the 1940s. After that point, schooling uniformly predicts schooling growth. In the 1970s, 1980s, and 1990s, the correlation coefficients between initial schooling and subsequent increases in the share with college degrees are .57, .66 and .54 respectively. This is a powerful fact.

Fact # 10: Firm size is strongly correlated with employment and income growth after 1980

Glaeser et al. (1992) found a strong negative correlation between average firm size and subsequent growth across large industrial groups within metropolitan areas. Glaeser, Kerr and Ponzetto (2010) show that smaller firm size predicts growth both across and within metropolitan areas. Our last fact is that firm size is correlated with population and income growth across our sample of counties.

Firm size is typically measured by looking at the ratio of the number of establishments to the number of employees within a metropolitan area or industrial cluster. In our case, we use the 1977 County Business Patterns data and calculate the average number of employees per establishment in each county in our sample. The mean of this variable is 12.74 in our sample and it ranges from 2.9 to 35. Very low average establishment sizes are typically in counties with low population. When we restrict our sample to include only those counties with more than 50,000 people in 1980, the mean of average establishment size is 15, and the range goes from 5.4 to 28. There is a strong positive correlation between county population and average establishment size.

Table 8 shows four growth regressions that include average establishment size. The first two look at population growth between 1980 and 2000. Columns 3 and 4 show results on growth in median income over the same two decades. Columns 1 and 3 look at our entire sample. Columns 2 and 4 look only at those counties that had at least 50,000 people in 1980. In all cases, we include our standing controls including the logarithms of initial income and population, the share of the labor force in manufacturing, our geographic controls and the initial share of the population with a college degree. The effect of these variables is unchanged from our previous regressions.

Regressions 1 and 2 both show the strong negative correlation between average establishment size and subsequent population growth. Across the entire sample, as average establishment size rises by four workers (approximately one standard deviation), subsequent population growth declines by .06 log points (approximately 6 percent). The effect is somewhat larger for more populous counties, and we find that as average establishment size rises by four workers, subsequent population growth falls by about 10 percent.

Regressions 3 and 4 show the strong negative connection between average establishment size and income growth. Across the entire sample, as average establishment size increases by four, income growth declines by .045 log points. Across the sample of more populous counties, a four person increase in average population size is associated with a .06 log point decrease in income growth. These effects are comparable in magnitude with the education effect on income growth and even stronger statistically.

While larger establishment sizes do seem to predict less growth of income and population, it is less clear how to interpret these facts. Glaeser et al. (1992) interpreted the positive connection between small firm size and later growth as evidence on the value of competition. Miracky (1995) observed the same phenomenon and associated it with the product life cycle. While this remains one plausible interpretation, the fact that these connections occur within very finely detailed industry groups, and controlling for average establishment age, speaks against this interpretation. Glaeser, Kerr and Ponzetto (2010) suggest that these connections suggest the value of local entrepreneurship. We prefer this latter interpretation, which will fit closely with the following model, but we certainly acknowledge that other interpretations are quite possible.

In the last two columns of Table 7, we also look at the correlation between firm size and growth during early decades. In this case, we use average establishment size in 1977. The ex post nature of this measure raises all of the concerns that we had about the ex post nature of using schooling in 1940. In this case, the negative relationship between firm size in 1977 and growth is not present during earlier decades. Again, this fact can either be interpreted as suggesting that the small firm size effect is specific to the past thirty years or that small firm size in 1977 doesn't capture small firm size during earlier years. Certainly, when Glaeser et al. (1992) looked at firm size in 1957, they found a negative correlation with subsequent growth.

3 Boston and Detroit

These ten facts spell out the arc of regional change in America's older regions. But to translate these facts into a framework, it makes sense to focus more deeply on two cities—Boston and Detroit—that have experienced these changes and whose histories help illustrate why education and an abundance of small firms have been so critical for the resilience of older regions.

3.1 Detroit

The city of Detroit has for so long been synonymous with the car industry that it is hard to imagine a Detroit before the automobile. Yet Detroit was booming before Henry Ford made his first Model T. Between 1820 and 1850, the city's population increased more than tenfold from 1,400 to 21,000 people and it increased to 206,000 by 1890. In the early years, America was populating the Midwest and waterways provided a vital means of transporting the agricultural wealth of the American hinterland. In the previous section, we found that proximity to the Great Lakes was positively correlated with county growth through the 1860s, and Detroit was particularly well-suited to benefit from that trend. Detroit's geographic advantage is that it sits on a narrow point of the Detroit River, which was part of the watery path from Iowa farmland to the tables of New York. By 1907, 60 million tons of goods were moving along that river, about three times as much as the total amount going through the ports of New York or London (Nolan 1997).

In the 19th century, Detroit was a city of entrepreneurs, like Hiram Walker, who capitalized on Detroit's access to vast water-borne traffic and proximity to Canada. Walker came to Detroit from Massachusetts in 1838, and achieved success selling whiskey to the thirsty men of Detroit (Blocker, Fahey and Tyrrell 2003: 294). He set up his distilling operation across the river in Windsor, Ontario, to avoid Michigan's growing temperance movement. Walker's importing of "Canadian Club" back into Detroit foreshadowed Detroit's role as one of bootleggers' favorite ports of entry for Canadian whiskey. Detroit's waterways made it a shipping point for bales of tobacco and a natural place for Hiram Walker to make cigars to accompany his whiskey. Walker's Globe Tobacco Company imported 4.5 million pounds of tobacco each year, employing 190 people to turn out 5,000 pounds of cigarettes and 3,000 pounds of chewing tobacco every day (Jones 2000).

Detroit Dry Dock was another of Detroit's many 19th century entrepreneurial firms. It was founded in 1866, and over the next thirty years, its engine works would become one of the most important shipbuilders on the great lakes. Another transplanted New Englander, Frank Kirby, who was educated at New York's Cooper Institute, would become its most famous engineer, designing more than 100 vessels. Henry Ford was one who came to work at Detroit Dry Dock (Olson 1997: 28). While Ford had already worked as a machinist, the Dry Dock was his first major exposure to technologically sophisticated engine production.

Detroit had access to plenty of wood and iron ore, and its shipyards were at the center of the Great Lakes system. It was natural that the city specialized in building ship engines, and its expertise in building and repairing engines helped make Detroit a natural place to build cars. The car was a new idea that combined two old ideas: the carriage and the engine. Both carriages and engines had long been made in Detroit. The engines were being built and serviced for the ships on the Great Lakes. The carriages were constructed from the abundant wood of Michigan's forests. Henry Ford got his start in the engine business. Billy Durant, the entrepreneur behind General Motors, began making horse-drawn carriages in nearby Flint.

In the later years of the 19th century, population growth was concentrated in more populated counties. One interpretation of this fact is that places with more people were also more likely to produce the entrepreneurs who would create the vast factories that were the trademark of this era of American industrialization. At the end of the 19th century, Detroit looked a lot like Silicon Valley did in the 1960s and 1970s. The motor city was a hotbed of small innovators, and many of those innovators focused on the new, new thing: the automobile. The basic science of the automobile had been worked out in Germany in the 1880s, but the German innovators had no patent protection in the U.S. As a result, Americans were competing furiously to figure out how to produce good cars on a mass scale.

In the early 1900s, Detroit seems to have had a budding automotive genius on every street corner. Ford, Ransom Olds, the Dodge Brothers, David Dunbar Buick, and the Fisher brothers all worked in the Motor City. Some of these men made cars, but Detroit supported their entrepreneurship by providing plenty of independent suppliers, like the Fisher brothers, who could cater to start-ups. Ford was able to open a new company with backing from the Dodge brothers, who were making engine and chassis components. They supplied Ford with both financing and parts.

Detroit's abundance of small firms and its independent-supplier model created plenty of innovation, but the most important innovation was to create a giant wholly-integrated car company. The successful car firms bought up their suppliers, as when General Motors acquired Fisher Body, and their competitors. The massive car companies that came out of

Detroit's innovation drove the smaller companies out of business, enveloped the independent suppliers and eventually turned Detroit from a model of innovation into a synonym for urban stagnation. The intellectually fertile world of independent urban entrepreneurs had been replaced by a small number of big companies that had everything to lose and little to gain from radical innovation.

As the car companies got out of the business of radical innovation and into the business of mass production, they no longer saw any advantages to locating in the city. In 1917, Ford began building his River Rouge plant in suburban Dearborn upstream from Detroit, a ninety-three building complex with 16 million square feet of workspace. River Rouge had docks, rail lines and its own electricity plant. The logic of reducing transport costs had been taken to its logical extreme in the ultimate integrated factory. Ford's River Rouge Plant was an early example of the suburbanization of manufacturing that would occur throughout the 20th century. Manufacturing is a space-intensive endeavor. When factories didn't need access to big city rail lines and ports, then it made sense to move them to places where space was cheaper.

After World War II, Detroit's decline again mirrored broad national trends. Population left places with cold weather that were close to the Great Lakes and moved to less dense locales. Long-run urban success depends on the ability of cities to reinvent themselves, creating new industries to replace the firms that falter. Detroit's extremely large firms can also be seen as part of its problem, given the correlation between small firms and population growth. In Detroit, the car industry had been so successful that it drove out any other industry that could have been a source of urban regeneration. Detroit was a single-sector city, dominated by three companies. It completely lacked the diversity and competition that engender growth. Moreover, the city of the assembly line had never invested in the skill base and skills have been highly correlated with urban reinvention.

Between 1950 and 2008, Detroit lost approximately 1 million people, more than half of its population. Today, nearly one-third of Detroit's citizens live in poverty. Detroit's median family income is 33,000 dollars, about 57 percent of the U.S. average. The unemployment rate is over 20 percent.[4] In 2008, Detroit had one of the highest murder rates in America, more than ten times that of New York City (U.S. Federal Bureau of Investigation 2009). Many American cities experienced a housing price collapse between 2006 and 2008. However, Detroit was unique in both missing the price boom during the early years of the decade and experiencing a full 25 percent price drop since the boom.[5]

[4] The facts in the three previous sentences are in the U.S. Bureau of the Census 2008 American Community Survey, and Gibson (1998).

[5] Case-Shiller Housing Price Index.

3.2 Boston[6]

Boston, like Detroit and all of America's older cities, also owed much to water. In the 17th century, Bostonian shippers were pioneers in the triangle trade that enabled Northern farmers to pay for European imports by shipping their agricultural products south to feed the more tropical colonies that had exports, like sugar, tobacco and cotton, that were valued on the eastern side of the Atlantic. In the 18th century, Boston's first-mover advantage in the triangle trade diminished substantially and the city was overtaken by New York and Philadelphia, both of which had access to better farmland, better river networks and greater proximity to the south. Yet in the early 19th century, Boston's skilled seafarers were able to reinvent the city around a global trading network that went to places as far off as Canton and South Africa. Faster trips and longer journeys decreased the relative cost of starting in Boston and increased the value of the city's human capital, which had been built up over centuries. As late as 1840, when New York had already become a manufacturing town and factories were sprouting in Lowell, Boston was still a city based on sails.

All that sail-specific human capital lost its value with the rise of steamships. In a few short years, Boston lost its strength in seafaring. But in the late 19th century, Boston reinvented itself yet again, this time around manufacturing. Fortunes made from the China trade soon founded factories. As engines got smaller, those factories were put within city limits. Steam power also drove trains, and Boston succeeded as the center of New England's rail network. Every one of America's major cities in 1850 grew dramatically over the next seventy years, as urban areas became centers of industry. The previous section noted the tendency of already populous places to grow more quickly at the end of the 19th century, and Boston was in the middle of the pack, growing along with the rest of urban America.

In the 20th century, the advantages of rail and urban factories disappeared in Boston, just as they vanished in Detroit. By the 1970s, the city was a hollowed-out hull. Real estate was priced far below construction costs. Ethnic strife, epitomized by an epic battle over school busing, tore the city apart. Yet Boston, unlike Detroit, managed to reinvent itself through the strength of its skills and its small-scale entrepreneurship. Boston had invested in education for centuries. The ability to read the Bible, and a steady supply of ministers, were seen as key tools in the Puritan battle against Catholicism. Early public investments in human capital, including Harvard College and the Boston Latin School, and a culture that emphasized education, led to a multi-century passion for schooling, exemplified by figures like Horace Mann and M.I.T. founder William Barton Rogers, who came to Massachusetts from Virginia attracted by "the impulses of a higher social life, which have so stirred my

[6] This section draws heavily on Glaeser (2005).

thoughts in my visits to New England," (Barton Rogers 1896: 264). Massachusetts remains the most educated state in the nation.

All that education has often produced successful entrepreneurs, along with more academic achievements. The selling point of Fidelity, Boston's most successful financial service firm, has always been its focus on research. Boston's management consulting industry began in 1886 when an M.I.T. chemist, Arthur D. Little, started his own firm to do contract scientific research. Initially, this research was primarily pure science, for example, helping to create General Motor's first Research and Development lab in 1913. Over the past 120 years, the firm had a remarkable number of significant intellectual accomplishments, including the development of operations research, high-altitude oxygen masks, computerized technologies for inventory control, and American Airlines' SABRE system.

Just as importantly, the consulting industry has few barriers to entry, and successful firms often produce their own competitors. Bruce Henderson left Arthur D. Little to start the Boston Consulting Group in 1963. Henderson's firm then spawned its own progeny when Bill Bain left them to form Bain and Company. The dynamic nature of this constantly mutating idea-oriented industry is a sharp contrast to Detroit's Big Three.

Boston's universities also spawned plenty of more purely scientific enterprises. A young Ph.D. in engineering from M.I.T., Vannevar Bush, partnered with his Tufts college roommate and another scientist to create the American Appliance Company. Their success came with the gaseous rectifier, an unattractive name for an electronic device that converted AC to DC current, and allowed radios to be plugged into the wall. The young entrepreneurs chose the snazzier name of Raytheon, and the firm has spent the last 85 years working on commercial applications of cutting edge science, especially missiles. In the 1950s and 1960s, engineers from M.I.T. and Harvard created companies like Wang Laboratories and Digital Equipment Corporation (DEC), which competed with IBM for a share of the growing computer industry. At its height, Wang had 40,000 employees and DEC had 140,000.

Boston's computer industry eventually lost out to Silicon Valley, quite possibly because the industry was looking a bit too much like Detroit. Even before the final demise of Wang and DEC, Berkeley regional scientist Annalee Saxenian was describing how the eastern firms were declining because they had become too insular and hierarchical, locked up in their large suburban headquarters. While these firms had sprung from connections between people made at large urban universities, they became isolated, non-urban, and their innovation waned.

