Contemporary Journal of Anthropology and Sociology

Using Function-Based Spatiality Theory to Examine County-Level Predictors of Kentucky Population Change (2000-2012)

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Abstract: This study utilizes a function-based spatiality approach to examine which social and demographic factors best predict Kentucky's 2000 to 2012 population change. Function-based spatiality seeks to integrate the ideas of co-evolution, sub-optimality, iteration, and guided agency from the complex adaptive systems perspective. Counties within a system are interconnected and thus co-evolve as each adjusts to social change. These changes, although complex, tend to be repetitive and thus predictable. The theory also argues that humans are free to make choices, such as migration, but choices are guided by the larger social structure. County-level data from the U.S. Census Bureau and Economic Research Service are used to show which factors most significantly predict Kentucky's population change. Preliminary results indicate that both the percentage living in a county in 1990 and 2000 were positively associated with population change. Also, the 1990 to 2000 change in median household income and the 1990 to 2000 change in the percentage of individuals identifying themselves as Hispanic positively predict population change, while the percentage identifying themselves as African American and counties found in the Appalachian region were negatively associated with Kentucky's 2000-2012 population change.

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INTRODUCTION

Geographical locations, like counties, gain population in two ways: natural increase, defined as having an excess of births over deaths, and in-migration, or having more individuals migrating into, as opposed to out of, a given territory (McFalls, 2007). Migration tends to select from the young, creating an older population base in counties experiencing out-migration. Consequently, these counties not only lose young migrants, but generally encounter a higher death rate compared to counties with high in-migration (Johnson, Nucci, & Long, 2005). Functional-based spatiality theory posits that space is central to determining population patterns within geographical spheres (ex. neighboring counties).

Demographic trends in Kentucky can act as a lens through which the theoretical approach can be validated, and can provide a useful model for further studies. Kentucky's population grew by an estimated 8.38 percent from 2000 to 2012, which is slower than the 9.7 percent change Kentucky experienced from 1990 to 2000 (United States Census Bureau, 2010). A closer examination of the data can help explain what is contributing to Kentucky's change in population growth. From 2000 to 2012, Kentucky's total population grew from 4,041,769 in 2000 to 4,379,730 in 2012. Furthermore, vital statistics show that from 2000 to 2012 Kentucky experienced 721,607 births and 523,164 deaths, for a natural increase (births minus deaths) of 198,433 individuals. Since Kentucky's population grew by 337,961 from 2000 to 2012, it can be concluded that about 58.7 percent of Kentucky's growth occurred because there were more births than deaths. Finally, from 2000 to 2012, Kentucky's number of in-migrants minus the number of out-migrants was 139,518, meaning that Kentucky gained population due to more people moving into the state than out of the state (Kentucky State Data Center 2014 and U.S. Census Bureau 2010).

However, not all of Kentucky's counties experienced the same level of population change, and several Kentucky counties experienced population loss. In a recent Population Reference Bureau article, Mather and Jarosz (2014) highlight that counties with aging populations tend to have low birth rates, making population loss a strong possibility. While the U.S. Census Bureau and the Kentucky State Data Center provide an array of population and social data for Kentucky counties, a multivariate approach is useful for helping understand which geographical and socio-demographic characteristics best predict 2000 to 2012 population change for Kentucky counties. Understanding population change can help policy makers make better informed decisions about sub-populations, (i.e. older and younger residents, non-metropolitan and metropolitan residents, etc.), business owners can improve their marketing and location strategies, and researchers can frame more meaningful questions and problems for further investigation. The purpose of this paper is to explain Kentucky's 2000 to 2012 population change using the functional-based spatiality approach to better explain factors that contribute to population change. Another purpose of the paper is to assess the impact demographic processes have in shaping population change. Specifically, two independent variables, migration (percent living in a different county in 1990 and 2000) and mortality and fertility (natural increase in 2000), have been created to test the impact of each demographic process on Kentucky counties 2000 to 2012 population change.

Theoretical Framework and Literature Review

An early analysis of migration begins with the statement that "fertility and mortality have much more elaborately developed methodologies than has migration" (Thomlinson, 1961). Since Thomlinson's (1961) observation, there have been many attempts to rectify these deficiencies. DeJong (2000) explains the significance of migration theory by writing, "Migration theory, once a stepchild of demography, has emerged as an important focus of scholarship in recent years, perhaps because of the increasing policy salience of internal and international population movements" (307).

The significance of migration has attracted the attention of many scholars attempting to assess who migrates and why. Scholars in the 1970s focused on financial benefits driving most migration decisions (Lee 1966; Sell & DeJong, 1978). Sell and DeJong (1978) then sought to address the issue of who migrates by analyzing who made the decisions behind migration. This line of research has been challenged by Sly and Wrigley (1986) who have complicated the discussion through finding substantial flaws in traditional notions of economical reasons for determining migration and asserting that migrants can move for non-economic reasons. In addressing this decision-making process, DeJong (2000) adds the complexity of gender and social norms through the lens of women's decision-making roles among Thai migrants.

