Metropolitan Structure Among Cities in Los Angeles County by Spheres of Influence

The basic model describes the mapping of minimally federated units of local government for the purposes of organization and subdivision of county territory. The results indicate the significance of local jurisdiction to the structure of government in metropolitan areas. The existence of local jurisdiction provides for the adoption and implementation in numbers of local jurisdictions and spatial competition by establishing local jurisdictional boundaries. The results demonstrate the importance of spatial or neighbor community competition for territorial control of land area, incorporation and annexation campaigns, municipal incorporation, annexation and merger decisions, reorganization efforts to regulate fragmentation and impose consolidation solutions, and the existence of unincorporated county territory and core city boundary expansion. Inasmuch the findings reveal the timing of municipal incorporation decisions and the existence of a core city annexation threat are critical in the evolution of both annexation and incorporation strategy and the formation of unincorporated municipal service district areas. As a consequence, local jurisdiction and minimal federalism represent two conditions necessary for guaranteeing the existence of an equilibrium in metropolitan structure.

Greater Metropolitan Area Fragmentation Numerical Solutions

The fragmentation of metropolitan areas by boundary division produces equilibrium in local jurisdiction. Boundary division generates a locally finite, integer set equal to the number of local jurisdictions. Additionally any rank ordering of local jurisdictions produces a finite integer sequence and therefore boundary division implies a fragmentation solution in the number of local jurisdictions. The stability of boundary division guarantees the existence of a local jurisdictional equilibrium by numbers of local jurisdictions in the spatial configuration of local jurisdictional boundaries. In this model, generally single county subdivision partitions county territory into a locally finite cover, consisting of incorporated & chartered filters derived from the organization of cities, towns, villages and township-boroughs. As a result, the spatial history of boundary decisions describes the sequence of partitions by determination of local jurisdictional boundaries.

The evolution of annexation and incorporation strategy and correspondence produces a spatial history of local jurisdictional boundary decisions. The sequence of decisions generates an evolutionary stable strategy derived from local division campaigns and county planning. The adoption and implementation of decisions produces a greater metropolitan agenda consisting of

- formation of the core city area.
- annexation campaign I: core area boundary expansion by corridor extension in town sections.
- incorporation campaign I: municipal incorporation of townships by town sections.
- reorganization campaign I: city-county consolidation.
- annexation campaign II: core area annexation and merger decisions.
- incorporation campaign II: cityhood for town sections by special charter.
- incorporation campaign III: cities by general law provision and county contract.
- reorganization campaign II: city-county consolidation by enclave areas.
- incorporation campaign IV: incorporation campaign for county edge cities.
- reorganization campaign III: city separation and independent city status.
- failure of annexation, incorporation and reorganization campaigns.
- formation of spheres of influence by boundary extension.

Annexation and incorporation decisions form a disk cover of a greater metropolitan area contained within a single county. The disk cover generates a Mogling game of locations, a Macy Village Plan and the two dimensional Village of Palmer model of planning, development and zoning. The Village of Palmer Plan produces a closed and bounded corridor of planning, development and zoning. This model extends the Mogling 3x3 game of locations and the Macy Village Plan in two dimensions. By doing so, this establishes corridor planning, in two and three dimensions, in extension to both an open cover and a closed, locally finite and bounded cover.

Local boundary subdivision is constructed by segmentation of county territory into local jurisdiction. Furthermore the aggregate summation of segmentation equals a partition in local division. The partition is a locally finite, integer set that may be expressed by a partition function. Inasmuch the finite cover is a correspondence and the partition represents a game in partition form with a partition number solution. As a result, the partition number equals a numerical solution to greater metropolitan area fragmentation. By solving the location game in partition form, it is possible to derive both an equilibrium in local jurisdiction and fragmentation solutions in numbers of local jurisdictions. Generally speaking, the fragmentation number equals the number of local jurisdictions, but there are settings where spatial competition also involves combinations and permutations of interactions among the numbers of units of government. In this setting, the jacknife resampling solution generates the number of comparisons required to determine spatial competition, such as interactions among neighboring local jurisdictions. In greater metropolitan areas, a fragmentation number does not measure the complexity of spatial competition in location and distance. Instead the number of jacknife or resampling comparisons equals the degree of spatial interaction and therefore competition among local jurisdictions.

In summary, a locally finite open cover guarantees the existence of local jurisdiction. The existence of local jurisdiction satisfies the minimal federalism condition for decentralization. Because local jurisdictions generates a minimally federated structure, local jurisdiction guarantees the existence of fragmentation. Any fragmentation solution is therefore equal to the numbers of local jurisdictions. The fragmentation number may be determined by numbers of local jurisdiction or derived from local jurisdictional boundaries. A count of the number of local jurisdictions may be obtained using either method, by units of government or mapping the numbers of local jurisdictions.

County organization forms a partition of State territory. Given the territorial integrity of The States, state boundaries provide a complete description of state territory and allow for county formation. Whereas territorial integrity and the Northwest Territorial Ordinances (1784, 1787) guarantee the existence of a locally finite and bounded cover by either town or township division of county territory. A locally finite closed cover exists by township organization of county territory. As a result, county boundaries form a complete partition of State territory and satisfies the minimal federalism condition. By doing so, this permits decentralization by county subdivision into major and minor civil district units of local government.

The formation of major and minor civil districts provides for a locally finite integer set of local jurisdictions. This set is the unit basis for determining a fragmentation number solution to metropolitan fragmentation in local government. The fragmentation number may also be derived by a map of local boundary division. Additionally mapping county subdivision guarantees the existence of a locally finite integer set in local jurisdictional boundaries. The adoption and implementation of a boundary function provides for planning, development & zoning.

A boundary function is a regulatory mechanism for determination of local jurisdictional boundaries. In a few states, a statewide commission is used to regulate local boundary division by annexation, mergers, consolidation and incorporation decisions. In most states, these local boundary functions are regulated by county units. In the absence of countywide regulation, local boundary division is determined by individual annexation and incorporation campaigns. The campaigns produce a spatial history of boundary decisions by county segmentation into affected and remainder areas of local jurisdiction. As a result, municipal annexation and incorporation decisions may be regulated by either state provision or county regulation of boundary functions and therefore local division.

As a consequence, any boundary function is in correspondence with local jurisdictional boundaries. The existence of local division, in the form of county subdivision, guarantees the existence of local jurisdiction in numbers of civil districts. A boundary function exists for forms of major and minor civil districts, in units of local government, and therefore fragmentation in numbers of local jurisdictions. A boundary function also exists for attaining, establishing and organizing minimal federalism and decentralization of intergovernmental relations. By determining the existence of local jurisdiction, local jurisdiction guarantees the existence of minimal federalism and decentralization of governance structures. By establishing a design structure, a boundary function provides a mechanism for planning, development and zoning regulation. Regulation of local boundary division not only produces an agenda for the spatial history of boundary decisions but also attains goals for design in county organization of territory, consolidation of territory by annexation and merger decisions, and regulation of fragmentation by independent and separable municipal incorporation decisions.

Analysis of Local Boundary Decisions and Division

Definition 1.0 D ≡ the number of municipal service districts = {1, ..., m}.

Definition 2.0 D = major and minor civil districts = $\{d_1, d_2, ..., d_m\}$.

Definition 3.0 J = the number of local jurisdictions = {1, ..., n}.

Definition 4.0 J = units of local government = $\{j_1, j_2, ..., j_n\}$.

Definition 5.0 J ≡ major and minor local jurisdictions = {1, ..., m}.

Definition 6.0 J ≡ major and minor civil districts = $\{j_1, j_2, ..., j_m\}$.

Lemma 1.0 I = {1, ..., n} is a finite integer set.

Lemma 2.0 I = {1, ..., m} is a finite integer set.

Proposition 1.0 Choice of a municipal service district plan, $\mathbb{C}(1, ..., m) = \{d_1, d_2, ..., d_m\}$.

Proposition 2.0 Adoption and implementation of major or minor local jurisdictions, $Å_i = \{j_1, j_2, ..., j_m\}$.

Proposition 3.0 Success or failure of adopting major or minor local jurisdictions is a binary choice through voting agendas constructed to make separation, annexation, merger, incorporation, consolidation and reorganization decisions. Å ≡ voting alternatives determined by referendum election = $\mathbb{C}(0,1)$. 0 = failure to support (equals the status quo). 1 = successful support for the voting alternative.

Proposition 4.0 Supporters and opponents of adopting major or minor local jurisdictions may be divided into two groups. 0 = locals. 1 = municipals. Define the distribution of votes = V. If $V_m > V_l \Rightarrow \mathbb{C}(0,1) = 1$ for adoption and implementation of a voting change. If $V_l > V_m \Rightarrow \mathbb{C}(0,1) = 0$ for ongoing adoption and implementation of the status quo.

Proposition 5.0 Choice of local jurisdiction: $Å = \mathbb{C}(1, 2, ..., m)$.

Definition 7.0 A fragmentation solution ≡ $\mathscr{F}(D) = J$.

Definition 8.0 A fragmentation number ≡ $\mathscr{F}(J) = n$.

Definition 9.0 The functional assignment of service responsibilities ≡ $\mathscr{F}(J) = m$.

Definition 10.0 The degree of local public good and service complexity ≡ $\mathbb{C}(m) = m$.

Proposition 6.0 $\mathbb{C}(m) = 1 \rightarrow$ single purpose, single dimensional good or service provision.

Proposition 7.0 $\mathbb{C}(m) \geq 2 \rightarrow$ general purpose, multi-dimensional good or service provision

Proposition 8.0 $\mathbb{C}(m) = Å \rightarrow$ adoption and implementation of a general purpose charter.

Proposition 9.0 $\mathbb{C}(Å) = \{0, 1, 2, ..., m\}$ ≡ incorporation status.

Proposition 10.0 $\mathbb{C}(J) = \{0, 1, 2, ..., m\}$ ≡ charter status.

Proposition 11.0 $\ell(J) = \{1, 2, ..., m\}$ ≡ special act charter, locally determined.

Proposition 12.0 $\mathfrak{L}(J) = \{1, 2, ..., m\}$ ≡ general law provision, locally determined by statewide provision.

Proposition 13.0 $R(J) = \{1, 2, ..., m\}$ ≡ state home rule provision.

Proposition 14.0 $R(Å) = \{1, 2, ..., m\}$ ≡ state planning, two local referenda, one for incorporation status, and then a second vote, conditional on the decision of the first vote, to adopt and implement a charter.

Proposition 15.0 $\rho(Å) = \{1, 2, ..., m\}$ ≡ local planning, two local referenda, one for incorporation and the second vote for a charter.

Definition 11.0 F ≡ number of surfaces.

Definition 12.0 V_p ≡ number of vertices.

Definition 13.0 E ≡ number of edges.

Theorem 1.0 (Euler's) $F + V_p = E + 2$.

Proposition 16.0 Number of vertices = distribution of boundary points.

Proposition 17.0 Number of edges = number of boundaries (boundary lines).

Lemma 3.0 m = number of dimensions $= \{1, ..., m\} = I$, an integer set or sequence.

Lemma 4.0 $V_p = 2^m$.

Theorem 2.0 $F + 2^m = E + 2$.

Proposition 18.0 $F = E - 2^m + 2$.

Proposition 19.0 $E = \mathfrak{L}(B) = m + 2^m - 2$.

Theorem 3.0 The number of dimensions ≡ $m = 1.44270 \bullet \log(E - F + 2)$.

Lemma 5.0 Hausdorff stability number ≡ $\mathfrak{H} = 1.44270$.

Theorem 4.0 (Log capacity I) The number of dimensions equals Hausdorff stability times a weighted logarithmic boundary capacity.
Proof. $m = \mathfrak{H} \bullet \log(E - F + 2)$.

Theorem 5.0 (Log capacity II) The number of local public goods and services equals the weighted log capacity of local jurisdictional boundaries in boundary division line correspondence with market areas for provision.
Proof. $m = \mathfrak{H} \bullet \log(E - F + 2)$. E = local boundary line division. F = the set of local public goods and services provided. $\mathfrak{H}$ = the stability number of dimensions.

