Ex-Urban Sprawl and Fire Response in the United States

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Keywords: urban sprawl, fire safety, fire response, property loses, loss of life.

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Abstract

Much has been written in the post-World War II era in the United States about the rise of suburbia and development beyond older city boundaries, whether such development has been called urban, suburban, or ex-urban sprawl. Many writers have focused on various issues concerning sprawl, especially on the unintended consequences that new development has had on (among other issues) municipal finances, neighborhood income and residential segregation, and transportation planning, this last one being important since post-World War II development has mostly centered around the automobile in the US. Over the last decade or so, a new area in the literature on sprawl has focused on how the "built-environment" of residential areas can impact health. For example, authors have chronicled how sprawled regions have higher auto vehicle accidents per capita, greater obesity rates, greater carbon emissions (due to greater travel by automobile), and delays in emergency medical service responses. This research note adds to these latest set of papers on sprawl by trying to empirically estimate the impacts of sprawl in metropolitan regions on fire incidents per capita, firefighter response times, property losses due to fire, and deaths due to fire. In this exploratory analysis the results indicate that urban sprawl is an important factor in influencing firefighting issues and outcomes in the US.

Keywords: urban sprawl, fire safety, fire response, property losses, loss of life.

Introduction

Sprawl is claimed to be low-density development with large lot home parcels and little mixed-use zoning (an intermingling of residential, retail and office land uses) and with most workers commuting to work at least several miles by automobile (Ewing 1997, Gordon and Richardson 1997, Glaeser and Kahn 2003). Whereas some dispute that sprawl exhibits negative externalities or point out that sprawl is hard to define and operationalize (Gordon and Richardson 1997), other writers have claimed that sprawl has been responsible for many problems in US society since the end of the Second World War in 1945. These writers have usually mentioned "white flight", racial segregation, municipal finance problems, transportation problems (traffic congestion, more and spending on roadways, etc.), and other problems as ones having their roots in residential and commercial development that is not well planned and centered around the automobile and relatively cheap fossil fuels (Atkinson and Oleson 1996; Barnett 1995; Burchell and Lisotkin 1995; Ewing 1997; Burchell et al., 1998; Carruthers and Ulfarsson 2002; Ciscel 2001; and Glaeser and Kahn 2003). Recently, a new set of authors have noted sprawl and its impact on health and public safety issues. Sprawl has been linked to weight and obesity problems (Schmidt 2004), various health problems (Frumkin 2002; Lopez 2004), higher traffic accident and fatality rates (Ewing, Schieber and Zegeer, 2003; Lucy 2003; and Lucy 2000) as well as emergency medical services delays (Lambert and Meyer 2006 and 2008; Trowbridge, et al 2009).

In a paper by American Farmland Trust (1998) that involved a case study of the Chicago area, police, fire and emergency medical services (EMS) were found to be delayed in their responses to various emergencies by sprawled development. In the course of doing research on this paper, so far no broader study has been found that chronicles whether slower police response times occur due to sprawl in other regions of the US. With regard to EMS, Lambert and Meyer (2006 and 2008) and Trowbridge, et al (2009) found new and sprawled development linked to delays in EMS response rates throughout the US, whereas Lambert, Srinivasan, and Min (2009) found that the most efficient EMS units of large cities in the US were those associated with the municipalities that had the least amount of sprawl and greatest residential density. Wilde (2008) found that EMS response time significantly affected mortality although not hospital utilization. With firefighter response, in a study of several major cities throughout the US, Katirai (2009 and 2011) found mixed results when assessing the impacts of sprawl and poverty on response times—in some cities, higher degrees of sprawl and poverty were associated with slower response times whereas in others these variables did not matter. The popular press, however, has cited slower fire response rates in various metro regions due to sprawl and new development, especially where the new development occupies former agricultural or forest land and is adjacent to existing forest land (Schlueb 2004; Dedman 2005; Fire Rescue News 2007; Roberts 2009). The US Fire Administration noted in March 2002 (Topical Fire Research Series, Vol. 2, Issue 16) that during the year 2000, 38% of new residential development in the US occurred in areas classified as the "wildland-urban interface", or WUI, areas which presented more challenges to suburban and rural fire districts. As stated by the National Fire Protection Association (NFPA):

> "More people worldwide are moving into areas prone to wildfire, and the threat to millions of individuals, their homes and to communities grows ever larger. Understanding the worldwide fire phenomenon and ways to mitigate its damage is paramount." (October 20, 2011).
> http://www.nfpa.org/newsReleaseDetails.asp?categoryid=488&itemId=53736

In this paper, using the US National Fire Incident Reporting System (NFIRS) published by the US Fire Administration (USFA) (http://www.usfa.fema.gov/statistics/), an attempt is made to see if there is a nationwide connection between new and ex-urban sprawled development and the following: firefighter response times, fire incidence rates, property loss due to fire, and deaths due to fire.

