The Relationship between the Physical Growth of the Central City and Metropolitan Socio-Economic Growth in US Metropolitan Areas from 1950 to 2000*

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Abstract: This paper examines Rusk's central city elasticity theory that the expansion of central city borders from annexations and consolidations relates to economic growth and development in US metropolitan areas. The theory, as explored and discussed in the literature appeared to lack an adequate and full range of empirical data to deeply or fully understand the relationship between his central city elasticity theory and metropolitan geo- and socio-economic conditions. Two major findings are that: central city elasticity levels are strongly supported over all five dependent variables for metropolitan geo- and socio-economic conditions for the both 92 central and 244 non-central neighboring cities. Accordingly, Rusk's central city elasticity theory that metropolitan socio-economic conditions depend on the growth of central cities is championed. In conclusion, Rusk's central city elasticity theory is an important contribution to explaining the relationship between central and non-central neighboring cities in US metropolitan areas

Keywords: Rusk's central city elasticity theory, Metropolitan, Central cities and non-central neighboring cities

INTRODUCTION

About 80% of the US population lived in metropolitan areas with population change increasing by a rate of 14% between 1990 and 2000 (US Census Bureau, 2000; Perry and Mackun, 2001; Frey, 2005; Pack, 2005). Population increases can be linked to hybrid forms that stimulate overall growth in metropolitan areas (Parks and Oakerson, 1993; Provo, 2002). Suburban population growth has increased much more

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than central city population growth (Pack, 2005). White collar suburbs with high tax bases have created more new jobs (Orfield, 1997). Geography research states that cities have spilled over into peripheral rural areas with new buildings and other development with the distinction between urban and rural areas diminishing or transforming into "hybrid forms" of regions in US metropolitan areas (Mookherjee et al., 2006, 29). "Hybrid, in between landscapes emerge that combine city and suburban qualities; that is, the suburb is being refashioned as the city with unique combinations of built forms, processes and imaginaries" (Clapson & Hutchison, 2010, 27). This view may be contrary to Rusk's theory of the expansion of central city political boundaries. According to Orfield (1997) and Pack (2005), advantages from growing employment and jobs have supplanted central city attractions; that is, metro-suburbs are no longer waiting to be included as temporary bedroom towns supporting central city workers. Some metro-suburbs may be more influential and hold higher employment rates, etc., than their central cities.

Many central city boundaries are fixed. Trends in metropolitan growth more tightly link both central cities and their suburbs, challenging radical changes such as even more rapid population growth, increases in poverty, or more deterioration of local economic conditions. However, Rusk still retains the "central city elasticity" concept for metropolitan areas because, even though a central city boundary may be frozen and surrounded by rapid-growing non-central neighboring cities, the central city retains a downtown business district that remains a perceived regional employment center. Central cities with high elasticity can also typically expand their boundaries as well and capture incorporated suburbs through annexation or consolidation. Metropolitan areas in which central cities have been able to expand through annexation have experienced better socio-economic conditions than those that went through limited annexation. From his analysis of all US metropolitan areas, Rusk provides a major premise that US metropolitan areas with physically-expanded central cities have been subjected to greater positive social and economic outcomes than those in which annexation is constrained. There are many metropolitan areas with population and other demographic changes that may well scrutinize Rusk's popular theory.

Therefore, this research explores central and suburban US cities using updated and supplementary data as suggested by David Rusk in his book, *Cities without Suburbs: A Census 2000 Update*. In his research, Rusk develops an urban area concept of "central city elasticity" using data from 1950 to 2000 on the development of vacant land and the expansion of city boundaries as a way to explain growth patterns. "The cities with the greatest elasticity had vacant city land to develop and the political and legal tools to annex new land" (Rusk, 2003, 12). Thus, metropolitan conditions related to job creation, income, population growth, and poverty are driven by central city elasticity.

Urban policy scholars have examined Rusk's findings from different perspectives, both challenging or supporting the theory with additional data and analysis.

Accordingly, this paper should contribute to urban policy studies because the relationship between the physical growth of central cities and metropolitan socio-economic growth in US metropolitan area is potentially useful to urban or metropolitan policy scholars and the dynamics metropolitan regional government may be improved.

LITERATURE REVIEW

Rusk's central city elasticity implies that: 1) elastic central cities surpass inelastic central cities with increases in job creation, income, better bond ratings and a more highly educated workforce; and 2) metropolitan areas having elastic central cities gain advantages in their metropolitan areas with greater economic growth, faster rates of job creation, and less racial segregation. Rusk argued that "the cities with the greatest elasticity had vacant city land to develop and the political and legal tools to annex new land" (Rusk, 2003, 12). That is, an elastic central city may create a coordinated, or cooperative, development climate that includes a shared tax base, or shared infrastructure and services such as water, sewer, and regional mass transit systems for metropolitan areas. Under this reasoning, metropolitan areas should be restructured as consolidated metropolitan governments, and given power to annex and absorb suburbs to diminish racial and economic segregation, reduce local fiscal imbalances, and control suburban sprawl (Orfield, 1997; Pinch and Patterson, 2000; Crane and Chatman, 2003; Rusk, 2003). Regional governments are also more likely to incorporate economic development projects that include neighboring non-central cities to reduce the transaction costs of information/coordination, negotiation, enforcement, and agencies (Feiock, 2007). This high political fragmentation of metropolitan areas makes equitable and efficient delivery of public goods and services difficult (Warner and Hefetz, 2002). Regional governments may be a policy prescription that can help the spatial organization of metropolitan areas and reduce urban problems (Basolo, 2003).