Because of the limitations of previous theoretical frameworks addressing population change, we employ a less commonly used theoretical framework to guide our model for population change. Function-based spatiality provides a theoretical model for incorporating non-metropolitan, urban, impoverished, elite, ethnically homogenous, and racially diverse characteristics into migration decisions. If the function of space is taken into consideration, population patterns tend to follow predictable norms, largely because the counties that fall within the system tend to be connected with one another within regional, national, and international spheres. Acknowledging the role of space in migration decisions is not a new idea (Roseman 1971; Roseman 1983). Function-based spatiality builds upon ideas that describe "'a new spatial division of labor,' in which places become differentiated according to the role that they play in the production process" (Cohen, 1990 p 383).

The theory of function-based spatiality acts as a component within the overarching model of complex adaptive systems theory. Complex adaptive systems theory is an inter-disciplinary theory that seeks to explain complex systems, such as political party organization, ecologies, and the economy (Holland, 1992). However, because it's very difficult to statistically test concepts from the overarching complex adaptive systems theory, we use the more specific function-based spatiality theory to test our hypotheses. One of the goals of function-based spatiality theory is to utilize the specific variable of how different places function within their spheres to move out of vague ideas of complex adaptive systems theory (Rands, 2014). The elements from function-based spatiality theory that we examine include co-evolution, sub-optimality, iteration, and structural versus individual migration, which are ideas from the overarching theory.

Co-evolution

First, function-based spatiality argues that all actors and communities are intertwined and have the ability to adapt to changes that occur within the system. This idea of co-evolution arises in migration shifts as it addresses the questions of: What community factors are responsible for a person's voluntary change of location?

(Fawcett, 1986). Function-based spatiality moves beyond individual-level migration as it also acknowledges changes in space caused by both in and out migration. Migration patterns therefore have co-evolutionary effects not only on the family, but on the communities they migrate to and from (Fryer, n.d.). Examples of co-evolution are seen in areas with a proportionally larger population of older adults (aged 65 and over) that are often associated with a declining population because migration tends to select those who are young adults (Erikson, Call, & Brown, 2012; Mather, 2012; Price, 2011; Turner, Brooks, & Arwood, 2010; Watkins, Rowles, & Bowles, 2004). Thus, migration patterns can generate a younger age structure for the receiving county, while simultaneously creating an older median age for the sending county.

The Appalachian region has distinct geographical, economic, and cultural functions. Kentucky's Appalachian counties, have a larger population aged 65 and older than areas outside of Appalachia (Scommegna, 2012; Watkins, Rowles, & Bowles, 2004). Although in-migration of retirees to retirement communities contributes to population change (Brown, Bolender, Kulcsar, Glasgow, & Sanders, 2011; Demographic and economic profile: Kentucky, 2006; Pollard & Mather, 2010), Appalachia does not have the conceptual function of a retirement community that is observed in the Southwest United States or Florida.

Migration patterns for those with varying educational attainment levels also cause counties to co-evolve. The migration of the college-educated creates a more educated population base for the receiving county, while at the same time, reducing the educational attainment levels of the sending county (Domina, 2006; Gyawali et al., 2013). Wilson (2009) argues that as the United States economy shifted from industrial to postindustrial, those with the least amount of education and skills were most likely to be left out of economic restructuring. At the county-level, counties that experienced the greatest in-migration have been those that have a wider range of opportunities, including jobs created for educated individuals that allow them to utilize their technological skills (Domina, 2006; Gyawali et al., 2013). The infrastructure of some counties has been developed to attract high-skilled workers, including those with high educational attainment levels.

Sub-optimality

Function-based spatiality theory posits that change results from attempts to improve sub-optimal conditions (Dodder & Dare, 2000). Function-based spatiality addresses the characterization of place concepts within a spatial context, demonstrating how the perceived functions of specific places can be connected with the optimality of the larger systems in which they operate (Rands, 2014; Stinner & Van Loo, 1992). For example, in the late 1970s, changing technology led to a deconcentration in manufacturing occupations (Shumway & Lethbridge, 1998). In metropolitan areas service sector jobs became the dominant industry in the postindustrial era (Sassen, 1990). Consequently, work became more centralized in metropolitan counties, and less centralized in non-metropolitan counties. This created migration patterns favoring large cities for service-sector employment and many previously involved in manufacturing adopted "anti-urban" attitudes (Christensen, Garkovich and Taylor, 1983).

Although much of the nation experienced service-sector growth in both the 1980s and 1990s, the South experienced comparatively greater service-sector gains (Beyers & Nelson, 1999). Furthermore, while much of the nation witnessed a decline in manufacturing jobs, the South actually experienced a 12.5 percent increase from 1985 to 1995 (Beyers & Nelson, 1999). This can be attributed to the sub-optimality of the South's agricultural function. From the mid-1980s both metropolitan and non-metropolitan counties experienced manufacturing gains in the South, leading to population growth (Beyers & Nelson, 1999; Johnson, 2012). Although the manufacturing industry slowed down considerably in the 2000s, counties with a high percentage of manufacturing jobs continued to gain migrants (Johnson, 2012).