But there were other skilled entrepreneurs, who were starting scrappy small firms that would make up for the decline in the Massachusetts computer industry. Itzhak Bentov is surely one of the most unusual of Boston's scientific entrepreneurs. A Czech émigré, with little formal education, he managed to come up with a wealth of new patents, including disposable hypodermic needles and Slenderoni, a diet spaghetti. He was a mystic and wrote a well-known book describing the universe as moving in a continuous big bang. He came to Boston in the 1960s, and started a firm called Meditech, which operated out of a church rectory in Watertown (the town between Cambridge and Waltham) and made steerable catheters. John Abele, a more traditional businessman, joined the firm as a partner in 1969 and began his career of producing new medical devices. Their partnership led to the formation of Boston Scientific, one of the world's major players in producing tiny devices that save lives. Another industrious, illustrious Boston partnership of a Nobel Laureate in Chemistry and a Nobel Laureate in Medicine founded in 1978 Biogen Idec, which is now an anchor of the technology sector surrounding M.I.T.

Boston's reinvention is a story where a one-time shipping city turned manufacturing hub succeeded as center of skill-intensive, often small-scale entrepreneurship. Human capital, in some way affiliated with the city's many universities, got commercial picking stocks, giving managerial advice, splicing genes and producing tiny catheters. Former manufacturing towns can reinvent themselves on the basis of skills and entrepreneurship.

4 Theoretical Framework

We now present a model of regional change, skills and resilience. The model will provide us with a framework that will enable us to understand better the reasons why skilled areas have grown more quickly over the past sixty years. In principle, it is possible that skilled places could have been growing more quickly because of improvements in productivity, amenities or housing supply. We need a formal framework to help separate these competing explanations. The model will also deliver some intuition as to why skills have been so important in the older areas of the U.S. that seems to have been hit by adverse shocks after World War II.

Utility is defined over consumption of land, denoted L, and a CES aggregate of measure G of differentiated manufactured goods, each denoted $c(\nu)$. Thus

$$U = \theta_i \left[\int_0^G c(\nu)^{\frac{\sigma-1}{\sigma}} \, d\nu \right]^{\frac{\mu\sigma}{\sigma-1}} L^{1-\mu}, \tag{3}$$

where $\theta_i > 0$ is a quality of life multiplier associated with the exogenous amenities of city i.

Commodities are costlessly tradable across cities. The demand function for each manufactured variety is $q(\nu) = \mu Y P^{\sigma-1} p(\nu)^{-\sigma}$, where Y is nominal aggregate income in the whole economy and $P = \left[\int_0^G p(\nu)^{1-\sigma} \, d\nu \right]^{1/(1-\sigma)}$ is the manufacturing price index, which we can set equal to one by a choice of numeraire. Conditional upon creating a new good, it takes ψx units of labor to produce x units of the good. If the wage in city i is w_i, the price charged for each good produced in the city equals $p(\nu) = w_i \psi \sigma / (\sigma - 1)$and labor demand from each manufacturer equals

$$n(\nu) = \left(\frac{\sigma - 1}{\sigma}\right)^{\sigma} \frac{\mu Y}{\psi^{\sigma-1}} w_i^{-\sigma}. \tag{4}$$

City i is endowed with an exogenous number of entrepreneurs, denoted E_i. Thus labor demand in the city equals

$$N_i = \left(\frac{\sigma - 1}{\sigma}\right)^{\sigma} \frac{\mu Y}{\psi^{\sigma-1}} E_i w_i^{-\sigma}. \tag{5}$$

and the equilibrium wage for a city with N_i full-time workers is

$$w_i = \frac{\sigma - 1}{\sigma} \left(\frac{\mu Y}{\psi^{\sigma-1}}\right)^{\frac{1}{\sigma}} \left(\frac{E_i}{N_i}\right)^{\frac{1}{\sigma}}, \tag{6}$$

while each entrepreneur earns profits

$$\pi_i = \frac{1}{\sigma} \left(\frac{\mu Y}{\psi^{\sigma-1}}\right)^{\frac{1}{\sigma}} \left(\frac{N_i}{E_i}\right)^{\frac{\sigma-1}{\sigma}}. \tag{7}$$

City i has a fixed quantity of immobile land, denoted by $\bar{L}_i$, which is owned by developers who reside in the city itself. Both workers, entrepreneurs, and developers spend a fraction $1 - \mu$ of their income on consumption of land. Hence equilibrium in the real-estate market implies that the price of land in city i is

$$r_i = \frac{1 - \mu}{\mu} \left(\frac{\mu Y}{\psi^{\sigma-1}}\right)^{\frac{1}{\sigma}} \frac{E_i^{\frac{1}{\sigma}} N_i^{\frac{\sigma-1}{\sigma}}}{\bar{L}_i}. \tag{8}$$

In an open-city model in which workers are fully mobile, their utility needs to be equalized across space. Spatial equilibrium then requires

$$\theta_i w_i r_i^{\mu-1} = \theta_j w_j r_j^{\mu-1} \text{ for all } i,\, j, \tag{9}$$

namely

$$\frac{1}{N_i} \left[\theta_i^{\sigma} E_i^{\mu} \bar{L}_i^{(1-\mu)\sigma}\right]^{\frac{1}{\mu+\sigma-\mu\sigma}} = \frac{1}{N_j} \left[\theta_j^{\sigma} E_j^{\mu} \bar{L}_j^{(1-\mu)\sigma}\right]^{\frac{1}{\mu+\sigma-\mu\sigma}} \text{ for all } i,\, j. \tag{10}$$

We consider a continuum of cities, each of which is arbitrarily small compared to the aggregate economy. Then

$$\log N_i = \kappa_N + \frac{\mu \log E_i + \sigma \log \theta_i + (1-\mu)\,\sigma \log \bar{L}_i}{\mu + \sigma - \mu\sigma}, \tag{11}$$

where

$$\kappa_N \equiv \log N - \log \int \left[\theta_j^{\sigma} E_j^{\mu} \bar{L}_j^{(1-\mu)\sigma}\right]^{\frac{1}{\mu+\sigma-\mu\sigma}} dj \tag{12}$$

is independent of idiosyncratic shocks affecting city i, letting $N = \int N_i di$ denote the aggregate size of the workforce.

Aggregate income is

$$Y = \frac{1}{\psi\mu}\left(\int E_j^{\frac{1}{\sigma}} N_j^{\frac{\sigma-1}{\sigma}} dj\right)^{\frac{\sigma}{\sigma-1}} = \frac{N}{\psi\mu}\frac{\left\{\int \left[\theta_j^{\sigma-1} E_j \bar{L}_j^{(1-\mu)(\sigma-1)}\right]^{\frac{1}{\mu+\sigma-\mu\sigma}} dj\right\}^{\frac{\sigma}{\sigma-1}}}{\int \left[\theta_j^{\sigma} E_j^{\mu} \bar{L}_j^{(1-\mu)\sigma}\right]^{\frac{1}{\mu+\sigma-\mu\sigma}} dj} \tag{13}$$

and we can write

$$\log w_i = \kappa_w + \frac{(1-\mu)\log E_i - \log \theta_i - (1-\mu)\log \bar{L}_i}{\mu + \sigma - \mu\sigma}, \tag{14}$$

where

$$\kappa_w \equiv \log \frac{\sigma-1}{\sigma} - \log \psi + \frac{1}{\sigma-1} \log \int \left[\theta_j^{\sigma-1} E_j \bar{L}_j^{(1-\mu)(\sigma-1)}\right]^{\frac{1}{\mu+\sigma-\mu\sigma}} dj, \tag{15}$$

and

$$\log r_i = \kappa_r + \frac{\log E_i + (\sigma-1)\log \theta_i - \log \bar{L}_i}{\mu + \sigma - \mu\sigma}, \tag{16}$$

where

$$\kappa_r \equiv \log \frac{1-\mu}{\mu} - \log \frac{\sigma-1}{\sigma} + \kappa_N + \kappa_w. \tag{17}$$

Through equations (11), (14), and (16), this model then provides us with the basis for our empirical work in Section 5. We assume that for each city i and time t the values of E, θ and $\bar{L}$ are respectively $E_{i,t}$, $\theta_{i,t}$ and $\bar{L}_{i,t}$ such that

$$E_{i,t+k} = E_{i,t} \exp\left(k\boldsymbol{\beta}^E \cdot \mathbf{X}^i + \varepsilon_{i,t+k}^E\right), \tag{18}$$

$$\theta_{i,t+k} = \theta_{i,t} \exp\left(k\boldsymbol{\beta}^\theta \cdot \mathbf{X}^i + \varepsilon_{i,t+k}^\theta\right), \tag{19}$$

and

$$\bar{L}_{i,t+k} = \bar{L}_{i,t} \exp\left(k\boldsymbol{\beta}^{\bar{L}} \cdot \mathbf{X}^i + \varepsilon_{i,t+k}^{\bar{L}}\right). \tag{20}$$

The parameter vectors $\boldsymbol{\beta}^E$, $\boldsymbol{\beta}^\theta$ and $\boldsymbol{\beta}^{\bar{L}}$ connect time-invariant city characteristics, denoted by

$\mathbf{X}^i$, with growth in E, θ and $\bar{L}$ respectively. The terms $\varepsilon^E_{i,t+k}$, $\varepsilon^\theta_{i,t+k}$, and $\varepsilon^{\bar{L}}_{i,t+k}$ are stochastic errors.

With these assumptions we can write

$$\log N_{i,t+1} - \log N_{i,t} = \frac{\mu \boldsymbol{\beta}^E + \sigma \boldsymbol{\beta}^\theta + (1-\mu)\,\sigma \boldsymbol{\beta}^{\bar{L}}}{\mu + \sigma - \mu\sigma} \cdot \mathbf{X}^i + \varepsilon^N_{i,t}, \tag{21}$$

and

$$\log w_{i,t+1} - \log w_{i,t} = \frac{(1-\mu)\,\boldsymbol{\beta}^E - \boldsymbol{\beta}^\theta - (1-\mu)\,\boldsymbol{\beta}^{\bar{L}}}{\mu + \sigma - \mu\sigma} \cdot \mathbf{X}^i + \varepsilon^w_{i,t}, \tag{22}$$

where $N_{i,t}$ and $w_{i,t}$ are the number of workers and the wage level in city i at time t, and $\varepsilon^N_{i,t}$ and $\varepsilon^w_{i,t}$ are error terms.

We could could perform a similar first difference for housing costs, but our data on housing costs typically involves home prices, which are a stock of value rather than a flow. The stock value of land in our model at time t, denoted $V_{i,t}$, can be interpreted as the discounted value of the flow of future land rents or future flow costs:

$$V_{i,t} = \mathbb{E}\left(\int_{k=0}^{\infty} e^{-\rho k} r_{i,t+k} dk\right) = r_{i,t}\mathbb{E}\left(\int_{k=0}^{\infty} e^{(g_r - \rho)k + \varepsilon^r_{t+k}} dk\right), \tag{23}$$

where

$$g_r \equiv \frac{\boldsymbol{\beta}^E + (\sigma - 1)\,\boldsymbol{\beta}^\theta - \boldsymbol{\beta}^{\bar{L}}}{\mu + \sigma - \mu\sigma} \cdot \mathbf{X}^i \tag{24}$$

is the time-invariant expected growth rate of future rents and ε^r_{t+k} the relative error term. For a time-invariant error distribution,

$$\log V_{i,t+1} - \log V_{i,t} = \log r_{i,t+1} - \log r_{i,t} = \frac{\boldsymbol{\beta}^E + (\sigma - 1)\,\boldsymbol{\beta}^\theta - \boldsymbol{\beta}^{\bar{L}}}{\mu + \sigma - \mu\sigma} \cdot \mathbf{X}^i + \varepsilon^V_{i,t}. \tag{25}$$

If then, for example, we have estimated coefficients for a variable, like schooling, in population, income and housing value growth regressions of B_{Pop}, B_{Inc} and B_{Val} respectively, then algebra yields the values

$$\beta^E_s = B_{Pop} + \sigma B_{Inc}, \tag{26}$$

$$\beta^\theta_s = -B_{Inc} + (1-\mu)\,B_{Val}, \tag{27}$$

and

$$\beta^{\bar{L}}_s = B_{Pop} + B_{Inc} - B_{Val}. \tag{28}$$

By combining these estimated coefficients, it is possible to uncover the underlying connections between a variable and growth in entrepreneurship, land availability and amenities.

4.1 Endogenous Entrepreneurship and Responses to Shocks

While the previous equations will serve to frame our empirical work in Section 5, we now focus on the connection between skills, entrepreneurship and regional resilience. An adverse regional shock can be understood as a reduction in the exogenous stock of entrepreneurs $\bar{E}_i$, due to death or technological obsolescence or migration, so only $(1-\delta_i)\,\bar{E}_i$ entrepreneurs remain. The ability of a region to respond to such a shock will depend on the production of new ideas. To address this, we endogenize entrepreneurship, and assume that all workers are endowed with one unit of time that they can spend either working or engaging in entrepreneurial activity. The time cost of trying to become an entrepreneur is a fixed quantity t. If the worker becomes an entrepreneur, she has an individual specific probability η of being successful. The value of an entrepreneurial attempt is thus $\eta\pi_i + (1-t)\,w_i$.