Theorem 6.0 Rectangular/Uniform Distribution City Plan.
Proof. 2-dimensional coordinate space. 4 boundary points. 4 boundary lines. Euler's Theorem. $2 + 2^2 = 4 + 2$.

Proposition 20.0 The number of dimensions equals the degree of complexity in provision of local public goods and services.

Proposition 21.0 The number of dimensions equals the functional assignment of responsibilities for local public good and service allocation.

Lemma 6.0 $\phi = R[\mathfrak{H}]$ ≡ a state home rule partition.
Lemma 7.0 $R[\mathfrak{H}] = \mathbb{C}$ ≡ a state home rule covering.
Lemma 8.0 Municipal service districts form a locally finite closed covering.

Definition 14.0 $B = \mathring{A}$ ≡ location and distance alternatives.
Definition 15.0 $B = A(t)$ ≡ land area in square miles.

Lemma 9.0 $\mathcal{T}(Bdy) = B$ ≡ the boundary function regulated by state and local planning.
Lemma 10.0 $Bdy(J) = B$ ≡ local jurisdictional boundaries.
Lemma 11.0 $\mathfrak{L}(B) = J$ ≡ a state determined local boundary division.
Lemma 12.0 $\ell(B) = J$ ≡ a locally determined boundary division.

Lemma 13.0 $\mathbb{C}(B) = J \equiv$ the distribution of Soddy Circles = a locally finite integer set in the number of local jurisdictions.

Lemma 14.0 A finite integer distribution of Soddy Circles = the number of municipal service districts.

Lemma 15.0 Municipal service districts = circular markets for local public good and service allocation.

Theorem 7.0 A locally finite integer distribution of Soddy Circles = the numbers of service dimensions and adjacent or neighbor local jurisdictions required to cover local jurisdictional boundaries.

Theorem 8.0 $\mathbb{C}(D) = n$, a fragmentation numerical solution = a locally finite number of Soddy Circles.

Theorem 9.0 $\mathcal{F}(J) = n$, a fragmentation numerical solution = the number of local jurisdictions.

Theorem 10.0 Spatial competition generates interactions among the number of local jurisdictions. The fragmentation numerical solutions equal a jacknife resampling solution in numbers of possible interactions.
Proof. $J = (N - 1) + (N - 2) + ... + (N - N)$. $J = \sum(N - i)$. $I = \{1, ..., N\}$.
Verification. For example J = 88 cities in Los Angeles County. Set each unit equal to 1. Compute the summation derived from 1 to 88 cities. Subtract 1 from each unit. The range equals 0 to 87. Compute the summation to determine the resampling solution. The jacknife resampling solution equals $87 + 86 + 85 + ... + 1 = 3828$, the total or complete number of possible interactions among the 88 cities. Cities with contiguous boundaries are defined as adjacent cities. The number of neighbor cities equals the number of adjacent cities with contiguous boundaries. Among the 88 cities, the number of neighboring cities equals 382 cities with contiguous boundaries. By division $382 / 3828 = .09979$. By verification approximately 10% of the total number of possible interactions are equal to adjacency by contiguous boundaries, 90% less than the total number of possible interactions..

Proposition 22.0 The number of times a city district interacts as a dyad equals the number of times each city district is an adjacent or neighboring district.

Proposition 23.0 The density of city districts equals the number of neighbor districts.

Theorem 11.0 $\mathcal{F}(J) = N$, a fragmentation numerical solution = the number of possible combinations of local jurisdictions.

Theorem 12.0 Bdy(J) = n, a fragmentation numerical solution = the local jurisdictional boundary division.

Lemma 16.0 County subdivision = local boundary division: $\mathbb{C}_{i.}(D) = Bdy(j)$.

Theorem 13.0 A statewide partition = a boundary division. $\phi(Å) = Bdy(J)$.

Definition 16.0 County organization ≡ $O(t) = \mathbb{C}$.

Lemma 17.0 An evolutionary stable strategy in county organization exists: $\phi(O_t) = \mathbb{C}$.

Definition 17.0 Local boundary decision ≡ $Bdy(j) = B_t$.

Theorem 14.0 A spatial history of boundary decisions ≡ $Bdy(J) = \Sigma B_t$. $t = \{1, ..., T\}$.

Lemma 18.0 An evolutionary stable strategy exists in the spatial history of local boundary decisions: $\phi(O_t) = \Sigma B_t$.

Proposition 23.0 Local jurisdictional boundary functions open = a frontier.

Proposition 24.0 Local jurisdictional boundary functions closed = a border.

Theorem 15.0 Bdy(J) = J ≡ boundary division, a local jurisdictional boundary function.

- Border(J) is a closed function. Border(J) = J ≡ local boundary division.
- Frontier(J) is an open function. Frontier(J) = J + sphere(J) ≡ local boundary division and spheres of influence.

Lemma 19.0 Local affairs policy dimension: $P = P(X)$.

Theorem 16.0 $P(X)$ is a local affairs dimension and a set of policy issues X. ϕ is a partition of $P(X)$. Then there is an equivalence relation R on $P(X)$.
Proof. For every $y, z \in P(X)$. $y \, R \, z$ if and only if there is some $U \in P(X)$ for $y \in U$ and $z \in U$.

Theorem 17.0 Local affairs policy space: $R = \phi(X) = \phi$.
Proof. $\phi = \phi(X)$. Existence of a local affairs policy dimension implies the adoption and implementation of a municipal service district cover. $X = 1$, single purpose district. $X > 1$, general purpose district.

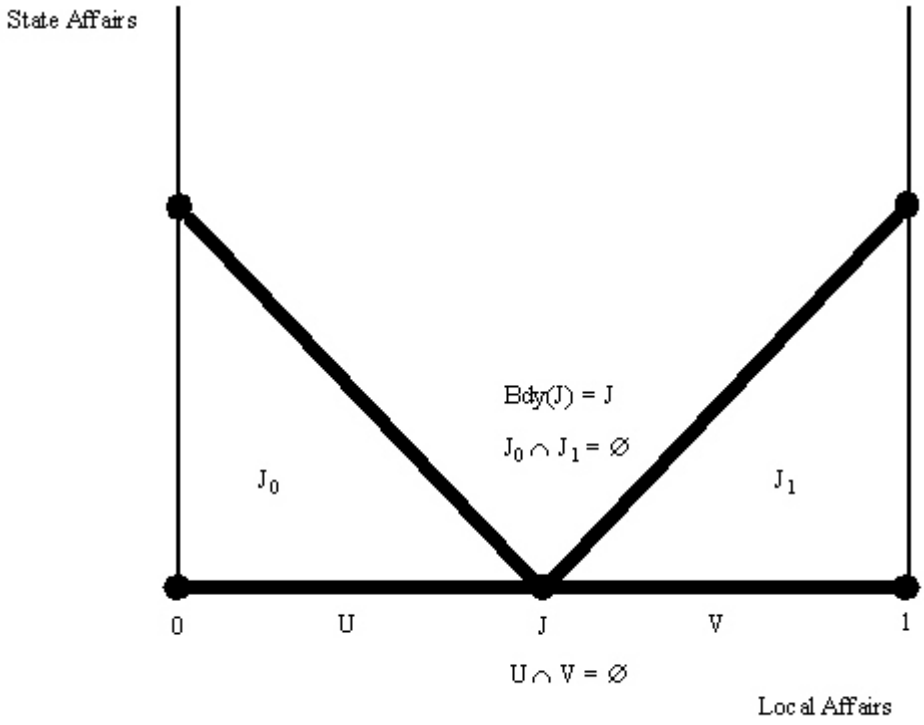
Theorem 18.0 (Minimal federalism) Let α and β be disjoint closed sets in $P(X)$. Then there exist disjoint open sets U, V in X such that $\alpha \subseteq U$ and $\beta \subseteq V$.

Theorem 19.0 (Decentralization I) The minimal federalism condition guarantees the existence of local jurisdiction.
Proof. **FIGURE 1.0**. $P(X) = X$. $U, V \in X$. $U \cap V = \varnothing$. $Bdy(J) = J$. $J = \{J_0 , J_1\}$. $J_0 \cap J_1 = \varnothing$. $U = J_0$. $V = J_1$. $(U = J_0) \cap (V = J_1) = \varnothing$. $[U \cap V = \varnothing] \rightarrow [J_0 \cap J_1 = \varnothing]$. $(U \cup V) \subseteq Bdy(J)$. $U, V \in J$.

Lemma 20.0 A boundary function incorporates local jurisdictional boundary division.

Theorem 20.0 (Decentralization II) The existence of a boundary function satisfies the minimal federalism condition.
Proof. **FIGURE 1.0**. $Bdy(J) = J$. $J = \{J_0 , J_1\}$. $J_0 \cap J_1 = \varnothing$. $U, V \in X$. $U \cap V = \varnothing$. $J_0 = U$. $J_1 = V$. $(J_0 = U) \cap (J_1 = V) = \varnothing$. $[J_0 \cap J_1 = \varnothing] \rightarrow [U \cap V = \varnothing]$. $J_0 , J_1 \in X$. $(J_0 \cup J_1) \subseteq P(X)$.

FIGURE 1.0 Minimal Federalism by Local Jurisdiction and Boundary Function



Proposition 25.0 City districts = municipal territory.

Proposition 26.0 Municipal service districts = county contract = remain unincorporated county territory.

Lemma 21.0 (Existence of spheres of influence I) Local jurisdictional boundaries + fringe areas = spheres of influence.

Proposition 27.0 Uniform municipal provision = rectangular distribution of city goods and services by town section of county territory.

Lemma 22.0 (Existence of spheres of influence II) Spheres of influence - local jurisdictional boundaries = fringe areas only.

Theorem 21.0 Given zero fringe areas, local jurisdictional boundaries are closed boundary functions.

Proof. Given fringe areas = 0, spheres of influence = local jurisdictional boundaries. Given fringe areas = 0, local jurisdictional boundaries form a boundary function. The boundary function is closed and therefore the sphere of influence border is coterminous with local jurisdictional boundaries. The sphere of influence border function mapping is coterminous with municipal boundaries. This mapping implies local jurisdictional boundaries are intact and therefore have territorial integrity. Any local jurisdiction with territorial integrity has a complete set of boundaries, continuous in the mapping of spheres of influence to local jurisdictional boundaries. As a result, the sphere of influence equals local jurisdiction. On this basis, spheres of influence guarantee the existence of local jurisdiction with closed boundary division.

Theorem 22.0 Given positive or nonzero fringe areas, local jurisdictional boundaries are open boundary functions.

Proof. Given fringe areas > 0, spheres of influence = local jurisdictional boundaries + fringe areas. The boundary function is open and therefore the sphere of influence frontier extends beyond local jurisdictional boundaries. The sphere of influence frontier function mapping incorporates municipal and municipal service district areas. This mapping implies local jurisdictional boundaries are not intact and therefore incomplete in correspondence with fringe areas. As a result, the sphere of influence equals local jurisdiction plus any extension of local jurisdiction to fringe areas. The fringe areas form municipal service districts, remain county territory and contract with the municipal districts to provide local public goods and services. On this basis, spheres of influence guarantee the existence of local jurisdiction with an open boundary division.

