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The Relationship between City Center Density and Urban Growth or Decline

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In this paper we contrast the spatial patterns of population density and other demographic changes in growing versus shrinking MSAs from 1980 to 2010. We find that, on average, shrinking MSAs show the steepest drop in population density near the Central Business District (CBD). Motivated by this fact, we explore the connection between changes in population density at the core of the MSA and MSA productivity. We find that changes in near-CBD population density are positively associated with per capita income growth at the MSA-level.

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Introduction

One striking characteristic of shrinking MSAs, such as Detroit and Cleveland, is the amount of vacant land and number of abandoned buildings in close proximity to the Central Business Districts (CBDs) of their central cities. This lies in stark contrast to growing MSAs, such as New York City, Chicago, San Francisco, or Boston. Yet, in many shrinking MSAs, as in Detroit and Cleveland, one can find suburbs that do not show the same signs of decline as can be seen within the city limits of the central city. The spatial patterns of population decline observed in Detroit and Cleveland are typical of MSAs that experience net population loss: of the 345 Metropolitan Statistical Areas (MSAs) we studied, the thirty-six MSAs that experienced population loss from 1980 to 2010 showed, on average, the steepest drop in population density in areas close to the CBD.

This paper compares demographic changes within growing cities to those within declining cities and explores the relationship between population density near the CBD and MSA-level income growth. We assemble a constant MSA boundary and constant census tract boundary data set for the years 1980, 1990, 2000, and 2010 and perform the first part of our analysis, documenting how population density and other demographic variables evolved as a function of distance to the CBD in growing versus shrinking MSAs. In the second part of our analysis, we construct MSA-level variables by summing and taking weighted means of the tract-level data to aggregate the variables of interest to MSA-level variables. We find that from 1980 to 2010, changes in population density near the CBD are positively associated with MSA-level income growth, while controlling for changes in population density for the MSA as a whole and initial characteristics of the MSA. This result points to a connection between MSA-level productivity growth and changes in population density near the CBD.

The first part of our analysis, which looks at within-MSA changes in population density and demographics in shrinking and growing cities, relates to a large body of literature on urban growth and suburbanization. Several examples include Rappaport (2003), Glaeser and Kahn (2001), Boustan and Shertzer (2010), and Baum-Snow (2007). Our work also relates to a set of recent papers that examine spatial patterns within cities such as Guerrieri, Hartley and Hurst (2011), Glaeser, Gottlieb and Tobio (2012), and Guerrieri, Hartley and Hurst (2012).

The second part of our analysis concerns the question of whether the drop in population density that we observe in shrinking cities might act to reinforce the negative shock that is the root cause of the MSA's decline. This question is related to a large body of literature on economies of agglomeration.[2] As Elvery and Sveikauskas (2010) point out, much of the recent empirical evidence on agglomeration points toward agglomeration effects that are present at short distances.[3] These short distance effects point in the direction of the importance of the exchange and diffusion of ideas as opposed to benefits purely driven by forces that are likely to operate at greater distances, such as labor market pooling and supply linkages. A dense CBD may serve as a coordination mechanism by guiding people and firms to a place where these exchanges are most likely to happen. While poly-centric MSAs may provide this as well, it

[2] For recent reviews of this literature see Duranton and Puga (2004), Rosenthal and Strange (2004), and Puga (2010).

[3] Rosenthal and Strange (2003), van Soest, Gerking, and van Oort (2006), Fu (2007), Arzaghi and Henderson (2008) are examples of this work. Elvery and Sveikauskas (2010) find the strongest agglomeration effects at longer distances (ten, twenty, or twenty-five miles), but also show that short distance effects (within two-and-a-half miles) tend to be stronger when the workforce is more educated and belonging to similar occupational categories, suggesting the importance of the exchange of ideas for short distance agglomerative effects.

seems plausible that having many diffuse areas of economic activity would make it harder for these informational spillovers to occur.

Given the importance of short distance agglomeration effects, we run OLS regressions of growth in MSA-level income on changes in population density near the CBD and changes in population density for the entire CBD and a host of initial-year MSA-level controls. We find that increases in population density near the CBD are associated with higher MSA-level income growth while increases in population density for the entire MSA are associated with lower income growth. This evidence points to a connection between density near the CBD and agglomerative benefits.

Methodology

In order to take a detailed look at within-MSA changes in population density and other demographics, we use the Neighborhood Change Database (NCDB) in conjunction with the Longitudinal Tract Database (LTDB) to construct measures of population and demographic variables for the years 1980, 1990, 2000, and 2010 that conform to 2010 census tract boundaries, and 2008 MSA boundaries. The use of constant geographical boundaries is especially important when considering growing MSAs, which may appear to lose population density as less populated counties farther from the CBD are developed and become part of the MSA.

For each MSA or Metropolitan Division (in cases when an MSA is broken into Metropolitan Divisions we use the Metropolitan Divisions rather than the entire MSA) we identify the latitude and longitude of the Central Business District (CBD) by taking the collection of census tracts listed in the 1982 Census of Retail Trade[4] for the central city of the MSA (the

[4] Available here: http://www.census.gov/geo/tiger/cbdct.pdf

city in the MSA with the largest population) and finding the centroid of that cluster of census tracts. We identify the CBD latitude and longitude for 268 MSAs in this manner. For the remaining 117 MSAs, whose central city was not listed in the 1982 Census of Retail Trade, we use the latitude and longitude found by geocoding the MSA's central city found using ArcGIS's 10.0 North American Geocoding Service. ArcGIS returns points that are, on average, very close to the CBDs from the Census of Retail Trade; for the 268 cities for which we have both, the mean distance between the two is 0.39 miles. One of the MSAs with the largest distances between the two is New York City, for which The Census of Retail Trade CBD corresponds to midtown, while ArcGIS returns a point in Lower Manhattan (on Chambers halfway between Broadway and Church). When calculating distance to CBD, we calculate the distance from the centroid of each 2010 census tract in the MSA to our central city CBD point.

Our sample consists of all census tracts in the continental United States that were part of a MSA in 2008 and that were fully covered by census tracts in 1980. To construct our sample, we start with the Neighborhood Change Database (NCDB) produced by Geolytics. The NCDB provides census tract level summary variables similar to those that can be found in US Census tract level summary files for 1980, 1990, and 2000. The benefit of the NCDB is that the data from years prior to 2000 (1970, 1980, and 1990) have been normalized to the year 2000 tract boundaries. Dropping observations associated with MSAs that were not completely covered by census tracts in 1980 eliminates 1,776 tracts (about 3.4 percent of the total); we begin with 1980 rather than 1970 because if we began in 1970 and dropped observations associated with MSAs that were not percent covered by census tracts in 1970, we would have had to drop about 15 percent of the sample.