Methods

The 2000 US NFIRS database gives data for fire incidents for 43 states [1] and usually lists fire incidences chronologically according to location (address with city and zip code), length of response time, property loss values, and civilian and firefighter casualties. Around three million cases were listed for 2000, of which two million were found to be useful for the purposes of this study since all variables of interest were in these two million cases. Unfortunately, there are several shortcomings with the database. The counties where the fire incidents occurred are not listed, and errors were found with regard to the correct fire district responding to an emergency, so using fire districts to pinpoint incident location was not used. For example, in Jefferson County, Kentucky all fire incidents were supposedly handled by the City of Louisville Fire and Rescue Department, when in fact there are 17 other fire districts that exist within the county, and in looking at the addresses and zip codes of fire incidents, not all incidents were handled by the City of Louisville Fire Department because certain zip codes corresponded to the areas covered by the other fire districts. In a small set of cases for some states, census tracts are disclosed, but there are not many of these. Additionally, unlike the Fatality Analysis Reporting System (FARS) database of the US Department of Transportation (http://www-

[1] Data was not available for the District of Columbia, Arizona, California, Connecticut, Maryland, North Dakota, Pennsylvania, and West Virginia. The 2000 NFIRS database is used along with the 2000 US Decennial Census in this paper because at the time this study was started, the 2010 NFIRS had not yet been released, and not all of the data for the 2010 US Decennial Census had been yet fully released.

nrd.nhtsa.dot.gov/cats/index.aspx), incidents are not classified as either urban or rural, a key distinction used by Lambert and Meyer (2006 and 2008) in estimating sprawl in various US counties. Finally, by the admission of USFA, many fire departments fail to completely fill out survey forms so that city and 5 digit zip code data are often incorrect or have to be filled in by USFA itself in order to complete a postal address for a fire incident (USFA National Fire Incident Reporting System 5.0 Data Analysis Guidelines and Issues). For example, if a 5 digit zip code and/or city is missing from an address, USFA will go ahead and complete the address by filling in the zip code and/or name of the city of the headquarters of the fire department reporting the incident, which may or not have the same zip code and/or city name as the location of the incident.

Nevertheless, despite these limitations, a geographic basis for the purpose of analyzing the data can be created by using US Census Bureau's 3-digit Zip Code Tabulation Areas (ZCTAs, pronounced "zik-tas"), which correspond to a cluster of zip codes in a geographic area that begins with the same first 3 digits (US Census Bureau). There are around 885 ZCTAs in the continental US and Alaska and Hawaii listed for the year 2000 by the Census. Using 3-digit ZCTAs and limiting the analysis to those ZCTAs which only contain urban and rural but non-farm populations and housing units (no ZCTAs with rural and farm populations and housing were used[2]), geographic regions are formed which closely align (around an 85% overlap) with

[2] "For Census 2000, the Census Bureau classifies as "urban" all territory, population, and housing units located within an urbanized area (UA) or an urban cluster (UC), and it forms UA and UC boundaries to encompass densely settled territory, which consists of:
• core census block groups or blocks that have a population density of at least 1,000 people per square mile and
• surrounding census blocks that have an overall density of at least 500 people per square mile
In addition, under certain conditions, less densely settled territory may be part of each UA or UC.
The Census Bureau's classification of "rural" consists of all territory, population, and housing units located outside of UAs and UCs. The rural component contains both place and nonplace territory. Geographic entities, such as census tracts, counties, metropolitan areas, and the territory outside metropolitan areas, often are "split" between urban and rural territory, and the population and housing units they contain often are partly classified as urban and partly classified as rural." (Source: www.census.gov/geo/www/ua/ua_2k.html)

the geographic boundaries of either combined statistical areas (CSAs) or metropolitan statistical areas (MSAs) and micropolitan areas throughout the 43 states that make up the database as confirmed through geographic information systems (GIS) analysis. Figure 1 shows the metropolitan and micropolitan areas covered in the US by the ZCTAs in the database, and Figure 2 illustrates the degree of overlap between the Louisville-Elizabethtown, KY-IN Metropolitan Statistical Area and its corresponding ZCTAs (the region's boundary is the MSA) and Figure 4 shows the degree of overlap between the Birmingham-Hoover, AL MSA and its corresponding ZCTAs. These urban regions take in most if not all the ZCTAs corresponding to them.