We assume that there is a distribution of η in the population such that the share of agents with probability of success no greater than η equals η^α for $\alpha \in (0,1)$.[7] Given this assumption, suppose that city i has a number M_i of potential entrepreneurs. All those with probabilities of success greater than $\bar{\eta}_i$ attempt entrepreneurship, while those with probability of success below $\bar{\eta}_i$ spend all their time as employees. Then the total number of entrepreneurs equals

$$E_i = (1-\delta_i)\,\bar{E}_i + \frac{\alpha}{1+\alpha}\left(1-\bar{\eta}_i^{1+\alpha}\right)M_i, \tag{29}$$

while the labor supply is

$$N_i = \left[1 - t\left(1-\bar{\eta}_i^{\alpha}\right)\right]M_i. \tag{30}$$

This implies that the market-clearing wage is

$$w_i = \frac{\sigma-1}{\sigma}\left(\frac{\mu Y}{\beta^{\sigma-1}}\right)^{\frac{1}{\sigma}}\left[\frac{\frac{(1-\delta_i)\bar{E}_i}{M_i} + \frac{\alpha}{1+\alpha}\left(1-\bar{\eta}_i^{1+\alpha}\right)}{1-t\left(1-\bar{\eta}_i^{\alpha}\right)}\right]^{\frac{1}{\sigma}}, \tag{31}$$

and the profits of each successful entrepreneur are

$$\pi_i = \frac{1}{\sigma}\left(\frac{\mu Y}{\beta^{\sigma-1}}\right)^{\frac{1}{\sigma}}\left[\frac{\frac{(1-\delta_i)\bar{E}_i}{M_i} + \frac{\alpha}{1+\alpha}\left(1-\bar{\eta}_i^{1+\alpha}\right)}{1-t\left(1-\bar{\eta}_i^{\alpha}\right)}\right]^{\frac{1-\sigma}{\sigma}}. \tag{32}$$

It is privately optimal for an agent to attempt entrepreneurship if and only if his probability of success is $\eta \geq tw_i/\pi_i$. Thus an equilibrium is given by

$$\bar{\eta}_i = 1 \text{ if } M_i < (\sigma-1)\,t\,(1-\delta_i)\,\bar{E}_i, \tag{33}$$

[7] In other words, $1/\eta$ has a Pareto distribution with a minimum of 1 and shape parameter α.

and if instead $M_i \geq (\sigma - 1)\, t\, (1 - \delta_i)\, \bar{E}_i$, by

$$\bar{\eta}_i \in [0,1] \ \text{ such that } \bar{\eta}_i = (\sigma - 1)\, t \frac{\frac{(1-\delta_i)\bar{E}_i}{M_i} + \frac{\alpha}{1+\alpha}\left(1 - \bar{\eta}_i^{1+\alpha}\right)}{1 - t\left(1 - \bar{\eta}_i^{\alpha}\right)}. \tag{34}$$

which is uniquely defined since the right-hand side is a monotone decreasing function of $\bar{\eta}_i$.

In particular if $t = 1$, so people are either would-be entrepreneurs or employees, then

$$\bar{\eta}_i = \begin{cases} 1 & \text{if } \ M_i < (\sigma - 1)(1 - \delta_i)\, \bar{E}_i \\ \left\{ \frac{(\sigma-1)\left[(1+\alpha)(1-\delta_i)\bar{E}_i + \alpha M_i\right]}{(1+\alpha\sigma) M_i} \right\}^{\frac{1}{1+\alpha}} & \text{if } \ M_i \geq (\sigma - 1)(1 - \delta_i)\, \bar{E}_i \end{cases}, \tag{35}$$

the total number of employers equals

$$E_i = \begin{cases} (1 - \delta_i)\, \bar{E}_i & \text{if } \ M_i < (\sigma - 1)(1 - \delta_i)\, \bar{E}_i \\ \frac{(1+\alpha)(1-\delta_i)\bar{E}_i + \alpha M_i}{1+\alpha\sigma} & \text{if } \ M_i \geq (\sigma - 1)(1 - \delta_i)\, \bar{E}_i \end{cases}, \tag{36}$$

and wages are

$$w_i = \begin{cases} \frac{\sigma-1}{\sigma}\left(\frac{\mu Y}{\beta^{\sigma-1}}\right)^{\frac{1}{\sigma}} \left[\frac{(1-\delta_i)\bar{E}_i}{M_i}\right]^{\frac{1}{\sigma}} & \text{if } \ M_i < (\sigma - 1)(1 - \delta_i)\, \bar{E}_i \\ \frac{\sigma-1}{\sigma}\left(\frac{\mu Y}{\beta^{\sigma-1}}\right)^{\frac{1}{\sigma}} \left[\frac{(1+\alpha)(1-\delta_i)\bar{E}_i + \alpha M_i}{(1+\alpha\sigma)(\sigma-1)^{\alpha} M_i}\right]^{\frac{1}{(1+\alpha)\sigma}} & \text{if } \ M_i \geq (\sigma - 1)(1 - \delta_i)\, \bar{E}_i \end{cases}. \tag{37}$$

In this case, for a closed city with an exogenous number $\bar{M}_i$ of agents choosing between employment and entrepreneurship, the following result holds.

Proposition 1 *In a closed city, both wages and the number of employers fall in response to a negative shock ($\partial \log w_i / \partial \delta_i < 0$ and $\partial E_i / \partial \delta_i < 0$), but these declines are smaller in magnitude if the endogenous supply of entrepreneurs is more elastic ($\partial^2 \log w_i / \partial \delta_i \partial \alpha \geq 0$ and $\partial^2 E_i / \partial \delta_i \partial \alpha \geq 0$).*

Proposition 1 delivers the connection between urban resilience and entrepreneurship in a closed-city framework. As older employers either go bankrupt or leave the city, this causes incomes in the city to decline. This negative shock can be offset by entrepreneurship, as a decline in wages causes entrepreneurship to become relatively more attractive. If the supply of entrerpreneurship is more elastic, which is captured by a higher value of the parameter α, then there is a stronger entrepreneurial response to urban decline and the impact of a negative shock on incomes becomes less severe.

To extend this to the open-city model, we assume that $t = 0$, so there is no time cost to entrepreneurship. In this case, everyone tries to be an entrepreneur, which means that the total number of employers equals

$$E_i = (1-\delta_i)\,\bar{E}_i + \frac{\alpha}{1+\alpha}N_i. \tag{38}$$

In this case, wages satisfy

$$w_i = \frac{\sigma-1}{\sigma}\left(\frac{\mu Y}{\beta^{\sigma-1}}\right)^{\frac{1}{\sigma}}\left[\frac{(1-\delta_i)\,\bar{E}_i}{N_i}+\frac{\alpha}{1+\alpha}\right]^{\frac{1}{\sigma}}. \tag{39}$$

In a closed city, it remains true that $\partial w_i/\partial\delta_i < 0$ and $\partial^2 \log w_i/\partial\delta_i\partial\alpha > 0$, so a greater endogenous supply of entrepreneurs offsets the negative effects of an exogenous shock to the number of employers.

When the city is open, people choose their location before the realization of their individual entrepreneurial ability η. Since the profits of a successful entrepreneur are

$$\pi_i = \frac{1}{\sigma}\left(\frac{\mu Y}{\beta^{\sigma-1}}\right)^{\frac{1}{\sigma}}\left[\frac{(1-\delta_i)\,\bar{E}_i}{N_i}+\frac{\alpha}{1+\alpha}\right]^{\frac{1-\sigma}{\sigma}}, \tag{40}$$

expected earnings equal

$$\begin{aligned} y_i &\equiv w_i + \frac{\alpha}{1+\alpha}\pi_i \\ &= \left(\frac{\mu Y}{\beta^{\sigma-1}}\right)^{\frac{1}{\sigma}}\left[\frac{\sigma-1}{\sigma}\frac{(1-\delta_i)\,\bar{E}_i}{N_i}+\frac{\alpha}{1+\alpha}\right]\left[\frac{(1-\delta_i)\,\bar{E}_i}{N_i}+\frac{\alpha}{1+\alpha}\right]^{\frac{1-\sigma}{\sigma}}, \end{aligned} \tag{41}$$

and spatial equilibrium requires $\theta_i y_i r_i^{\mu-1} = \bar{U}$ for all i. With a continuum of atomistic cities, the following result holds.

Proposition 2 *Expected earnings, the total number of employers, and the price of land decrease in the exogenous negative shock to the endowment of employers (*$\partial y_i/\partial\delta_i < 0$, $\partial E_i/\partial\delta_i < 0$*, and* $\partial r_i/\partial\delta_i < 0$*) and increase in the endogenous rate of entrepeneurship (*$\partial y_i/\partial\alpha > 0$, $\partial E_i/\partial\alpha > 0$*, and* $\partial r_i/\partial\alpha > 0$*). The labor supply and city population (*$\Lambda_i = (1-\delta_i)\,\bar{E}_i + N_i$*) increase in the endogenous rate of entrepreneurship (*$\partial\Lambda_i/\partial\alpha = \partial N_i/\partial\alpha > 0$*). If the endogenous supply of entrepreneurship is sufficiently elastic, population decreases with an exogenous negative shock to the endowment of employers (*$\alpha \geq 1/(\sigma^2-1) \Rightarrow \partial\Lambda_i/\partial\delta_i < 0$*).*

In the limit case $\mu = 1$*, the labor supply and city population both decrease with an exogenous negative shock to the endowment of employers (*$\partial\Lambda_i/\partial\delta_i < \partial N_i/\partial\delta_i < 0$*). Moreover, a greater endogenous supply of entrepreneurship mutes the proportional impact of a negative endowment shock on expected earnings, the total number of employers and city population*

($d^2 \log y_i / (d\delta_i d\alpha) > 0$,$d^2 \log E_i / (d\delta_i d\alpha) > 0$, *and* $d^2 \log \Lambda_i / (d\delta_i d\alpha) > 0$*).*

Proposition 2 makes the point that entrepreneurship can substitute for a decline in an area's core industries in a way that keeps population, earnings, and real-estate values up. A higher rate of exodus for older industries will cause a city to lose both population and income, but that can be offset if the city also has a higher rate of new entrepreneurship.

What factors are likely to make entrepreneurship more common? One possibility is skilled workers have a comparative advantage at producing new ideas. To capture this possibility, we assume that there are two types of workers. Less skilled workers have one unit of human capital and have a value of $\alpha/(1+\alpha)$ equal to $\underline{\eta}$. The assumption that skilled workers are more likely to be successful entrepreneurs is supported by the evidence in Glaeser (2009). More skilled workers have $1+H$ units of human capital, where $H > 0$, and have a value of $\alpha/(1+\alpha)$ equal to $\bar{\eta}$. We assume that the high and low human capital workers are perfect substitutes in production and that the share of high human capital workers in city i is fixed at h_i (this is a closed-city model). In this case, the total number of employers equals

$$E_i = (1-\delta_i)\bar{E}_i + \left[h_i\bar{\eta} + (1-h_i)\underline{\eta}\right] N_i. \tag{42}$$

The unsiklled wage, i.e., the wage per effective unit of human capital, equals

$$w_i = \frac{\sigma-1}{\sigma}\left(\frac{\mu Y}{\beta^{\sigma-1}}\right)^{\frac{1}{\sigma}} \left\{\frac{(1-\delta_i)\bar{E}_i + \left[h_i\bar{\eta} + (1-h_i)\underline{\eta}\right] N_i}{(1+h_i H) N_i}\right\}^{\frac{1}{\sigma}}, \tag{43}$$

which yields the following result.

Proposition 3 *If* $H\bar{E}_i/N_i + (1+H)\underline{\eta} > \bar{\eta} > (1+H)\underline{\eta}$*, then there exists a value* $\bar{\delta}_i$ *of the exogenous negative shock for which changes in human capital have no impact on the wages earned by each type of worker (*$\delta_i = \bar{\delta}_i \Leftrightarrow \partial w_i/\partial h_i = 0$*). If* δ_i *is above that value wages rise with the share of skilled workers (*$\delta_i > \bar{\delta}_i \Leftrightarrow \partial w_i/\partial h_i > 0$*), and if* δ_i *is below that value wages decline with the share of skilled workers (*$\delta_i < \bar{\delta}_i \Leftrightarrow \partial w_i/\partial h_i < 0$*).*

If $\bar{\eta} \geq H\bar{E}_i/N_i + (1+H)\underline{\eta}$*, then wages for both classes of workers rise with the share of skilled workers (*$\partial w_i/\partial h_i \geq 0$ *for all* $\delta_i \in [0,1]$*), and if* $\bar{\eta} \leq (1+H)\underline{\eta}$ *wages for both classes of workers fall with the share of the population that is skilled.*

Proposition 3 illustrates one way in which human-capital externalities might work. There are always two effects of having more skilled workers on earnings. More skilled workers can depress earnings because they are more productive and therefore lower the marginal product of labor when the number of employers is held fixed. But more skilled workers also increase the number of employers, and this causes wages to rise. If $\bar{\eta}$ is higher than $H\bar{E}_i/N_i + (1+H)\,\underline{\eta}$, so skilled workers have a real comparative advantage at innovation, then wages will always rise with the share of skilled workers. This is one way in which human capital externalities might operate.

The proposition also illustrates the connection between adverse shocks and the value of having more skilled workers in the city. When there is more adverse economic shock that destroys the stock of old employers, then it is more likely that skilled workers will increase wages for everyone. When the shock is less severe, then skilled workers are less likely to improve everyone's welfare.

Proposition 3 examines the potential impact that skills can have on urban wages and success in the face of a downturn. The human capital needed to innovate might also result from experience in management, especially of smaller firms. We will not formally model this, but just note that the human capital needed to develop new firms may come from working in smaller, more entrepreneurial ventures. These smaller firms could, therefore, also be a source of urban resilience.

5 Why Do Educated Cities Grow?

We now turn to the primary statistical exercise of this paper: an examination of the link between education and metropolitan growth. Since we are focusing entirely on this later period, we switch from counties to metropolitan areas to be in line with past research. We also use data from entire United States. We follow Shapiro (2006) and Glaeser and Saiz (2004) and attempt to assess the reasons why skilled cities might grow more quickly. We differ from these earlier studies in two primary ways. First, we estimate all of our results for different regions. This enables us to estimate whether human capital has different effects in declining areas (e.g. the Midwest) and growing areas. Second, we use the methodology described in Section 4, which enables us to assess whether human capital is increasing population growth because of increasing productivity (or entrepreneurship), amenities or housing supply.

One set of regressions focus on metropolitan area level regressions, where our basic method is to regress:

$$\log \frac{Y_{2000}}{Y_{1970}} = B_Y \cdot \text{Schooling}_{1970} + \text{Other Controls}. \tag{44}$$

In this case, Y denotes one of three outcome variables: population, median income and self-reported housing values. We focus only on the long difference between 1970 and 2000.

Our second approach is to use individual data and estimate:

$$\log Y_t = \text{MSA Dummies} + \text{Individual Controls} + B_Y \cdot \text{Schooling}_{1970} \cdot I_{2000}, \tag{45}$$

where Y in this case indicates either labor-market earnings or self-reported housing values. We pool together data for 1970 and 2000. In the case of the earnings regressions, individual controls include individual schooling, age and race. In the case of the housing value regressions, individual controls include structural characteristics such as the number of bedrooms and bathrooms. In both cases, we allow the coefficients on these characteristics to change by year and we include an indicator variable that takes on a value of one if the year is 2000.