Iteration

Function-based spatiality argues that historically derived relationships between space and function influence migration, making generalized prediction possible. The iteration of migrations, extending in an ever growing influence across time and space, creates measurable data and trends that further reinforce the identities of the location. For example, businesses tend to locate in counties and communities that are best prepared to meet the demands of the market (Axelford & Cohen, 2000; Jervis, 1997; Scott, 2008). Counties that experience population growth are more likely to attract businesses, and in turn in-migrants. This leads to an increase in fertility for counties experiencing growth from migration.

Individuals from various racial/ethnic groups are amongst these in-migrants. Initial settlement is strongly influenced by ethnic networks. Subsequent moves, often within the same state, are more closely related to correlations between immigrant skills and the economic functions of place (Kritz & Nogle, 1994). Kentucky's Hispanic population growth is not random, but is a product of selection to locations that are experiencing job growth in their economic functions. Minority populations are growing more quickly than the dominant-group white population, but the wage gap between white and minority populations stands as an indicator of differing employment patterns. The increase in minority population is likely both a product of minority populations having a higher fertility rate than whites, and reflects the increased in-migration of Hispanics and Asians (Lichter, 2012; Price, 2011).

Kentucky's Hispanic population increased by 121.6% between 2000 and 2010 (Price, 2011). The intersection of spatial function and migrant skill provides a spectrum across which population growth is observed. Although population growth is typically associated with urban areas, researchers have increasingly found Hispanic population growth in non-metropolitan areas as well. Non-metropolitan occupations, like manufacturing and agriculture, have attracted Hispanic workers (Kandel & Parrado, 2005; Lawson, Jarosz, & Bonds, 2010; Lichter, 2012; Lichter & Johnson, 2006; Parrado & Kandel, 2010).

Explaining Kentucky's African American population is complex. From 2000 to 2010, the African American population increased only slightly and over half of the state's African American population resides in the less-affluent Louisville metropolitan area (U.S. Census Bureau 2010). The correlation between higher African American populations and high poverty rates can be explained through the application of function-based spatiality. Historical exploitation and connection to geographic areas without positive economic functions have left many African Americans in disadvantaged locations (Albrecht & Albrecht, 2007). Not all Kentucky's counties are experiencing an increase in the percentage of African Americans. According to Price (2011), the percentage of African Americans in non-metropolitan areas has been declining, whereas the percentage has been growing in metropolitan areas. Kentucky's African American population, for instance, was at 10.7% in metropolitan areas and 2.3% in non-metropolitan areas in 2000 (Demographic and economic profile: Kentucky, 2006). However, Scommegna (2012) found that smaller minority populations in Appalachian counties actually experienced a boost in population, indicating various patterns amongst Kentucky's non-metropolitan counties.

Commuting patterns are repetitive patterns that tend to emerge within the metropolitan-non-metropolitan hierarchy (Soja, 2000). Because travel time can be affected by access to, or the expansion of, a highway system, past literature has documented the correlation between the expansion of highways and the change in population (Chi, 2010; Voss & Chi, 2006). This suggests that commuting time would decrease with highway expansion, thereby creating population growth or decline in corresponding areas. Additionally, possible migrants, especially young adults with families, may be attracted by the choice to live in a county adjacent to a core city, where family ties can more easily be maintained, live in more affordable housing, and have access to an environmentally friendly living condition, while having a relatively easy commute to the core metropolitan area for work (Beale & Fuigett, 2011). Function-based spatiality explains much of this extended reciprocal movement as technology has allowed people to take advantage of the different functions of several increasingly distant geographical spaces.

Geographical: Structural versus Individual Migration

Massey (1990) provides an appropriate introduction to the discussion of whether structures or individual decisions act as predominant determinants in migration decisions. "The issue here is whether migration is better understood in individual or structural terms – whether migration is appropriately viewed as an aggregate outcome of individual decisions or whether it is the product of powerful structural changes in society that supersede [sic.] individual actions" (3). Individual actors are agents, guided by the larger social structure. Thus, function-based spatiality theory allows for the integration of push/pull principles used to explain migration through the structural lens while allowing that individual actions have transformative impacts on structures. Function-based spatiality refines traditional theories of migration by arguing that when considering whether to migrate or not, actors weigh the costs of staying against the benefits of migrating to a new destination. Some may actually choose to remain in their place of origin because they value the attachment to their family, community, and natural amenities the county has to offer over fulfilling some occupational dream in another county (Brooks et al., 2012). Some may remain in an area despite occupational aspirations because they share a moral or political identity (Barone, 2013). For some, counties remain structurally disadvantaged because community members lack the resources to migrate. Thus, the choice to migrate is often limited.