Next, we convert the 1980, 1990, and 2000 tract level tabulation variables to Census 2010 tract boundaries using the 2000 to 2010 tract conversion tool discussed in Logan, Xu, and Stults (2012).[5] The conversion tool uses population and land area weighting to reweight count or mean variables to adjust for census tracts that have changed from 2000 to 2010. After converting the NCDB data to 2010 tract boundaries, we merge it with census tract population, race, and age tabulations from the 2010 census and education, income, and poverty rate census tract estimates from the 2006 – 2010 American Community Surveys (ACS). We limit our sample to 345 MSAs in the continental United States for which we have at least ten census tracts. Our final sample contains a set of consistently defined variables for 1980, 1990, 2000, and 2010 for 57,403 consistently defined census tracts in 345 MSAs. It is important to note that our MSAs are defined using the 2008 MSA definitions and the boundaries we use do not change over time.

The Relationship between Growth and City Center Density and Other Demographics

We break our sample of 345 MSAs into three groups. The first group consists of the 36 MSAs that lost population between 1980 and 2010 (see Table 1 for the list of these MSAs), the second group consists of the 272 MSAs with population growth between 0 and 100 percent from 1980 to 2010, and the third group consists of the 37 MSAs whose populations grew in excess of 100 percent over the same period (see Table 2 for the list of these MSAs). We refer to these groups as shrinking, moderate growth, and fast growth MSAs, respectively, throughout the chapter.

We find that shrinking MSAs display markedly different patterns in population density and demographic changes near their CBDs compared to the moderate and fast growth MSAs. In

[5]Available here: http://www.s4.brown.edu/us2010/Researcher/Bridging.htm.

particular, from 1980 to 2010, shrinking MSAs lost about a third of their population density near the CBD, on average. In contrast, moderate growth and fast growth MSAs had slight gains in population density near the CBD. In conjunction with the loss of population density, compared to growing MSAs, tracts near the CBD in shrinking cities also experienced smaller gains in educational attainment, less growth in average household income, greater increases in poverty rates, and an increase in the fraction of the population that is African American.

Figure 1 presents plots of locally weighted mean population densities (census tract population per square mile) in 1980 and 2010. In each plot (and in all subsequent figures), the line with short dashes indicates the mean for the group of shrinking MSAs, the solid line indicates the mean for the group of moderate growth MSAs, and the line with long dashes and dots indicates the mean for the group of fast growth MSAs.

Figure 2 shows mean changes in population density for each of the three groups of MSAs. The figure displays plots of population changes for 1980-1990, 1990-2000, 2000-2010, and for the entire period: 1980-2010.

A number of features of these plots are worth noting. First, in each decade, and as a result for the period as a whole, population density in the group of shrinking MSAs fell the most near the CBD, and fell very little or not at all 30 miles away from the CBD. In contrast, population density in moderate growth cities grew slightly at all distances from the CBD, and population density of fast growth MSAs grew the most ten to fifteen miles from the CBD. Second, while the shrinking MSAs were higher density than the growing MSAs in 1980, by 2010 growing and shrinking MSAs have very similar density versus distance to CBD profiles. Third, while the 1980s and 2000s saw big drops in center city density for shrinking cities, the 1990s also saw a drop in density near the CBD for shrinking MSAs in the 1990s, but it was smaller.

Given the marked differences in density changes, we next investigate how the spatial patterns have changed for a series of variables related to urban growth literature. Figure 3 contains a different variable in each column. The left column shows the fraction of the population with a Bachelor's or higher degree in 1980, in 2010, and the change in that fraction from 1980 to 2010. The right column shows the fraction of the population aged twenty-five to thirty-four for the same time period.

Several interesting features stand out in the education plots. First, in 1980, the group of MSAs that subsequently shrink already have much lower levels of educational attainment at all distances than the MSAs that subsequently grow. This is particularly true at distances within five miles of the CBD. By 2010, educational attainment in the moderate growth cities was the highest of the three groups at most distances. It is also interesting that between five and fifteen miles from the CBD, educational attainment in the shrinking cities caught up with that of the fast growing cities by 2010. However, at distances farther than fifteen miles from the CBD and also between zero and five miles of the CBD, the growing MSAs had higher educational attainment in 2010 than the shrinking MSAs. In fact, near the CBD, the gap in educational attainment between the shrinking and growing MSAs widened from about ten percentage points in 1980 to about fifteen percentage points in 2010 as shrinking MSAs only saw increases of ten percentage points near the CBD compared to increases of roughly seventeen percentage points for both types of growing MSAs.

The right column of Figure 3 shows how the fraction of the population aged twenty-five to thirty-four varies with distance to the CBD in 1980, in 2010, and how that has changed from 1980 to 2010. The plots for 1980 and 2010 reveal a gap near the CBD between the growing and shrinking MSAs in the fraction of people aged twenty-five to thirty-four. This gap stayed fairly constant between 1980 and 2010. The striking feature of the plots is that in all three groups of MSAs, the fraction of the population aged twenty-five to thirty-four has fallen more in tracts that are farther from the CBD.

Figure 4 shows the log of mean household income (real, in terms of 2010 dollars) in the right column and the poverty rate in the left column. Average household income and poverty rates were similar in the three groups of MSAs in 1980. For all three groups of MSAs, income rose with distance to the CBD and poverty rates fell with distance to CBD. The same patterns held in 2010 except that while average household income rose by about 0.3 log points in the growing MSAs, the growth was much lower in shrinking MSAs. In fact, close to the CBD shrinking cities experienced roughly zero growth in average household income from 1980 to 2010. While poverty rates in all three groups of cities rose from 1980 to 2010, the largest increase was among the shrinking MSAs. This pattern of lower income and higher poverty levels could potentially be a problem for shrinking MSAs as tax bases decline and the need for services increases as poverty levels increase.

Figure 5 shows how the fraction of African American (left column) and Hispanic (right column) residents vary with distance to the CBD in 1980, in 2010, and how that has changed over the period. In 1980, the fraction of residents that were African American was around 30 percent near the CBD for the shrinking MSAs. In contrast African Americans made up closer to 20 percent or less of the population near the CBD in the moderate and fast growth MSAs. This is likely a legacy of the African American migration into northern factory towns and the subsequent decline of the manufacturing industry over the past thirty years as our shrinking MSAs list has a large share of rust belt cities. From 1980 to 2010 the fraction of residents that are African-American rose the most within ten miles of the CBD for shrinking MSAs, rising 5 to

10 percentage points. For the fast growth MSAs the fraction of residents that are African American fell within two miles of the CBD, but rose farther from the CBD.