(Insert Figures 1 to 3 around here)

Based on models developed in other articles (Kvalseth and Deems, 1979; Ewing, et al 2003; Lambert and Meyer 2006 and 2008; Katirai 2009) and scatter diagram results, a double log, least squares model (see equation 1 below) was chosen for the models developed from the variables below. All variables are based on the 2000 Census of Population and Housing, the 2000 National Fire Incident Reporting System.

$$\text{Ln } Y = \beta 0 + \beta 1 \text{ Ln } X1 + \beta 2 \text{ Ln } X2 + \beta 3 \text{ Ln } X3 + \beta 4 \text{ Ln } X4 + \beta 5 \text{ Ln } X5 + \varepsilon \qquad (1)$$

<u>Dependent Variables:</u>

1. Mean Response Time in Minutes: The mean response rate of firefighters (paid and/or volunteer) to fires for each ZCTA. The more sprawled an area, it is expected that the response times to fire emergencies should be longer than otherwise on average, similar to the findings of Lambert and Meyer (2006; 2008) and Trowbridge, et al (2009).
2. Incidents Per Capita: The number of fire emergencies per capita for each ZCTA. There were 1,331,500 fires in 2010 according to the National Fire Protection Association or

NFPA (http://www.usfa.fema.gov/statistics/estimates/nfpa/index.shtm). Similar to Ewing, et al, (2003) the incidents for an area are put on per capita basis in order to make valid comparisons among regions of different sizes.

3. Property Loss Per Capita: The total property loss per capita for each ZCTA. According to the NFPA, the value of property losses was around $11.6 billion in 2010 (http://www.usfa.fema.gov/statistics/estimates/nfpa/index.shtm). Again, to make comparison among regions of different sizes, losses are put on per capita basis.
4. Deaths Per Capita: The sum of firefighter and civilian deaths per capita for each ZCTA. In 2010, there were 3,120 deaths from fire according to the NFPA (http://www.usfa.fema.gov/statistics/estimates/nfpa/index.shtm). Again, a per capita basis is done for comparison purposes.

Independent variables:

1. Total Fire Fighters and Staff, Paid and Volunteer: The sum of paid and volunteer firefighters and their support staff (dispatchers, aids, etc.) for each ZCTA. This is used as a control variable when testing to see if a sprawl effect matters when it comes to response time, incidents, property loss or death (Lambert and Meyer 2008). According to NFIRS, approximately two-thirds of all fire departments in the US are volunteer, and 95% of these serve districts of less than 25,000 people, many of these in suburban and semi-rural areas. This variable is hypothesized to have an inverse relationship with each of the dependent variables.[3] (http://www.usfa.fema.gov/statistics/estimates/nfpa/index.shtm).

[3] The total number of firefighters and support staff was tried on a per square mile basis, but this variable was highly correlated with the variable "Area in Square Miles", another variable used in the models, and this high degree of correlation resulted in issues of multicollinearity. Total numbers per region were used instead, and the results using this variable do not exhibit symptoms of multicollinearity.

2. Median Household Income: The 1999 median household income for each ZCTA. This is used as a measure of a region's financial capacity to pay for firefighting services and is another control variable (Lambert and Meyer 2006 and 2008). The greater the income in an area, usually the greater the financial resources available and used via local taxes to fight fires, and so this variable is hypothesized to have an inverse relationship with each of the dependent variables.
3. Median Age of Homes: The median age for all homes for each ZCTA. Usually the newer the homes, the more sprawl (Lambert and Meyer 2006 and 2008)—newer development is usually in fringe areas. However, newer homes are probably less resistant to fire due to the fact that their electrical wiring and other contents are not that old and worn yet when compared to older homes. Therefore, the sign for this variable in its relationship with the dependent variables is not hypothesized because its influence on them is uncertain.
4. Area in Square Miles: The number of square miles for each ZCTA. The hypothesis is that usually the larger the area, the harder it is to provide it with fire services, although if there are more fire districts and firefighters to compensate for the size, then a larger area does not present a problem (Lambert and Meyer 2006 and 2008). This variable is hypothesized to have a positive relationship when it comes to the four dependent variables, holding everything else constant.
5. Ex-Urban Sprawl: The number of rural but non-farm population and housing units (those in census block groups below 500 people per square mile) divided by total population and housing for each ZCTA. Because urban and rural non-farm land areas within each ZCTA are not delineated by the US Census (only land area for entire ZCTA is given) it is not possible to construct a density index as done by Lambert and Meyer (2006; 2008) where

the authors created a density index by calculating urban population and urban housing units per urban square mile. No ZCTAs with any rural and farm population and housing were used in the analysis, and so this paper's definition of ex-urban sprawl comes close to how Webster's Dictionary defines ex-urbia: "a residential area outside of a city and beyond suburbia." (http://Websterdictionary.org/definition/exurbia). This variable takes into account low density development that is still within metropolitan areas and is the key variable of interest. The hypotheses are that the greater this measure of ex-urban sprawl, the greater the values of the dependent variables, and hence its relationship with each of the dependent variables should be positive.