Geographical location also serves as an indicator of population change (Brooks et al., 2012; Erikson, Call, & Brown, 2012; Johnson, 2011; Kandel & Parrado, 2005; Lawson, Jarosz, & Bonds, 2010; Lichter, 2012; Watkins, Rowles, & Bowles, 2004). The migration of individuals seeking higher-paying employment to metropolitan counties from non-metropolitan counties stands as an example of the geographical role. Yet, not all non-metropolitan counties have experienced out-migration as the agrarian and low-wage functions of some counties have led to an in-migration. Research shows that in Kentucky positive impressions of non-metropolitan settings has a direct influence on the decisions to move to small towns (Christensen, Garkovich & Taylor). The function of the small town acts as a determinant for in-migration. This is also true of Hispanics, lower-wage workers, and older individuals (Brown et al., 2011; Beale & Fuguitt, 2011; Kandel & Parrado, 2005; Lawson, Jarosz, & Bonds, 2010; Lichter, 2012; Lichter & Johnson, 2006; Parrado & Kandel, 2010). While the functions of non-metropolitan areas act as positive determinants for some, as a whole, metropolitan growth exceeds growth in non-metropolitan areas (Beale & Fuguitt, 2011; Demographic and economic profile: Kentucky, 2006).

In addition to factors related to metropolitan/non-metropolitan status, Kentucky's Appalachian counties have experienced population loss. According to Scommegna (2012), the Appalachian region experienced both growth and decline in population between 2000 and 2010: around a quarter of the region gained population, while about a third of the region lost population. Such declines may be attributed to Appalachia's large (42%) non-metropolitan population (The Appalachian Region, 2013) and its extensive out-migration of youth (Johnson, 2011; Obermiller & Howe, 2004). It is possible that the Appalachian region's lack of economic diversity and function as a retirement community influence the decision of residents to migrate.

Besides economic interests, natural amenities may impact migration. The traditional definitions of amenities include the natural resources of an area that are designated as desirable (Albrecht & Albrecht, 2007). Amenities are often measured according to a scale based on topographical ruggedness, climate, and relative water area (Brown et al., 2011; Hammond & Thompson, 2011; Kandel & Parrado, 2005). Additionally, scholars have argued for tourism to be included in an area's natural amenities (Brown et al., 2011; Lawson, Jarosz, & Bonds, 2010). Recent scholarship posits that social and cultural amenities also act to influence migration (Barone, 2013). Thus, the cultural functions of San Francisco's Chinatown or Dearborn's Islamic Center act as amenities influencing migration. In relation to the propensity to migrate, previous literature supports the idea that amenities are attractive pull factors to a location. Likewise, counties that lack natural amenities may experience out-migration, which contributes to population loss (Albrecht & Albrecht, 2007; Brooks et al., 2012; Brown et al., 2011; Kandel & Parrado, 2005; Lawson, Jarosz,& Bonds, 2010). Employing the theory of function-based spatiality provides insight into the significance of both natural and cultural amenities on migration patterns. Hence, it is possible that some remain in non-metropolitan, Appalachian counties, not because they feel stuck, but because they prefer the functions of a non-metropolitan community.

Median Household Income

Median household income is especially important for predicting migration patterns (Albrecht and Albrecht 2007; Brooks et al. 2012). Counties with higher levels of median household income are more likely to attract future businesses, especially those requiring technological skills (Bentele, 2007). This demonstrates the co-evolutionary aspect of migration and place. Economically affluent counties attract businesses requiring technological skills, which generally have higher wages, continuing the cycle of affluence. An increasing median household income indicates the presence of a stable or growing job market, which can be explained by the principle of iteration. Finally, Albrecht and Albrecht (2007) correlated the rise in certain service sector jobs to both higher median household incomes and to overall population growth. High-skill workers may rationally decide to migrate to locations that offer higher wages. This then leads to an increase in fertility.

Hypotheses

Table I presents the research hypotheses as well as the research decision. Hypotheses were divided into several categories, including demographic, co-evolution, sub-optimality, structural vs. individual migration, and economic.