Pressure to solve those urban problems (Pinch and Patterson, 2000) undermines the local economic competitiveness of metropolitan areas as a whole through their component local governments' fiscal inequalities and imbalances from so many competitive and overlapping local governments. Fragmentation in governmental urban public policies supposedly creates economic segregation, local fiscal imbalance, and housing sprawl, resulting in part from inelastic central cities constrained by the highly fragmented and independent local governments in their metropolitan areas. Local government autonomy in creating public policies affects the ability of residents to get jobs as well as increasing their annual household income. Household economic disparities have also entrenched local economic inequality more, with families stuck in poverty from one generation to the next (Dreier, Mollenkopf, & Swanstrom, 2001). The key connection in these situations is the perpetuation of economic inequalities generated from local fiscal imbalances in city funding of public goods and services throughout a region (Ostrom & Bish, 1988).

In addition to elasticity, “urban sprawl” is a term regularly used as a unit of analysis to explain US metropolitan growth (Mookherjee et al., 2006). Population growth and migration outward from central cities lead to urban sprawl (Kurban & Persky, 2007). Burchell et al. (2005, 38) warn that open space and farm land will disappear due to inefficient or low density land development based on the profit motive. Those authors provide the example where the size of the Chicago metropolitan area expanded by 46% while population grew by only 4%. The number of buildings, dwelling units, roads, and highways grew into land areas comprised of farms and open spaces. That is, urban sprawl in metropolitan areas makes for long distances between homes, jobs, and shopping centers (Ciscel, 2001). These long travel distances unwittingly encourage people to use cars more often (Crane and Chatman, 2003). Then, the urban metropolitan sprawl itself forces local governments to accommodate resident drivers by shortening vehicle travel time, which consumes tax revenues better spent elsewhere earlier.

To solve such metropolitan problems of economic segregation and local government fiscal imbalances and development sprawl, Rusk (2003, 89) suggests that metropolitan governments be led by central cities to implement three regional policies: 1) regional inclusionary zoning; 2) regional land use and transportation planning; and 3) regional tax-base sharing. State governments also need to lead, too, because metro governments must act within legal frameworks set by their states; that is, some states can provide only limited services such as transportation planning, sewage treatment, and air quality control according to their state statutes (American Planning Association, 2002). Thus, mechanisms of regional governance reduce negative externalities or spill-over effects produced by uncontrolled development within governmentally-fragmented metropolitan areas (Downs, 1994; Orfield, 1997; Norris, 2001). Metropolitan governance that promotes regional cooperation can integrate public goods and services with efficiency and intra-regional equity to achieve economies of scale (Warner and Hefetz, 2002; Rusk, 2003). More unified regional governance will enhance economic growth, while highly fragmented regions will lag behind (Basolo, 2003). Regionalists emphasize not only that more collaborative regional governance structures will improve economic segregation, local fiscal imbalance, and urban sprawl, but also that they will enhance the competitiveness of regions in the global economy as well (Anas, 2000; Briffault, 2000). For these reasons, Rusk’s central city elasticity theory robustly supports a strong role of the central city related to adjacent cities in a metropolitan area as the best way toward achieving effective regional benefits. Creating new boundaries for metropolitan governments by local consolidation and annexation by the central city would decrease social and economic segregation, local government fiscal imbalances, and developmental sprawl since metropolitan regions commonly lack formal legal or political means to control such things (Rusk, 2003).

However, opponents of Rusk's metropolitan government argue that fragmented metropolitan areas promote efficiency in the provision of public services, democratic citizenship, and self-determination by territorial communities (Briffault, 2000). If all political decisions were taken at a highly centralized level, it would be difficult to vary policies in light of diverse local needs and preferences. The ability of central cities to work together with suburban cities is also difficult because some state laws limit and affect local annexation and consolidation and their own revitalization may have been limited by surrounding non-central cities. Fragmented metropolitan areas lead local governments to the efficient production and distribution of public goods and services for the needs and desires of their taxpayers (Tiebout, 1956; Blair, Staley, and Zhang, 1996; Anas, 1999). Taylor (1991) also argues that local competition makes cities race with other cities by constructing infrastructure and other physical public facilities to accommodate urban growth. Accordingly, delivery of public goods and services would be provided to the advantage of the fragmented and competitive systems of local government rather than metropolitan governments in metropolitan areas (Parks & Oakerson, 1993).

In an empirical criticism of Rusk's metropolitan regionalism, Blair et al. (1996) argue that Rusk's central city elasticity theory cannot in itself explain the relationship between the elasticity and the ability of a central city to share the benefits of its overall metropolitan area. They also criticize Rusk, stating that his empirical evidence and methods are too weak to explain the nexus between elasticity and development. Their empirical research suggests that elasticity explains only small portion of metropolitan variables such as employment and population growth. They state that his elasticity theory is not significant for explaining changes in metropolitan area income and poverty. Accordingly, Rusk's central city elasticity research has been inadequate for clarifying the differences between the elasticity of central cities and metropolitan economic welfare in terms of per capita income and changes in the poverty rate in the 1980s (Blair et al., 1996). Accordingly, they argue that Rusk's central city elasticity theory, as an example of metropolitan regionalism, can do little to support metropolitan economic welfare.