The Hispanic share of the population was greatest in the fast growth MSAs in 1980 and increased the most in the fast growth MSAs from 1980 to 2010, expanding by at least 10 percentage points at all distances from the CBD. The moderate growth MSAs also saw substantial increases in the Hispanic population over this period. The shrinking MSAs had the least growth in the fraction of the population that is Hispanic, increasing by less than 5 percentage points at all distances from the CBD. It is also interesting to note that, in 1980, shrinking MSAs possessed a lower fraction of Hispanics at all distances from the CBD compared to the growing cities. Lack of existing social networks and lack of economic opportunity may both play a role in explaining the slower growth of Hispanic population in shrinking MSAs compared to growing MSAs.

Changes in City Center Density and MSA Income Growth

The first part of our analysis focused on differences in population density and demographic changes as a function of distance to the CBD between shrinking, moderate growth, and fast growth MSAs from 1980 to 2010. A natural question that arises from this analysis is whether changes in population density and other demographics near the CBD are associated with broader MSA-wide changes. In this section we examine the relationship between the growth of average MSA household income and changes in population density near the CBD. The question we would like to answer is whether increases in near-CBD population density are related to MSA income growth above and beyond the relationship of MSA income growth to MSA population (or population density) growth. To address this question, we analyze an MSA-level dataset created from the constant geography tract-level data described above. Specifically, we run OLS regressions of MSA income growth on changes in population density near the CBD and changes in population density for the MSA as a whole while controlling for the initial demographic and occupational characteristics of the MSA.

Table 3 presents summary statistics for the variables of interest: MSA income growth and changes in population density as well as the initial year demographic controls. The first row reveals that the mean growth rate of real per capita income from 1980 to 2010 for our sample of 345 MSAs was 2.78, meaning that per capita income almost tripled over the period. The standard deviation was 0.66. The next three rows show the mean population density within 2.5, 5, and 7.5 miles of the CBD, respectively. These measures are constructed by dividing the total population (measured in thousands of people) living in census tracts with centroids within the boundary by the total land area (measured in square miles) within those census tracts. Rows 2 through 4 show that the mean population density for our sample of MSAs within 2.5, 5, and 7.5 miles of the CBD, was 4.22, 2.57, and 1.77 thousand people per square mile, respectively. The standard deviations of these near CBD population densities reveal a large amount of variation, each standard deviation larger than its respective mean. The fifth row reveals that the mean population density for the MSAs in our sample was 2.58 thousand people per square mile in 1980, with a similar sized standard deviation of 2.65.

The next four rows of Table 3 show the mean changes in the same four population density measures from 1980 to 2010. On average, the increase in population density within 2.5 miles of the CBD was only about 20 people per square mile. However, the mean masks a large amount of variation revealed by the standard deviation, which is 1.25 thousand people per square mile. The mean changes in population density increase as the area considered increases from within 2.5 miles of the CBD up to the whole MSA. The standard deviations of these changes are all large compared to the means. The last four rows of Table 3 show the means and standard deviations of the initial year (1980) MSA demographic characteristics used as controls: log population, per capita income, fraction of population with a Bachelor's or higher degree. In addition to these controls, our preferred specification also includes MSA occupational shares. These shares are defined as the fraction of employed people sixteen years and older that work in the following occupations: 1. Professional and technical occupations; 2. Sales workers; 3. Administrative support and clerical workers; 4. Precision production, craft, and repair workers; 5. Operators, assemblers, transportation, and material moving workers; 6. Service workers; 7. Nonfarm laborers . (Farm, forestry, and fishing workers are the omitted share.)

Table 4 presents the results of OLS regressions of MSA income growth on changes in population density near the CBD and changes in population density for the MSA as a whole. Column 1 presents the simplest specification: a regression of MSA per capita income growth on the change in population density within 5 miles of the CBD and the change in population density in the MSA as whole. All three variables are defined over the period from 1980 to 2010. The coefficient on change in population density within 5 miles of the CBD is positive and statistically significantly different from zero. The value of 0.171 implies that a one standard deviation increase in population density within 5 miles of the CBD (0.84 thousand more people per square mile) is, on average, associated with 14 percentage points more in income growth over the 30 year period, which translates to about 5 percent higher income growth compared to the mean of 278 percentage points. In contrast, the coefficient on the change in population density for the MSA as a whole is negative and statistically different from zero. The value of -0.116 implies that a one standard deviation increase in population density at the MSA level (0.86 thousand people per square mile) is associated with a 10 percentage point decrease in per capita income growth, or a 3.6 percent reduction in the growth rate of income per capita.

Column 2 of Table 4 presents the results of a similar specification except that controls for initial year (1980) population density (within 5 miles of the CBD and MSA-level), and log population have been added. The coefficients on the change in population density near the CBD and the change in population density for the MSA as a whole increase slightly in magnitude and remain statistically different from zero. The coefficients on the initial population controls are not statistically different from zero. Column 3 adds additional initial year demographic controls: log 1980 per capita income, and the fraction of the population with a Bachelor's or higher degree, both defined for the entire MSA. The addition of these controls reduces the magnitude of change in population density near the CBD, though it remains statistically different from zero. With the addition of these controls, initial log population is now positively associated with per capita income growth. The new controls, log initial income and the fraction of the population with a Bachelor or higher degree, are significantly negatively and positively associated with per capita income growth, respectively. The addition of these controls helps explain a lot more of the variation in income growth. The R-squared increases from 0.02 to in columns 1 and 2 to 0.37 in column 3.

Column 4 of Table 4 adds the eight occupational share variables mentioned in the discussion of the summary statistics. The addition of these variables does not have much of an impact on the coefficient on population density near the CBD, but does increase the magnitude of the coefficient on the change in the population density of the MSA as a whole. This is our preferred specification. The aim is to see how changes in near CBD population density and overall MSA population density correlate with MSA income growth while controlling for a number of initial year differences in demographics and occupational structures that might be correlated with subsequent income growth. The coefficients imply that after controlling for all of these initial year demographic and occupational factors, a one standard deviation increase in near CBD population density is associated with about a 12 percentage point increase in income per capita, which is roughly 4 percent of the mean growth in per capita income. The coefficient on MSA-level change in population density implies that a one standard deviation increase is associated with a 17 percentage point decrease in per capita income, or roughly 6 percent of mean income growth.