Our primary focus is on the coefficient B_Y that multiplies the interaction between the share of the adult population with college degrees in 1970 and the year 2000. Essentially, this coefficient is assessing the extent to which housing values and incomes increased in more educated places. We prefer this specification to the raw income growth or housing value growth regressions because these regressions can control for differences in the returns to various individual characteristics.

One novelty of our work here is that we estimate the impact of education separately by regions. To do this, we interact B_Y with four region dummies, and thereby allow the impact of schooling on population, income and housing value growth to differ by region. These different regional parameter estimates will then imply different estimates of the underlying parameters found using the formulas of the last section.

Table 9 shows our results for metropolitan area level regressions. In all regressions, we include the initial values of the logarithm of population, median income and housing values. We also include three region dummies (the Midwest is the omitted category). The first regression shows the overall impact of education in this sample. As the share of the adult population with college degrees increased by 5 percent in 1970, predicted growth between 1970 and 2000 increases by about 8 percent.

The other coefficients in the regression are generally unsurprising. Growth was faster in the South and the West. Gibrat's law holds and population is unrelated to population growth. Places with higher housing values actually grew faster, perhaps because their expensiveness reflected a higher level of local amenities. Places with higher incomes grew more slowly, perhaps reflecting the movement away from high-wage, manufacturing metropolitan areas.

The second regression allows the impact of education in 1970 to differ by region. The strongest effect appears in the South, where a 5 percent increase in share of adults with college degrees in 1970 is associated with 19 percent faster population growth. The second largest coefficient appears in the Northeast. In that region, the coefficient is about the national average, even though it is not statistically significant. The coefficient is slightly smaller in the Midwest, where a 5 percentage point increase in the share of adults with college degrees in 1970 is associated with a 6.5 percentage point predicted increase in population between 1970 and 2000. In this case, however, the coefficient is statistically significant. In the West, the impact of education on population growth is negative and insignificant.

Our third regression looks at median growth in income. Income mean reverts, but increases in high housing value areas, perhaps suggesting that wealthier people are moving to higher-amenity areas. Incomes rose by less in the West; the other region dummies are statistically insignificant. There is a strong positive effect of initial education levels, which reflects in part the returns to skill and the tendency of skilled people to move to already skilled areas. As the share of the population with college degrees in 1970 increased by 5 percent, median incomes increase by 4 percent more since then.

The fourth regression estimates different initial education by region. Education has a positive effect on income growth in all four regions. The biggest impact is in the West, where income growth increases by .07 log points as the share of the population with college degrees in 1970 increases by 5 percentage points. The smallest impact of education on income growth is in the Midwest, where the coefficient is less than half of that found in the West.

The fifth and sixth regressions turn to appreciation in median housing values. Housing values rose by more in more populous metropolitan areas. Prices increased somewhat less in initially higher-income areas, perhaps reflecting the mean reversion of income levels. Prices, however, did not themselves mean revert. The West had much more price appreciation than the other three regions. As the share of the population with college degrees in 1970 increased by 5 percentage points, housing values increased by about 4 percent more.

The sixth regression allows the impact of college education on housing-value growth to differ by region. In this case, we find a big positive effect in the West, and far smaller effects in all other regions. In the West, prices rose by more than 10 percent more as the share of the population with college degrees in 1970 increased by 5 percentage points. In the other regions, the impact of education is statistically insignificant and less than one-fifth of its impact in the West. It is notable that the region where education had its weakest impact on population growth is the area where it had its largest impact on housing-value growth. This difference shows the value of examining the impact of education by region.

Table 10 turns to wages and housing values using individual-level data. We look at annual earnings and restrict our sample to prime-age males (between 25 and 55), who work at least 30 hours a week and over 40 weeks per year. These restrictions are meant to limit issues associated with being out of the labor force. We control for individual human-capital characteristics, including years of experience and education, and allow for the impact of these variables to differ by area. As such, these coefficients can be understood as the impact of skills on area income growth correcting for the movement of skilled people across places and the rise in the returns to skill. All regressions also control for the initial levels of income, population and housing values, just like the metropolitan area level regressions. We also have MSA dummies in each regression, controlling for the permanent income differences between places.

The first regression shows a raw coefficient of .557, which implies that as the share of college graduates in a metropolitan area in 1970 increases by 5 percentage points, earnings rise by .028 log points more over the next thirty years. Comparing this coefficient with the coefficient on education (.8) in regression 3 in Table 10 suggests that almost a third of the metropolitan-area coefficient is explained by the rise in returns to skill at the individual level and increased sorting across metropolitan areas. The second regression adds in industry dummies, and the coefficient drops to .442.

The third regression compares the impact of education at the area level with education at the industry level in 1970. In this case, we allow the MSA dummies to differ by year, so these effects should be understood as across industries but within metropolitan area. The cross-industry effect of education on income growth is also positive, but it is much weaker than the effect at the metropolitan area level.

Regressions 4 and 5 look the impact of the initial education level in the MSA-industry. We calculate the share of workers in that metropolitan area in that industry in 1970 with college degrees. We then control for MSA-year dummies and industry fixed effects in regression 4. We find that more skilled sectors are seeing faster wage growth. Regression 5 shows that this effect does not withstand allowing the industry effects, nationwide, to vary by year.

Regression 6 essentially duplicates regression 1 of the table allowing the coefficient on education to differ by region. In this case, however, unlike the metropolitan area level tables, we find that there are few significant regional differences. The coefficient is slightly higher in the Northeast, but the effects are generally quite similar and close to the national effect.

In regressions 7 and 8 we estimate housing price appreciation using individual-level housing data and controlling for individual housing characteristics. Regression 7 shows the overall national coefficient of 3.3. Regression 8 estimates different effects by region, and again shows that housing price appreciation has gone up faster in the West.

Table 11 then shows our estimated coefficients, using the formulas in Section 4: $\beta_j^E = B_{Pop} + \sigma B_{Inc}$, $\beta_j^\theta = -B_{Inc} + (1-\mu) B_{Val}$, and $\beta_j^{\bar{L}} = B_{Pop} + B_{Inc} - B_{Val}$. We do this in two ways. These enable us to combine these coefficients and assess whether education is acting on housing supply, productivity or amenities. To implement these equations we use a value of .7 for μ, which is compatible with housing representing 30 percent of consumption. For σ, we use a value of 4, which corresponds to an average mark-up of 33 percent. Jaimovich and Floetotto (2008) present some support for this calibration, which only impacts on the estimated connection between skills and productivity growth.

The first three columns show results for the country and each region using only the metropolitan area level coefficients. Columns 4-6 shows results using the metropolitan area estimates for population growth and the area-level estimates for income and housing price growth. The estimates show standard errors estimated by bootstrap. However, we believe that these standard errors substantially overstate the actual precision of these estimates, since they take into account only the error involved in our estimated parameters, not the possibility that our assumed parameters, and indeed the model itself, are at best noisy approximations of reality.

The first column shows a positive connection between productivity growth and skills everywhere. The national coefficient is about 5, meaning that as the share of the population with college degrees increase by 5 percent, the growth in the number of entrepreneurs over the next 30 years increases by 25 percent. The coefficient is somewhat higher in the South and somewhat lower in the West, but these differences are not statistically significant. Using these national metropolitan-area coefficients, we find that the impact of education on the growth of productivity, or entrepreneurship, is reasonably homogeneous across regions. .

The second column shows results for amenity growth. In every region the coefficient is negative, suggesting that amenities have been shrinking rather than growing in skilled areas. This comes naturally out of the model because real wages have, according to our formulation, been shrinking in skilled places. Again, with the metropolitan area level coefficients, the impact of skills on amenities is fairly similar across regions. However, if housing were a larger share of consumption or if housing prices were actually proxying for the growth of all prices, then the real wage effect would be zero and hence the implied connection between skills and amenity growth would be zero as well.

The third column looks at the growth of housing supply. Overall, skills have been associated with increases in housing supply, but there are very substantial regional differences. In the South, there is an extremely strong implied relationship between skills and housing supply growth. In the West, the implied relationship is negative. These differences reflect the very different relationship between skills and population growth in the South and in the West. We think that in a richer model with a better developed construction sector, these effects would appear as a movement along a supply curve rather than an actual shift in the supply of housing, and that the differences between West and South could be explained, at least in part, by very different housing supply elasticities (as found by Saiz, forthcoming).

Columns 4-6 show results using individual-level regressions for housing and income..In Column 4, the skills coefficient on entrepreneurship growth is smaller, reflecting the fact that the connection between skills and income growth is lower in the individual-level regressions. We believe that these estimates are more defensible. As in Column (1), the connection between skills and entrepreneurship seems strongest in the South and weakest in the West. In this case, the gulf in estimated coefficients is much larger and statistically significant. Understanding this regional gap seems like an important topic for future research.

Column 5 shows the connection between skills and amenity growth. Overall, the estimated coefficient is positive, but it is negative in three out of four regions. Only in the West are skills positively associated with implied amenity growth, meaning that only in the West are skills associated with declines in real wages. In the other regions, skills are associated with rising real wages, which implies a decline in amenities. As discussed above, we do not take ths implication all that seriously, because it is quite sensitive to assumptions about the connection between housing prices and the overall price level. Moreover, if unobserved skill levels are rising in skilled metropolitan areas, then the rise in real wages, and hence the implied decline in amenity levels, would also be somewhat illusory. We are more confident about the difference between regions—the rise in the value of amenities in skilled areas in the West—than we are about the overall sign in the rest of the nation.

Column 6 shows the land growth effects, which are positive everywhere but in the West. Just as in Column (4), the West is the one region where skills seem associated with a decline in housing availability. In this case, the effect seems to be quite strong, statistically and economically; and indeed, the West is so powerful that it makes the estimated national coefficient negative. Housing supply has grown very little in skilled areas in the West, perhaps because educated Westerners have been particularly effective in pushing for limits on new construction.

Overall, this exercise leads to three main conclusions. First, the impact of education on productivity seems to be quite clear everywhere. Second, the growth of skilled places has far more to do with rising productivity than with amenity growth outside of the West, and indeed, amenity levels may have been declining in skilled areas. This conclusion echoes the findings of Shapiro (2006) and Glaeser and Saiz (2004). Third, skills seem to depress housing supply growth in the American West, and that is a substantial difference with other regions. This negative connection could reflect the ability and taste of skilled people for organizing to oppose new construction.

6 Education and Unemployment in the Great Recession

The previous section focused on the role that education played in mediating cities' ability to respond to the great shocks of the mid-20th century, but there has also been a more recent crisis. According to the National Bureau of Economic Research, a recession began in December 2007. Unemployment then rose significantly in 2008 and 2009, rising above 10 percent in October 2009. But while the recession impacted on all of America, it did not hit every place equally. In February 2010, the unemployment rate was over 20 percent in Merced, California, and over 15 percent in Detroit, Michigan. At the same time, the unemployment rate in Minneapolis, Minnesota, was 7.7 percent and in Boulder, Colorado, only 6.5 percent.[8]

Just as education predicted the ability of older, colder cities to survive the mid-20th century shocks, skills also predict the ability of cities today to weather the storm. Figure 7 shows the -.44 correlation between the share of adults with a college degree in a metropolitan area and the unemployment rate in that area as of January 2010. In a sense, this is unsurprising. After all, the unemployment rate was 15.2 percent for high school dropouts and 4.9 percent for college graduates.[9] But it turns out that the relationship between area unemployment and area education is too high to be explained merely by the composition of the population.

We construct a predicted unemployment rate based on the composition of the population as of 2000 (the latest date available with reliable data) and the national unemployment rate for these different educational groups. Specifically:

$$\text{Predicted Unemployment} = \sum_{\text{Groups}} U^{\text{USA}}_{\text{Group}} \cdot \text{Share}^{\text{MSA}}_{\text{Group}}, \tag{46}$$

where $U^{\text{USA}}_{\text{Group}}$ is the national unemployment rate for the group and $\text{Share}^{\text{MSA}}_{\text{Group}}$ is the share of the adult labor force in each group in each metropolitan area as of 2000. We used the national rates of unemployment, which were 5.1 percent for those with college degrees, 17.6 percent for high school dropouts and 10.25 percent for the remainder.

Figure 8 shows that .48 correlation between actual unemployment and our predicted unemployment measure. The key fact is that the slope shown by the line in the figure is

[8] U.S. Department of Labor, Bureau of Labor Statistics. "Metropolitan Area Employment and Unemployment – April 2010," news release, June 2, 2010. http://www.bls.gov/news.release/pdf/metro.pdf.

[9] U.S. Department of Labor, Bureau of Labor Statistics. "Table A-4. Employment Status of the Civilian population 35 years and over by educational attainment," news release, June 4, 2010. http://www.bls.gov/news.release/empsit.t04.htm.

1.78. As predicted unemployment falls by 5 percent; actually unemployment declines by almost 8 percent. Education is predicting a decline in unemployment that is greater than the national relationship between education and unemployment would imply. This provides yet another piece of evidence suggesting the existence of human capital spillovers.

Of course, as in most forms of evidence for these spillovers, there are many interpretations of this fact. It is possible that it is just a coincidence that unemployment rates were unusually low in highly educated areas. It is possible that people who live in educated areas are more skilled than their years of schooling would suggest. Certainly, it would be reasonable to believe that people who are skilled along unobservable dimensions sort into more skilled cities. Of course, if human capital spillovers take the form of enhancing unobserved skill levels (as in Glaeser 1999), then the unobserved-skill hypothesis becomes quite similar to the human capital spillover hypothesis.

The model suggested in this paper emphasizes that skilled workers are both employers and employees. According to this model, the strong negative effect of education on unemployment may reflect the ability of more skilled entrepreneurs to find opportunity in a downturn. Of course, that interpretation is now merely a hypothesis and further work will be needed to determine whether it is correct.

7 Conclusion

The regional history of the eastern United States is best understood as a progression of different eras during which local attributes waxed and waned in importance. We observe few universal growth laws, and many relationships which hold during some periods but not others. Gibrat's law does not always hold. During some periods growth is faster in more populous places, and during others population moves to more sparsely populated areas. Warmth positively predicts growth during the late 19th and 20th centuries, but not during the early parts of the two centuries.

To us, these findings support the view that regional and urban change is best understood not as the application of time-invariant growth processes, but rather as a reflection of large-scale technological change. These processes are quite amenable to formal modeling, but only to formal models that respect the changing nature of transportation and other technologies. The 19th century was primarily agricultural, and the spread west reflected the value of gaining access to highly productive agricultural land. The Great Lakes were a magnet because they lowered otherwise prohibitive transport costs. During the late 19th century, America became increasingly industrial and the population moved to places that began the era with more population. Cities that had formed as hubs for transporting the wealth of

American agriculture became centers for producing manufactured goods such as cars.