Those challenges to Rusk's metropolitan regionalism should at least be able to address how metropolitan areas are fragmented by greater economically self-sufficient autonomy (Swanstrom, 2001) because of diverse local needs and a preference for carrying out the delivery of public goods and services by territorial communities (Boyne, 1998; Sclar, 2000). Even though there is no doubt that suburbs are in the process of creating new clusters that perform many of the same functions that cities used to perform in metropolitan areas (Kurban and Persky, 2007), Rusk contributes to the debates over fragmentation and regionalism using a large number of metropolitan areas (Levine, 2001). Rusk's metropolitan regionalism tries to explain inequality and fix local fiscal imbalances and development sprawl. Accordingly, his central city elasticity theory is still commonly presented, argued, and debated (Levine, 2001).

METHODS, DATA, AND HYPOTHESES

Methods

Multiple Analysis of Variance (MANOVA) can test interaction effects of independent interval variables on multiple dependent interval variables. The purpose of MANOVA is to compare groups formed by interval independent variables on group differences in a group of dependent variables (Todman and Dugard, 2007). MANOVA can also use interval scale variables as covariates. Accordingly, this research employs MANOVA to uncover the relationship between central city elasticity levels and geographic and socio-economic conditions in central or suburban cities of US metropolitan areas.

This study examines two populations: 1) 92 central cities are selected from the 92 MSAs with populations exceeding 500,000 (out of a total of 361 MSAs in the United States); and 2) 244 non-central neighboring cities in the same 92 MSAs randomly sampled from among 724 non-central neighboring cities with populations exceeding 25,000.

The central city elasticity levels are developed as independent variables. The central city elasticity scores range from 4 to 40. Even though 97 MSAs of the 361 MSAs across US metropolitan regions have populations over 500,000 US, this research also excludes five MSAs (El Paso, McAllen, Salt Lake City, Spokane, and Boise) that have either more than 78% Hispanic or less than 1.3% Black or 6.3% Hispanic populations because Rusk's book excluded those areas due to their homogeneous population (Rusk, 2003). Statistical analysis using MANOVA is applied to develop information about the relationships. Multivariate Analysis of Covariance is applied to examine the interaction effects of independent variables on multiple dependent variables (Stevens, 2002; Todman and Dugard, 2007).

Data

The independent variables are the central city elasticity levels in Table 1. Rusk ranks 521 central cities by their relative levels of elasticity, based on the expansion of city limits from 1950 to 2000 to explain growth patterns of central cities in regions. Central city elasticity ranged from the lowest score of 4 for New York, Newark, Boston, Detroit, and Washington DC to the highest score of 40 for Anchorage and others. Table 1 also shows the five levels of central city elasticity proposed by Rusk (2003): zero (4-12); low (12.5-20.5); medium (21.0-26.0); high (26.5-31.0); and hyper-elastic (31.5-40).

Table 1. Variables and Data Source

Independent Variables	Data Source
Central City Elasticity Level (score): zero (4-12); low (12.5-20.5); medium (21.0-26.0); high (26.5-31.0); and hyper-elastic (31.5-40)	David Rusk. *Cities Without Suburbs*; *A Census 2000 Update*
Dependent Variables	**Data Source**
Census Regions (dummy variable) (South and West = 0 vs. Midwest and Northeast = 1)	US Census Bureau
Population Growth Rate (1990-2000)	
Per Capita Income Growth Rate (1990-2000)	
Poverty Rate Change (1989-1999)	
Employment Growth Rate (1990-2000)	

Blair et al. (1996) used a different method of analysis in their evaluation of Rusk's central city elasticity theory over a decade ago employing four dependent variables: population, income, poverty, and employment. This research adds regional census factors because Rusk's central elasticity theory indicates strong regional characteristics. Lower elasticity levels are generally located in metropolitan regions in the Midwest and the Northeast ("The Rust Belt"), while higher elasticity levels are largely found in metropolitan regions in the South and the West ("The Sun Belt"). Therefore, the first dependent variable for the analysis is census region. The dependent variable is a dummy variable that is assigned a value of one (1) if a local government is in the Midwest or Northeast census regions, and a value of zero (0) if it is in South or West census regions. This dummy variable makes it possible to determine where local governments exist in those regions.

Table 1 shows the five dependent variables: 1) Census Regions (South and West vs. Midwest and Northeast); 2) Population defined as rate of growth in population between 1990 and 2000; 3) Income defined as rate of growth in per capita income between 1990 and 2000; 4) Poverty defined as change in poverty rate between 1989 and 1999; 5) Employment defined as rate of growth in employment between 1990 and 2000 in the 92 US MSAs.

Figure 1 shows the census region map and Table 2 shows the number of sampled cities and their percentage among the four census region and between the two regional dummy variables. The percentage of central cities in the four regions is 22.8% in the West, 35.9% in the South, 19.6% in the Midwest, and 21.7% in the Northeast. The 92 central cities represent the 92 MSAs in the four regions.