Columns 5 and 6 present estimates of the same specification as column 4, except that instead of defining near the CBD as within 5 miles, near is defined as within 2.5 miles and within 7.5 miles of the CBD in columns 5 and 6, respectively. While the coefficient on the change in population density near the CBD is smaller in magnitude that it is in column 4, it is still significantly different from zero, and a one standard deviation increase in population density near the CBD still implies about the same 12 percentage point increase in income growth as it did in column 4. However, changing the definition of "near the CBD" to "within 7.5 miles" (in column 6) results in a coefficient harder to distinguish from zero and implies that a one standard deviation increase in population density near the CBD is associated with less than a 9 percentage point increase in per capita income at the MSA level.

Discussion

We find that growth in population density near the CBD is positively associated with income growth at the MSA level. While this finding appears to be robust to adding a number of initial year demographic controls and to some variation in the definition of proximity to the

CBD, it is unclear what mechanisms may underlie this relationship. One explanation is that loss of density near the CBD might adversely affect MSA-level income growth by decreasing short distance agglomerative benefits, such as the exchange of ideas and information. An alternative explanation is that the causality runs in the opposite direction. It could be the case that rising income, especially at the upper end of the income distribution, results in a segment of the population who value a short commute so much that they trade the space available in the suburbs for the reduced commute of the area near the CBD. If the market responds by adding residential housing units near the CBD, then population density near the CBD could increase.[6]

A desire to differentiate between these two possible scenarios led us to consider potential instruments that might be correlated with near CBD population density and which would not be expected to influence MSA-level income growth except by way of their influence on near CBD population density. One potential instrument is the measure of area (land or water) unavailable for development within fifty kilometers of the CBD as calculated in Saiz (2010). This fraction of the area within fifty kilometers of the CBD that is unavailable for development is associated with increases in population density within 2.5 miles of the CBD. Taking our column 5 specification, and altering it so that changes in population density within 2.5 miles of the CBD is instrumented with the fraction undevelopable variable and dropping the initial year population density variables, results in a first stage F statistic of 10.37 and a t statistic on the unavailable variable of

[6] Leroy and Sonstelie (1983) show how a pattern of high income people moving back to the CBD from the suburbs could occur when modes of transportation such as the car are adopted first by high income people and then by low income people. Lin (2002) provides empirical support for this hypothesis. Brueckner, Thisse, and Zenou (1999) posit that variation in amenity levels may explain variation across cities in the degree to which high income households tend to be concentrate in the suburbs versus near the CBD.

3.22. However, including the initial population density measures using the 5 or 7.5 mile definitions of "near the CBD" result in much lower first stage F and t statistics.

The other issue is whether it is plausible that the fraction of area unavailable for development within fifty kilometers of the CBD could influence MSA-level income growth in some manner other than by way of population density near the CBD. Saiz (2010) discusses why one would expect productivity to be correlated with the fraction of area unavailable for development: with many possible places to develop a city, places where development is more costly must have some natural advantage in productivity or amenity. Higher productivity could result in a correlation between area unavailable for development and income levels. However, it is unclear whether one would expect area unavailable to have an effect on income growth. For these reasons, we do not put much emphasis on the IV results.[7] However, we find the robustness of the association between changes in population density near the CBD and MSA-level income growth interesting. We think that exploring the mechanisms that may link changes in population density near the CBD to MSA-level productivity is an area for future policy-oriented research. If core density is important for productivity then policymakers across the entire MSA might want to consider measures aimed at keeping the center city densely populated.

Conclusion

Anecdotal evidence from Detroit and Cleveland suggests that shrinking MSAs have lost the most population density near their CBDs. We find that, on average, this is true for the 36 MSAs that have lost population from 1980 to 2010. We find steep drops in population density

[7] For the curious reader two-stage least squares results from the specification noted above with an F of 10.37 yield a coefficient on change in population density near the CBD of 0.527 and with a standard error of 0.182.

for shrinking cities close to the CBD which die off as distance from the CBD increases. This pattern is not evident in growing MSAs. In conjunction with the drops in population density near the CBDs of shrinking MSAs, we find less of an increase in educational attainment than in places farther away from the CBD in shrinking MSAs, and less of an increase in educational attainment than in places near the CBD in growing cities. On average, shrinking MSAs also have lower increases in income, higher increases in poverty rates, and more of an increase in the fraction of the population that is African American near the CBD than do growing MSAs. Changes in the fraction of the population that is Hispanic are larger in growing MSAs than in shrinking MSAs but these changes do not display much of a relationship with distance to the CBD in either type of MSA. Finally, the fraction of the population that is between the ages of twenty-five and thirty-four falls more as distance to the CBD increases. This pattern is very similar in growing and shrinking MSAs.

In the second part of our analysis we turn to the question of whether changes in population density near the CBD are related to changes in MSA-level productivity that are reflected in the growth of income per capita in the MSA. In OLS regressions we find a positive partial correlation between changes in population density near the CBD and MSA-level income growth from 1980 to 2010 while controlling for changes in overall MSA-level population density over the same period and controlling for a number of initial-year (1980) MSA characteristics. We explore a potential instrument for changes in population density but are not convinced that it is a strong enough instrument. We hope that further research uncovers the mechanisms that underlie the positive association between changes in population density near the CBD and MSA-level income growth, allowing leaders to craft informed policies to build stronger and more resilient cities.

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Table 1

MSAs that shrank (in population) 1980-2010
Anderson, IN Metropolitan Statistical Area
Battle Creek, MI Metropolitan Statistical Area
Bay City, MI Metropolitan Statistical Area
Binghamton, NY Metropolitan Statistical Area
Buffalo-Niagara Falls, NY Metropolitan Statistical Area
Cleveland-Elyria-Mentor, OH Metropolitan Statistical Area
Danville, IL Metropolitan Statistical Area
Danville, VA Metropolitan Statistical Area
Davenport-Moline-Rock Island, IA-IL Metropolitan Statistical Area
Decatur, IL Metropolitan Statistical Area
Detroit-Livonia-Dearborn, MI Metropolitan Division
Dubuque, IA Metropolitan Statistical Area
Duluth, MN-WI Metropolitan Statistical Area
Elmira, NY Metropolitan Statistical Area
Flint, MI Metropolitan Statistical Area
Huntington-Ashland, WV-KY-OH Metropolitan Statistical Area
Johnstown, PA Metropolitan Statistical Area
Kokomo, IN Metropolitan Statistical Area
Lima, OH Metropolitan Statistical Area
Mansfield, OH Metropolitan Statistical Area
Muncie, IN Metropolitan Statistical Area
New Orleans-Metairie-Kenner, LA Metropolitan Statistical Area
Niles-Benton Harbor, MI Metropolitan Statistical Area
Parkersburg-Marietta-Vienna, WV-OH Metropolitan Statistical Area
Peoria, IL Metropolitan Statistical Area
Pine Bluff, AR Metropolitan Statistical Area
Pittsburgh, PA Metropolitan Statistical Area
Pittsfield, MA Metropolitan Statistical Area
Saginaw-Saginaw Township North, MI Metropolitan Statistical Area
Springfield, OH Metropolitan Statistical Area
Toledo, OH Metropolitan Statistical Area
Utica-Rome, NY Metropolitan Statistical Area
Waterloo-Cedar Falls, IA Metropolitan Statistical Area
Weirton-Steubenville, WV-OH Metropolitan Statistical Area
Wheeling, WV-OH Metropolitan Statistical Area
Youngstown-Warren-Boardman, OH-PA Metropolitan Statistical Area