Results

(Insert Tables 1 and 2 around here).

The descriptive statistics for these variables are in Table 1. As you can tell from the correlation matrix presented in Table 2 there appear to be no issues with regard to multicollinearity among the independent variables if one uses a cutoff of $r \geq |0.9|$ or a variance inflation factor (VIF) ≥ 10.0 (Lewis-Beck 1980; Levine et al 2008, pages 625-626), although there appear to be a high correlations between LN Area and LN Ex-urban Sprawl (positive sign).

(Insert Tables 3 to 6 around here)

In looking at the beta coefficients and for p-values with values less than 0.05 for the model in Table 3, the mean response time in minutes for firefighting units is best explained by the degree of ex-urban sprawl in a region as well as how large of an area has to be covered (of course, these two variables are highly correlated). The total number of firefighters and their staff in an area is statistically significant only at $\alpha = 0.10$, although the sign of the coefficient as hypothesized is correct—the greater the coverage by firefighter personnel, the lower the mean response time. The sign of the median household income variable has its hypothesized sign, but like the variable median age of homes, it does not achieve statistical significance. However, the only 0.24, although in the social sciences such a reading is not considered bad (Anderson, Sweeney, and Williams 2006, page 563). Further research would need to be conducted to see what other variables, if any, could be linked to shorter or longer response times. However, the ex-urban sprawl variable is statistically significant, and could be the key determinant of the differences between urban and ex-urban response times.

In examining the model in Table 4, this model has a moderate amount of explanatory power (r-square = 0.59), and all but the area in square miles variable are statistically significant. For the variable median age of homes, according to the US NFIRS (2010), homes typically 40 years or older are more prone to fire than newer ones on average because they have a much higher rate of electrical malfunctioning which can cause fires (due often to old wiring). Therefore, although newer homes are usually in more sprawled and newly developed areas, these homes may actually be less vulnerable to fire because of their age, holding everything else constant, and so the positive coefficient makes sense. At the same time, the ex-urban sprawl variable, median household income, and total firefighters and staff all are good predictors of incidents per capita and have the hypothesized signs.

The model in Table 5 shows the weakest results of the four models covered in this paper with a r-square of only 0.10. All but the variables area in square miles and median household income achieve statistical significance (p-values < 0.05), although are in square miles is statistical significant at $\alpha < 0.10$. Total firefighters and staff in the region help to minimize property loss whereas older homes in an area raise the level of property losses, all other things held constant. The ex-urban sprawl variable has the largest beta coefficient value and has the greatest impact on the property loss per capita, so the sprawl variable does matter, although other variables or effects not in the model could exist that would possibly explain property losses per capita more fully. Further research would have to be done to look for other variables.

Finally, the model in Table 6 shows that the ex-urban sprawl variable is linked to deaths per capita in each ZCTA and has the hypothesized sign, positive. The greater the ex-urban sprawl in a region, all other things held constant, the greater the fire fatalities per capita. Perhaps this is so because so many ex-urban areas, as mentioned earlier, adjoin wilderness areas which can have devastating and dangerous wildfires, fires that are potentially more dangerous and can spread faster than fires in typical residential or commercial areas. According to Fahy (2009) around 18% of all firefighter fatalities from 1999 to 2008 (not including those of September 11, 2011) occurred during or because of wildland fire fights. With the exception of area in square miles, all other variables in this model are statistically significant as well (p-value < 0.05) and have the sign hypothesized, and the explanation of variance is around 35% (r-square = 0.35). Interestingly, the median household income variable is statistically significant and has a negative sign, which may indicate that some fringe areas may be minimizing their vulnerability to fire emergencies through paying for preventative techniques or for a greater amount of fire services.

Discussion

With the rapid development of ex-urban and fringe residential areas over the years, the externalities created by these areas in the form of certain health and safety issues with regard to traffic fatalities and EMS delays have been raised and examined over the years (Ewing, et al