Figure 1. 2000 Census Regions of the United States

Source: US Census Bureau 2000

Table 2. Percentage of Sampled Central Cities by Region

Four Regions	Percentage and Number of Sampled Central Cities	
	By Region	By Variable
West (13 States)	22.8% (21)	58.7% (54)
South (16 States)	35.9% (33)	
Midwest (12 States)	19.6% (18)	41.3% (38)
Northeast (9 States)	21.7% (20)	
Total	100% (92)	

Table 3 shows the percentage of all 724 suburbs and the 244 sampled suburbs in the four regions and between the two regional dummy variables. The percentage of all 724 suburbs by region is 34.1% in the West, 21.8% in the South, 29.4% in the Midwest, and 14.7% in the Northeast. The percentage of the 244 sampled suburbs by region is 25.9% in the West, 26.6% in the South, 30.3% in the Midwest, and 17.2% percent in the Northeast. There are 3.4% fewer cities among the 244 sampled cities than in the 724 suburbs in the Sun Belt. Correspondingly, cities sampled from the Rust Belt are overrepresented by about 3.4%.

Table 3. Percentage of Sampled Suburbs by Region

Four Regions	Percentage and Number of 724 Suburbs		Percentage and Number of 244 Sampled Suburbs	
	By Region	By Variable	By Region	By Variable
West (13 States)	34.1% (247)	55.9% (405)	25.9% (63)	52.5% (128)
South (16 States)	21.8% (158)		26.6% (65)	
Midwest (12 States)	29.4% (213)	44.1% (319)	30.3% (74)	47.5% (116)
Northeast (9 States)	14.7% (106)		17.2% (42)	
Total	100% (724)		100% (244)	

A random sample almost always provides an estimate that is close to the parameters. The variability of a statistic from a random sample is the sample size, not the population size, that is, the variability of a statistic from a random sample does not significantly rely on the size of the population. A margin of error of 5% and a confidence level of 95% for 724 non-central neighboring cities requires approximately 244 non-central neighboring cities randomly for this research (Appendix 1).

Hypotheses

Two hypotheses are used to test each central city elasticity score across the five dependent variables. The hypotheses investigate the relationship between central city elasticity level and the dependent variables in the 92 central cities and 244 non-central neighboring cities.

> **Hypothesis-1:** The central city elasticity level of the 92 central cities will influence each dependent variable: region (South and West vs. Midwest and Northeast), population growth rate, per capita income growth rate, change in poverty rate, and employment growth rate.

> **Hypothesis-2:** The central city elasticity level of the 244 non-central neighboring cities will influence each dependent variable: region (South and West vs. Midwest and Northeast), population growth rate, per capita income growth rate, change in poverty rate, and employment growth rate.

DATA ANALYSIS

The multivariate analysis of covariance summary statistics for the 92 central and 244 non-central neighboring cities is shown in Table 4. Roy's Largest Root tests focus on the independent variables and their interactions. That is, is each effect significant? The elasticity levels for the 92 central cities have a Roy's LR value of 1.597, F = 27.465, p = 0.000. Roy's LR value for the 244 non-central neighboring cities is 0.779, F = 37.102, p = 0.000. Accordingly, each effect test for the 92 central and 244 non-central neighboring cities indicates significant values overall for central city elasticity levels at the 0.05 level. As shown in Table 5, below, Rusk's five central city elasticity levels require estimated marginal means to determine statistically how the strong or

Table 4. Multivariate Tests

Effect		Value	F	Hypothesis df	Sig.
92 Central Cities	Wilks' Lambda	0.385	27.465	5.000	0.000
	Roy's Largest Root	1.597	27.465	5.000	0.000
244 Non-central Cities	Wilks' Lambda	0.562	37.102	5.000	0.000
	Roy's Largest Root	0.779	37.102	5.000	0.000

a. Exact statistics

weak relationships between each dependent variable and the independent variables change as nominal values from a central city with a zero to a hyper elasticity level in the MANOVA.

Table 5. Estimated Marginal Means of Elasticity Levels for the 92 Central Cities

Dependent Variable	Level	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Census Regions (South and West vs. Midwest and Northeast)	zero	0.160	0.076	0.010	0.310
	low	0.250	0.094	0.062	0.438
	medium	0.667	0.097	0.473	0.860
	high	0.882	0.092	0.700	1.064
	hyper	0.947	0.087	0.775	1.120
Rate of Growth in Population	zero	-2.704	2.231	-7.138	1.730
	low	-2.031	2.788	-7.573	3.511
	medium	7.280	2.880	1.556	13.004
	high	13.512	2.705	8.135	18.888
	hyper	19.253	2.559	14.167	24.338
Rate of Growth in Per Capita Income	zero	41.843	2.361	37.151	46.535
	low	47.628	2.951	41.763	53.493
	medium	47.647	3.048	41.589	53.704
	high	46.655	2.863	40.965	52.345
	hyper	49.531	2.708	44.149	54.913
Change in Poverty Rate	zero	1.049	0.560	-0.063	2.161
	low	-0.677	0.700	-2.067	0.714
	medium	-0.145	0.722	-1.581	1.291
	high	0.122	0.679	-1.226	1.471
	hyper	-1.281	0.642	-2.556	-0.005
Rate of Growth in Employment	zero	-5.863	7.971	-21.707	9.980
	low	-1.838	9.964	-21.643	17.966
	medium	7.905	10.291	-12.549	28.359
	high	11.957	9.667	-7.256	31.170
	hyper	41.532	9.144	23.358	59.706