Table 1. Research Hypotheses

Category	Hypothesis
Demographic	
	H_1: There is a positive relationship between the percent living in a different county in 1990 and 2000 and 2000 to 2012 population change.
	H_2: There is a positive relationship between the 2000 natural increase and 2000 to 2012 population change.
Co-Evolution	
	H_3: There is a negative relationship between the median age of a population and 2000 to 2012 population change.
	H_4: There is a positive relationship between the 1990 to 2000 percentage change in population aged 25 and older with at least a college-degree and 2000 to 2012 population change.
Sub-Optimality	
	H_5: There is a positive relationship between the 1990 to 2000 percentage change in occupations that are classified within the manufacturing sector and2000 to 2012 population change.
	H_6: There is a positive relationship between the 1990 to 2000 percentage change in occupations that are classified within the health and service sector and 2000 to 2012 population change.
Iteration	
	H_7: There is a positive relationship between the 1990 to 2000 percentage change in a county's percentage of Hispanic-origin residents and 2000 to 2012 population change.
	H_8: There is a negative relationship between a county's percentage of African American residents and 2000 to 2012 population change.
	H_9: There is a positive relationship between the 1990 to 2000 percentage change in the percentage of residents commuting to another county for work and 2000 to 2012 population change.
Geographical	
	H_{10}: There is a negative relationship between increased rurality and 2000 to 2012 population change.
	H_{11}: There is a negative relationship between Appalachian counties and 2000 to 2012 population change.
	H_{12}: There is a positive relationship between natural amenity scores and 2000 to 2012 population change.
Economic	
	H_{12}: There is a positive relationship between the 1990 to 2000 percentage change in median household income and 2000 to 2012 population change.
	H_{13}: There is a positive relationship between the 1990 to 2000 percentage change in the percentage living in poverty and 2000 to 2012 population change.

METHODOLOGY

Data and Units of Analysis

Kentucky's 120 counties were used as the unit of analysis for this study. Data sources included records from the U.S. Census Bureau and U.S. Department of Agriculture's Economic Research Service (United States Department of Agriculture, 2013). Specifically, population change data were utilized from the U.S. Census Bureau's population estimates, meaning that all population figures are subject to some degree of error.

Dependent Variable

The dependent variable for this study was the logged county-level 2000 to 2012 rate of population change for Kentucky counties.[1] Population change can be positive or negative, with positive figures indicating that the county gained more population from 2000 to 2012. Because negative values cannot be logged, a constant (the smallest value plus one) was added to every population change score. Data for this variable came from the American Community Survey estimates.

Independent Variables

Fourteen independent variables were observed in this study. Two variables were created to capture the importance of demographic processes (i.e. fertility, mortality, and migration). First, to capture the impact of long-term migration, the percentage of residents who lived in a different county in 1990 and 2000 was observed. Secondly, a variable capturing the 2000 natural increase rate was created by subtracting the number of deaths from the number of births and dividing the result by the total population and multiplying by 100.

Data for the predictor variables were taken from the 1990 and 2000 U.S. Census Bureau to ensure that the independent variables occurred prior to the dependent variable, thus demonstrating a time order relationship. Several variables were created to examine how social and economic changes from 1990 to 2000 impact Kentucky's 2000 to 2012 population change. Specifically, 1990 to 2000 percentage change variables were created for: the percentage of residents age 25 and older with a Bachelor's degree or higher, the percentage of workers within the manufacturing industry, the percentage of workers within the health and service sector, the percentage of residents commuting to another county for work, the percentage identifying as Hispanic, the median household income, and the percentage of individuals living below the poverty line.

In addition to the 1990 to 2000 change variables, two variables, median age and the percentage of residents who identified themselves as African American were examined using 2000 data only. This decision was made because no significant change occurred from 1990 to 2000. The 2000 measure, while static, seemed to provide more meaningful analysis.

Next, Non-metropolitan-Urban Continuum codes were used to help identify a county's degree of non-metropolitanity based on population size and access to urban areas (For a full discussion on Non-metropolitan-Urban Continuum Codes see the United States Department of Agriculture 2013). Codes range from "1" to "9," with "9" indicating the greatest degree of non-metropolitanity. Counties with Non-metropolitan-Urban Continuum Codes ranging from "1" to "3" are classified as metropolitan, while those ranging from "4"

[1] Calculation for 2000-2012 population change: ((2012 population-2000 population)/2000 population)) *100

to "9" are classified as non-metropolitan. For this study, one dummy variable was created to capture Kentucky counties with a Non-metropolitan-Urban Continuum code of "9," indicating the most non-metropolitan counties in Kentucky. Twenty-five Kentucky counties have been assigned a Non-metropolitan-Urban Continuum score of "9," meaning a fifth of the state's counties have been identified as being extremely non-metropolitan. In addition to the degree of non-metropolitanity, a dummy variable was created to measure whether or not the county was considered part of the Appalachian region. Finally, McGranahan (1999) developed county-level natural amenity scores to observe a county's climate, topography, and water area. Natural amenity scores can be either positive or negative because they are taken as standard deviations from the United States' national mean. Lower amenity scores signify a lack of natural amenities.

Modeling Strategy

First, descriptive statistics were calculated to display the means, standard deviations, and minimum and maximum values for the dependent variable and independent variables. An ordinary least square regression model was then utilized to examine the influence of geographic and socio-demographic factors on the 2000 to 2012 population change. Prior to running the analysis, diagnostics were conducted to check for multi-collinearity, outliers, heterscedasticity, and non-normality in the residuals (Fox, 1991). The variance inflation factors for all independent variables were much smaller than five, reducing multi-collinearity concerns.