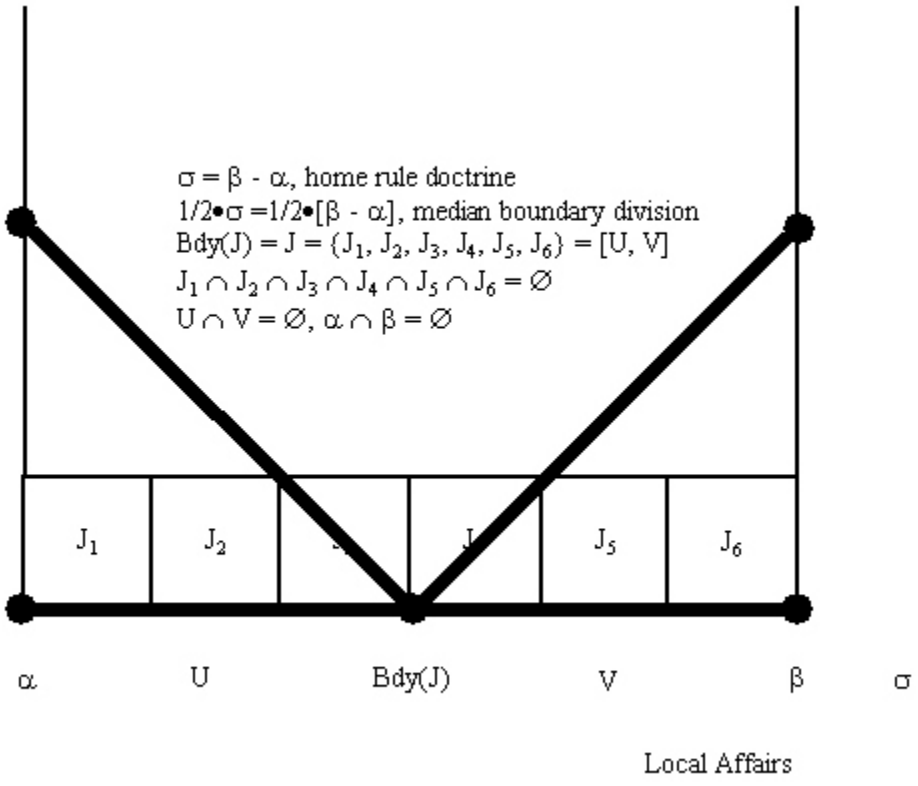
Theorem 23.0 (Decentralization III) Spheres of influence guarantee the existence of local jurisdiction.
Proof. **FIGURE 2.0**.

Theorem 24.0 (Decentralization IV) Spheres of influence extend local jurisdictional boundaries.

Theorem 25.0 (Local boundary division I) The existence of local jurisdiction satisfies the minimal federalism condition.
Proof. **FIGURE 2.0**.

Theorem 26.0 (Local boundary division II) The existence of local jurisdictional boundaries satisfies the minimal federalism condition.
Proof. **FIGURE 2.0**.

FIGURE 2.0 Minimal Federalism in Local Affairs



Lemma 23.0 Minimal federalism satisfies the Hausdorff condition.

Lemma 24.0 Local jurisdiction satisfies the Hausdorff condition.

Lemma 25.0 Local jurisdictional boundaries satisfy the Hausdorff condition.

Lemma 26.0 Home rule doctrines satisfy the Hausdorff condition.

Lemma 27.0 Boundary division by functional determination satisfies the Hausdorff condition.

Theorem 27.0 The local affairs dimension satisfies the Hausdorff condition.
Proof. **FIGURE 2.0**.

Theorem 28.0 The local affairs policy space satisfies the Hausdorff condition.

Theorem 29.0 Decentralization satisfies the Hausdorff condition.

Theorem 30.0 Local boundary division by partition satisfies the Hausdorff condition.

Theorem 31.0 Local boundary division by closed (finite and integer) district covering satisfies the Hausdorff condition.

Proposition 28.0 Spheres of influence are congruent with municipal service district boundaries.

Proposition 29.0 Spheres of influence form circular market areas for local public goods and services in unincorporated territory.

Proposition 30.0 Spheres of influence form spatial competition among local jurisdictions equal to Soddy Circles in unincorporated territory.

Lemma 28.0 Existence of sphere of influence boundary points = closed and bounded set of location alternatives.

Lemma 29.0 Existence of sphere of influence boundary points = compact set of location alternatives.

Theorem 32.0 An equilibrium in local jurisdiction exists.

Theorem 33.0 An equilibrium in local jurisdictional boundary division exists.

Theorem 34.0 A spatial competition equilibrium exists in location and distance.

Theorem 35.0 A local jurisdictional equilibrium guarantees the existence of a fragmentation numerical solution: $\mathscr{F}(J) = J$,

Theorem 36.0 A local jurisdictional boundary equilibrium guarantees the existence of a fragmentation numerical solution: $Bdy(J) = J$.

Theorem 37.0 An equilibrium exists in local jurisdiction and local jurisdictional boundaries: $\mathscr{F}(J) \doteq Bdy(J)$.

Lemma 30.0 Choice of local jurisdiction $\equiv \mathbb{C} = \mathbb{C}(1, ..., m) = J$.

Lemma 31.0 Local division by partition $\equiv \phi = \phi(1, ..., n) = J$.

Theorem 38.0 Choice of local jurisdiction is equal to local division by partition.

Theorem 39.0 Local jurisdictional fragmentation forms a finite cover and partition.
Proof. $\mathscr{F}(J) = \mathbb{C} = \phi$.

Theorem 40.0 Local jurisdictional boundary fragmentation forms a finite cover and partition.
Proof. $Bdy(J) = \mathbb{C} = \phi$.

Proposition 31.0 A single point service island exists at a point of boundary intersection.

Proposition 32.0 A linear corridor service island exists at a two points or more boundary intersection.

Proposition 33.0 A fringe area service island exists by intersection at multiple points and is therefore contiguous with local jurisdictional boundary lines.

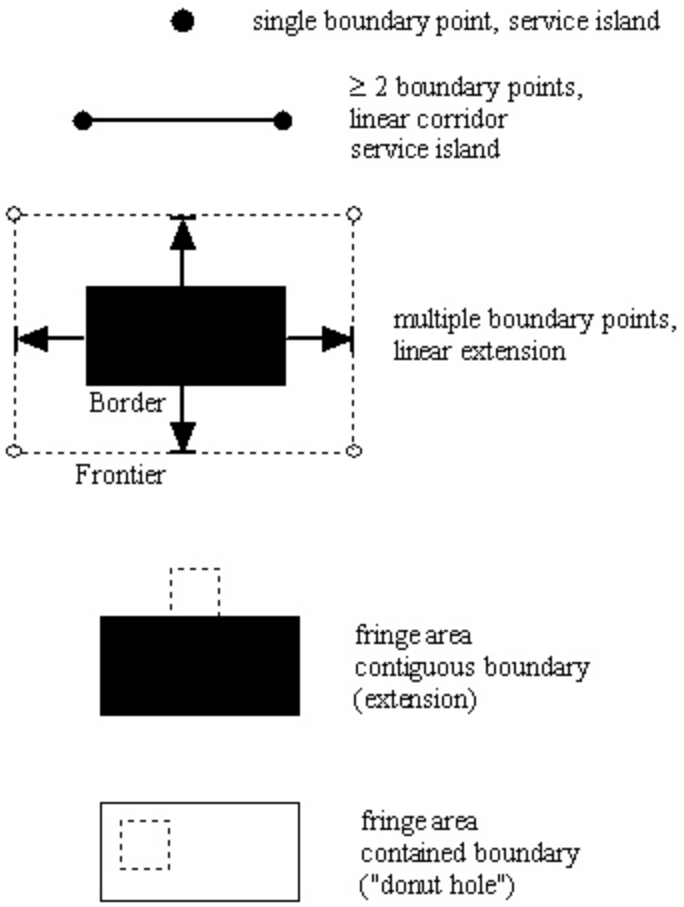
Proposition 34.0 A “donut hole” fringe area is both contained and coterminous within local jurisdictional boundary lines.

Proposition 35.0 An edge fringe area is contiguous and not contained with local jurisdictional boundary lines.

Lemma 32.0 Spheres of influence are derived from by local boundary points.

Lemma 33.0 Spheres of influence are constructed by local boundary division lines.

FIGURE 3.0 Models of Unincorporated Municipal Service District Areas



Definition 18.0 $\epsilon(p)$ = point of boundary intersection.

Definition 19.0 $\ell(j) \equiv$ linear extension/lineal corridor.

Definition 20.0 $\ell(B)$ = fringe area.

Definition 21.0 $\mathfrak{L}(B) \equiv$ linear expansion/lineal extension.

Definition 22.0 $\mathring{A}(j) \equiv$ city land area in location and distance.

Definition 23.0 $Bdy(j) \equiv$ city boundary delimitation.

Theorem 41.0 Spheres of influence exist equal to a distribution of boundary points.
Proof. Definitions 18 through 21. Propositions 31-35. **FIGURE 3.0**.

Theorem 42.0 A city land area dis-contiguous point exists.
Proof. ∈(p) ⊂ Å(j). **FIGURE 4.0**.

Theorem 43.0 A service island exists by single boundary point intersection.
Proof. ∈(p) ∩ Bdy(j). **FIGURES 4 & 5**.

Theorem 44.0 A city corridor remains unincorporated territory surrounded by municipal land area.
Proof. ℓ(j) ⊂ Å(j). **FIGURE 4.0**.

Theorem 45.0 A city boundary remains unincorporated territory
Proof. ℓ(j) ∩ Bdy(j). **FIGURE 4.0**.

Theorem 46.0 A fringe donut hole area exists contained within municipal territory.
Proof. ℓ(B) ⊂ Å(j). **FIGURE 4.0**.

Theorem 47.0 A fringe edge area exists intersecting with municipal boundaries.
Proof. ℓ(B) ∩ Bdy(j). **FIGURE 4.0**.

Theorem 48.0 Multiple dis-contiguous areas exist within municipal territory and by intersection with municipal boundaries.
Proof. ℒ(B) ⊂ Å(j). ℒ(B) ∩ Bdy(j). **FIGURE 4.0**.

Theorem 49.0 A linear extension exists derived from municipal boundaries into unincorporated county territory.
Proof. ℒ(B) ∩ Bdy(j). **FIGURES 3 & 4**.

FIGURE 4.0

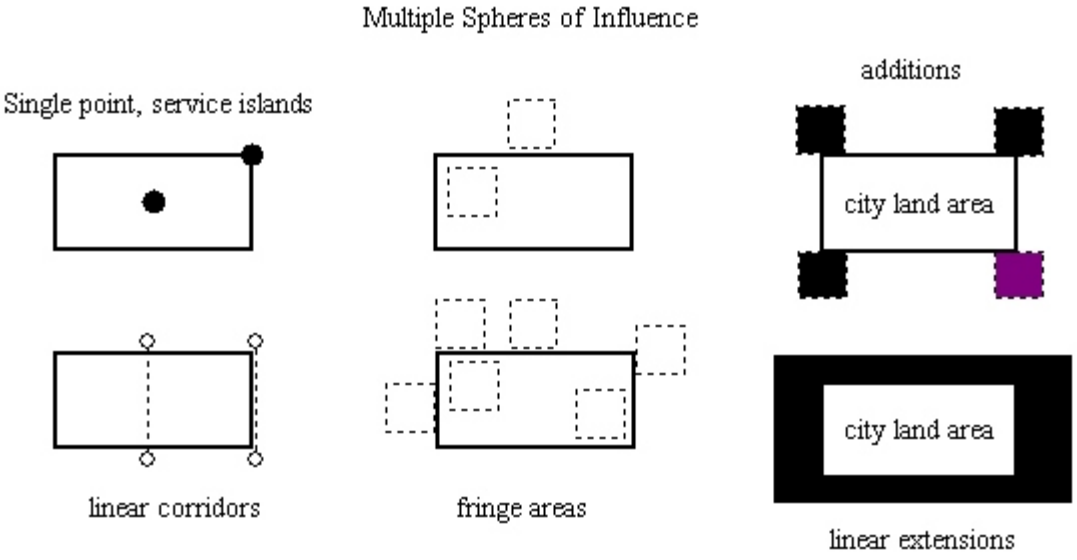
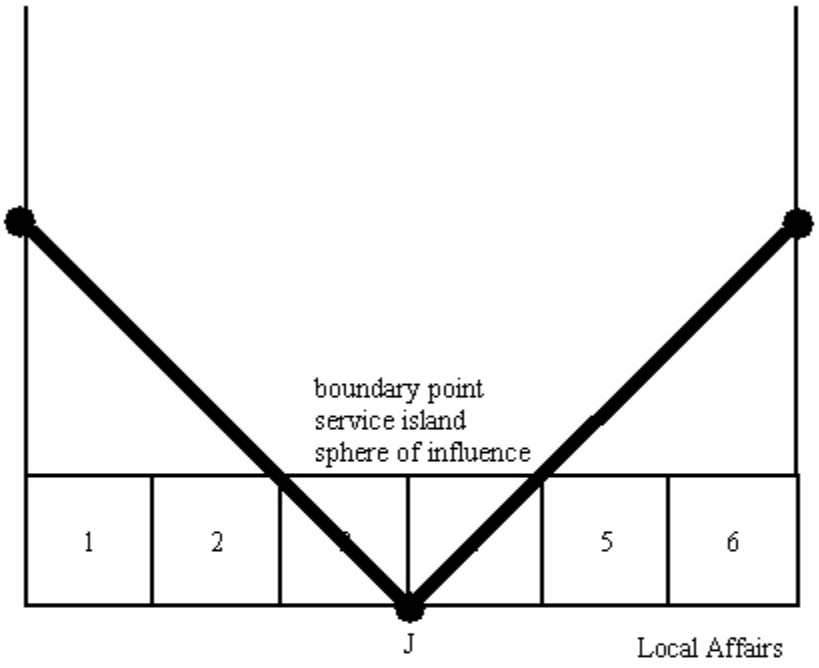


FIGURE 5.0 Single Point, Service Island = Boundary Point Sphere of Influence



boundary point
local jurisdictional boundaries exist
single point, service island
municipal service district cover
service island
sphere of influence
umsa area
county territory

Lemma 34.0 Spheres of influence = linear extensions and contiguous boundary points.