2003: Lucy 2003; and Lambert and Meyer 2006 and 2008; Trowbridge, et al 2009). This paper has added to the list of safety concerns which occur in fringe and newly developed areas by noting the link between ex-urban sprawl and fire response. On average, mean response times to fire emergencies are longer in ex-urban areas than in more urban and suburban ones, and fire incident rates, fire property losses, and human casualties due to fire are higher in ex-urban areas than in other types of settlement patterns, holding all other things constant. As mentioned in other papers and works, in a society which encourages home ownership through mortgage tax breaks and the promotion of the "American Dream", and which also encourages further outward development from older neighborhoods through continuous road construction projects, new home construction in formerly rural and forested areas is highly likely, although rising fuel and energy costs may mitigate this trend somewhat. However, as noted earlier in this paper, along with these events come the negative externalities associated with sprawl (race and income segregation, municipal finance problems, etc.). Clearly, as the analysis above indicates, the safety hazards of living in ex-urban areas have to be added to these list of externalities, unless enough regions of the country internalize the externalities by raising the taxes and spending the money necessary to minimize fire emergencies to a greater degree than what exists now, especially given the evidence that most ex-urban and sparsely populated areas are more likely than not served by low-cost, volunteer fire departments. Otherwise, many local jurisdictions, in doing either benefit-cost analyses or cost-effectiveness analyses of their fire protection services may decide to start limiting the growth of new developments that do not pay for the costs of additional and adequate public services. Such policies are often done through the enactment of growth boundaries or higher impact fees for new development.

The results in this paper need are limited by the fact that it would have been better to measure fire response at the fire district level, but because of inconsistent data entries, this was not possible. If better data later presents itself, the analysis should be re-done at the district level. Nevertheless, the ZCTA data used here is a fair and a fairly accurate way to represent regional built environments for the purposes of analysis. Further research needs to be done on how certain jurisdictions are dealing with the settlement of wildlands and other ex-urban areas with regard to fire protection. Unfortunately, due to the high costs of obtaining the data, insurance ratings of homes in different areas were not used to gauge the risk of settling and living in ex-urban areas. Perhaps future researchers can obtain this data, although the results in this paper strongly show ex-urban living to be risky with regard to delayed fire response, fire casualties, property loss, and higher incidents per capita, all else held constant.

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Table 1—Descriptive Statistics

Variable	Mean	Std. Dev.
Mean Response in Minutes	6.8041	2.91945
Incidents per Capita	0.0001	0.00035

Property Loss Per Capita	$0.0032	0.02369
Deaths Per Capita	0.00001	0.00004
Median Household Income in 1999	$45,381.86	13151.93
Total Firefighters and Staff, Volunteer & Paid	1260.65	1380.012
Median Age of Housing Units	35.94	10.74
Area in Square Miles	502.19	1580.43
Total population: Urban	504,962.8	479,939.38
Total population: Rural; Nonfarm	12,333.64	19,386.15
Housing units: Urban	206,674.13	192,029.46
Housing units: Rural; Nonfarm	4777.12	7492.74

Table 2—Pearson Correlation Coefficients

		1	2	3	4	5	6	7	8	9
1. LN Mean Response	Pearson Correlation	1	.331	.034	.114	.450	-.243	-.196	.490	.028
	Sig. (2-tailed)		.000	.395	.058	.000	.000	.000	.000	.462

	N	686	685	621	277	652	686	686	686	685
2. LN Incidents Per Capita	Pearson Correlation	.331	1	.389	.581	.510	-.456	.154	.220	-.431
	Sig. (2-tailed)	.000		.000	.000	.000	.000	.000	.000	.000
	N	685	721	655	290	685	721	721	721	721
3. LN Property Loss Per Capita	Pearson Correlation	.034	.389	1	.370	.179	-.123	.139	-.027	-.204
	Sig. (2-tailed)	.395	.000		.000	.000	.002	.000	.497	.000
	N	621	655	656	291	620	656	656	656	655
4. LN Total Deaths Per Capita	Pearson Correlation	.114	.581	.370	1	.274	-.319	.263	-.061	-.394
	Sig. (2-tailed)	.058	.000	.000		.000	.000	.000	.300	.000
	N	277	290	291	291	277	291	291	291	290
5. LN Ex-urban Sprawl	Pearson Correlation	.450	.510	.179	.274	1	-.365	-.184	.688	-.011
	Sig. (2-tailed)	.000	.000	.000	.000		.000	.000	.000	.765
	N	652	685	620	277	686	686	686	686	685
6. LN Median Household Income	Pearson Correlation	-.243	-.456	-.123	-.319	-.365	1	-.063	-.311	.119
	Sig. (2-tailed)	.000	.000	.002	.000	.000		.093	.000	.001
	N	686	721	656	291	686	722	722	722	721
7. LN Median Age of Housing Units	Pearson Correlation	-.196	.154	.139	.263	-.184	-.063	1	-.389	-.252
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.093		.000	.000
	N	686	721	656	291	686	722	722	722	721
8. LN Area in Square Miles	Pearson Correlation	.490	.220	-.027	-.061	.688	-.311	-.389	1	.332
	Sig. (2-tailed)	.000	.000	.497	.300	.000	.000	.000		.000
	N	686	721	656	291	686	722	722	722	721
9. LN Total Firefighters and Staff	Pearson Correlation	.028	-.431	-.204	-.394	-.011	.119	-.252	.332	1
	Sig. (2-tailed)	.462	.000	.000	.000	.765	.001	.000	.000	
	N	685	721	655	290	685	721	721	721	721

Table 3—Dependent Variable is Mean Response Time

	Unstandardized Coefficients	Standardized Coefficients	t	Sig.