There were outliers and residual issues for several variables including the 2000 to 2012 population change, the percentage employed in manufacturing, the percentage commuting to another county for work, the percentage of residents age 25 and older with a Bachelor's degree or higher, natural increase, and the percentage of residents living in a different county in 1990 and 2000. After logging each of these variables, re-analyzing the z-scores, and re-plotting the residuals, there were no further outliers or residual concerns. To test whether heterscedasticity was a concern, a Breusch-Pagan test was conducted for all independent variables, including the logged variables. The null hypothesis, which states that the error of the variances is equal, was not rejected. Finally, as with the dependent variable, some of the percentage change variables requiring transformation contained negative values. For example, many counties experienced a decrease in the number of manufacturing occupations. Because transforming the data requires a positive value, a constant was added to each score by setting the lowest value to one.

Three separate analyses were conducted with Model I examining the impact that those living in a different county in 1990 and 2000 and the 1990 to 2000 natural increase had on Kentucky 2000 to 2012 population change. Model II examines each of the independent variables with the exception of those living in a different county and natural increase. Finally, the full model, Model III, includes all independent variables, including those living in a different county and the natural increase.

Descriptive Results

Table 2 presents the means, standard deviations, and minimum and maximum values for the dependent and independent variables for this analysis. From 2000 to 2012, Kentucky's counties averaged a 4.79 percent growth. Scott County's 48.4 percent gain was the state's greatest percent change from 2000 to 2012. At the other end of the spectrum, Fulton County, experienced the state's greatest percentage decline.

Kentucky counties averaged 18.53 percent living in a different county in 1990 than 2000, with a natural increase rate of 3.05. In 2000, Kentucky's counties had a median age of 36.64. In terms of employment, from 1990 to 2000, Kentucky's counties averaged a 12.54 percent change in manufacturing and a 24.08 percent change in the health and service sector. With regards to race/ethnicity, Kentucky's counties averaged just over three and a half percent African American. From 1990 to 2000, Kentucky's counties averaged a 65.28 percent increase in the Hispanic population and a 14.69 percent increase in the percentage commuting to another county for work. The mean natural amenity score for Kentucky was 3.43, which is higher than the national average. Finally, Kentucky's counties averaged a 35.51 percent gain in median household income and almost a 27 percent decline in the percentage of individuals in poverty.

Table 2: Descriptive Statistics (N=120)

	Mean	SD	Minimum	Maximum
Dependent Variable				
2000-2012 Population Change	4.79	11.01	-15.83	48.38
Independent Variables				
Percent Lived in Different County in 1990 and 2000	18.53	6.42	5.7	38.2
Natural Increase Rate (2000)	3.05	3.23	-7.28	15.29
Median Age (2000)	36.64	2..78	27.9	41.5
1990-2000 Change in Percent of Population Age 25+ with College Degree	18.19	13.58	-28.96	49.14
1990-2000 Change in % Manufacturing	12.54	24.88	-71.8	66.75
1990-2000 Change in % Health and Service Sector	24.08	10.79	-1.4	90.57
1990-2000 Change in % Hispanic	65.28	27.24	-55	100
% African American (2000)	3.58	4.38	0	23.7
1990-2000 Change in Percent Commuting to Another County for Work	14.69	14.72	-31.4	58.54
Rural Continuum Score of "9."	.18	.38	0	1
Appalachian State	.43	.5	0	1
Natural Amenity Score	3.43	.56	2	4
1990-2000 Change in Median Income	35.51	6.63	6.29	53.19
1990-2000 Change in Percent Living in Poverty	-26.87	21.05	-118.07	23.94

Multivariate Results

Table 3 displays the multiple regression results. Model 1 includes the two population processes variables. Model 1 explains 20 percent of the variance. Both the percent living in a different county in 1990 and 2000 (b=1.88; p≤0.001) and the 1990 to 2000 natural increase rate (b=1.58; p≤0.01) are positively associated with population change. The standardized coefficients reveal that the percent living in a different county in 1990 and 2000 had a stronger impact on population change than the natural increase.

Model 2 includes all the independent variables, with the exception of the two population processes variables. About 33 percent of the variance is explained in model 2. Three variables positively predict population change. First, as the 1990 to 2000 percentage working within the manufacturing industry increased (b=.16; p≤0.05), the 2000 to 2012 population change increased. Next, as the 1990 to 2000 percent identifying as Hispanic (b=.4; p≤0.001) increased, the 2000 to 2012 population change increased. Finally, as the 1990 to 2000 median household income (b=.02; p≤0.05) increased, the 2000 to 2012 population change became more positive. Three variables, median age (b=-0.07; p≤0.05), the 2000 percentage identifying as African American (b=-0.4; p≤0.001), and counties located within the Appalachian region (b=-0.38; p≤0.01), were negatively related to population change. According to the standardized coefficients, the percentage of residents identifying as African American had the strongest impact on population change, followed by whether or not the county was in the Appalachian region and median age.