Theorem 50.0 Existence of sphere of influence boundary points = linear extension and nonlinear constraints.

Proposition 36.0 Existence of sphere of influence = angle path of boundary points.

Proposition 37.0 Existence of sphere of influence = directional orientation or trajectory of boundary points.

Proposition 38.0 Existence of sphere of influence = linear extension sequence of points.

Proposition 39.0 Existence of sphere of influence boundary points = baseline.

Proposition 40.0 Existence of sphere of influence boundary points = status quo and reversion levels in boundary division.

Proposition 41.0 Existence of sphere of influence boundary points = initial settlement point, status quo town square and town sectional planning, development, zoning.

Theorem 51.0 Existence of sphere of influence boundary points = single point, service island district of county territory.
Proof. Proposition 31.0. FIGURE 3.0. Definition 18.0. Theorem 43.0. FIGURES 4.0 and 5.0.

Theorem 52.0 Existence of sphere of influence boundary points = linear corridor extension, boundary expansion of local jurisdictional boundary division.
Proof. Proposition 32.0. FIGURE 3.0. Definition 19.0. Theorem 44.0. FIGURE 4.0.

Theorem 53.0 Existence of sphere of influence boundary points = range of failed annexation of county territory.
Proof. At least a single town or town section. FIGURE 6.0.

Theorem 54.0 Existence of sphere of influence boundary points = range of failed cityhood incorporation of county territory.
Proof. Two or more town sections. FIGURE 7.0.

FIGURE 6.0 Failed Annexation in 1 Town Section of County Territory

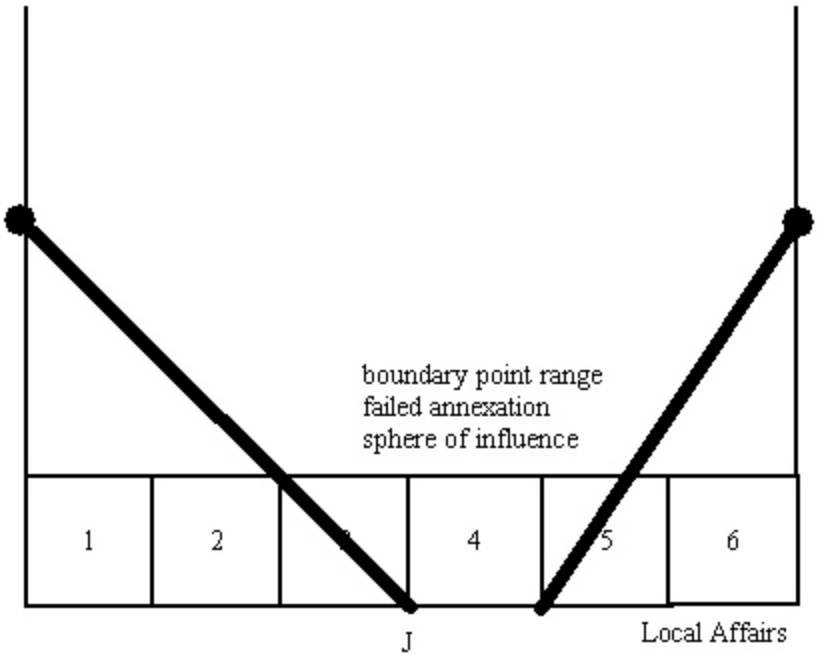
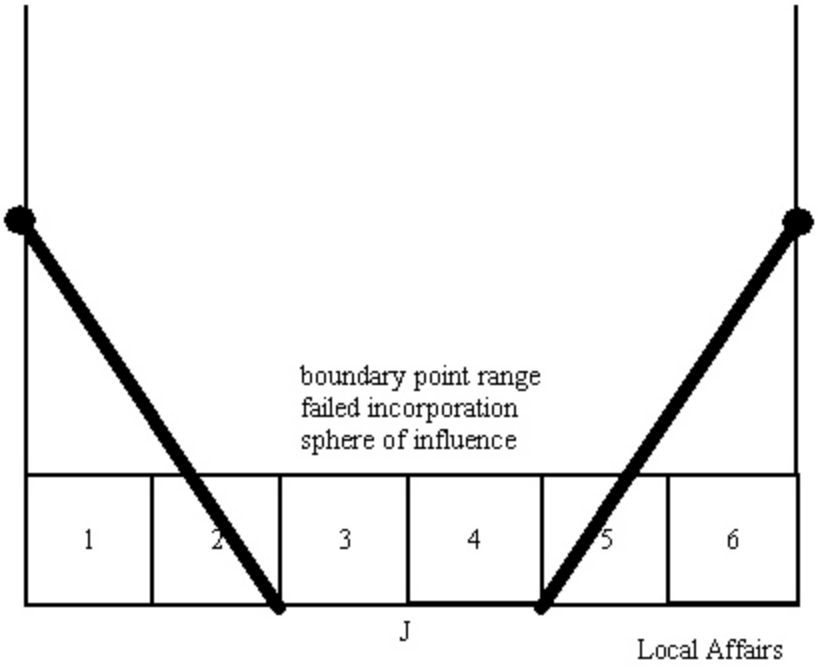


FIGURE 7.0 Failed Incorporation in 2 Town Sections of County Territory



Proposition 42.0 Existence of sphere of influence boundary points = boundary expansion.

Proposition 43.0 Existence of sphere of influence boundary points = boundary delimitation.

Proposition 44.0 Existence of sphere of influence boundary points = boundary division.

Theorem 55.0 Existence of sphere of influence boundary points = product differentiated, minimally federated and decentralized, distribution of (Soddy) circles, circular market areas

Proof. Assume circular markets within the town square sections in **FIGURE 3.0, 4.0 and 5.0**. Given a distribution of Soddy circles, there exists a locally finite integer number of circles distributed among the six town squares in **FIGURES 3.0** through **5.0**. The existence of local jurisdictions establish a minimally federated and decentralized structure of local government organization. The units of government are fragmented and therefore form a product differentiated provision of local public good and service allocation. **Propositions 42.0, 43.0, and 44.0**. The sphere of influence boundary points guarantee the existence of local jurisdiction, local jurisdictional boundaries and a mapping of the set of local jurisdictional boundaries.

Theorem 56.0 Existence of sphere of influence boundary points = product differentiated, minimally federated and decentralized, distribution of location and distance alternatives.

Theorem 57.0 The existence of spheres of influence transfers functions derived from county to municipal or city territory.

Proposition 45.0 Single point municipal service district = point of intersection.

Lemma 35.0 Service island = point of intersection + a radius.

Proposition 46.0 Two point municipal service district = linear corridor.

Lemma 36.0 Fringe area = two points of intersection + a radius.

Lemma 37.0 Service island = fringe area contained within a city boundary.

Proposition 47.0 Fringe area adjacent to the city boundary = distribution of boundary points.

Lemma .38.0 Perimeter service island = fringe areas adjacent to the city boundary by linear expansion

Theorem 58.0 Sphere of influence = linear extension of local jurisdictional boundaries.

Lemma 39.0 Local jurisdictional boundaries intact = coterminous local boundary division.

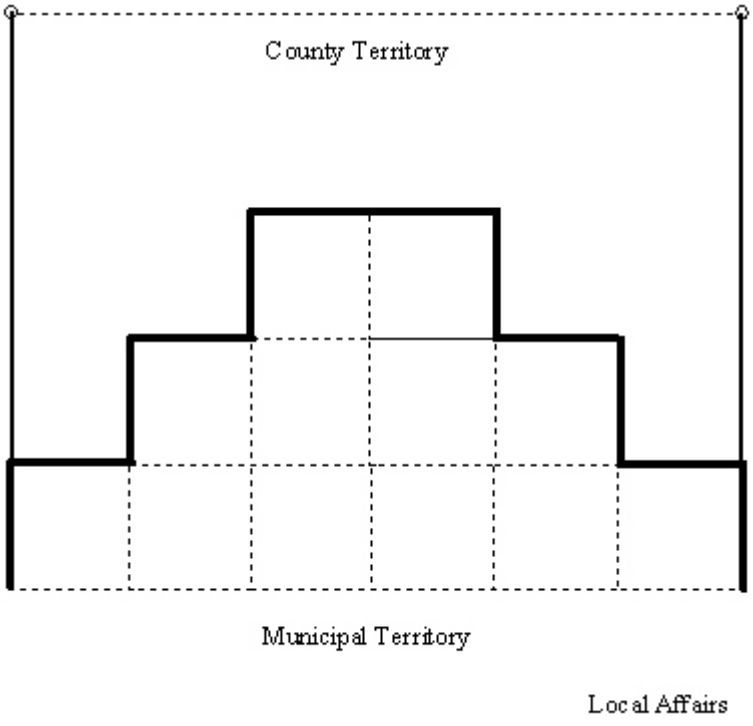
Theorem 59.0 Municipal territory = municipal bounded areas + spheres of influence areas.

Lemma 40.0 Consolidation produces municipal territory ≡ $C(B_t) = \mu(Å)$.
Proof. City-County consolidation = city and county merger. City and County merger = metropolitan county government. Consolidated city and county government = regional city.

Lemma 41.0 Separation produces municipal territory ≡ $S(B_t) = \mu(Å)$.
Proof. City-County separation or separate incorporation = independent and separable status for municipal territory.

Lemma 42.0 Amalgamation decisions produce municipal territory ≡ $Am(B_t) = R(A)$.
Proof. Multiple county mergers = county merger decisions. County merger = consolidated county government. Consolidated county government = metropolitan government.