Model	B	Std. Error	Beta		
(Constant)	2.474	.678		3.647	.000
LN Total Firefighters & Staff	-.029	.015	-.070	-1.842	.066
LN Area in Square Miles	.069	.013	.273	5.215	.000
LN Median Age of Housing Units	-.043	.044	-.037	-.981	.327
LN Median Household Income	-.065	.058	-.042	-1.111	.267
LN Ex-urban Sprawl	.059	.012	.242	4.858	.000

Adjusted R-square: 0.24

N = 650

Table 4—Dependent Variable is Fire Incidents Per Capita

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	7.250	3.541		2.048	.041
LN Total Firefighters and Staff	-1.179	.081	-.396	-14.492	.000
LN Area in Square Miles	.082	.070	.044	1.169	.243
LN Median Age of Housing Units	1.809	.231	.209	7.838	.000
LN Median Household Income	-2.783	.306	-.249	-9.100	.000
LN Ex-urban Sprawl	.738	.063	.423	11.739	.000

Adjusted R-square: 0.59

N = 684

Table 5—Dependent Variable is Property Loss, $, Per Capita

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	-2.934	4.664		-.629	.530
LN Total Firefighters and Staff	-.277	.113	-.110	-2.448	.015
LN Area in Square Miles	-.192	.107	-.115	-1.797	.073
LN Median Age of Housing Units	1.157	.305	.155	3.790	.000
LN Median Household Income	-.625	.404	-.066	-1.549	.122
LN Ex-urban Sprawl	.393	.089	.266	4.418	.000