The omnibus F test is the first step in the MANOVA process of analysis in Table 6. The F test appears in the "Corrected Model" of the tests of between-subjects effects. Is the model significant for each dependent variable? The corrected model test results are the same as the Elasticity Levels MANOVA for the 92 central cities because this model has one degree of freedom. Accordingly, Table 6 shows the results for hypothesis 1. In Table 6 the all F values, except for the Rate of Growth in Per Capita Income F value, are statistically significant for each dependent variable at the 0.05 significance level. Accordingly, the F tests in the corrected model support the research hypothesis that the central city elasticity levels in the 92 central cities will influence each dependent variable: region (South and West vs. Midwest and Northeast), population growth rate, change in poverty rate, and employment growth rate, but not for the rate of growth in per capita income. The multivariate of covariance summary statistics for Rusk's central city elasticity levels for the 92 central cities is shown in Table 6. There are significant effects for census regions: F = 18.099, P = 0.000; population growth rate F = 14.504, P = 0.000; change in poverty rate F = 2.097, P = 0.088 (at the 0.1 significance level); and employment growth rate F = 4.336, P = 0.003.

The partial eta squared means show the independent variable effects on each dependent variable, controlling for any variation in the model, as illustrated above Table 6. As the partial eta squared is a measure of effect size for use in MANOVA like R^2 in a multiple linear regression. Therefore, the central city elasticity level is strongly related to census region and population. The poverty rate and employment growth are

Table 6. Tests of Between-Subjects Effects and Multivariate Analysis of Variance Summary of Elasticity Levels for the 92 Central Cities

Source	Dependent Variable	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Central City Elasticity 2000 or Corrected Model	Census Regions (South and West vs. Midwest and Northeast)	10.323	4	2.581	18.099	0.000***	0.454
	Rate of Growth in Population	7216.774	4	1804.193	14.504	0.000***	0.400
	Rate of Growth in Per Capita Income	752.454	4	188.113	1.350	0.258	0.058
	Change in Poverty Rate	65.671	4	16.418	2.097	0.088*	0.088
	Rate of Growth in Employment	27553.428	4	6888.357	4.336	0.003***	0.166

a. Parameter Estimates B in General Linear Model General Linear Model (MANOVA) (*P<0.1, **P<0.05, and ***P<0.01) (Fixed Factor: Central City Elasticity level) also weakly affected by central city elasticity levels.

The findings show that there are statistical effects in the means of each dependent variable from Rusk's central elasticity levels: region (South and West vs. Midwest and

Table 7. Estimated Marginal Means

Dependent Variable	Level	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Region	zero	0.230	0.039	0.154	0.306
	low	0.615	0.066	0.486	0.745
	medium	0.794	0.070	0.656	0.933
	high	0.774	0.074	0.629	0.919
	hyper	1.000	0.079	0.844	1.156
Rate of Growth in Population (1990-2000)	zero	12.896	2.392	8.184	17.608
	low	8.823	4.072	0.802	16.844
	medium	32.159	4.361	23.569	40.749
	high	36.819	4.567	27.823	45.816
	hyper	38.111	4.893	28.471	47.751
Rate of Growth in Per Capita Income (1989-1999)	zero	44.944	1.260	42.462	47.426
	low	39.080	2.144	34.856	43.304
	medium	44.522	2.297	39.998	49.047
	high	52.848	2.405	48.109	57.586
	hyper	50.822	2.577	45.745	55.899
Change in Poverty rate	zero	0.973	0.258	0.465	1.482
	low	1.684	0.439	0.819	2.549
	medium	0.649	0.470	-0.277	1.576
	high	-0.202	0.493	-1.173	0.768
	hyper	-0.290	0.528	-1.330	0.749
Rate of Growth in Employment (1990-2000)	zero	11.910	3.249	5.509	18.311
	low	6.176	5.531	-4.720	17.071
	medium	31.169	5.924	19.499	42.838
	high	38.328	6.204	26.107	50.549
	hyper	45.769	6.647	32.674	58.864

Northeast); population growth rate; change in poverty rate; and employment growth rate. Accordingly, central city expansion or annexation influences the geographic and socio-economic conditions, except for the per capita rate of income growth in the central cities in US metropolitan areas. The central cities in the South and West census regions have higher expansion or annexation. That is, the physical expansion or annexations by central cities usually occur in the South and West census regions. Higher central city expansions and/or annexations are associated with a higher population growth rate, higher employment growth rate, and with a decreased poverty rate in the central cities in US metropolitan areas.

For the 244 non-central neighboring cities, Rusk's five central city elasticity levels need estimated marginal means to determine statistically how the relationships between the dependent and independent variables change from a lower elasticity level to higher one and the results are show above in Table 7. The partial eta squared show that the dependent variables are explained by independent variable levels in Table 8. Accordingly, the central city elasticity levels are strongly related to census region. Population, per capita income, poverty rate, and employment growth are also weakly affected by the central city elasticity level. Therefore, the census region is a very important dependent variable.