Table 2

MSAs that Grew by more than 100% (in population) 1980-2010

Athens-Clarke County, GA Metropolitan Statistical Area
Atlanta-Sandy Springs-Marietta, GA Metropolitan Statistical Area
Austin-Round Rock-San Marcos, TX Metropolitan Statistical Area
Bakersfield-Delano, CA Metropolitan Statistical Area
Blacksburg-Christiansburg-Radford, VA Metropolitan Statistical Area
Boise City-Nampa, ID Metropolitan Statistical Area
Bradenton-Sarasota-Venice, FL Metropolitan Statistical Area
Cape Coral-Fort Myers, FL Metropolitan Statistical Area
Charlotte-Gastonia-Rock Hill, NC-SC Metropolitan Statistical Area
Charlottesville, VA Metropolitan Statistical Area
College Station-Bryan, TX Metropolitan Statistical Area
Colorado Springs, CO Metropolitan Statistical Area
Dallas-Plano-Irving, TX Metropolitan Division
Fayetteville-Springdale-Rogers, AR-MO Metropolitan Statistical Area
Fort Collins-Loveland, CO Metropolitan Statistical Area
Fort Worth-Arlington, TX Metropolitan Division
Greeley, CO Metropolitan Statistical Area
Hanford-Corcoran, CA Metropolitan Statistical Area
Laredo, TX Metropolitan Statistical Area
Las Cruces, NM Metropolitan Statistical Area
Las Vegas-Paradise, NV Metropolitan Statistical Area
Madera-Chowchilla, CA Metropolitan Statistical Area
McAllen-Edinburg-Mission, TX Metropolitan Statistical Area
Naples-Marco Island, FL Metropolitan Statistical Area
Ocala, FL Metropolitan Statistical Area
Olympia, WA Metropolitan Statistical Area
Orlando-Kissimmee-Sanford, FL Metropolitan Statistical Area
Phoenix-Mesa-Glendale, AZ Metropolitan Statistical Area
Port St. Lucie, FL Metropolitan Statistical Area
Provo-Orem, UT Metropolitan Statistical Area
Raleigh-Cary, NC Metropolitan Statistical Area
Reno-Sparks, NV Metropolitan Statistical Area
Riverside-San Bernardino-Ontario, CA Metropolitan Statistical Area
Sebastian-Vero Beach, FL Metropolitan Statistical Area
West Palm Beach-Boca Raton-Boynton Beach, FL Metropolitan Division
Wilmington, NC Metropolitan Statistical Area
Yuma, AZ Metropolitan Statistical Area

Table 3

	Mean	Std Dev.
Growth of Average Per Capita Income 1980-2010	2.78	0.66
Population Density w/in 2.5 miles of CBD 1980 (population density measured in 1000s of people per sq. mi.)	4.22	4.31
Population Density w/in 5 miles of CBD 1980 (population density measured in 1000s of people per sq. mi.)	2.57	3.11
Population Density w/in 7.5 miles of CBD 1980 (population density measured in 1000s of people per sq. mi.)	1.77	2.58
MSA Population Density 1980 (population density measured in 1000s of people per sq. mi.)	2.58	2.65
Change in Population Density w/in 2.5 miles of CBD 1980-2010 (population density measured in 1000s of people per sq. mi.)	0.02	1.25
Change in Population Density w/in 5 miles of CBD 1980-2010 (population density measured in 1000s of people per sq. mi.)	0.19	0.84
Change in Population Density w/in 7.5 miles of CBD 1980-2010 (population density measured in 1000s of people per sq. mi.)	0.23	0.64
Change in MSA Population Density 1980-2010 (population density measured in 1000s of people per sq. mi.)	0.35	0.86
Log MSA Population 1980	12.47	1.03
Log MSA Per Capita Income 1980	8.78	0.18
Fraction of Population with Bachelor or Higher Degree 1980	0.16	0.06

Table 4

Dependent Variable: Growth of Per Capita Income 1980-2010

	(1)	(2)	(3)	(4)	(5)	(6)
Definition of Near CBD (radius)	5 Miles	5 Miles	5 Miles	5 Miles	2.5 Miles	7.5 Miles
Change in Population Density Near CBD 1980-2010	0.171	0.203	0.144	0.143	0.102	0.135
(population density measured in 1000s of people per sq. mi.)	(0.060)	(0.087)	(0.071)	(0.065)	(0.041)	(0.085)
Change in MSA Population Density 1980-2010	-0.116	-0.147	-0.142	-0.195	-0.182	-0.168
(population density measured in 1000s of people per sq. mi.)	(0.049)	(0.066)	(0.062)	(0.061)	(0.059)	(0.063)
Population Density Near CBD 1980		0.029	-0.010	-0.024	0.032	-0.011
		(0.041)	(0.028)	(0.026)	(0.019)	(0.032)
Population Density in MSA 1980		-0.026	0.018	0.035	-0.038	0.026
		(0.047)	(0.029)	(0.027)	(0.032)	(0.028)
Log MSA Population 1980		-0.006	0.178	0.199	0.158	0.167
		(0.040)	(0.077)	(0.077)	(0.069)	(0.077)
Log MSA Per Capita Income 1980			-2.375	-3.041	-3.025	-3.031
			(0.800)	(0.861)	(0.857)	(0.880)
Fraction of Population with Bachelor or Higher Degree 1980			4.327	4.453	4.174	4.431
			(0.762)	(2.020)	(1.966)	(2.006)
Occupational Shares 1980	No	No	No	Yes	Yes	Yes
R-squared	0.02	0.02	0.37	0.48	0.48	0.47
Observations	345	345	345	345	345	345