Adjusted R-square: 0.10

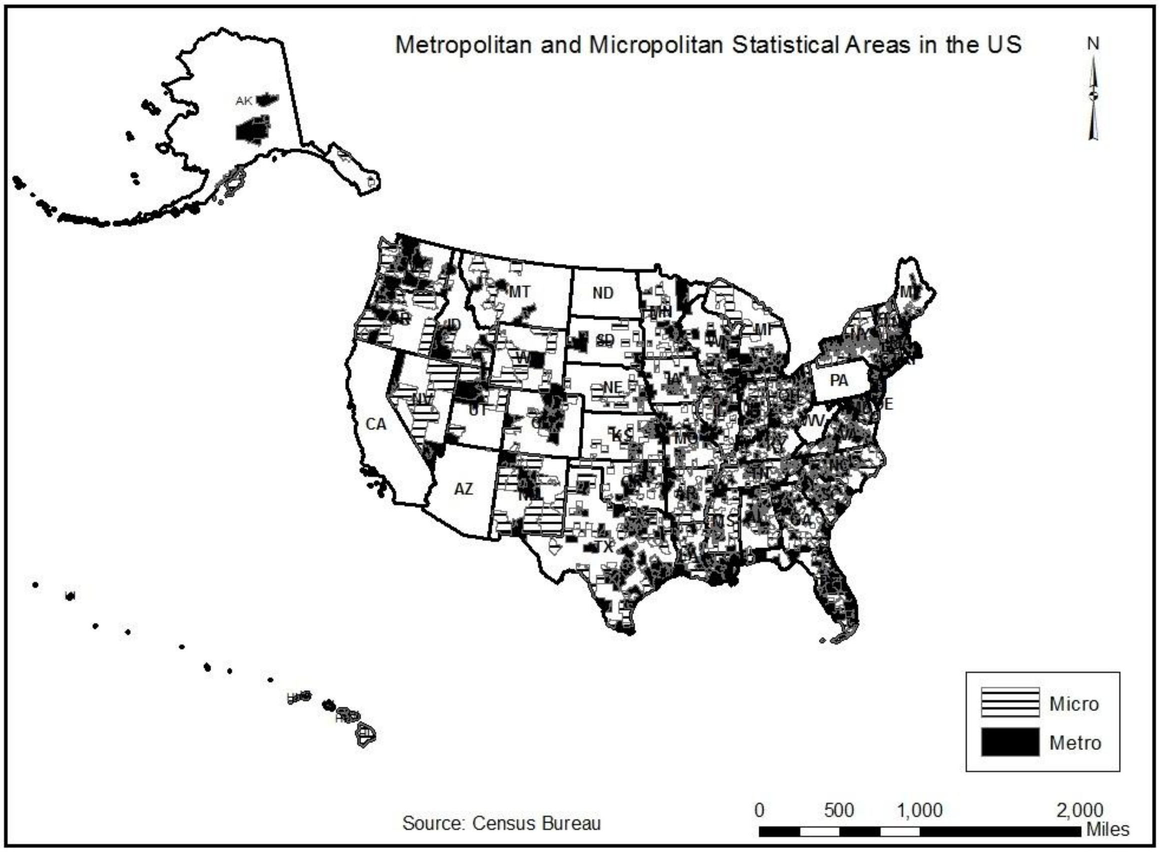
N = 618

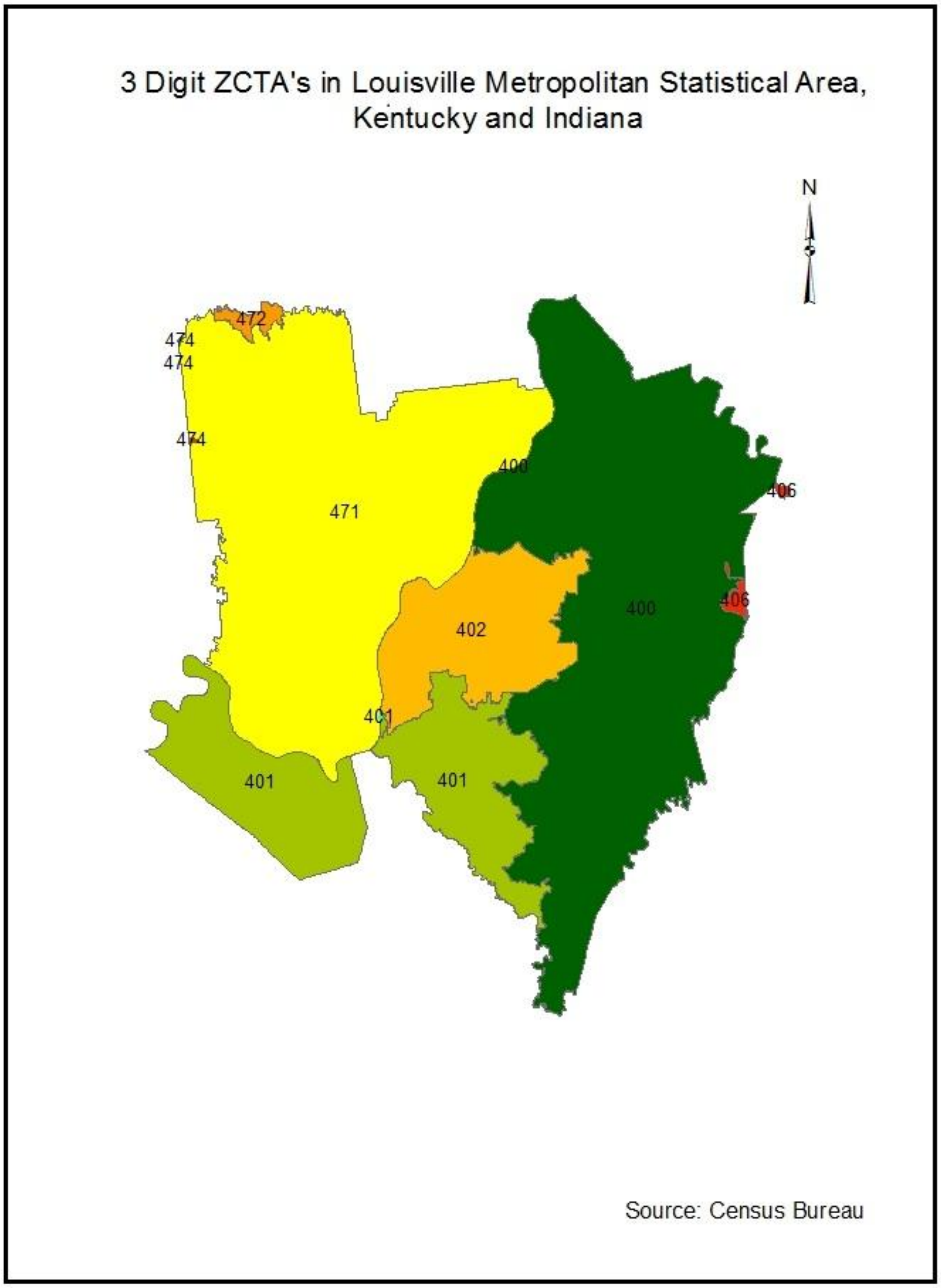
Table 6—Dependent Variable is Deaths Per Capita

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	3.057	3.297		.927	.355
LN Total Firefighters and Staff	-.521	.084	-.373	-6.178	.000
LN Area in Square Miles	-.035	.076	-.042	-.466	.641
LN Median Age of Housing Units	.607	.207	.159	2.932	.004
LN Median Household Income	-1.260	.279	-.242	-4.520	.000
LN Ex-urban Sprawl	.239	.061	.316	3.915	.000