The omnibus F test appears in Table 8. The corrected model test results are the same as the elasticity level MANOVA for the 244 non-central neighboring cities because this model has one degree of freedom. Table 8 shows the results for hypothesis 2. All

Table 8. Tests of Between-Subjects Effects in Multivariate Analysis of Variance for the Elasticity Levels for the 244 Non-Central Neighboring Cities

Source	Dependent Variable	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Central City Elasticity 2000 or Corrected Model	Census Regions (South and West vs. Midwest and Northeast)	20.626	4	5.156	30.636	0.000***	0.339
	Rate of Growth in Population	33085.865	4	8271.466	12.794	0.000***	0.176
	Rate of Growth in Per Capita Income	4110.535	4	1027.634	5.730	0.000***	0.088
	Change in Poverty Rate	97.344	4	24.336	3.235	0.013**	0.051
	Rate of Growth in Employment	47283.736	4	11820.934	9.908	0.000***	0.142

a. Parameter Estimates B in General Linear Model General Linear Model (MANOVA) (*P<0.1, **P<0.05, and ***P<0.01) (Fixed Factor: Central City Elasticity level)

F values are statistically significant for each dependent variable at the 0.05 significance level. Accordingly, the corrected model F tests accept the research hypothesis that the central city elasticity levels of the 244 non-central neighboring cities will influence each dependent variable: region (South and West vs. Midwest and Northeast); population growth rate; per capita income growth rate; change in poverty rate; and employment growth rate. That is, there are statistical effects on Rusk's central elasticity levels for the 244 non-central neighboring cities at the 0.05 significance level in the means of each dependent variable: region (South and West vs. Midwest and Northeast); population growth rate; per capita income growth rate; change in poverty rate; and employment growth rate.

The summary statistics for the multivariate analysis of variance of Rusk's central city elasticity levels for the 244 non-central neighboring cities is shown in Table 8. There are statistically significant relationships between Rusk's central city elasticity levels and all dependent variables for the 244 non-central neighboring cities. Table 8 shows significant effects for census region F = 30.636, P = 0.000; rate of growth in population F = 12.794, P = 0.000; rate of growth in per capita income F = 5.730, P = 0.000; change in poverty rate F = 3.235, P = 0.013; and rate of growth in employment F = 9.908, P = 0.000.

That is, the results for the 244 non-central neighboring cities reveal that expansions or annexations by central cities in US metropolitan areas are related to census regions (South and West vs. Midwest and Northeast). Non-central neighboring cities in the South and West census regions are affected by higher central city expansion. Higher central city expansion are also related to higher population growth rates, higher capita per income growth, a decrease in the poverty rate, and higher employment growth rates in the non-central neighboring cities in US metropolitan areas. That is, central city expansions and annexations are strongly associated with all geographical and socio-economic conditions for the non-central neighboring cities in US metropolitan areas.

CONCLUSION

This research offers further empirical evidence supporting Rusk's conclusions by using a larger data set. Rusk concluded that the growth of central cities through local annexations and consolidations is related to metropolitan geography and socio-economic conditions. That is, his theoretical concept is that elasticity in the growth patterns of central cities from 1950 to 2000 affects metropolitan conditions in terms of region, jobs, income, population, and poverty. That is, metropolitan location and socio-economic conditions relate to the growth of central cities.

Accordingly, there is an important contribution in understanding the connection between central and non-central neighboring cities in US metropolitan areas because this research provides empirical evidence to buttress Rusk's city elasticity theory in the city elasticity hypotheses for the 92 central and 244 non-central neighboring cities of US metropolitan areas. Therefore, the central city's expansion or annexations influence their metropolitan conditions. That is, Rusk's central city elasticity theory of US metropolitan area cities is championed.

The overall characteristics of central city growth affect non-central cities' socio-economic conditions in US metropolitan areas. That is, this research has endeavored to develop an understanding of Rusk's central city elasticity theory about the physical expansion of central cities of US metropolitan regions. Accordingly, the overall characteristics of Rusk's theory can provide new information to metropolitan planners and policy makers about what factors central cities should consider and for when regional decision makers attempt to initiate new regional policies to improve infrastructure and public facilities in metropolitan areas.

For the further research, richer data from a longer period will be needed. Future research can also better address and examine Rusk's central city elasticity theory by using multiple regressions or the path method.

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APPENDIX 1.