Figure 1

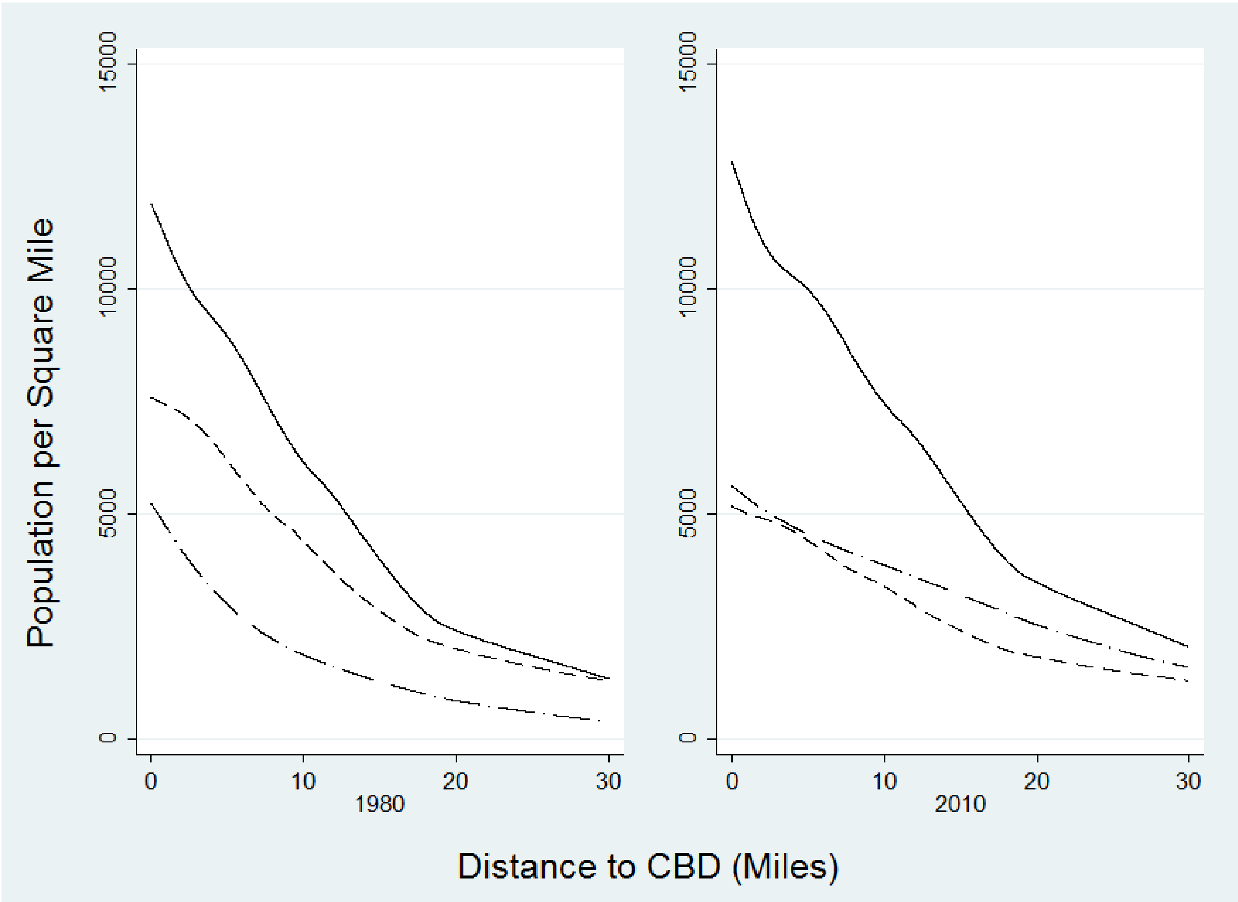
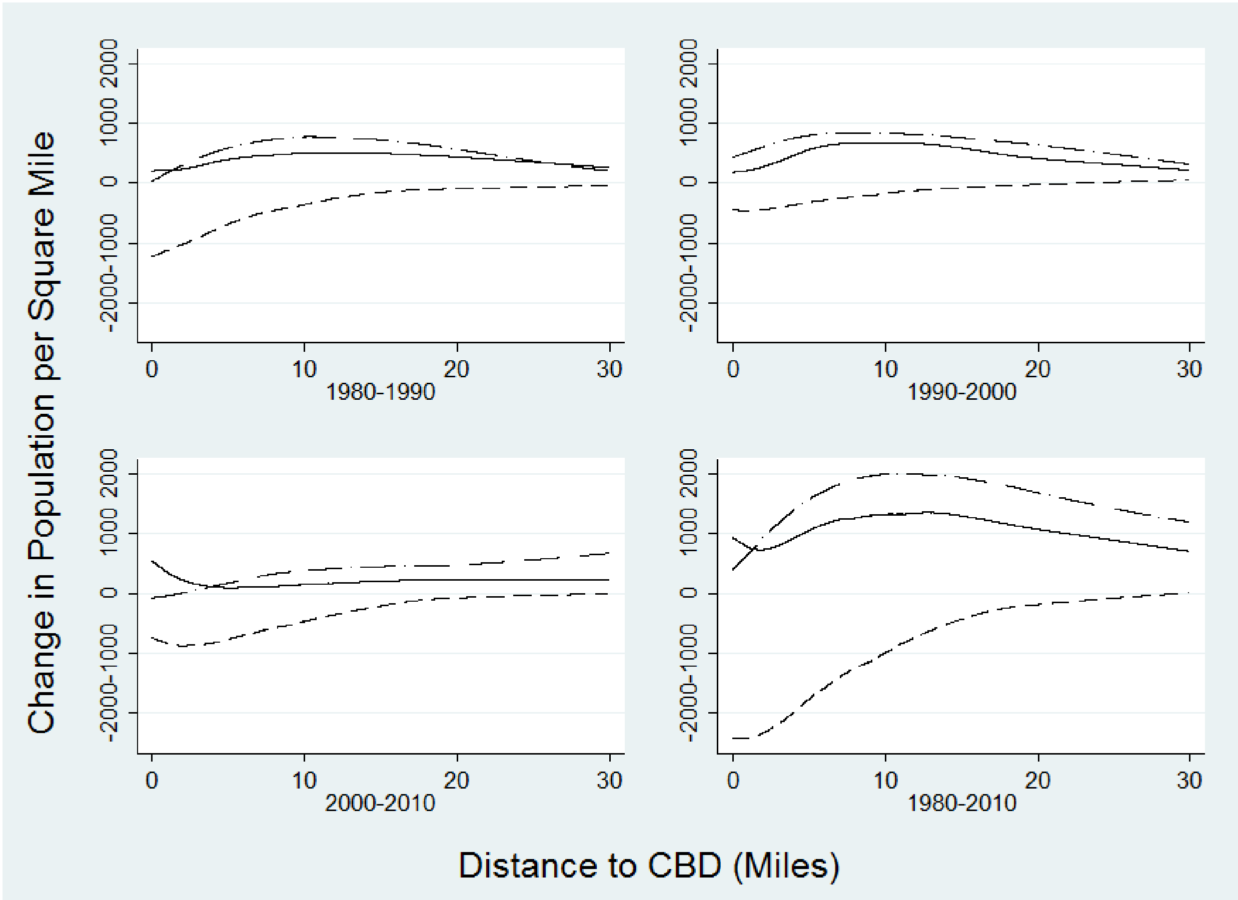