Adjusted R-square: 0.35

N = 275


Metropolitan and Micropolitan Statistical Areas in the US
N
AK
MT
ND
SD
NE
KS
CA
AZ
UT
PA
Micro
Metro
Source: Census Bureau
0 500 1,000 2,000
Miles


3 Digit ZCTA's in Louisville Metropolitan Statistical Area,
Kentucky and Indiana
N
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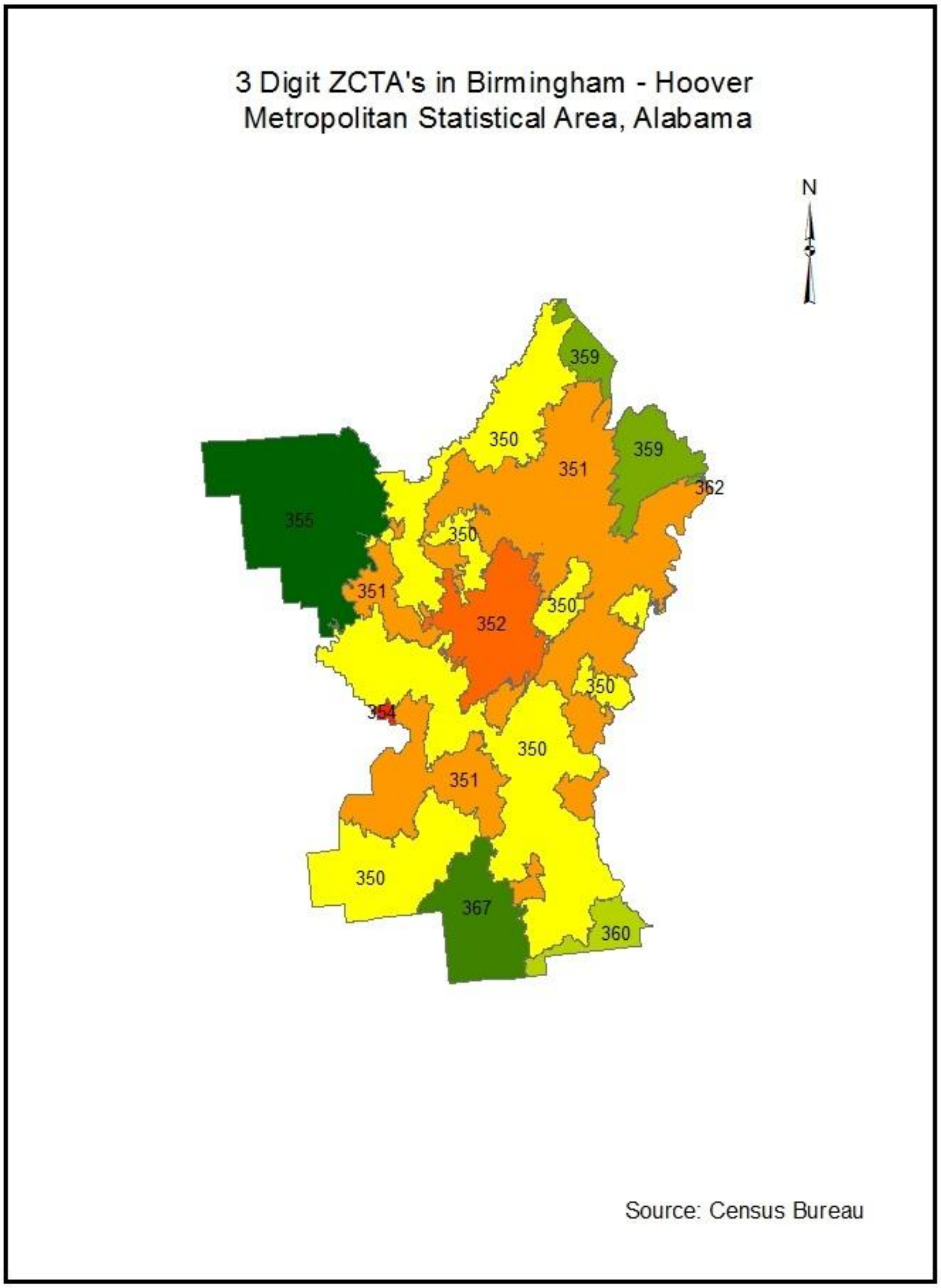
474
474
474
400
406
471
402
400
406
401
401
401
Source: Census Bureau



3 Digit ZCTA's in Birmingham - Hoover
Metropolitan Statistical Area, Alabama
N
359
350
359
351
362
355
350
351
350
352
350
354
350
351
350
367
360
Source: Census Bureau