FIGURE 8.0 Municipal and County Territory

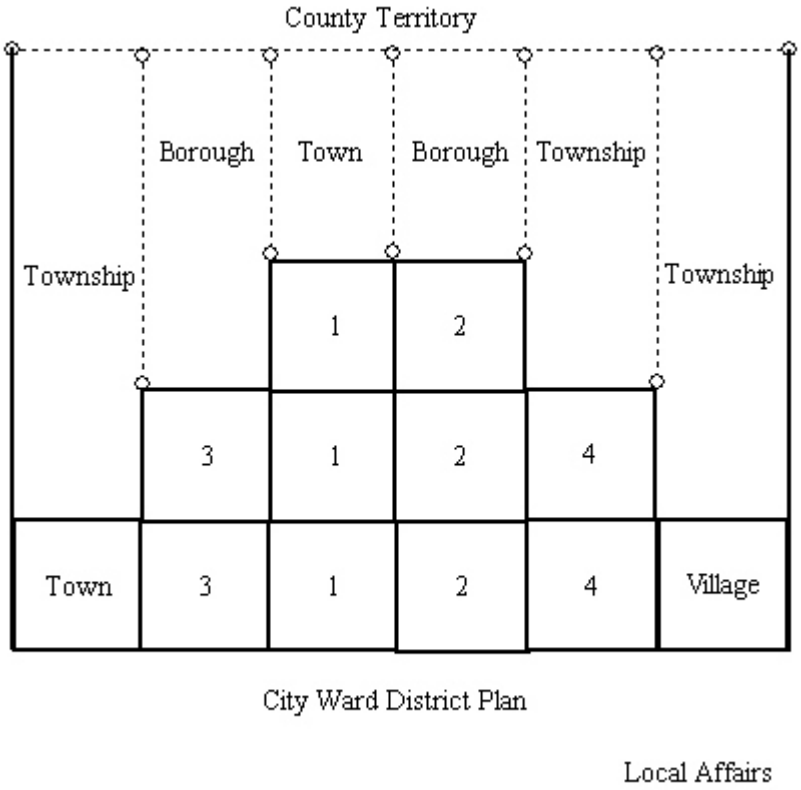


Proposition 48.0 A single unified unincorporated area forms a locally finite open cover of county territory.

Proposition 49.0 A citywide district forms a locally finite open cover of municipal territory.

Lemma 43.0 Merger decisions produce municipal territory ≡ $M(B_t) = \mu(Å)$.
Proof. Merger decisions are bilateral decisions between two local jurisdictions to consolidate territory. City district consolidation extends municipal territory for the purposes of local public good and service allocation. The merger may be between a city and an incorporated town, borough district, or village and township. The township may be unincorporated, but organized county territory, unorganized or by charter status able to bloc municipal annexation. Merger decisions linearly extend and therefore expand municipal boundaries. Borough districts represent ward districts in county territory, in small town and rural areas. Ward districts represent a district covering of municipal territory, in urban and incorporated city areas.

FIGURE 9.0 City Ward District Plan and Choice of Local Jurisdiction in County Territory



Proposition 50.0 Choice of local jurisdiction forms a locally finite closed cover of county territory.

Proposition 51.0 A complete borough-ward district plan forms a locally finite closed cover of county territory

Proposition 52.0 A municipal plan forms a locally finite open cover of county territory.

Proposition 53.0 A city ward district plan forms a locally finite closed cover of municipal territory.

Proposition 54.0 Statewide county organization forms a partition of State territory.

Proposition 55.0 Statewide county organization forms a closed cover of State territory.

Proposition 56.0 County-township organization forms a locally finite closed cover of county territory.

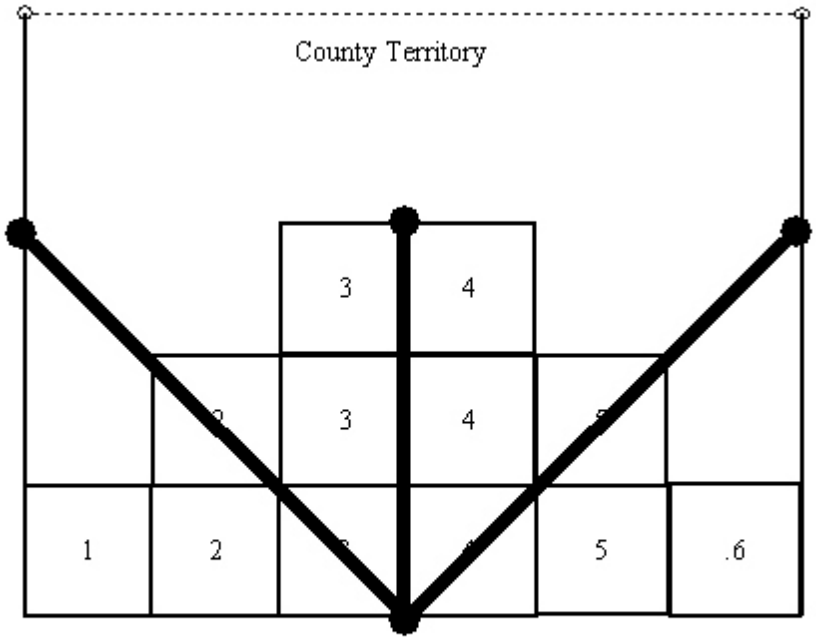
Proposition 57.0 County organization/subdivision by local jurisdiction forms a locally finite open cover of county territory.

Proposition 58.0 County subdivision by city incorporation forms a locally finite open cover of county territory.

Lemma 44.0 Annexation produces municipal territory ≡ $A(B_t) = \mu(Å)$.

Proof. City district plan is a rectangular market area for provision of local public goods and services. A ward district plan exists by town section. The ward district plan may be linearly extended by directional orientation derived from the core central city area or centrum of municipal territory. The linear corridors extend into unincorporated county territory. Boundary expansion is by linear extension into county territory. Annexation and boundary change is by direction and town section.

FIGURE 10.0 Linear Extension Boundary Strategy



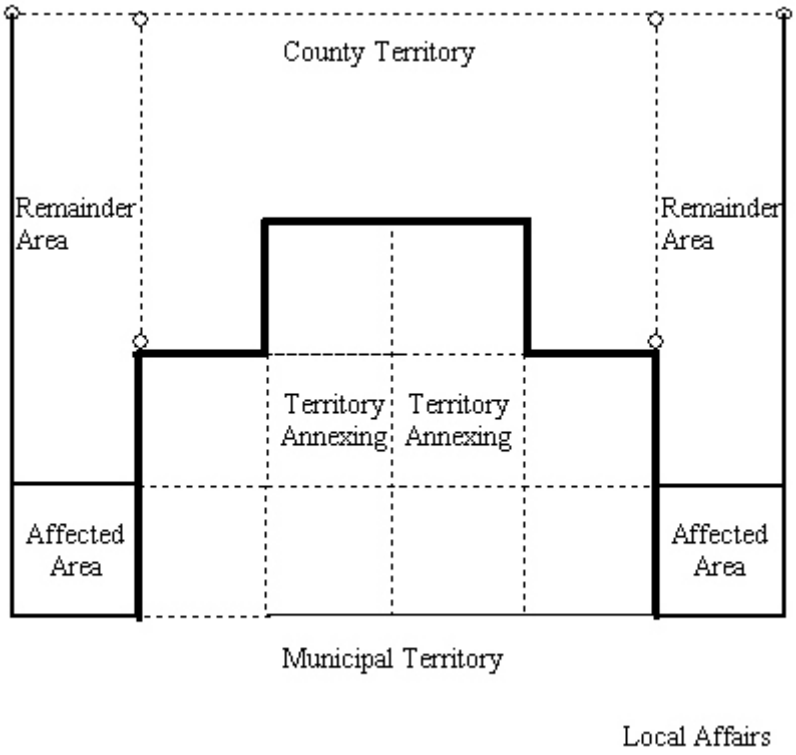
City Ward District Plan

Local Affairs

Theorem 60.0 Annexation and boundary change.

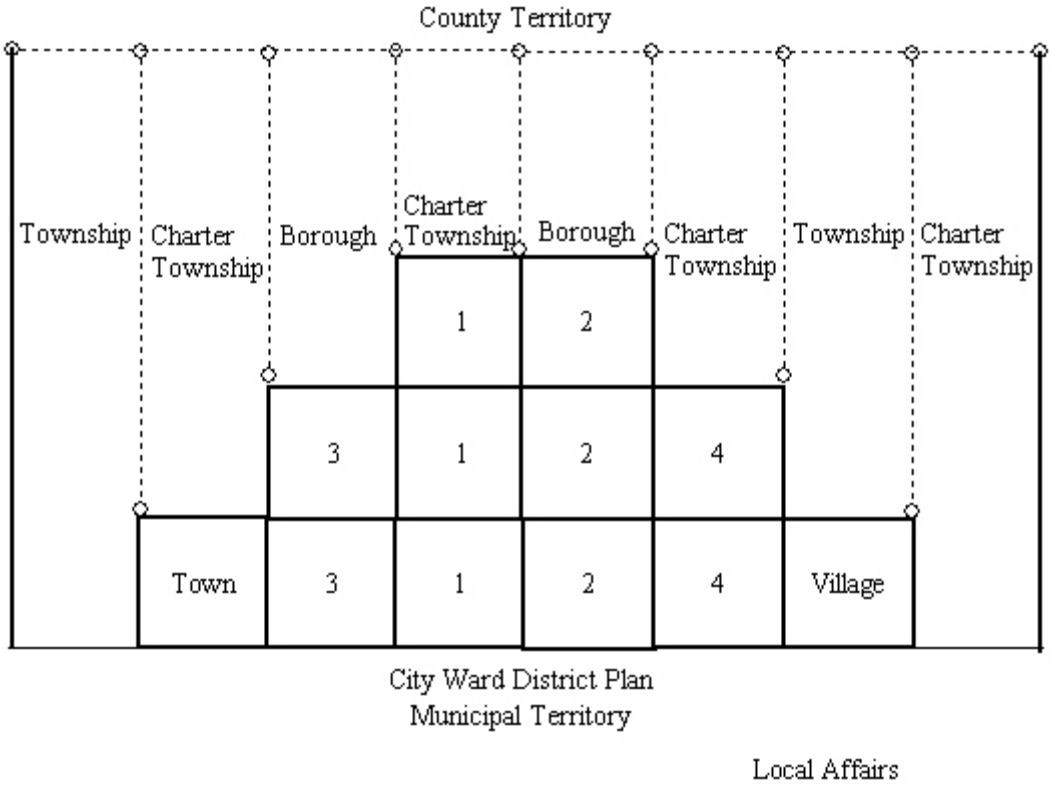
Proof. Boundary change equals boundary expansion or contraction. Boundary change occurs by linear extension. Boundary division is the result of a spatial history of boundary decisions. Boundary decisions may be state or locally regulated boundary functions. Annexation boundary decisions divide local jurisdiction into three categories: annexing areas, areas affected by annexation and remainder areas not included in the annexation decision.

FIGURE 11.0 Annexation Strategy and Boundary Change Correspondence



Theorem 61.0 Boundary change by municipal campaign and decision.
Proof. Local boundary division guarantees the existence of a decentralized, minimally federal structure of local jurisdiction. A boundary function permits boundary changes in local jurisdiction. The municipal decisions involve the areas proposing a boundary change, the areas affected by the boundary change and any areas remaining in county territory by choice of local jurisdiction.

FIGURE 12.0 Boundary Strategy and Choice of Local Jurisdiction



Lemma 45.0 Incorporation produces municipal territory ≡ $I(B_t) = \mu(Å)$.

Definition 24.0 Location-fixed boundaries ≡ frozen district boundary lines.

Theorem 62.0 Municipal incorporation produces a location-fixed spatial competition among local jurisdictions.

Proof. Incorporation and charter status blocks additional boundary changes to existing local jurisdictions. In the limit, fragmentation of cities becomes a fixed spatial configuration or mapping of local jurisdictions. Local division guarantees the existence of local boundary lines. Boundaries remain intact, but there is no potential for additional linear extension of boundaries. Boundary functions guarantee a status quo boundary points in mapping, given complete spatial competition among local jurisdictions. Local jurisdictional boundaries may remain open, with limited potential for boundary change to incorporate sphere of influence areas. Where local jurisdictional boundaries are both intact and coterminous, the boundary functions are closed and there is no potential for boundary change. The existence of closed boundary functions guarantees frozen municipal district boundaries.