Population per Square Mile
15000
10000
5000
0
0
10
20
30
1980
15000
10000
5000
0
0
10
20
30
2010
Distance to CBD (Miles)

Figure 2



Change in Population per Square Mile
-2000 -1000 0 1000 2000
0 10 20 30
1980-1990
1990-2000
2000-2010
1980-2010
Distance to CBD (Miles)

Figure 3

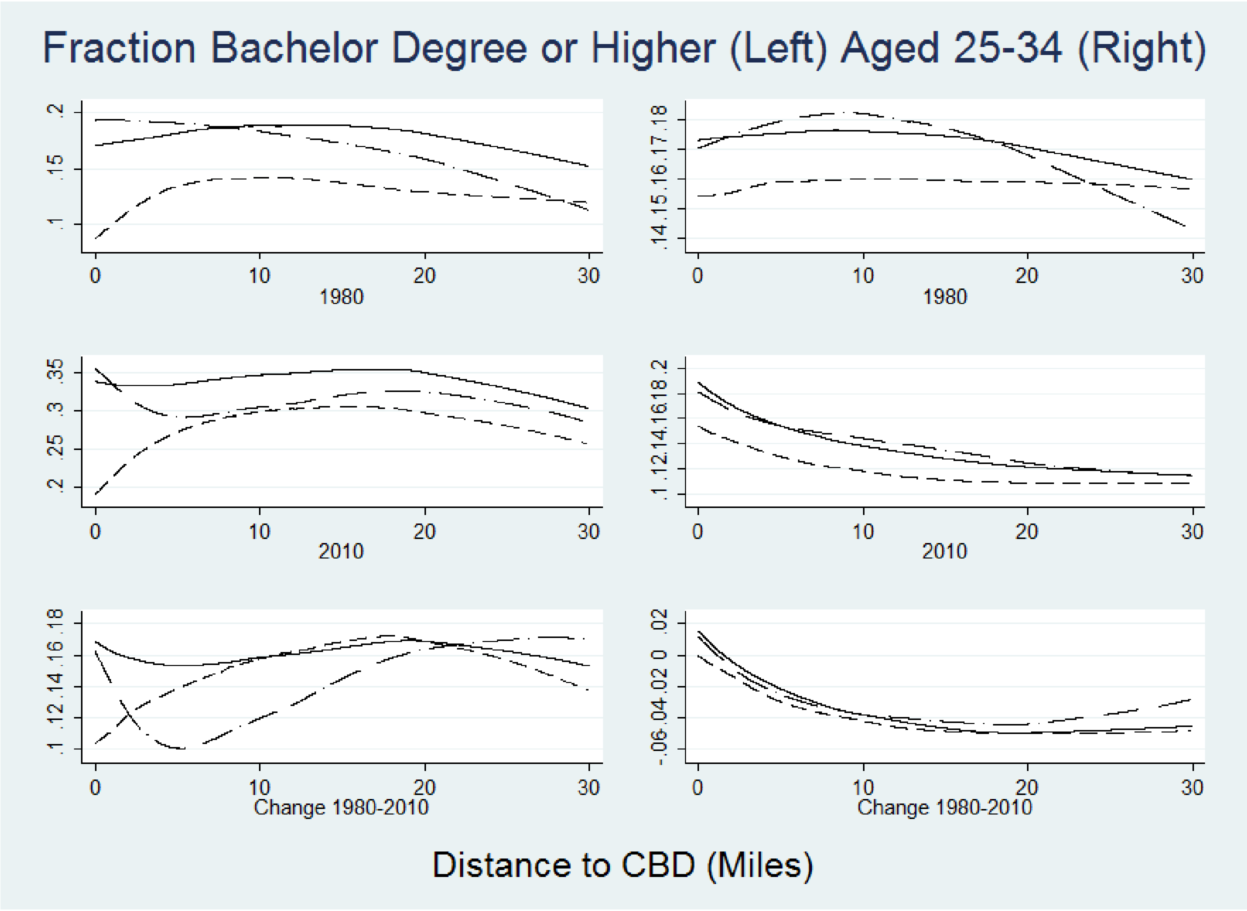
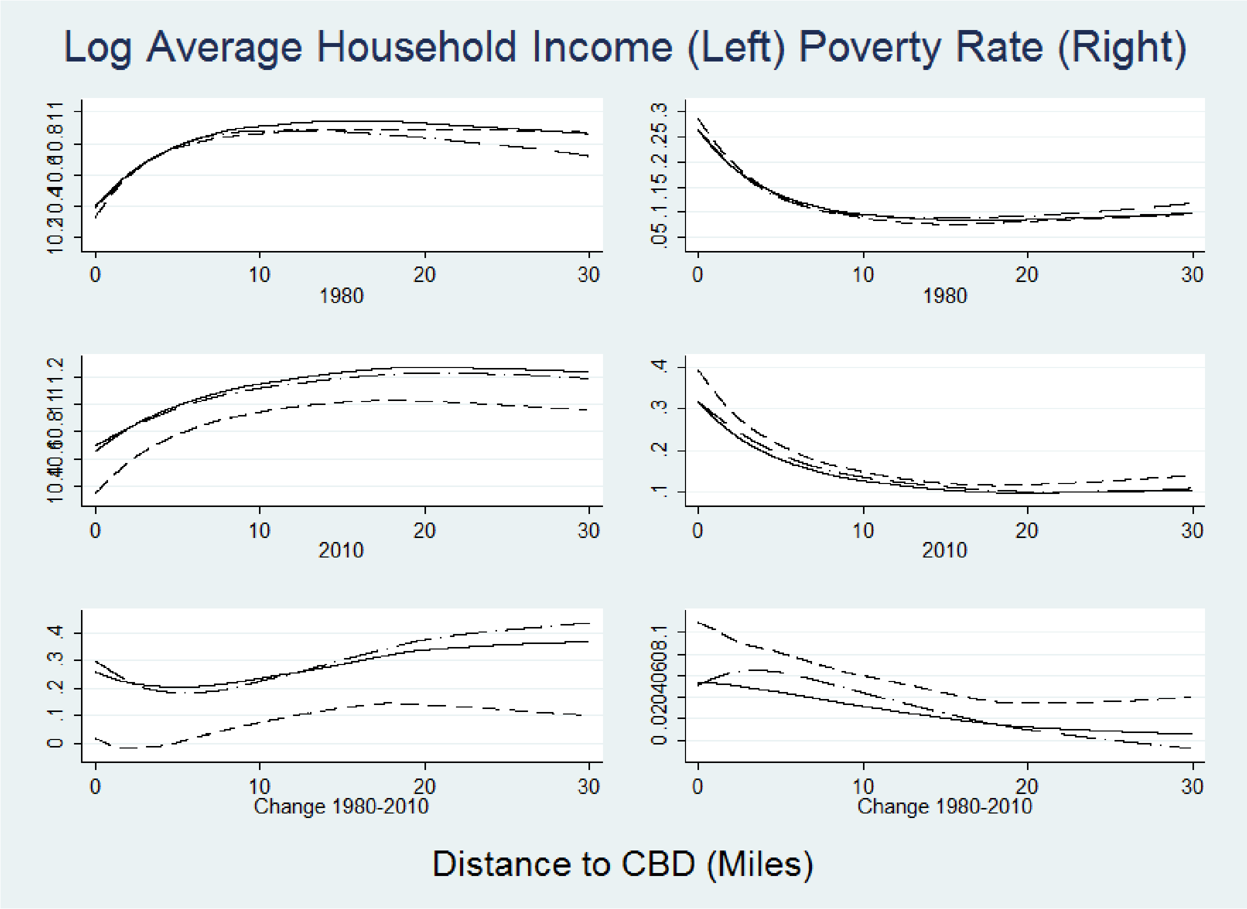
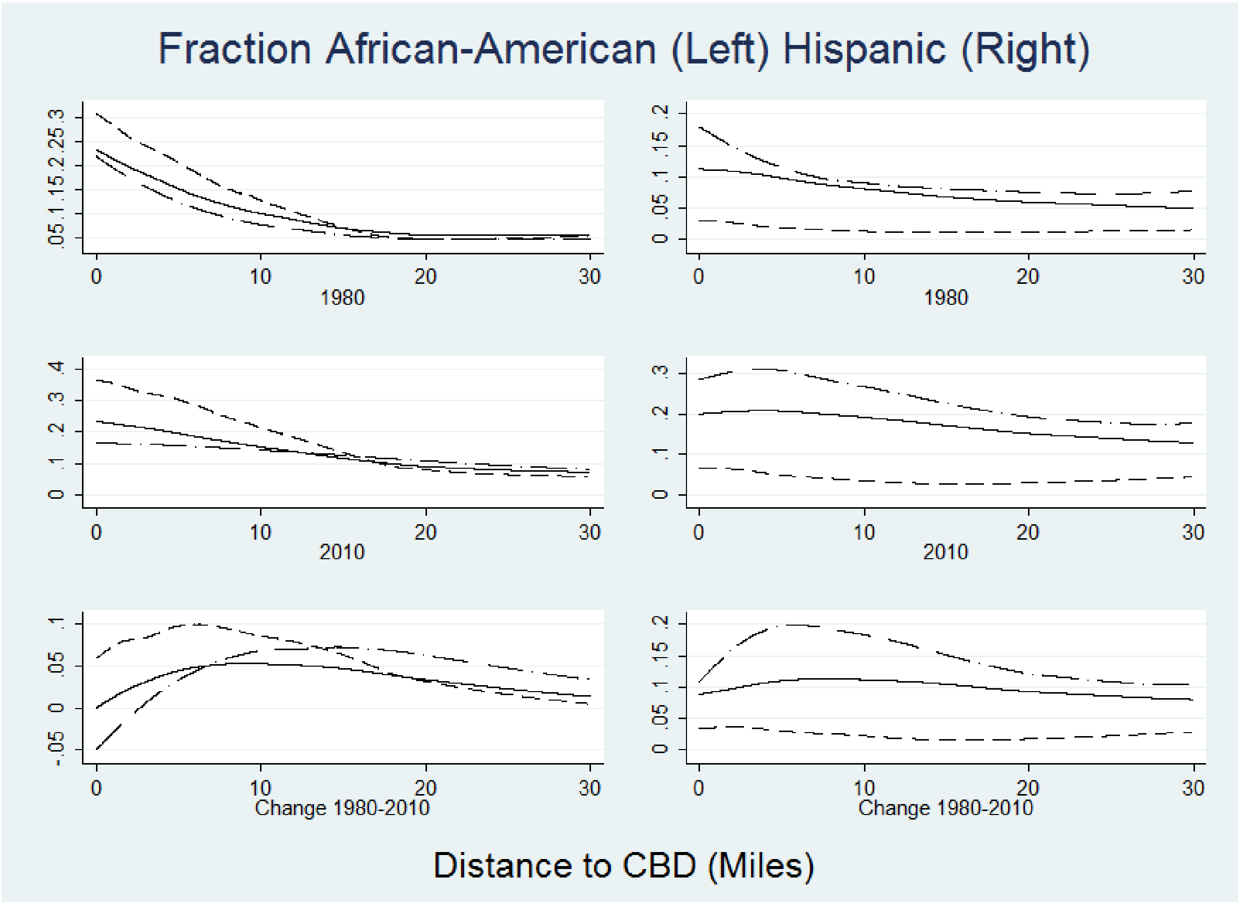

Fraction Bachelor Degree or Higher (Left) Aged 25-34 (Right)
.1
.15
.2
0
10
20
30
1980
.14 .15 .16 .17 .18
0
10
20
30
1980
.2
.25
.3
.35
0
10
20
30
2010
.1 .12 .14 .16 .18 .2
0
10
20
30
2010
.1 .12 .14 .16 .18
0
10
20
30
Change 1980-2010
-.06 -.04 -.02 0 .02
0
10
20
30
Change 1980-2010
Distance to CBD (Miles)

Figure 4



Log Average Household Income (Left) Poverty Rate (Right)
1980
1980
2010
2010
Change 1980-2010
Change 1980-2010
Distance to CBD (Miles)

Figure 5


Fraction African-American (Left) Hispanic (Right)
.05 .1 .15 .2 .25 .3
0 10 20 30
1980
0 .05 .1 .15 .2
0 10 20 30
1980
0 .1 .2 .3 .4
0 10 20 30
2010
0 .1 .2 .3
0 10 20 30
2010
-.05 0 .05 .1
0 10 20 30
Change 1980-2010
0 .05 .1 .15 .2
0 10 20 30
Change 1980-2010
Distance to CBD (Miles)