244 Randomly Selected Non-Central Neighboring Cities

MSAs	Central City	Neighboring Cities
Akron, OH	Akron	Ohio/Kent
Albany-Schenectady-Troy, NY	Albany	New York/Troy
		New York/Saratoga Springs
Atlanta-Sandy Springs-Marietta, GA	Atlanta	Georgia/Marietta (County Seat)
		Georgia/East Point
		Georgia/Roswell
Baltimore-Towson, MD	Baltimore	Maryland/Annapolis (County Seat)
Birmingham-Hoover, AL	Birmingham	Alabama/Bessemer
		Alabama/Homewood
Boston-Cambridge-Quincy, MA-NH	Boston	Massachusetts/Lawrence
		Massachusetts/Lynn
		Massachusetts/Peabody
		Massachusetts/Everett
		Massachusetts/Malden
		Massachusetts/Marlborough
		Massachusetts/Newton
		Massachusetts/Woburn
		Massachusetts/Franklin
		Massachusetts/Cambridge
		NH/Dover (County Seat)
Bridgeport-Stamford-Norwalk, CT	Bridgeport	Connecticut/Danbury
Charlotte-Gastonia-Concord, NC-SC	Charlotte	North Carolina/Gastonia (County Seat)
		SC/Rock Hill
Chicago-Naperville-Joliet, IL-IN-WI	Chicago	Illinois/Arlington Heights
		Illinois/Chicago Heights
		Illinois/Cicero
		Illinois/Des Plaines
		Illinois/Downers Grove
		Illinois/Glenview
		Illinois/Maywood
		Illinois/Northbrook
		Illinois/Skokie
		Illinois/Tinley Park

MSAs	Central City	Neighboring Cities
Chicago-Naperville-Joliet, IL-IN-WI	Chicago	Illinois/Dekalb
		Illinois/Wheaton (County Seat)
		Illinois/Woodridge
		Illinois/St. Charles
		Illinois/Gurnee
		Illinois/Highland Park
		Illinois/Mundelein
		Illinois/Round Lake Beach
		Illinois/Joliet (County Seat)
		Illinois/Naperville
		IN/Hammond
Cleveland-Elyria-Mentor, OH	Cleveland	Ohio/Cleveland Heights
		Ohio/Euclid
		Ohio/Garfield Heights
		Ohio/Westlake
		Ohio/Mentor
		Ohio/Brunswick
		Ohio/Medina (County Seat)
Columbus, OH		Ohio/Dublin
		Ohio/Reynoldsburg
		Ohio/Newark (County Seat)
Dallas-Fort Worth-Arlington, TX	Dallas	Texas/Allen
		Texas/Plano
		Texas/Carrollton
		Texas/Cedar Hill
		Texas/Irving
Dallas-Fort Worth-Arlington, TX	Dallas	Texas/Lancaster
		Texas/Richardson
		Texas/Rowlett
		Texas/The Colony
		Texas/Cleburne (County Seat)
		Texas/Denton
		Texas/Arlington
		Texas/Fort Worth
		Texas/Hurst
		Texas/Mansfield
		Texas/North Richland Hills

MSAs	Central City	Neighboring Cities
Dayton, OH	Dayton	Ohio/Beavercreek
		Ohio/Fairborn
		Ohio/Trotwood
Denver-Aurora, CO	Denver	Colorado/Broomfield
		Colorado/Northglenn
		Colorado/Thornton
		Colorado/Englewood
		Colorado/Littleton (County Seat)
		Colorado/Lakewood
Des Moines-West Des Moines, IA	Des Moines	Iowa/Ankeny
		Iowa/Urbandale
Detroit-Warren-Livonia, MI	Detroit	Michigan/Madison Heights
		Michigan/Rochester Hills
		Michigan/Royal Oak
		Michigan/Troy
		Michigan/Port Huron (County Seat)
		Michigan/Dearborn Heights
		Michigan/Livonia
		Michigan/Southgate
Grand Rapids-Wyoming, MI	Grand Rapids	Michigan/Grand Rapids (County Seat)
		Michigan/Kentwood
Greensboro-High Point, NC	Greensboro	North Carolina/Greensboro (County Seat)
		North Carolina/High Point
Harrisburg-Carlisle, PA	Harrisburg	Pennsylvania/Harrisburg (County Seat)
Hartford-West Hartford-East Hartford, CT	Hartford	Connecticut/Middletown (County Seat)
Houston-Sugar Land-Baytown, TX	Houston	Texas/Pearland
		Texas/Sugar Land
		Texas/Friendswood
		Texas/League City
		Texas/La Porte
		Texas/Pasadena
Indianapolis-Carmel, IN	Indianapolis-Carmel	Indiana/Noblesville (County Seat)
		Indiana/Lawrence
Kansas City, MO-KS	Kansas City	Kansas/Leawood
		Kansas/Olathe (County Seat)
		Kansas/Overland Park
		Kansas/Leavenworth (County Seat)
		Missouri/Blue Springs

MSAs	Central City	Neighboring Cities
Los Angeles-Long Beach-Santa Ana, CA	Los Angeles	California/Alhambra
		California/Azusa
		California/Bellflower
		California/Burbank
		California/Inglewood
		California/Long Beach
		California/Monrovia
		California/Norwalk
		California/Pasadena
		California/Pomona
		California/Rancho Palos Verdes
		California/Redondo Beach
		California/Rosemead
		California/Thousand Oaks
		California/Buena Park
		California/Fountain Valley
		California/La Habra
		California/Laguna Hills
		California/San Juan Capistrano
Memphis, TN-MS-AR	Memphis	Arkansas/West Memphis
		TN/Collierville
		TN/Germantown
Miami-Fort Lauderdale-Miami Beach, FL	Miami	Florida/Hollywood
		Florida/Coral Springs
		Florida/Deerfield Beach
		Florida/Aventura
		Florida/Lauderdale Lakes
		Florida/Miramar
		Florida/Tamarac
		Florida/Homestead
		Florida/Miami Beach
		Florida/Boca Raton
		Florida/Jupiter
Milwaukee-Waukesha-West Allis, WI	Milwaukee	Wisconsin/Franklin
		Wisconsin/Oak Creek
		Wisconsin/Wauwatosa