Finally, during the post-war era, transportation costs fell still further and the population de-concentrated. The Great Lakes declined and people moved to the Sun Belt. The older areas that were best placed to reinvent themselves had a heavy concentration of skills and a disproportionate number of small firms. Industry no longer created a strong reason for concentration in populated counties, but it was increasing valuable to be around skilled people. Our model formally addressed reinvention in skilled areas.

When we examine the channels through which skills affect growth, we find that productivity growth was significantly higher in more skilled areas, at least outside of the West. But in the West, skilled areas appear to have experienced faster amenity growth, perhaps because skilled people located in areas that were inherently more attractive. Skills were positively correlated with housing supply growth in the Midwest and South, but strongly negatively associated with housing supply growth in the West.

America has experienced dramatic changes over the past 200 years, and population change doesn't appear to follow any form of strict rule. There has been a great deal of population persistence in the eastern U.S., but population change has followed different patterns at different times. Over the past thirty years, skills and small firms have been strongly correlated with growth, but that may not always be the case.

A Appendix

A.1. Proof of Proposition 1

The response of wages to a negative shock is

$$\frac{\partial \log w_i}{\partial \delta_i} = \begin{cases} -\frac{1}{\sigma(1-\delta_i)} & \text{if} \quad \delta_i < 1 - \frac{M_i}{(\sigma-1)\bar{E}_i} \\ -\frac{\bar{E}_i}{\sigma\left[(1+\alpha)(1-\delta_i)\bar{E}_i+\alpha M_i\right]} & \text{if} \quad \delta_i > 1 - \frac{M_i}{(\sigma-1)\bar{E}_i} \end{cases} < 0, \tag{A1}$$

such that

$$\frac{\partial^2 \log w_i}{\partial \delta_i \partial \alpha} = \begin{cases} 0 & \text{if} \quad \delta_i < 1 - \frac{M_i}{(\sigma-1)\bar{E}_i} \\ \frac{\bar{E}_i\left[(1-\delta_i)\bar{E}_i+M_i\right]}{\sigma\left[(1+\alpha)(1-\delta_i)\bar{E}_i+\alpha M_i\right]^2} & \text{if} \quad \delta_i > 1 - \frac{M_i}{(\sigma-1)\bar{E}_i} \end{cases} \geq 0 \tag{A2}$$

with a convex kink at $\delta_i = 1 - M_i / \left[(\sigma-1)\bar{E}_i\right]$.

The number of entrepreneurs reacts according to

$$\frac{\partial E_i}{\partial \delta_i} = \begin{cases} -\bar{E}_i & \text{if} \quad M_i < (\sigma-1)(1-\delta_i)\bar{E}_i \\ -\frac{1+\alpha}{1+\alpha\sigma}\bar{E}_i & \text{if} \quad M_i > (\sigma-1)(1-\delta_i)\bar{E}_i \end{cases} < 0, \tag{A3}$$

such that

$$\frac{\partial^2 E_i}{\partial \delta_i \partial \alpha} = \begin{cases} 0 & \text{if} \quad M_i < (\sigma-1)(1-\delta_i)\bar{E}_i \\ \frac{\sigma-1}{(1+\alpha\sigma)^2}\bar{E}_i & \text{if} \quad M_i > (\sigma-1)(1-\delta_i)\bar{E}_i \end{cases} \geq 0, \tag{A4}$$

with a convex kink at $\delta_i = 1 - M_i / \left[(\sigma-1)\bar{E}_i\right]$.

A.2. Proof of Proposition 2

Expected earnings are increasing in the exogenous endowment of entrepeneurs and in endogenous entrepreneurship, while they are decreasing in the labor supply:

$$\frac{\partial \log y_i}{\partial N_i} = -\frac{(\sigma-1)(1-\delta_i)^2 \bar{E}_i^2}{\sigma^2 N_i \left[\frac{\sigma-1}{\sigma}(1-\delta_i)\bar{E}_i + \frac{\alpha}{1+\alpha}N_i\right]\left[(1-\delta_i)\bar{E}_i + \frac{\alpha}{1+\alpha}N_i\right]} < 0, \tag{A5}$$

$$\frac{\partial \log y_i}{\partial (1-\delta_i)\bar{E}_i} = \frac{(\sigma-1)(1-\delta_i)\bar{E}_i}{\sigma^2 \left[\frac{\sigma-1}{\sigma}(1-\delta_i)\bar{E}_i + \frac{\alpha}{1+\alpha}N_i\right]\left[(1-\delta_i)\bar{E}_i + \frac{\alpha}{1+\alpha}N_i\right]} > 0, \tag{A6}$$

and

$$\frac{\partial \log y_i}{\partial \frac{\alpha}{1+\alpha}} = \frac{N_i\left[\frac{2\sigma-1}{\sigma}(1-\delta_i)\bar{E}_i + \frac{\alpha}{1+\alpha}N_i\right]}{\sigma \left[\frac{\sigma-1}{\sigma}(1-\delta_i)\bar{E}_i + \frac{\alpha}{1+\alpha}N_i\right]\left[(1-\delta_i)\bar{E}_i + \frac{\alpha}{1+\alpha}N_i\right]} > 0. \tag{A7}$$

The price of land is

$$r_i = \frac{1-\mu}{\mu}\left(\frac{\mu Y}{\beta^{\sigma-1}}\right)^{\frac{1}{\sigma}} \bar{L}_i^{-1}\left[(1-\delta_i)\bar{E}_i + \frac{\alpha}{1+\alpha}N_i\right]^{\frac{1}{\sigma}} N_i^{\frac{\sigma-1}{\sigma}}, \tag{A8}$$

which is increasing in the exogenous endowment of entrepeneurs, in endogenous entrepreneurship, and in the labor supply:

$$\frac{\partial \log r_i}{\partial N_i} = \frac{\frac{\sigma-1}{\sigma}\left(1-\delta_i\right)\bar{E}_i + \frac{\alpha}{1+\alpha}N_i}{N_i\left[\left(1-\delta_i\right)\bar{E}_i + \frac{\alpha}{1+\alpha}N_i\right]} > 0, \tag{A9}$$

$$\frac{\partial \log r_i}{\partial\left(1-\delta_i\right)\bar{E}_i} = \frac{1}{\sigma\left[\left(1-\delta_i\right)\bar{E}_i + \frac{\alpha}{1+\alpha}N_i\right]} > 0, \tag{A10}$$

and

$$\frac{\partial \log r_i}{\partial \frac{\alpha}{1+\alpha}} = \frac{N_i}{\sigma\left[\left(1-\delta_i\right)\bar{E}_i + \frac{\alpha}{1+\alpha}N_i\right]} > 0. \tag{A11}$$

The spatial-equilibrium requirement $\theta_i y_i r_i^{\mu-1} = \bar{U}$ can be written

$$\frac{\theta_i \bar{L}_i^{1-\mu}\left[\frac{\sigma-1}{\sigma}\left(1-\delta_i\right)\bar{E}_i + \frac{\alpha}{1+\alpha}N_i\right]}{N_i^{\frac{\mu+\sigma-\mu\sigma}{\sigma}}\left[\left(1-\delta_i\right)\bar{E}_i + \frac{\alpha}{1+\alpha}N_i\right]^{\frac{\sigma-\mu}{\sigma}}} = \left(\frac{1-\mu}{\mu}\right)^{1-\mu}\left(\frac{\beta^{\sigma-1}}{\mu Y}\right)^{\frac{\mu}{\sigma}}\bar{U}. \tag{A12}$$

With a continuum of cities, changes in a single atomistic city i do not affect the aggregate variables on the right-hand side, so comparative statics can be taken from

$$\begin{aligned}\Omega \quad &\equiv \tfrac{\mu+\sigma-\mu\sigma}{\sigma}\log N_i + \tfrac{\sigma-\mu}{\sigma}\log\left[\left(1-\delta_i\right)\bar{E}_i + \tfrac{\alpha}{1+\alpha}N_i\right] - \log\left[\tfrac{\sigma-1}{\sigma}\left(1-\delta_i\right)\bar{E}_i + \tfrac{\alpha}{1+\alpha}N_i\right] \\ &= 0,\end{aligned} \tag{A13}$$

such that

$$\frac{\partial\Omega}{\partial N_i} = \frac{\frac{(\mu+\sigma-\mu\sigma)(\sigma-1)}{\sigma}(1-\delta_i)^2\bar{E}_i^2 + 2(1-\mu)(\sigma-1)(1-\delta_i)\bar{E}_i\frac{\alpha}{1+\alpha}N_i + (1-\mu)\sigma\left(\frac{\alpha}{1+\alpha}\right)^2 N_i^2}{N_i\left[(1-\delta_i)\bar{E}_i + \frac{\alpha}{1+\alpha}N_i\right]\left[\frac{\sigma-1}{\sigma}(1-\delta_i)\bar{E}_i + \frac{\alpha}{1+\alpha}N_i\right]} > 0, \tag{A14}$$

$$\frac{\partial\Omega}{\partial\frac{\alpha}{1+\alpha}} = -\frac{N_i\left[\left(\sigma-\mu+\sigma\mu\right)\left(1-\delta_i\right)\bar{E}_i + \mu\sigma\frac{\alpha}{1+\alpha}N_i\right]}{\sigma^2\left[\left(1-\delta_i\right)\bar{E}_i + \frac{\alpha}{1+\alpha}N_i\right]\left[\frac{\sigma-1}{\sigma}\left(1-\delta_i\right)\bar{E}_i + \frac{\alpha}{1+\alpha}N_i\right]} < 0, \tag{A15}$$

and

$$\frac{\partial\Omega}{\partial\left(1-\delta_i\right)\bar{E}_i} = \frac{\left(1-\mu\right)\frac{\alpha}{1+\alpha}N_i - \mu\frac{\sigma-1}{\sigma}\left(1-\delta_i\right)\bar{E}_i}{\sigma\left[\left(1-\delta_i\right)\bar{E}_i + \frac{\alpha}{1+\alpha}N_i\right]\left[\frac{\sigma-1}{\sigma}\left(1-\delta_i\right)\bar{E}_i + \frac{\alpha}{1+\alpha}N_i\right]} \tag{A16}$$

which switches from positive to negative as μ ranges in $(0,1)$.

The exogenous endowment of entrepreneurs has an ambiguous impact on the labor supply:

$$\frac{\partial N_i}{\partial(1-\delta_i)\bar{E}_i} = \frac{N_i\left[\mu\frac{\sigma-1}{\sigma}(1-\delta_i)\bar{E}_i - (1-\mu)\frac{\alpha}{1+\alpha}N_i\right]}{(\mu+\sigma-\mu\sigma)(\sigma-1)(1-\delta_i)^2\bar{E}_i^2 + 2(1-\mu)\sigma(\sigma-1)(1-\delta_i)\bar{E}_i\frac{\alpha}{1+\alpha}N_i + (1-\mu)\sigma^2\left(\frac{\alpha}{1+\alpha}\right)^2 N_i^2}, \tag{A17}$$

such that for all $\mu \in (0,1)$

$$\frac{\partial^2 N_i}{\partial\mu\partial(1-\delta_i)\bar{E}_i} > 0 \text{ and } \frac{\partial N_i}{\partial(1-\delta_i)\bar{E}_i} \in \left(-\frac{\frac{\alpha}{1+\alpha}N_i^2}{\sigma\left[(\sigma-1)(1-\delta_i)^2\bar{E}_i^2 + 2(\sigma-1)(1-\delta_i)\bar{E}_i\frac{\alpha}{1+\alpha}N_i + \sigma\left(\frac{\alpha}{1+\alpha}\right)^2 N_i^2\right]}, \frac{N_i}{\sigma(1-\delta_i)\bar{E}_i}\right). \tag{A18}$$

Expected earnings are decreasing in δ_i

$$\begin{aligned}
\frac{d\log y_i}{d(1-\delta_i)\bar{E}_i} &= \frac{\partial \log y_i}{\partial(1-\delta_i)\bar{E}_i} + \frac{\partial \log y_i}{\partial N_i}\frac{\partial N_i}{\partial(1-\delta_i)\bar{E}_i} \\
&\geq \frac{\partial \log y_i}{\partial(1-\delta_i)\bar{E}_i} + \frac{\partial \log y_i}{\partial N_i}\frac{N_i}{\sigma(1-\delta_i)\bar{E}_i} \\
&= \frac{(\sigma-1)^2(1-\delta_i)\bar{E}_i}{\sigma^3\left[\frac{\sigma-1}{\sigma}(1-\delta_i)\bar{E}_i+\frac{\alpha}{1+\alpha}N_i\right]\left[(1-\delta_i)\bar{E}_i+\frac{\alpha}{1+\alpha}N_i\right]} > 0,
\end{aligned} \tag{A19}$$

and so are the total number of employers

$$\begin{aligned}
\frac{dE_i}{\partial(1-\delta_i)\bar{E}_i} &= 1 + \frac{\alpha}{1+\alpha}\frac{\partial N_i}{\partial(1-\delta_i)\bar{E}_i} \\
&= \frac{(\sigma-1)\left[(\mu+\sigma-\mu\sigma)(1-\delta_i)^2\bar{E}_i^2+\left[2(1-\mu)\sigma+\frac{\mu}{\sigma}\right](1-\delta_i)\bar{E}_i\frac{\alpha}{1+\alpha}N_i+(1-\mu)(\sigma+1)\left(\frac{\alpha}{1+\alpha}\right)^2N_i^2\right]}{(\mu+\sigma-\mu\sigma)(\sigma-1)(1-\delta_i)^2\bar{E}_i^2+2(1-\mu)\sigma(\sigma-1)(1-\delta_i)\bar{E}_i\frac{\alpha}{1+\alpha}N_i+(1-\mu)\sigma^2\left(\frac{\alpha}{1+\alpha}\right)^2N_i^2} > 0,
\end{aligned} \tag{A20}$$

and the price of land

$$\begin{aligned}
\frac{d\log r_i}{d(1-\delta_i)\bar{E}_i} &= \frac{\partial \log r_i}{\partial(1-\delta_i)\bar{E}_i} + \frac{\partial \log r_i}{\partial N_i}\frac{\partial N_i}{\partial(1-\delta_i)\bar{E}_i} \\
&> \frac{\partial \log r_i}{\partial(1-\delta_i)\bar{E}_i} - \frac{\partial \log r_i}{\partial N_i}\frac{\frac{\alpha}{1+\alpha}N_i^2}{\sigma\left[(\sigma-1)(1-\delta_i)^2\bar{E}_i^2+2(\sigma-1)(1-\delta_i)\bar{E}_i\frac{\alpha}{1+\alpha}N_i+\sigma\left(\frac{\alpha}{1+\alpha}\right)^2N_i^2\right]} \\
&= \frac{\frac{\sigma-1}{\sigma}\left[(1-\delta_i)^2\bar{E}_i^2+\frac{(2\sigma-1)}{\sigma}(1-\delta_i)\bar{E}_i\frac{\alpha}{1+\alpha}N_i+\left(\frac{\alpha}{1+\alpha}\right)^2N_i^2\right]}{\left[(1-\delta_i)\bar{E}_i+\frac{\alpha}{1+\alpha}N_i\right]\left[(\sigma-1)(1-\delta_i)^2\bar{E}_i^2+2(\sigma-1)(1-\delta_i)\bar{E}_i\frac{\alpha}{1+\alpha}N_i+\sigma\left(\frac{\alpha}{1+\alpha}\right)^2N_i^2\right]} > 0.
\end{aligned} \tag{A21}$$