The full model, which included all independent variables, including the two demographic processes variables, explained 38.2 percent of the variance. As in Model 1, both the percent living in a different county in 1990 and 2000 (b=1.42; p≤0.001) and the 1990 to 2000 natural increase rate (b=1.65; p≤0.01) positively predicted population change. Two other variables, the 1990 to 2000 percent change in those identifying as Hispanic (b=0.12; p≤0.01) and the 1990 to 2000 change in median household income (b=0.02; p≤0.05), also positively predicted Kentucky's counties 2000 to 2012 population change. Finally, two variables were negatively associated with population change. First, as the 2000 percentage identifying as African American (b=-0.09; p≤0.01) increased, the 2000 to 2012 population change decreased. Also, when the county was located in Kentucky's Appalachian region (b=-0.25; p≤0.05), the trend was for negative population change. Once again, the standardized coefficients revealed that the percent living in a different county in 1990 and 2000 had the strongest impact on population change.

(Continued on next page)

Table 3: OLS Regression Analysis of Kentucky's Population Change, 2000 to 2012 (N=120)

	Model 1		Model 2		Model 3	
	b's (SE)	**Standardized Coefficients**	**b's (SE)**	**Standardized Coefficients**	**b's (SE)**	**Standardized Coefficients**
Percent Lived in Different County 1990 and 2000	1.88 (.5)	.33***			1.42 (.6)	.32***
Natural Increase Rate (2000)	1.58 (.63)	.22**			1.64 (.8)	.26**
Median Household Income (2000)			-.07 (.03)	-.28*	.01 (.04)	
1990-2000 Change in Percent with B.S. Degree or Higher			.11 (.09)	.02	.07 (.09)	.01
1990-2000 Change in % Manufacturing			.16 (.1)	-.16*	.1 (.1)	-.08
1990-2000 Change in % Health and Service Sector			.06 (.1)	-.04	.02 (.1)	-.01
1990-2000 Change in % Hispanic			.4 (.12)	.2**	.2 (.12)	.14**
% African American (2000)			-.09 (.02)	-.32***	-.09 (.02)	-.28**
1990-2000 Change in Percent Commuting			.07 (.19)	-.03	.02 (.19)	.00
Rural Continuum Score "9"			-.00 (.2)	-.02	-.00 (.2)	-.02
Appalachian State			-.38 (.16)	-.29**	-.25 (.17)	-.17*
Natural Amenity Score			.02 (.13)	-.01	.02 (.12)	-.00
1990-2000 Change in Median Household Income			.02 (.12)	.14*	.02 (.12)	.13*
1990-2000 Change in Percent Poverty			-.00 (.00)	-.05	.00 (.00)	.02
Constant	-1.23		5.46		-1.43	
R-Squared	.2		.325		.382	
Root MSE	.78		.74		.72	

In summary, the percentage of the population employed within the manufacturing industry was significant in Model 2, but not in the full model. Four variables, the 1990 to 2000 change in Hispanic population, the 2000 percentage identifying as African American, the dummy variable measuring whether the county was located in the Appalachian region, and the 1990 to 2000 change in median household income, were significant predictors of population change in both Model 2 and the full model. Finally, the two demographic process variables, the percent living in a different county in 1990 and 2000 and the 1990 to 2000 natural increase rates, were positive predictors of population change in both Model 1 and the full model.

DISCUSSION AND CONCLUSION

The purpose of this paper was to use a function-based spatiality approach to examine Kentucky's 2000 to 2012 population change. The 2010 Census updates allow researchers to document population trends, including which factors are most influential in affecting population change. A function-based spatiality framework recognizes the complexity of factors for migration and the interconnectivity between counties. The theory also allows for individual decisions for migration with outcomes seen as patterns across the larger social structure.

Both demographic process variables positively predicted population change, meaning that both migration and natural increase were significant in predicting Kentucky's counties 2000 to 2012 population change. However, it appears that migration patterns in the 1990s had a stronger impact on Kentucky's 2000 to 2012 population change than the natural increase, thus justifying the importance of migration. Counties with a higher percentage of residents living in their county in 1990 and 2000 tended to experience positive 2000 to 2012 population change, meaning that migration patterns in the preceding decade continued to persist and affect population change in the next decade. Thus, although slightly more than half of Kentucky's growth occurred because of natural increase, when other variables are controlled for, migration had a stronger impact on population change.

Of the two co-evolution hypotheses, only Hypotheses III, which predicted that median age would negatively impact population change, was accepted, but only in model II. It appears that the effect of median age is negated when the two demographic variables are added to the regression equation. This only partially supports function-based spatiality theory because residing in another county the previous census and the natural increase appear to be better predictors for population change. It is possible that the co-evolution variables, especially median age, would have a greater impact outside of Kentucky. Or, because Kentucky has 7 bordering states, maybe counties touching the Kentucky border impact Kentucky population change that was not captured in this study.