FIGURE 13.0 Core-Periphery Choice of Local Jurisdiction and Imperfect Competition

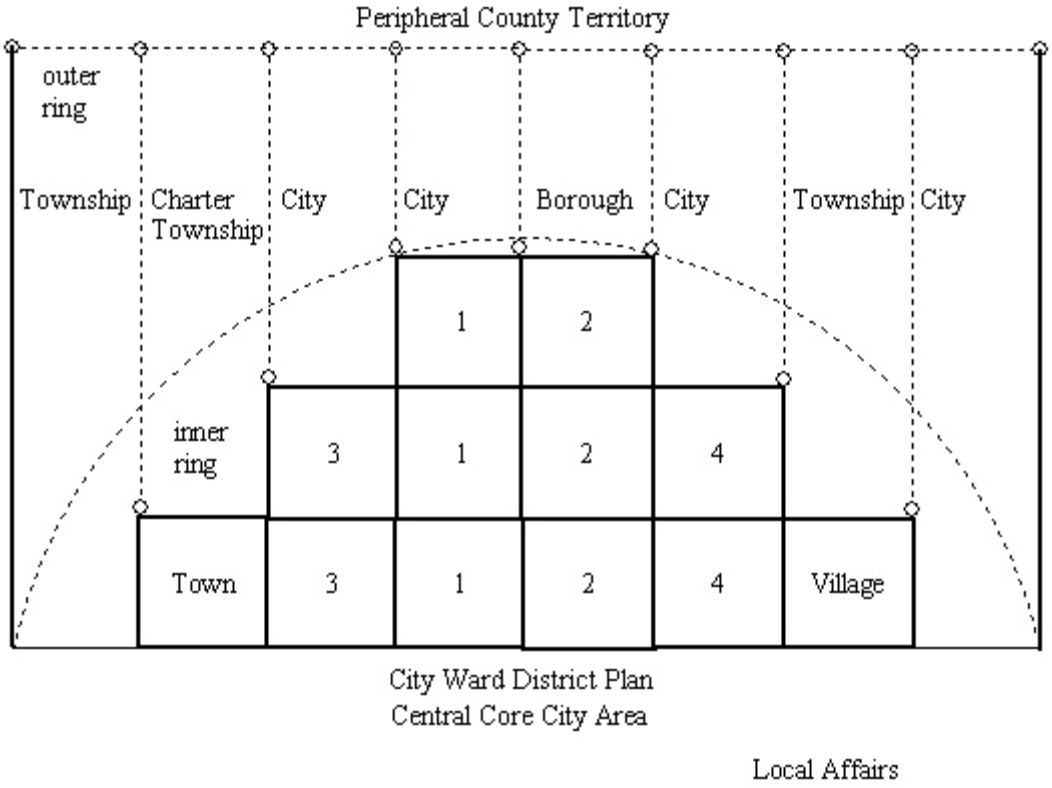
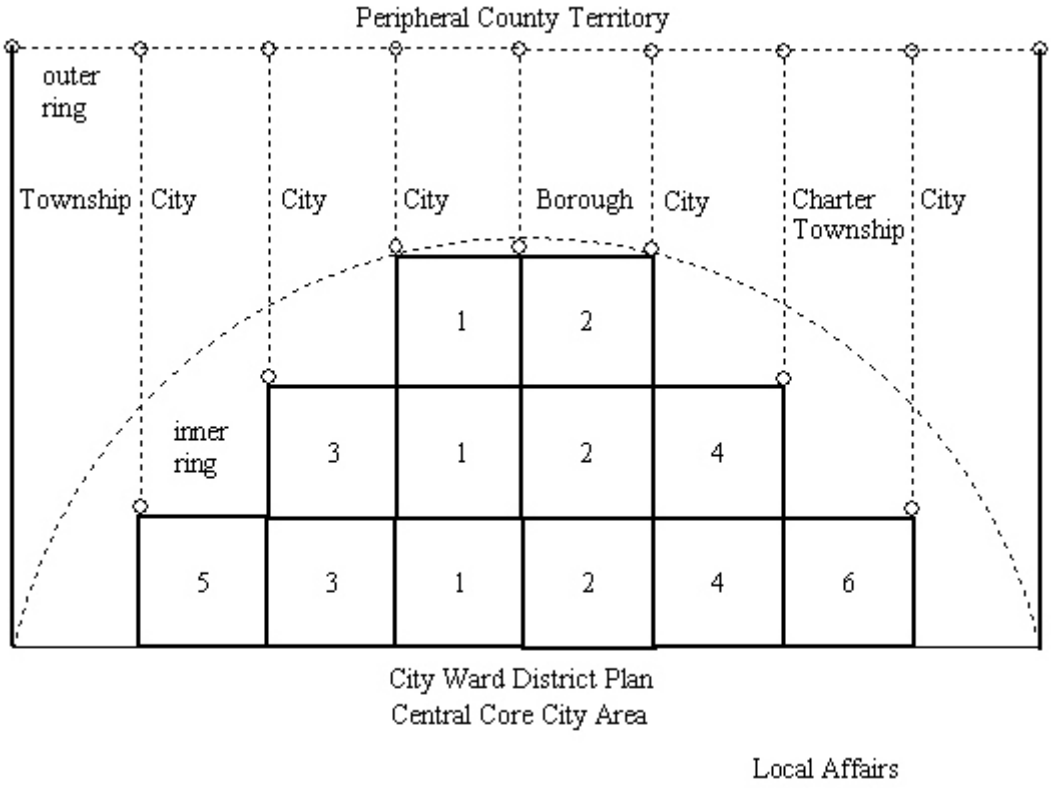


FIGURE 14.0 Core-Periphery Fragmentation and Spatial Competition



Proposition 59.0 Incorporation of cities produces a core and periphery structure of the greater metropolitan area.

Proposition 60.0 Incorporation of cities produces a compact set of local jurisdictions.

Proposition 61.0 Incorporation of cities produces circular market areas in the provision of local public goods and services.

Proposition 62.0 (Soddy circles) Incorporation of cities are equivalent to a finite distribution of integer radius circular markets for the allocation of local public goods and services.

Proposition 63.0 Incorporation of cities produces a differentiated and therefore fragmented choice of local jurisdiction.

Proposition 64.0 Incorporation of cities produces fragmented local jurisdictional boundaries.

Proposition 65.0 Incorporation of cities generates spatial competition in location and distance.

Proposition 66.0 Incorporation of cities blocks municipal annexation, merger and therefore boundary changes.

Municipal Service Districts in Unincorporated County Territory

The existence of a local boundary division guarantees fragmentation in numbers of local jurisdiction and local jurisdictional boundary fragmentation. Local boundary division lines provide a mapping of local jurisdiction equal to a fragmentation number solution. Local boundary lines may be either intact or extensive. If local jurisdictional boundary lines are intact, the boundaries are coterminous with the map of local jurisdiction. Extensive boundary lines incorporate both local jurisdictional boundaries and additional municipal service district areas remaining unincorporated in county territory.

As a result, local boundary division may form either an open or closed cover. Inasmuch the division consists of a locally finite, integer set of numbers. It is locally determined because these involve local boundary divisions. It is finite equal to a fragmentation numerical solution in the numbers of local jurisdictions. It is also finite in the number of dimensions covered by incorporation and charter status in the allocation of local public goods and services. Lastly, the integer set of local jurisdictions is also be a sequential ordering, in year of incorporation, population size, land area, and other fundamental or technical factors for modeling conditions of imperfect and spatial competition. Any ordering of a set of local jurisdictions provides additional description of local jurisdictional fragmentation. By doing so, fragmentation numbers generate integer sequences that both increase complexity and generalize fragmentation solutions.

The existence of lineal extensions implies three dimensional corridors of planning, development and zoning in municipal and county territory. A two dimensional analysis suggests the importance of spatial competition among local jurisdictions and the spatial configuration of local jurisdictional boundary lines. In this setting, a spatial configuration is a mapping of local jurisdictional boundary lines and any additions or extensions of territory to provide local public goods and services. The spatial configuration consists of a mapping of boundary points for the purposes of local jurisdiction and any extensions of territorial authority. Inasmuch the boundary delimitation guarantees the existence of local autonomy and therefore satisfies the conditions of minimal federalism and decentralization, consistent with a fragmentation of local jurisdiction by choice of incorporation and charter status. Local autonomy evolves from a spatial history of boundary campaigns and decisions and any state or locally determined boundary functions.

Linear boundary functions are guaranteed to exist by grid organization of county territorial subdivision. Boundary functions may be completely locally determined only by the evolution of county organization and the formation of cities. In many settings, boundary functions are also statewide-general law provisions guaranteed by centralization of local affairs, to regulate local jurisdictional fragmentation and local jurisdictional boundary fragmentation. In a few settings, boundary functions are delegated to local authorities, by county partition, to organize the subdivision of county territory by choice of local jurisdiction. In these settings, municipal territorial campaigns and decisions are regulated by county planning, development and zoning. In The States with county home rule, the adoption and implementation of a county charter and charter amendments permits county regulation of local affairs pertaining to both municipal territory and unincorporated county territory.

Unincorporated county territory is frequently treated as single district unit through county governance. Even so, population centers exist in county territory that may produce variation in local public good and service allocations. With regard to planning data, the use of federal census tracts establishes CDPs (Census Defined Places) that describe unincorporated population centers. These areas may be mapped by town section producing unincorporated municipal service district areas. Generally speaking, the county land areas are less than a single, 6 by 6 or 36 square mile, township area. These may consist of more than a single town section, but the areas are spatially closer to multi-town section borough districts or charter township areas derived from township remnants of municipal annexation and incorporation decisions.

Unincorporated areas may also be defined by physical delimitation of CDP population centers. In these settings, the areas consist of intact town sections located on county boundary lines. Given population variation, county boundary areas may be located a considerable distance from the city population centers of incorporated places. Municipal annexation and incorporation decisions factor in county boundary lines, by boundary function, producing the potential for edge areas derived from sets of town sections located within a short distance of county boundaries.. Annexation and incorporation campaigns may emphasize the potential for municipal territory incorporating "all the way to the county line," eliminating the potential for fragmentation. The existence of edge cities, with coterminous municipal and county boundaries suggests it may be easier to incorporate sets of town sections near county boundaries than to extend existing city limits to the county line. Even so, municipal incorporation campaigns fail and annexations sometimes form corridors from existing cities to county boundaries and therefore divide existing unincorporated county territory into fragmented, independent and separable fringe areas.

Other physical limitations include Forest Preserve areas, Water Resources and uneven terrains, such as those generated in the colonial grid, that contour the shape of local jurisdictional boundaries. The Forest Preserve lands provide a strict development boundary by state and national regulation. Water resource districts incorporate the considerations of risk of flood damage and clean water supply, oftentimes on the basis of regional water management districts. Mountainous areas also form valley boundaries on local jurisdiction that establish isolated areas.

Besides creating physical boundaries, the use of special purpose districts differentiates and varies among unincorporated county territories. When unincorporated territory is not treated as a single unit, the adoption and implementation of boundaries and single purpose districts generates distinct unincorporated areas. The distinctiveness of these areas form unincorporated municipal service areas defined as an UMSA territory. Among the home rule counties, there is some delegation of planning, development and zoning decisions to community council districts in unincorporated areas. The community council districts may be either appointive, by the county legislature, or elected by districts adopted and implemented for unincorporated areas. More generally, many counties permit unincorporated area residents to form multiple special districts, producing what can best be described as a municipal service district area. These municipal service districts are neither incorporated cities, nor general purpose districts. However, they do provide sufficient variation in special district goods and services to support municipal status for unincorporated areas based on the demand and supply conditions in targeted areas of county territory. These conditions suggest the potential for municipal annexation and incorporation of enclave areas in county territory.

The enclave potential for annexation and incorporation varies by unincorporated area. Unincorporated enclave areas are generally too small to be incorporated as independent and separate cities. As a fringe area, the potential for incorporation status is limited by the number of town sections and the size of the population of the fringe area. As a result, the choice is between annexation to adjacent existing cities or remaining unincorporated county territory. For those areas that remain unincorporated county territory, the possibilities exist for contracting with county government to provide additional public goods and services. Other possibilities include forming special districts allowed by county government regulation.