City population equals $\Lambda_i \equiv (1-\delta_i)\,\bar{E}_i + N_i$, which is increasing in $(1-\delta_i)\,\bar{E}_i$ if, but not only if,

$$\sigma^2 \geq \frac{1+\alpha}{\alpha} \geq 2 \Leftrightarrow \alpha \geq \frac{1}{\sigma^2-1}. \tag{A22}$$

The elasticity of endogenous entrepreneurship α increases the labour supply

$$\frac{\partial N_i}{\partial\frac{\alpha}{1+\alpha}} = -\frac{\partial\Omega/\partial\frac{\alpha}{1+\alpha}}{\partial\Omega/\partial N_i} > 0, \tag{A23}$$

and therefore population, as well as the total number of employers

$$\frac{dE_i}{d\frac{\alpha}{1+\alpha}} = N_i + \frac{\alpha}{1+\alpha}\frac{\partial N_i}{\partial\frac{\alpha}{1+\alpha}} > 0, \tag{A24}$$

land prices

$$\frac{d\log r_i}{d\frac{\alpha}{1+\alpha}} = \frac{\partial \log r_i}{\partial\frac{\alpha}{1+\alpha}} + \frac{\partial \log r_i}{\partial N_i}\frac{\partial N_i}{\partial\frac{\alpha}{1+\alpha}} > 0, \tag{A25}$$

and expected earnings

$$\frac{d\log y_i}{d\frac{\alpha}{1+\alpha}} = \frac{\partial \log y_i}{\partial\frac{\alpha}{1+\alpha}} + \frac{\partial \log y_i}{\partial N_i}\frac{\partial N_i}{\partial\frac{\alpha}{1+\alpha}} > 0, \tag{A26}$$

which can be verified with tedious but straightforward algebra.

In the limit case $\mu = 1$, the response of the labor supply simplifies to

$$\frac{\partial N_i}{\partial \delta_i} = -\frac{N_i}{\sigma \left(1 - \delta_i\right)} < 0, \tag{A27}$$

which yields for expected earnings

$$\frac{d^2 \log y_i}{d\delta_i d\alpha} = \frac{(\sigma-1)^2 (1-\delta_i) \bar{E}_i^2 \left[\frac{2\sigma-1}{\sigma}(1-\delta_i)\bar{E}_i + 2\frac{\alpha}{1+\alpha}N_i\right]}{(1+\alpha)^2 \sigma^3 \left[\frac{\sigma-1}{\sigma}(1-\delta_i)\bar{E}_i + \frac{\alpha}{1+\alpha}N_i\right]^2 \left[(1-\delta_i)\bar{E}_i + \frac{\alpha}{1+\alpha}N_i\right]^2} \left[N_i + \frac{\alpha}{1+\alpha}\frac{\partial N_i}{\partial \frac{\alpha}{1+\alpha}}\right] > 0 \ , \tag{A28}$$

for the number of employers

$$\frac{d^2 \log E_i}{d\delta_i d\alpha} = \frac{\left(\sigma - 1\right) \bar{E}_i}{\left(1 + \alpha\right)^2 \sigma \left[\left(1 - \delta_i\right) \bar{E}_i + \frac{\alpha}{1+\alpha} N_i\right]^2} \left[N_i + \frac{\alpha}{1 + \alpha} \frac{\partial N_i}{\partial \frac{\alpha}{1+\alpha}}\right] > 0, \tag{A29}$$

and for city population

$$\frac{d^2 \log \Lambda_i}{d\delta_i d\alpha} = \frac{\left(\sigma - 1\right) \bar{E}_i}{\sigma \left[\left(1 - \delta_i\right) \bar{E}_i + N_i\right]^2} \frac{\partial N_i}{\partial \frac{\alpha}{1+\alpha}} > 0. \tag{A30}$$

A.3. Proof of Proposition 3

Wages depend on the share of skilled workers according to

$$\frac{\partial \log w_i}{\partial h_i} = \frac{\left(\bar{\eta} - \underline{\eta}\right) N_i - \left(1 - \delta_i\right) H \bar{E}_i - \underline{\eta} H N_i}{\sigma \left(1 + h_i H\right) \left\{\left(1 - \delta_i\right) \bar{E}_i + \left[\underline{\eta} + h_i \left(\bar{\eta} - \underline{\eta}\right)\right] N_i\right\}}, \tag{A31}$$

so

$$\bar{\eta} \geq H \frac{\bar{E}_i}{N_i} + \left(1 + H\right) \underline{\eta} \Rightarrow \frac{\partial \log w_i}{\partial h_i} \geq 0 \text{ for all } \delta_i \in [0, 1], \tag{A32}$$

and

$$\bar{\eta} \leq \left(1 + H\right) \underline{\eta} \Rightarrow \frac{\partial \log w_i}{\partial h_i} \leq 0 \text{ for all } \delta_i \in [0, 1]. \tag{A33}$$

If $H\bar{E}_i/N_i + (1 + H)\underline{\eta} > \bar{\eta} > (1 + H)\underline{\eta}$, then

$$\frac{\partial \log w_i}{\partial h_i} = 0 \Leftrightarrow \delta_i = 1 - \frac{\bar{\eta} - \left(1 + H\right) \underline{\eta}}{H \bar{E}_i / N_i} \equiv \bar{\delta}_i, \tag{A34}$$

and wages are increasing in h_i for $\delta_i > \bar{\delta}_i$ and decreasing in h_i for $\delta_i < \bar{\delta}_i$.

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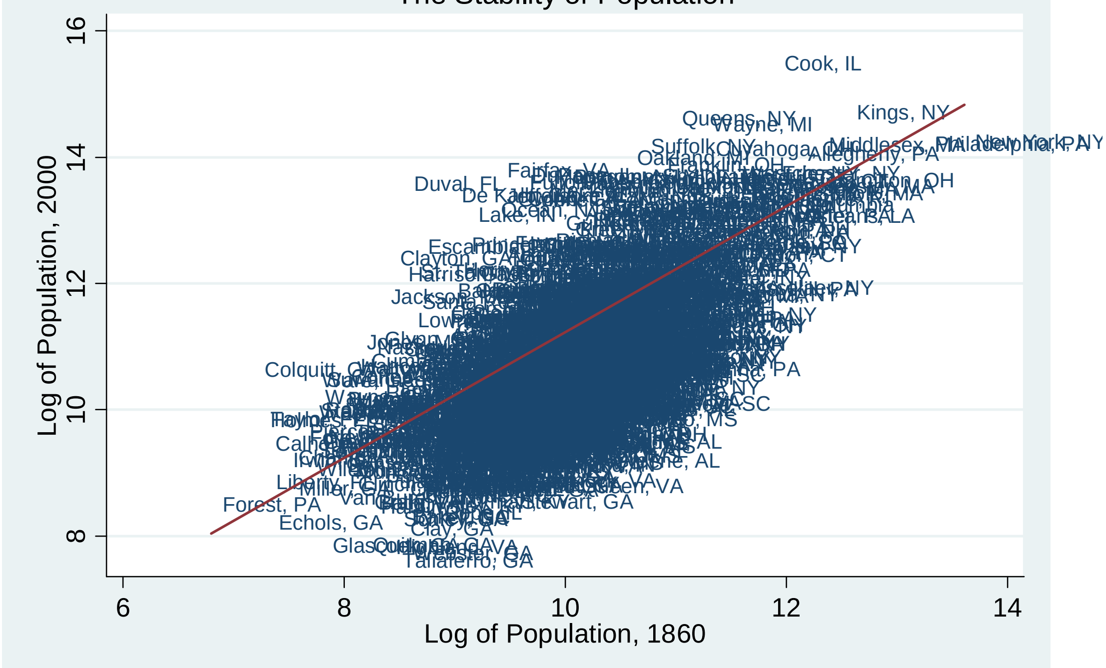
Figure 1
The Stability of Population



Source: County-level U.S. Census data from ICPSR 2896 - Historical, Demographic, Economic, and Social Data: The United States, 1790-2000.

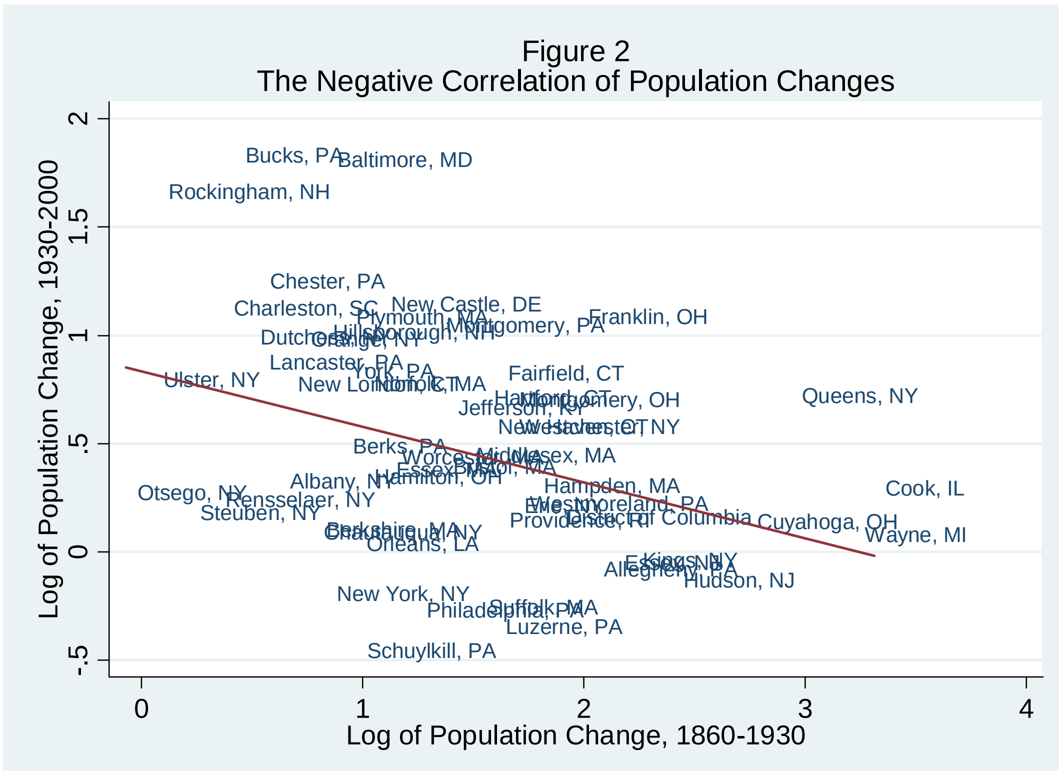
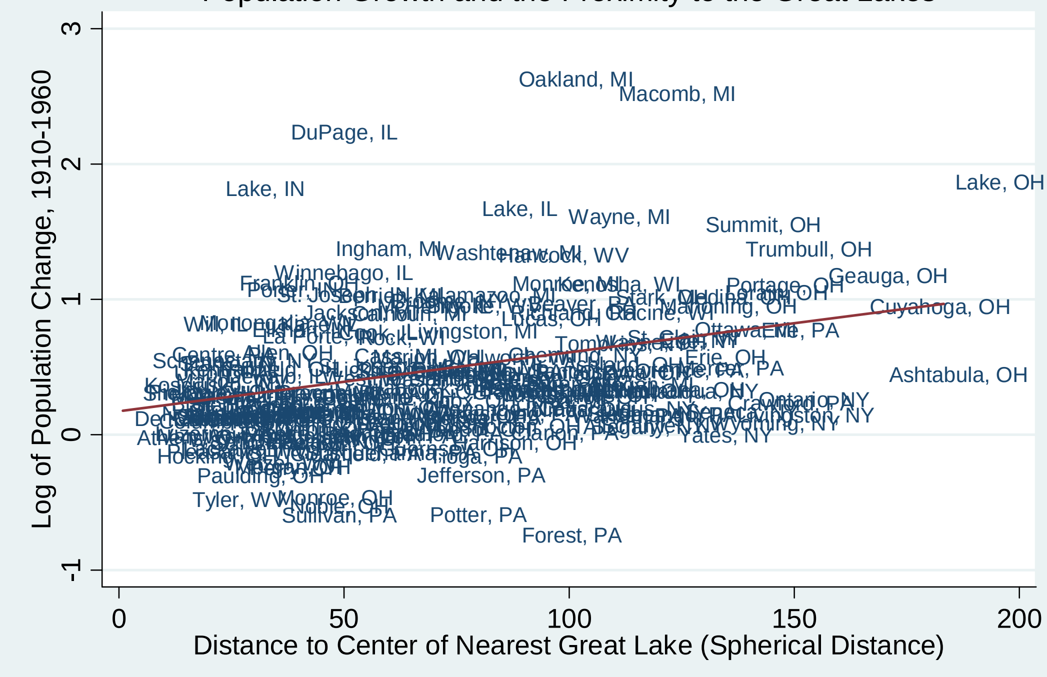