Of the sub-optimality hypotheses, only Hypotheses IV, which predicted that the percentage change of jobs that are manufacturing and population change are related, was accepted in model II only. Once again, when the demographic variables are added to the regression equation, the effect of manufacturing occupational change is diminished. This result is a bit surprising given Kentucky's long history with manufacturing. While several states saw a decline in manufacturing, Kentucky actually gained manufacturing jobs (Beyers & Nelson, 1999; Johnson, 2012). Again, bordering states with larger cities may affect population change. For example, Fort Campbell, Kentucky, borders Tennessee near Clarksville. Many individuals may live in Clarksville, but work in Kentucky.

The two race/ethnicity hypotheses were supported in both models. This supports function-based spatiality's concept of iteration which postulates that as the Hispanic population increases in Kentucky, it will continue to increase in areas predominantly connected to agricultural and manufacturing, which tend to attract low-skill migrants. Additionally, as Wilson (2009) notes, structural constraints, like institutional discrimination experiences, make it difficult to compete in society. It appears that having a high percentage of African Americans within the county's boundaries leads to population decline. Albrecht and Albrecht (2007) found that as an exploited group, who has traditionally represented the bottom of the social hierarchy, minority populations, including African Americans, may be limited, and even excluded from certain economic opportunities. For example, African Americans living in the inner-city may not witness businesses moving to the suburban counties.

Of the geographical variables, only the Appalachian dummy variable significantly predicted population change. Hypothesis XII predicted that Appalachian counties would be negatively related to population change. Appalachian counties lack a perceived function as retirement communities, tend to lack economic diversity, are non-metropolitan, and are characterized by having higher than average poverty rates. These factors may push residents to make the choice to migrate to a larger city with more economic and educational opportunities. This lack of economical resources also does not draw new population that could increase fertility rates.

Finally, Hypothesis XIII, which predicted that median household income would positively impact population change, was supported. Indeed, median household income appears to be the single strongest predictor of population change. As predicted by the function-based spatiality model, median income can work as a cause of positive population change and consequence of negative population change. Counties that have low income levels may experience out-migration to counties with a stronger economic base, especially if the out-migrants are seeking better educational and occupational opportunities. Also, unlike other theories that imply that potential migrants may desire to migrate, but lack the resources to do so, function-based spatiality recognizes that some residents may actually desire, and ultimately choose to stay in their home county of residence, even if it means sacrificing economic advancements.

In summary, several of the hypotheses received at least partial support. In the full-model, the percentage living in a different county in 1990 and 2000, the 2000 natural increase rate, the 1990 to 2000 change in the percentage of Hispanic residents, the 1990 to 2000 percentage of African American residents, whether or not the county was identified as Appalachian, and 1990 to 2000 median household income all predicted Kentucky's counties 2000 to 2012 population change.

Limitations

There are several limitations that require cautious interpretation of the results. First, the narrow geographical focus is cause for concern. While there are benefits of focusing on a single state, additional studies are necessary to refine findings. Focusing on other states, or expanding the study to an entire region, would allow for geographical comparisons and is suggested for future research.

Next, Johnson (2011) argues that spatial autocorrelation statistics are more effective in capturing the longitudinal changes that can occur over time. The current study is better described as cross-sectional, rather than longitudinal because two single time periods are observed. Future studies can benefit from applying statistical methods that capture the longitudinal potential of the data and can capture the impact of neighboring counties with similar characteristics.

Despite these limitations, this study makes several contributions to the current literature. First, function-based spatiality is relatively new and can be applied and tested with other states, or even a larger region. This study also offers a multivariate analysis for describing which indicators are most important in predicting Kentucky's counties population patterns.

Practical Implications

As businesses, governmental institutions, and individual actors analyze and make decisions regarding resource allocation, a solid comprehension of the underpinnings of demographic change is invaluable. At the county, regional, state, and national levels, factors and processes of migration are vital components for evaluating counties with differing populations and roles within their nested spheres. Function-based spatiality provides stakeholders with a theoretical model through which the interconnectivity of counties can be assessed in support of services most necessary for public good. Stakeholders can also implement positive economic reform through a better understanding of the spatial relationships.

Understanding demographic change through the use of function-based spatiality provides businesses with a framework whereby business can work in conjunction with the predominant spatial norms rather than compete against the historically solidified functions of the place. Utilizing function-based spatiality in demography, governmental agencies can seek to attract business that will be successful within the contexts of place. For example, the newly acquired function as a supplier of oil and gas in North Dakota and Appalachia has led to population gains in counties, which due to lack of attractive functions, have historically lost population (Mather and Jarosz, 2014). While much of this growth has occurred because of in-migration, the younger age structure helps raise the fertility rate as well. For those interested in policy, it is important to ask whether newly developing functions such as gas extraction, are sustainable over time. While adding younger people may create a demand for new services, which could potentially attract businesses, this increased population creates new challenges, such as over-crowded schools, housing needs, and congested traffic (Mather and Jorosz, 2014). Although in its theoretical infancy, this study shows the implementation of function-based spatiality as a viable tool in understanding demographic shifts in Kentucky. It is hoped that future studies will provide additional insights into this new perspective on migration and demographics.

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