Special districts cover a wide variety of local public goods and services in county territory. These incorporate such matters as land use zones and urban planning and development districts. These special districts are used by unincorporated residents to fund capital infrastructure, transportation, street, road and bridge improvements and maintenance. Water management districts protect clean water supply and maintain functional responsibility for water resources. Other special districts cover emergency services, such as policing, fire protection and health care or hospital districts. County schools may be provided by a single unified school district or through city, town, borough, village and township school districts. The States also permit consolidation of local jurisdictional boundaries for the purposes of funding education and school buildings. What is important is that spheres of influence allow for county territory to be consolidated with municipal territory for the purposes of providing city services, such as planning, development and zoning, and emergency and land use management in substitution for special purpose county environmental districts (for water, fire, and land use—agriculture versus residential and commercial or industrial zoning).

Spheres of influence are increasingly hot spot areas impacted by climate change in weather conditions, forming areas with emergency management issues and environmental damage. Spheres of influence are unincorporated county areas that either remain county territory with special provisions or consolidate with municipal territory for the purposes of local public good and service allocation. Spheres of influence vary in location and distance or shape of the area affected by the choice of local jurisdiction. Spheres of influence also vary in population and land area, derived from single point, service islands to distributions of boundary points in n-gonal fringe areas. Spheres of influence may be determined by a single point of intersection, a linear corridor, a fringe contained within city territory, or by linear extension to unincorporated county areas that are contiguous with municipal boundaries.

Service islands are generated by local jurisdictional land areas, boundary division lines, and a distribution of boundary points. A single point service island is an intersection of two linear corridors. In the Macy model of a village plan, the point intersection describes the village center in the model. Two point service islands establish a linear corridor in planning, development and zoning. These corridors may be coterminous with local jurisdictional boundary lines or subdivide local jurisdictional land areas. A corridor may also represent a lineal extension of local jurisdiction and therefore define a sphere of influence territory. Lineal extensions with a contiguous boundary produce a service island district cover with zero measure space and set asides to adjacent local jurisdictions in a linear corridor of unincorporated territory consisting of the area of the boundary line between local jurisdictions. In this setting, the residential areas are in two different cities, with the commercial frontage space in unincorporated county territory.

Service islands and fringe areas are generally contiguous with local jurisdictions. Fringe areas are separable and independent unincorporated county territory. In situations where there have been failed annexation and incorporation campaigns, the fringe areas consist of incorporated small cities (towns, villages, or boroughs) by closed town section and township range area. An area is considered a failed attempt if an intact area remains unincorporated after an annexation or incorporation campaign. Still other areas may also be considered failed annexations if the territory is designated by county planning as an enclave area with potential for annexation to specific local jurisdictions. Failed incorporations are generally more rare than the service island and fringe areas making up the set of enclaves with potential for municipal annexation. Failed incorporations areas usually involve more than a single town section, but less than a full township area. In some settings, these consist of an incorporated borough district or charter township remainders of full townships after successful municipal annexation(s). A failed incorporation is an intact town sectional area of unincorporated county territory with congruence to the area proposed for incorporation by campaign but rejected by decision. Failed incorporation areas are defined by remaining unincorporated county territory and intact from any municipal annexation decisions.

Existence of Spheres of Influence in Los Angeles County Territory

Los Angeles County is the most populated county in the United States. It has 88 incorporated cities, with boundary functions regulated by State law beginning in 1963. The intent of the legislation was to reduce fragmentation by incorporation of new cities and fragmentation of county territory by municipal annexation.

The boundary functions are regulated by County in the State of California. By delegation, these Local Area Formation Commissions (LAFCOs) have the functional responsibility for local boundary functions. The Commissions appoint members of the County Commission (Board of Supervisors) and additional members representing cities and the county governments. The existence of state boundary regulation guarantees state involvement in local boundary division in the form of county planning. County planning is in addition to any municipal campaigns or decisions deliberating annexation, incorporation and charter status.

In California, county planning also established a State role in the formation of special districts (1965) and spheres of influence by 1972 legislation. The purpose of the 1972 legislation was create a mechanism, in the form of spheres of influence, to allow cities to provide local public goods and services to fringe areas within areas covered by their local jurisdictional boundaries. These areas included both service islands and fringe areas that had not, as yet, been annexed within municipal territory. The legislation also allowed cities to enter into joint agreements to provide local public goods and services to unincorporated county territory. The intent was to reduce bilateral and multilateral annexation competition for county territory. What had evolved through the spatial history of annexation decisions was pairing and groupings of cities contesting for county territory. The result was a fragmented spatial configuration of county territory with unincorporated areas being left out of cities and other cities annexing to the edges or boundary points of existing cities. This bilateral and multilateral competition for unincorporated areas produced failed annexations, with some areas excluded as buffer zones among cities and other areas not supporting the decision to annex put forth by one of the competitors in pursuit of county territory.

The spheres of influence legislation eliminated the requirement for incorporation status to provide local public goods and services. The sphere of influence area could contract with Los Angeles County government to provide additional services and establish special purpose districts to fund a wide variety of local public goods and services. The sphere of influence could also contract with a single adjacent city, two adjacent cities in a joint operating agreement, or three or more cities in a multi-lateral agreement. The initial reactions to the 1972 legislation produced a significant reduction in municipal annexation activity and a large number of two-city, joint agreements to share functional responsibility for a sphere of influence area of county territory adjacent to both cities municipal boundaries. On this basis, county planning produced the desired result to transfer unincorporated areas to cities where the unincorporated area was within the spheres of influence of one or two cities.

From 1972 onward, the spatial history of boundary decisions evolved to reduce the number of cities involved in the joint sharing agreements. These reductions eliminated all of the spheres of influence responsibilities held by three or more cities. There was also a substantial reduction in the number of joint operating agreements sharing functional responsibilities for unincorporated areas. As a result, the number of cities providing for spheres of influence reduced to single city contracting provisions with unincorporated areas. This result implies these cities were the most likely to annex the targeted unincorporated areas, even though this has not yet occurred. For the purposes of county planning, development and zoning, this produces a pairing of unincorporated areas with adjacent municipal territory and a still remaining large set of unincorporated areas not included in spheres of municipal influence. These latter areas contract with Los Angeles County and provide funding for municipal service district areas.

Organization of the county partition evolved in California with Los Angeles County one of the original 1850 counties. Los Angeles County also contained Kern (1866), Orange (1869), Riverside (1893), and San Bernardino (1853). Given the size of the land areas, these changes represent far more significant boundary changes by county reorganization than any potential territorial reforms by municipal annexation, merger or incorporation decisions. Within Los Angeles County, the county-township system existed but the evolution of townships was influenced by county reorganization. By 1870 Los Angeles County established a township system and adopted and implemented a five member commission plan, board of supervisors with supervisor districts not apportioned to individual townships. City incorporation began by town section with small cities forming outside of the original town square plan enacted for the City of Los Angeles prior to statehood. Town incorporation was voted on by town residents and decided by the Los Angeles County Commission.

By 1900, county residents had lived under town and county-township government for a thirty year period, including the economic collapse of the 1890's. Population growth led to some deliberation of Los Angeles city-county consolidation and additional county reorganization into two or more counties. Some of this discussion was derived from efforts to reorganize unincorporated county territory. In other instances, the population growth in both the City and County of Los Angeles produced demands for boundary expansion of municipal services into county territory. Some of this effort produced a strengthening of municipal government and county home rule by (1911) State constitutional and general law provision. Locals, such as the San Fernando Valley Taxpayer's Association, also produced reports on the costs of public goods and services provided by Greater Los Angeles area government.

Beginning with the town square plan, the City of Los Angeles pursued a linear corridor strategy for boundary extension and therefore expansion of city land area. The linear corridors went to the Northwest, via the Cahuenga Pass, from the East to West San Fernando Valley with a single municipal annexation. The City annexed in a western corridor along Sunset Boulevard to the Pacific Ocean. This corridor produced new city incorporations and multiple annexations of county territory and mergers of towns with the City of Los Angeles. The southern corridor extended Main Street from downtown to the Pacific Ocean and Port of Los Angeles. This corridor corresponded with the annexation of a large number of town sections of county territory adding significant amounts of land area to the City of Los Angeles. Like the boundary expansion into the San Fernando Valley and westward through the Centinela Valley to the Pacific Ocean, this produced new incorporations, annexations and town mergers with the City of Los Angeles. The twin LA Harbor cities of Wilmington and San Pedro were connected to downtown Los Angeles by the 101 Harbour Freeway "shoestring" annexation gate. South Bay coastal cities were incorporated along the Pacific Ocean to prevent annexation to Los Angeles. Lastly, eastern corridor extension was generally blocked by the Los Angeles River and resulted in the incorporation of San Gabriel Valley cities that became some of the most active cities in adopting and implementing annexation campaigns. Even today, these cities have dis-contiguous, single point service islands, donut hole areas of county territory surrounded by city boundaries and multiple fringe areas constituting failed annexations adjacent to municipal boundaries. In summary, the City of Los Angeles pursued a long-run annexation strategy that evolved through a spatial history of boundary decisions. These decisions produced a linear extension of Los Angeles City territory in corridors dispersed throughout Los Angeles County.

The annexation strategy of the City of Los Angeles did not eliminate the formation of unincorporated areas or new cities by incorporation and charter status. Some of the cities adopted and implemented city charters with county commission approval of specific provisions. The rest of the cities adopted incorporation status by referendum vote and charter provision derived from the general laws of the state. For both decisions there were two votes, a yes-no vote on municipal incorporation and a vote on officials elected to positions described by city charter.

Most cities adopted the five member commission plan for the city legislature and held no separate election for chief executive, instead preferring to select a Mayor from the membership of the city council. The cities implemented the commission plan by rotation of the legislative seats and positions. By doing so, city elections were held every two years, with three of the five seats up for reelection. The top two vote getters receiving a four year term and the third place finisher receiving a two-year term. The position of Mayor was implemented by selecting one of the two members elected to a four year term, every two years.

Many of the cities adopted and implemented an executive plan by appointing a city manager. City manager's are appointed by approval of the city council. The duration of service is determined by a majority of the city council or commission, with changes occurring during the legislative cycle or rotation of electing members of city council to two and four year terms. The defeat or reelection of incumbents to different positions may produce city manager turnover. Most of the 88 cities elect by city district generating citywide election returns, for a single at-large and multi-member district magnitude consisting of a three to five member delegation size being elected in each term. As a result, these charter provisions describe the alternatives selected for the local affairs dimension to adopt and implement a general purpose, city district.

The fragmentation of Los Angeles County territory is best described by the spatial history of Los Angeles City annexations and 87 city incorporation and charter decisions. Spheres of influence legislation emerges in 1972 during the long-run of fragmentation of cities in Los Angeles County. The spheres of influence legislation represents some of the finishing touches of the evolution of fragmentation in the attempt to reduce fragmentation into additional new cities or form dis-contiguous county territory produced by municipal annexation. As a result of spatial competition, fragmentation produces a large number of small unincorporated areas in an inefficient remainder configuration of county territory.

For the purposes of local public good and service allocation, county planning of boundary functions attempts to reduce fragmentation of county territory. Because county reorganization involved the largest intact unincorporated areas, those decisions produce the most amount of fragmentation of county territory by increasing the number of counties. Even so, the adoption and implementation of city and county home rule provisions increased fragmentation by increasing the number of cities. Besides incorporation and charter status, fragmentation of county territory increased to the point where municipal annexation evolved into a bilateral or multilateral contest among cities. This spatial competition ceases and desists with the attainment of coterminous boundaries and this produces a permanent location fixity in any map of municipal boundaries. As a result, spatial competition and municipal boundary strategies produce frozen city district boundaries with no potential for boundary expansion. The cities with potential spheres of influence have not attained location fixed boundaries. For these unincorporated areas, there is some potential for municipal annexation and possible new city incorporation determined by the size and shape of the unincorporated county territory.