Figure 2
The Negative Correlation of Population Changes

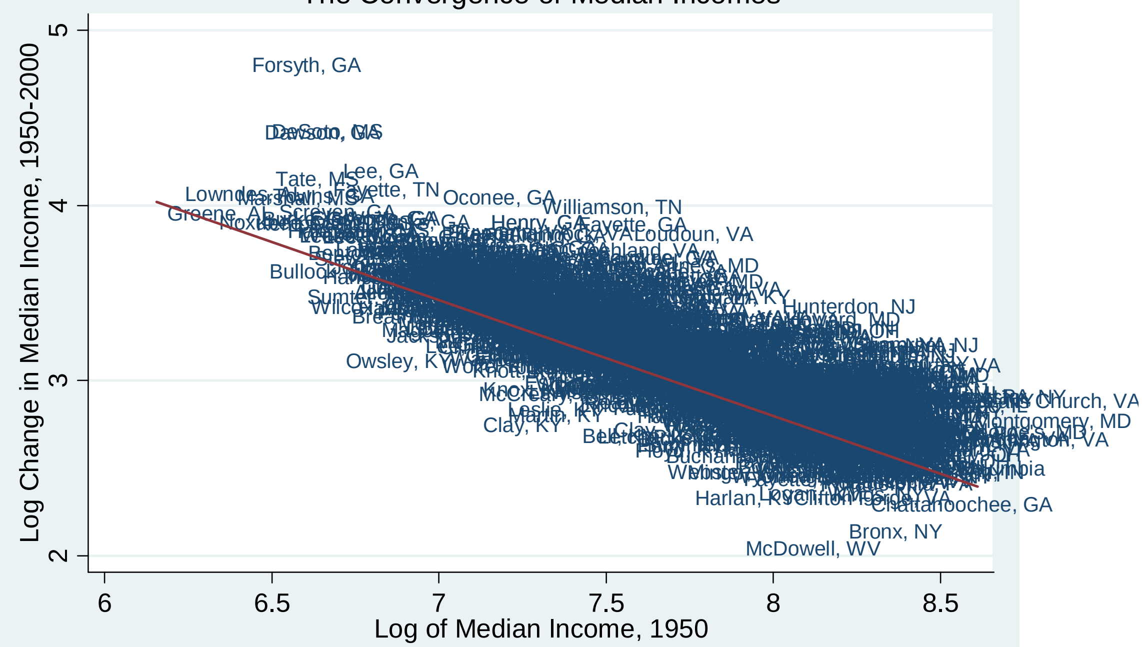
Note: Figure shows the 54 counties that had more than 50,000 people in 1860.
Source: County-level U.S. Census data from ICPSR 2896 - Historical, Demographic, Economic, and Social Data: The United States, 1790-2000.

Figure 3
Population Growth and the Proximity to the Great Lakes

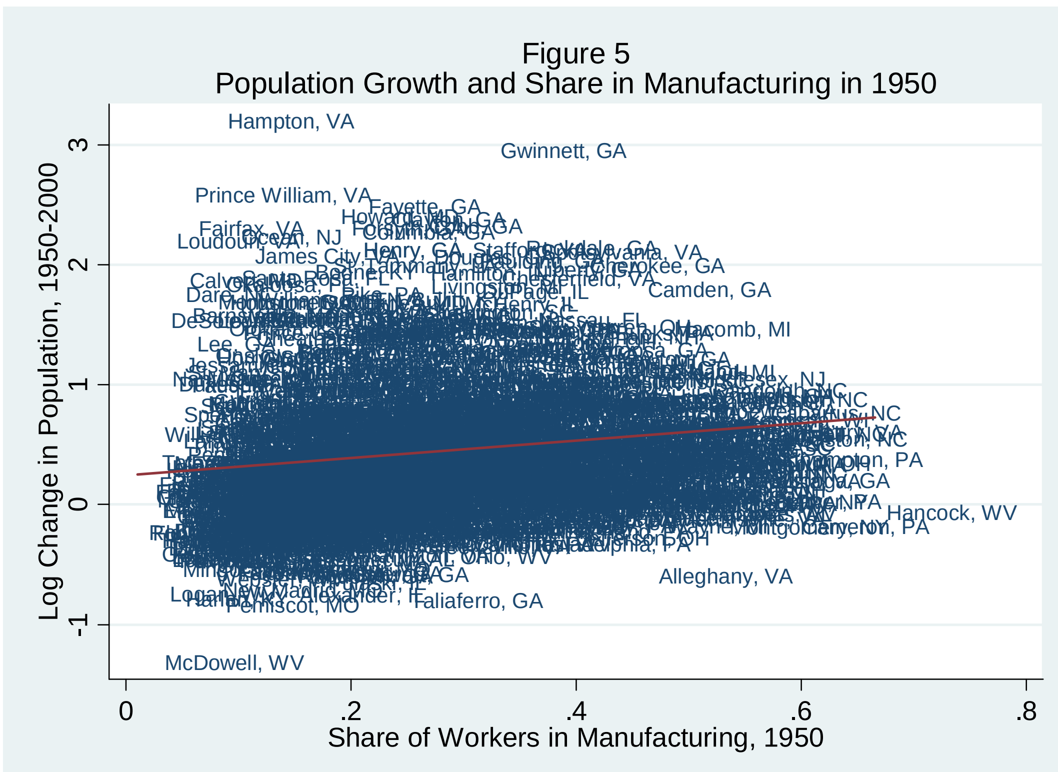


Note: Figure shows the counties that are within 200 miles of a Great Lake.
Source: County-level U.S. Census data from ICPSR 2896 - Historical, Demographic, Economic, and Social Data: The United States, 1790-2000.

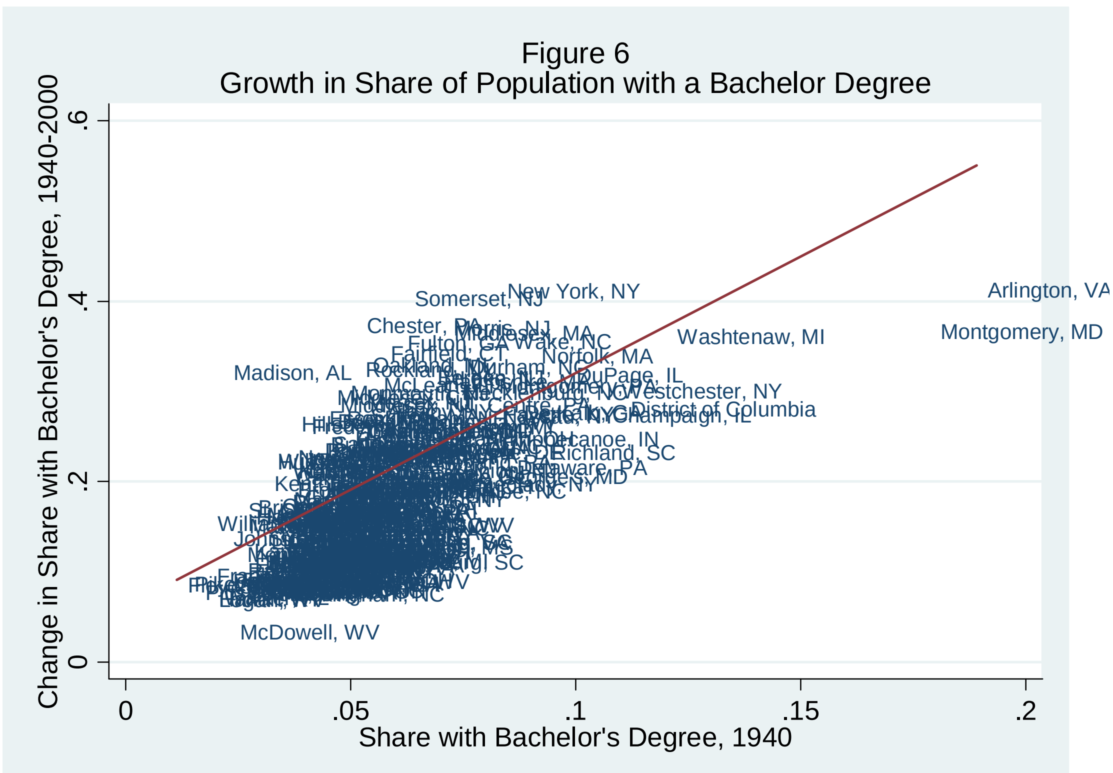
Figure 4
The Convergence of Median Incomes



Source: County-level U.S. Census data from ICPSR 2896 - Historical, Demographic, Economic, and Social Data: The United States, 1790-2000.



Source: County-level U.S. Census data from ICPSR 2896 - Historical, Demographic, Economic, and Social Data: The United States, 1790-2000.

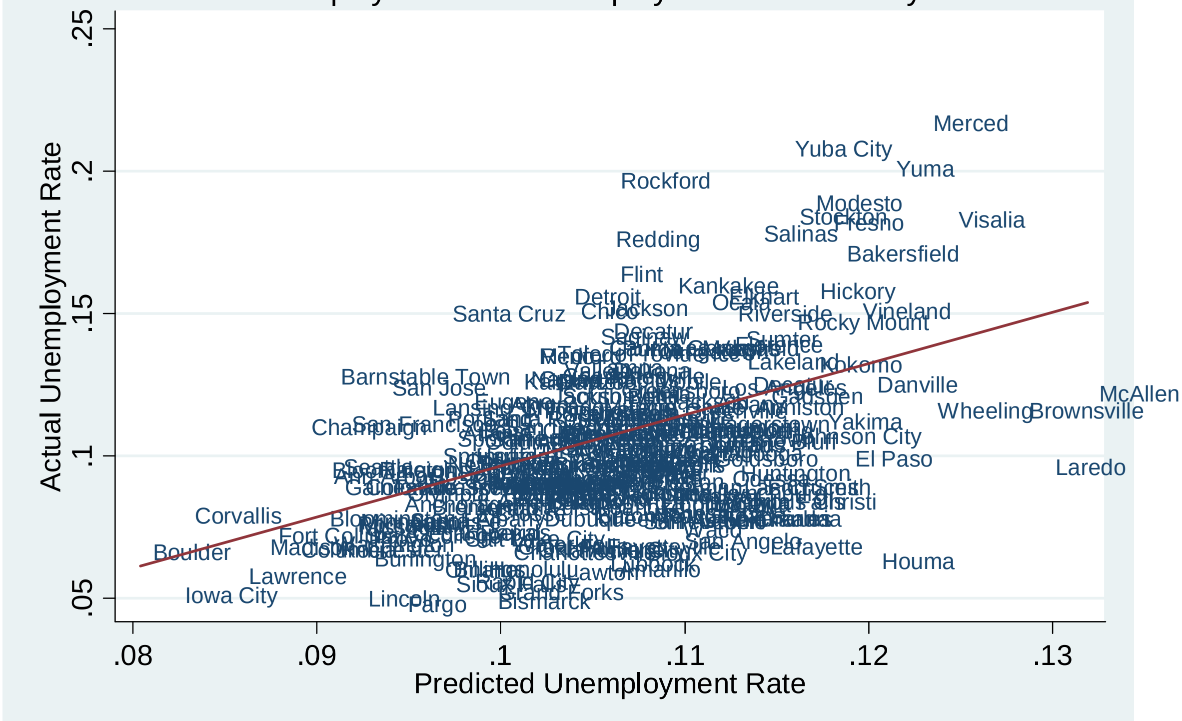


Note: Figure shows the counties that had more than 50,000 people in 1940.
Source: County-level U.S. Census data from ICPSR 2896 - Historical, Demographic, Economic, and Social Data: The United States, 1790-2000.

Figure 7
Unemployment in January 2010 and Education in 2000

Source: Metropolitan Statistical Area level data from the U.S. Census.

Figure 8
Actual Unemployment and Unemployment Predicted by Education



Source: Metropolitan Statistical Area level data from the U.S. Census, and Actual Unemployment Rate from the U.S. Department of Labor, Bureau of Labor Statistics.

Table 1:
Population Growth Correlations

Decades	(1) Correlation with Lagged Population Change	(2) Correlation with Lagged Population Change (50,000+)	(3) Correlation with Initial Log Population	(4) Correlation with Initial Log Population (50,000+)
1790s	.	.	-0.4681	-0.9505
1800s	0.3832	0.6462	-0.5625	0.1316
1810s	0.3256	0.4766	-0.5674	-0.0463
1820s	0.4423	0.5231	-0.5136	0.4178
1830s	0.4452	0.9261	-0.6616	0.241
1840s	0.4634	0.8978	-0.5122	0.3922
1850s	0.4715	0.7661	-0.319	-0.0392
1860s	0.3985	0.4631	0.0111	0.0065
1870s	-0.1228	0.4865	-0.3614	-0.0205
1880s	0.3978	0.4541	-0.1252	0.3323
1890s	0.4935	0.5382	-0.1181	0.3691
1900s	0.4149	0.6454	0.1754	0.2947
1910s	0.5027	0.5778	0.2747	0.0903
1920s	0.476	0.4675	0.3381	0.1494
1930s	0.3005	0.4887	0.0415	-0.1585
1940s	0.4151	0.6752	0.3863	-0.0649
1950s	0.7397	0.7327	0.3985	0.0444
1960s	0.7225	0.8196	0.2922	0.0311
1970s	0.3821	0.4349	-0.2247	-0.4462
1980s	0.641	0.7096	0.1062	-0.0693
1990s	0.737	0.7863	-0.0197	-0.157

Source: County level data from ICPSR 2896 - Historical, Demographic, Economic, and Social Data: The United States, 1790-2000.

Table 2: Geography Correlation Tables

	(1)	(2)	(3)
Decades	**Correlation with Longitude**	**Correlation with Proximity to Great Lake**	**Correlation with January Temperature**
1790s	-0.2646	0.3746	-0.0008
1800s	-0.4368	0.4307	-0.226
1810s	-0.3496	0.4473	-0.1891
1820s	-0.2857	0.3053	-0.1514
1830s	-0.3304	0.2631	-0.2676
1840s	-0.3414	0.1442	-0.2424
1850s	-0.3145	0.0703	-0.3466
1860s	-0.1495	0.1028	-0.3229
1870s	-0.046	-0.1188	0.2575
1880s	-0.0256	-0.0336	0.1571
1890s	-0.1145	-0.0771	0.2273
1900s	0.1159	0.0153	0.1339
1910s	0.1448	0.1185	-0.005
1920s	0.1733	0.1182	-0.0802
1930s	-0.0144	-0.0462	0.0379
1940s	0.2431	0.1665	-0.13
1950s	0.2401	0.2075	-0.1843
1960s	0.1313	0.0915	-0.1062
1970s	-0.0435	-0.163	0.2088
1980s	0.1974	-0.1107	0.2243
1990s	-0.0027	-0.1567	0.2702

Sources: County level data from ICPSR 2896 - Historical, Demographic, Economic, and Social Data: The United States, 1790-2000. Geographical information from ESRI GIS data.