MSAs	Central City	Neighboring Cities
Milwaukee-Waukesha-West Allis, WI	Milwaukee	Wisconsin/West Allis
		Wisconsin/Brookfield
		Wisconsin/Menomonee Falls
Minneapolis-St. Paul-Bloomington, MN-WI	Minneapolis	Minnesota/Coon Rapids
		Minnesota/Apple Valley
		Minnesota/Bloomington
		Minnesota/Brooklyn Park
		Minnesota/Plymouth
		Minnesota/Richfield
		Minnesota/St. Louis Park
		Minnesota/Maplewood
		Minnesota/Roseville
		Minnesota/Shoreview
		Minnesota/St. Paul
Nashville-Davidson—Murfreesboro, TN	Nashville	Tennessee/Murfreesboro (County Seat)
		Tennessee/Smyrna
		Tennessee/Hendersonville
New Haven-Milford, CT	New Haven	Connecticut/Naugatuck
		Connecticut/Waterbury
New York-Northern New Jersey-Long Island, NY-NJ-PA	New York	New Jersey/Englewood
		New Jersey/Garfield
		New Jersey/Paramus
		New Jersey/Sayreville
		New Jersey/Long Branch
		New Jersey/Passaic
		New Jersey/Paterson
		New Jersey/Elizabeth (County Seat)
		New Jersey/Linden
		New Jersey/Rahway
		NY/Lindenhurst
		NY/New Rochelle
		NY/Port Chester
		NY/White Plains (County Seat)
		NY/Yonkers
Oklahoma City, OK	Oklahoma City	Oklahoma/Midwest City
Omaha-Council Bluffs, NE-IA	Omaha	NE/Bellevue

MSAs	Central City	Neighboring Cities
Orlando-Kissimmee, FL	Orlando	Florida/Apopka
		Florida/Altamonte Springs
Oxnard-Thousand Oaks-Ventura, CA	Oxnard	California/Moorpark
		California/Simi Valley
Palm Bay-Melbourne-Titusville, FL	Palm Bay	Florida/Melbourne
Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	Philadelphia	PA/Chester
Phoenix-Mesa-Scottsdale, AZ	Phoenix	Arizona/Chandler
		Arizona/Glendale
		Arizona/Mesa
		Arizona/Scottsdale
		Arizona/Casa Grande
Pittsburgh, PA	Pittsburgh	Pennsylvania/Plum
Portland-Vancouver-Beaverton, OR-WA	Portland	Oregon/Lake Oswego
		Oregon/Tigard
		Oregon/McMinnville (County Seat)
Poughkeepsie-Newburgh-Middletown, NY	Poughkeepsie	New York/Middletown
Providence-New Bedford-Fall River, RI-MA	Providence	Massachusetts/Fall River
		RI/Cranston
Richmond, VA	Richmond	Virginia/Petersburg (County Seat)
Riverside-San Bernardino-Ontario, CA	Riverside	California/Corona
		California/Indio
		California/Moreno Valley
		California/Palm Desert
		California/Palm Springs
		California/Temecula
		California/Yucaipa
Rochester, MN	Rochester	Minnesota/Rochester (County Seat)
Sacramento—Arden-Arcade—Roseville, CA	Sacramento	California/Rocklin
		California/Sacramento (County Seat)
		California/Davis
		California/Woodland (County Seat)
St. Louis, MO-IL	St. Louis	Illinois/Alton
		MO/Chesterfield

MSAs	Central City	Neighboring Cities
San Diego-Carlsbad-San Marcos, CA	San Diego	California/Carlsbad
		California/Poway
		California/Fremont
		California/Oakland (County Seat)
		California/Pleasanton
		California/Antioch
		California/Danville
		California/Martinez (County Seat)
		California/Pittsburg
		California/Novato
		California/Belmont
		California/Pacifica
San Jose-Sunnyvale-Santa Clara, CA	San Jose	California/Hollister (County Seat)
		California/Milpitas
		California/Mountain View
		California/Saratoga
Seattle-Tacoma-Bellevue, WA	Seattle	Washington/Federal Way
		Washington/SeaTac
		Washington/University Place
		Washington/Edmonds
Springfield, MA	Springfield	Massachusetts/Westfield
Stockton, CA	Stockton	California/Tracy
Tampa-St. Petersburg-Clearwater, FL	Tampa	Florida/Clearwater (County Seat)
Tucson, AZ	Tucson	Arizona/Oro Valley
Virginia Beach-Norfolk-Newport News, VA-NC	Virginia Beach	VA/Hampton
		VA/Norfolk city
Washington-Arlington-Alexandria, DC-VA-MD-WV	Washington	MD/Gaithersburg
		VA/Alexandria
		VA/Leesburg (County Seat)
		VA/Manassas city
Worcester, MA	Worcester	Massachusetts/Leominster