Table 3:
Population Growth Regressions

	Change in Population					
	(1) *1800-1830*	(2) *1830-1860*	(3) *1870-1900*	(4) *1900-1930*	(5) *1940-1970*	(6) *1970-2000*
Average January Temperature	-0.025	-0.033	0.008	0.007	-0.002	0.009
	(0.003)**	(0.003)**	(0.001)**	(0.001)**	(0.002)	(0.001)**
Distance to Center of Nearest Great Lake	0.008	0.004	0.001	0.001	0.002	-0.001
	(0.001)**	(0.001)**	(0.000)*	(0.000)**	(0.000)**	(0.000)
Longitude	-0.038	-0.005	-0.000	0.011	0.017	0.008
	(0.005)**	(0.005)	(0.002)	(0.002)**	(0.003)**	(0.002)**
Log of Population, 1800	-0.255					
	(0.025)**					
Log of Population, 1830		-0.551				
		(0.021)**				
Log of Population, 1870			-0.126			
			(0.014)**			
Log of Population, 1900				0.125		
				(0.013)**		
Log of Population, 1940					0.103	
					(0.012)**	
Log of Population, 1970						-0.021
						(0.008)**
Constant	0.628	6.320	1.379	-0.407	0.523	0.872
	(0.57)	(0.505)**	(0.268)**	(0.263)	(0.28)	(0.213)**
Observations	368	788	1210	1276	1324	1338
R-squared	0.63	0.60	0.14	0.11	0.13	0.09

Note: Standard Errors in parenthesis (* significant at 5%; ** significant at 1%).
Sources: County level data from ICPSR 2896 - Historical, Demographic, Economic, and Social Data: The United States, 1790-2000. Geographical information from ESRI GIS data.

Table 4: Income Growth Correlations

Decades	(1) Correlation with January Temperature	(2) Correlation with Lagged Income	(3) Correlation with Lagged Income Growth	(4) Correlation with Share Manuf. In 1950
1950s	0.4023	-0.5692		-0.1215
1960s	0.4807	-0.7732	0.2888	-0.4119
1970s	0.3107	-0.6857	0.3303	-0.4911
1980s	0.1842	0.0904	-0.2839	0.086
1990s	0.07	-0.3492	-0.1966	-0.271

Source: County level data from ICPSR 2896 - Historical, Demographic, Economic, and Social Data: The United States, 1790-2000.

Table 5: Education Correlations

Decades	(1) Population Correlation with Lagged BA Share	(2) Income Correlation with Lagged BA Share	(3) Population Correlation with Lagged BA Share (100,000+)	(4) Income Correlation with Lagged BA Share (100,000+)
1940s	0.5904		0.3332	
1950s	0.482	-0.2517	0.3634	0.0291
1960s	0.3758	-0.3864	0.346	0.1586
1970s	-0.0961	-0.369	0.1122	-0.0391
1980s	0.3194	0.3564	0.3908	0.4739
1990s	0.1269	-0.2334	0.2396	-0.1017

Source: County level data from ICPSR 2896 - Historical, Demographic, Economic, and Social Data: The United States, 1790-2000.

Table 6: Income and Population Growth Regressions, 1950-2000

	Income Growth	*Population Growth*
Share of Workers in Manufacturing, 1950	0.3025	0.5597
	(0.05)	(0.1369)
Log of Population, 1950	-0.0868	-0.2817
	(0.0139)	(0.0381)
Mean January Temperature	-0.0003	0.0198
	(0.0008)	(0.0022)
Longitude	0.0048	0.0107
	(0.0012)	(0.0032)
Distance to Center of Nearest Great Lake	-0.0009	-0.0007
	(0.0002)	(0.0006)
Share with Bachelor Degrees, 1950	2.5141	4.3104
	(0.3098)	(0.8479)
Log of Population/Bachelor Degree Interaction, 1!	1.1749	2.7005
	(0.2127)	(0.5822)
Log of Median Income, 1950	-0.7392	0.4600
	(0.0221)	(0.0605)
Constant	8.8912	-3.2321
	(0.2083)	(0.57)
Observations	1328	1328
R-squared	0.7476	0.1833

Sources: County level data from ICPSR 2896 - Historical, Demographic, Economic, and Social Data: The United States, 1790-2000. Geographical information from ESRI GIS data.

Table 7: Education and Firm Size Correlations with Population Growth

	(1)	(2)	(3)	(4)
Decades	**Correlation with Share of BAs in 1940**	**Correlation with Share of BAs in 1940 (50,000+)**	**Correlation with avg. est. size 1977**	**Correlation with avg. est. size 1977 (50,000+)**
1790s	0.0105	-0.309	0.1152	0.2688
1800s	-0.1012	0.3758	0.0627	0.7698
1810s	-0.096	-0.2574	0.0142	0.391
1820s	-0.0543	0.3583	0.1338	0.7404
1830s	-0.0102	0.5014	0.093	0.7733
1840s	-0.008	0.381	0.113	0.5929
1850s	0.0208	0.1145	0.0651	0.0149
1860s	0.1457	0.0671	0.0779	0.2524
1870s	-0.1386	-0.0157	0.0134	0.2407
1880s	0.0079	0.1089	0.1676	0.3557
1890s	-0.1269	0.0522	0.0751	0.2893
1900s	0.1711	0.2133	0.222	0.2529
1910s	0.2265	0.1866	0.3172	0.3638
1920s	0.4162	0.3581	0.3476	0.2414
1930s	0.2304	0.3216	0.1594	0.0225
1940s	0.5904	0.5613	0.3336	0.1356
1950s	0.4953	0.3619	0.2273	0.0286
1960s	0.383	0.3298	0.1259	-0.0974
1970s	-0.1614	-0.1199	-0.1786	-0.353
1980s	0.1129	0.0806	-0.0862	-0.3212
1990s	-0.0878	-0.1116	-0.1715	-0.2893

Source: County level data from ICPSR 2896 - Historical, Demographic, Economic, and Social Data: The United States, 1790-2000.

Table 8: Income and Population Growth Regressions, 1980-2000

	Log Change in Population, 1980-2000		*Log Change in Median Income, 1980-2000*	
	(1)	(2)	(3)	(4)
	Full Sample	*Counties with 50,000+*	*Full Sample*	*Counties with 50,000+*
Share of Workers in Manufacturing, 1980	0.338	0.600	0.390	0.434
	(0.063)**	(0.117)**	(0.031)**	(0.052)**
Log of Population, 1980	-0.017	-0.039	0.001	0.008
	(0.007)*	(0.013)**	(0.003)	(0.006)
Share with Bachelor's Degree, 1980	0.493	0.830	0.966	0.846
	(0.145)**	(0.188)**	(0.071)**	(0.084)**
Distance to Center of Nearest Great Lake	0.000	0.000	0.000	0.000
	(0.000)*	(0.000)**	(0.000)**	(0.000)**
Average Establishment Size, 1977	-0.016	-0.022	-0.011	-0.012
	(0.002)**	(0.003)**	(0.001)**	(0.001)**
Log of Median Income, 1980	0.519	0.646	-0.065	0.062
	(0.039)**	(0.071)**	(0.019)**	(0.032)
Longitude	0.005	0.001	0.006	0.007
	(0.002)**	(0.002)	(0.001)**	(0.001)**
Mean January Temperature	0.010	0.009	-0.003	-0.004
	(0.002)**	(0.002)**	(0.001)**	(0.001)**
Constant	-4.629	-6.027	1.982	0.737
	(0.382)**	(0.663)**	(0.187)**	(0.297)*
Observations	1336	444	1336	444
R-squared	0.28	0.45	0.31	0.52

Note: Standard Errors in parenthesis (* significant at 5%; ** significant at 1%).

Sources: County level data from ICPSR 2896 - Historical, Demographic, Economic, and Social Data: The United States, 1790-2000. Geographical information from ESRI GIS data. Average establishment size in 1977 from County Business Patterns.

Table 9:
Metropolitan Area Level Regressions

	Log Change in Population, 1970-2000		*Log Change in Median Income in 2000 $, 1970-2000*		*Log Change in Median Housing Value in 2000 1970-2000*	
	(1)	(2)	(3)	(4)	(5)	(6)
Log population, 1970	-0.007	-0.007	0.003	0.003	0.056	0.057
	(0.019)	(0.019)	(0.006)	(0.006)	(0.013)**	(0.013)*
Log Median Income in 2000 $, 1970	-0.769	-0.841	-0.391	-0.403	-0.297	-0.328
	(0.191)**	(0.191)**	(0.061)**	(0.062)**	(0.133)*	(0.135)*
Log Median Housing Value in 2000 $, 1970	0.273	0.272	0.173	0.174	-0.008	0.004
	(0.117)*	(0.115)*	(0.037)**	(0.038)**	(0.081)	(0.082)
South Dummy	0.146	-0.133	0.030	0.015	0.028	0.012
	(0.054)**	(0.122)	(0.017)	(0.040)	(0.038)	(0.087)
East Dummy	-0.054	-0.077	-0.010	-0.039	0.054	0.041
	(0.057)	(0.158)	(0.018)	(0.052)	(0.040)	(0.112)
West Dummy	0.384	0.632	-0.044	-0.145	0.299	0.052
	(0.051)**	(0.135)**	(0.016)**	(0.044)**	(0.035)**	(0.096)
College completion among population 25 or above, 1970	1.528		0.797		0.802	
	(0.445)**		(0.142)**		(0.310)*	
South Dummy * Percent BA in 1970		3.840		0.673		0.405
		(0.772)**		(0.252)**		(0.548)
East Dummy * Percent BA in 1970		1.498		0.839		0.424
		(1.310)		(0.428)		(0.929)
West Dummy * Percent BA in 1970		-0.573		1.364		2.257
		(0.812)		(0.265)**		(0.576)*
Midwest Dummy * Percent BA in 1970		1.314		0.583		0.363
		(0.597)*		(0.195)**		(0.424)
Constant	5.264	6.074	2.275	2.407	2.801	3.040
	(1.576)**	(1.595)**	(0.504)**	(0.521)**	(1.100)*	(1.132)*
Observations	257	257	257	257	257	257
R-squared	0.43	0.47	0.38	0.40	0.34	0.36

Note: Standard Errors in parenthesis (* significant at 5%; ** significant at 1%).
Source: Metropolitan Statistical Area data from the US Census.

Table 10:
Individual Level Regressions

	Log Real Wage in $ 2000						*Log Real Housing Value in $2000*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
% of Pop 25+ with a BA (1970), MSA, year 2000 dummy*	0.557	0.472					3.339	
	(0.195)**	(0.121)**					(1.278)**	
*% of Pop 25+ with a BA (1970), Industry, * year 2000 dummy*			0.089					
			(0.016)**					
*% of Pop 25+ with a BA (1970), Industry-MSA, * year 2000 dummy*				0.028	0.002			
				(0.008)**	(0.009)			
Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects Detail	MSAs	MSAs and Industry	MSA-Year and Industry	MSA-Year and Industry	MSA-Year and Industry-Year	MSAs	MSAs	MSAs
*% of Pop 25+ with a BA (1970), MSA, * year 2000 dummy * Northeast dummy*						0.788		1.649
						(0.285)**		(0.738)*
*% of Pop 25+ with a BA (1970), MSA, * year 2000 dummy * Midwest dummy*						0.599		0.435
						(0.289)*		(0.690)
*% of Pop 25+ with a BA (1970), MSA, * year 2000 dummy * South dummy*						0.631		1.246
						(0.188)**		(0.632)*
*% of Pop 25+ with a BA (1970), MSA, * year 2000 dummy * West dummy*						0.589		3.734
						(0.224)**		(0.664)**
Constant	10.400	7.254	7.952	7.426	8.783	10.634	10.843	10.853
	(0.017)**	(0.286)**	(0.307)**	(0.313)**	(0.344)**	(0.019)**	(0.063)**	(0.062)**
Observations	402490	402490	377891	364266	364266	402490	426295	426295
R-squared	0.33	0.38	0.38	0.38	0.39	0.33	0.36	0.36

Notes:

(1) Robust standard errors in parentheses. Standard errors clustered by MSA, Industry, and Year (1)-(5) or MSA-Year (6)-(8)

(2) Wage regressions data only for males 25-55, who are in the labor force, who worked 35 or more hours per week and 40 or more weeks per year, and who earned over a certain salary (equal or more than if they had worked half-time at minimum wage).

(3) Individual-level data (wages, housing prices, and controls) from IPUMS

(4) MSA-level data (baPct1970 in MSA, Population, Log of Real Housing Value, and Log of Real Income) from aggregate level Census data.

(5) Wage regressions includes controls for individual education, age, and race, as well as the interaction of those variables with a dummy variable for year 2000. Housing regressions include housing quality controls as well as the interaction of those variables with a dummy variable for year 2000.

(6) Industry and Industry-MSA BA Shares calculated using IPUMS data.

(7) Includes controls for initial (1970) values for population, median income, and median housing value interacted with a year 2000 dummy.

Table 11: Estimated Coefficients

	MSA-level Coefficients			***Individual-level Coefficients***		
	β_i^E	β_i^θ	$\beta_i^{\bar{L}}$	β_i^E	β_i^θ	$\beta_i^{\bar{L}}$
Nation	4.716	-0.556	1.523	3.757	0.444	-1.253
	(0.8462)	(0.1058)	(0.5155)	(0.2384)	(0.0543)	(0.0625)
East	4.855	-0.712	1.913	4.650	-0.293	0.638
	(2.857)	(0.3348)	(1.3959)	(0.4088)	(0.1163)	(0.1656)
Midwest	3.647	-0.475	1.534	3.711	-0.469	1.478
	(1.04)	(0.1464)	(0.499)	(0.3372)	(0.0795)	(0.0955)
South	6.531	-0.552	4.108	6.366	-0.258	3.225
	(1.6537)	(0.2009)	(0.8856)	(0.3037)	(0.075)	(0.091)
West	4.883	-0.687	-1.466	1.785	0.531	-3.717
	(1.8953)	(0.2167)	(1.1022)	(0.3553)	(0.0929)	(0.1267)

Notes:
(1) MSA-level coefficients are from Table 9, and Individual-level coefficients are from Table 10.
(2) Values used were s =4 and μ=.7. See Section V for formulas.