In summary, county planning introduces a three-sided negotiation among cities, the areas affected by boundary decisions and any areas remaining in county territory. County planning regulates boundary functions and therefore changes in county subdivision, choice of local jurisdiction and incorporation status of county territory. Choice of local jurisdiction is a locally finite open district cover based on the decisions made for incorporation and charter status. County subdivision is a locally finite closed cover based on county organization of a partition of State territory. Both choice of local jurisdiction and county subdivision are finite integer sets of alternatives on the local affairs dimension determined by State home rule doctrine.

Fragmentation of Los Angeles County

Los Angeles County contains 88 incorporated cities. Given this fragmentation number of cities, the jacknife resampling solution indicates there are 3828 pairings or combinations of cities forming a spatial competition equilibrium. The number of census defined places varies by census, with the 2020 data indicating 49 CDPs and 137 total number of unincorporated areas in county territory. By comparison the 2000 county data indicates 147 unincorporated areas in county territory with differences in the naming and boundary areas of specific unincorporated areas. As a result, the 147 areas in the precise 2000 data are not the same as those described for 137 areas by 2020. Given these two data points, there are somewhere between 135 to 150 uniquely defined unincorporated areas remaining in county territory. Data is collected by each individual city revealing uncounted municipal service district islands and fringe areas generated by dis-contiguous city boundaries. These single point, service islands exist in the municipal territory of all 88 cities and number from one to two or more service islands.

Derived from the 1972 legislation, the number of spheres of influence equals 174 extensions of municipal territory. By doing so, these provide for the adoption and implementation of municipal service districts throughout the unincorporated areas of Los Angeles County. The number of spheres of influence range from zero to fifteen by individual cities. The average number of spheres of influence equals 1.98 or approximately two spheres of influence per-city. The standard deviation equal 2.59 indicating substantial variation among the cities in the numbers of spheres of influence. As a result, the covariation index equals 1.31 suggesting a relatively large amount of variation in city usage of spheres of influence.

The shape of the distribution is asymmetric with the cities having the largest numbers of spheres of influence the exceptional cases. Two cities, Los Angeles and Covina have the largest numbers of spheres of influence with 15 and 12 respectively. The distribution of spheres of influence also indicates there is a greater concentration of cities at less than the average number of spheres of influence. This result confirms that 70%+ of the cities have zero or only 1 or 2 spheres of influence. More generally, the skewness coefficient equals almost 2.5 and the kurtosis coefficient equals 8.6 indicating a non-normal distribution of sphere of influence. Inasmuch there are cities with five or more spheres of influence, with the other 76 cities divided between 32 cities with 0 spheres of influence and the other 44 cities having between 1 to 4 spheres of influence.

The distribution z-tests for the S-F and S-W statistics are 5 to 6 z-units from the average for a standard normal curve. The tests for normality reveal a very low probability of generating the city distribution of spheres of influence derived from a normal distribution. The findings for the J-B test indicate both significant skewness and kurtosis in the city distribution.

TABLE 1.0 SPHERES OF INFLUENCE

Number	Frequency	Percent	Cumulative Percent
0	32	36.4	36.4
1	17	19.3	55.7
2	15	17.0	72.7
3	4	4.5	77.3
4	8	9.1	86.4
5	5	5.7	92.0
6	4	4.5	96.6
7	1	1.1	97.7
12	1	1.1	98.9
15	1	1.1	100.0
Total	88	100.0	

FIGURE 15.0 Distribution of Spheres of Influence in Los Angeles County

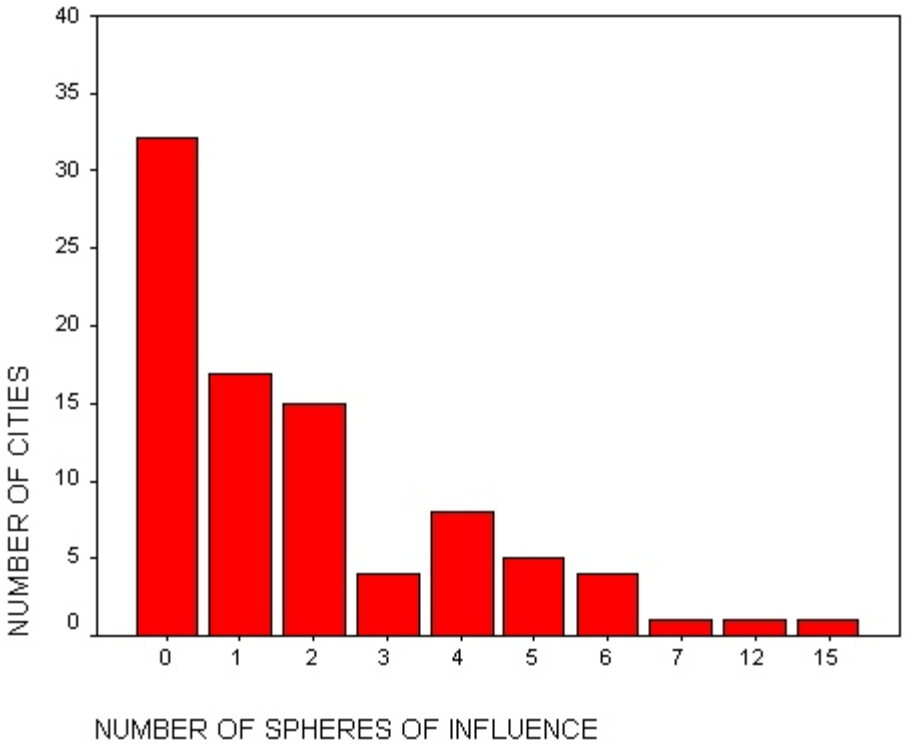


TABLE 2.0 Descriptive Statistics Spheres of Influence

N	88
Mean	1.98
Std. Error of Mean	.28
Median	1.00
Std. Deviation	2.59
Skewness	2.400
Kurtosis	8.264
Sum	**174**

TABLE 3.0 Inequality Measures of Spheres of Influence

relative mean deviation	.45911701
coefficient of variation	**13102776**
standard deviation of logs	.72551083
Gini coefficient	**.61742424**
Mehran measure	.80786015
Piesch measure	.52220629
Kakwani measure	.332009
Theil entropy measure	.72999625
Theil mean log deviation measure	-.11430536

TABLE 4.0 Tests of Normality of the Distribution of Spheres of Influence

Skewness/Kurtosis tests for Normality

Variable	Obs	Pr(Skewness)	Pr(Kurtosis)	joint adj chi2(2)	joint Prob>chi2
spheres	88	0.0000	0.0000	45.38	0.0000

Shapiro-Francia W' test for normal data

Variable	Obs	W'	V'	z-test	Prob>z
spheres	88	0.84087	13.039	5.034	0.00001

Shapiro-Wilk W test for normal data

Variable	Obs	W	V	z-test	Prob>z
spheres	88	0.79336	15.342	6.015	0.00000

There are 32 of the 88 cities with zero or no spheres of influence. These cities are considered to have intact boundaries that are coterminous with municipal boundaries. As a result, these cities have closed boundaries with no extension of municipal boundaries into county territory.

Among these 32 cities, there are 26 cities with frozen city district boundaries. These cities are surrounded by municipal territory, with zero spheres of influence and no adjacent unincorporated county territory. What is important is that there are only municipal boundaries contiguous with municipal territory. Frozen city districts have no potential for boundary expansion and therefore have location fixed municipal boundaries. Given spatial competition from neighbor cities and no unincorporated areas, these 26 cities form a compact set of spatial competition among cities consistent with a model of imperfect competition described by fragmentation of cities. Any amount of spatial competition in location and distance is equal to the fragmentation numerical solution in numbers of cities. As reported in **TABLE 5.0**, the number of neighbor cities ranges from 1 to 9 cities among those with frozen city district boundaries.

The median number of neighbor cities equals 4 neighbor cities per-municipal jurisdiction. The standard deviation in neighbor cities equals 3.5 indicating some city variation in numbers of neighbor cities. There is significant skewness and kurtosis in the distribution of neighbor cities, with the largest numbers the exceptional cities. As a result, 85% of the cities have 6 or fewer neighbor cities. Among the 13 cities with 7 or more neighbor cities, the City of Los Angeles has the largest number of neighbor cities equal to 30 cities. The other 12 cities range from 7 to 10 neighbor cities.

TABLE 5.0 Frozen City District Boundaries by Number of Neighbor Cities

City	Neighbor Cities	City	Neighbor Cities
Downey	9	Manhattan Beach	4
Commerce	7	South Pasadena	4
Alhambra	6	Maywood	3
Bell	6	Palos Verdes Estates	3
Bellflower	6	Rolling Hills	3
Paramount	6	Artesia	2
Bell Gardens	5	Beverly Hills	2
Norwalk	5	Hawaiian Gardens	2
Redondo Beach	5	West Hollywood	2
Vernon	5	San Fernando	1
Cudahy	4	Santa Monica	1
Lakewood	4	Signal Hill	1
Lomita	4	Westlake Village	1
N = 26 cities		Avalon*	0

Avalon, on Santa Catalina Island, has zero neighbor cities and one adjacent unincorporated area.

TABLE 6.0 Descriptive Statistics on the Number of Adjacent Cities

N	88
Mean	4.34
Std. Error of Mean	.37
Median	4.00
Std. Deviation	3.50
Skewness	4.620
Kurtosis	32.837
Sum	382

FIGURE 16.0 Distribution of Contiguous Cities in Los Angeles County

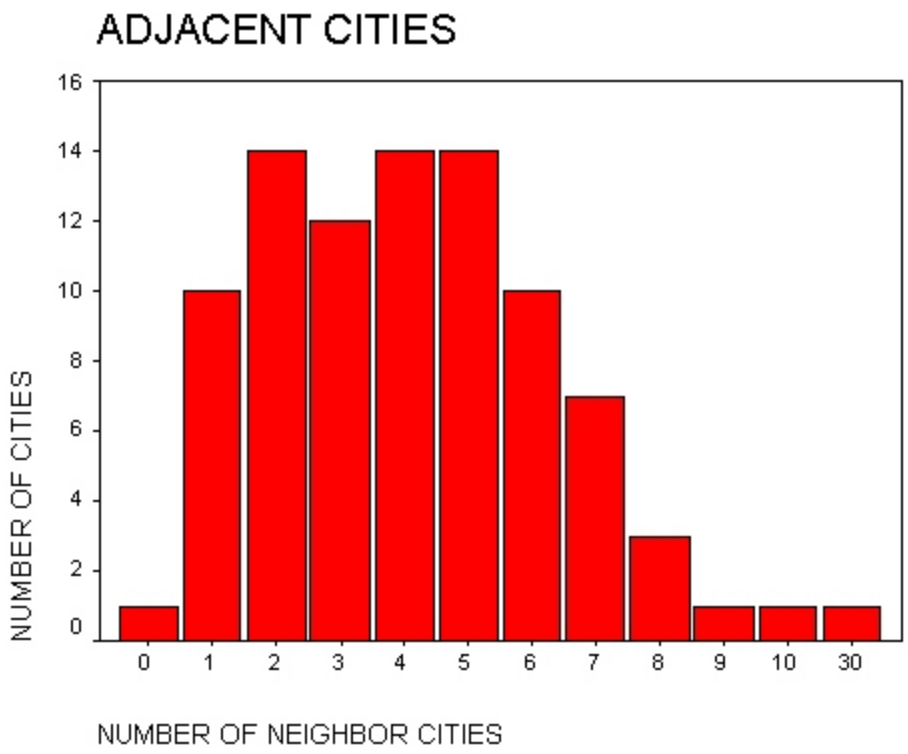


TABLE 7.0

Neighbor Cities	Number of Cities	Percent	Cumulative Percent
0	1	1.1	1.1
1	10	11.4	12.5
2	14	15.9	28.4
3	12	13.6	42.0
4	14	15.9	58.0
5	14	15.9	73.9
6	10	11.4	85.2
7	7	8.0	93.2
8	3	3.4	96.6
9	1	1.1	97.7
10	1	1.1	98.9
30	1	1.1	100.0
Total	88	100.0	

Among 12/13 exceptional cases, only two cities, Downey and Commerce have location fixed municipal boundaries. The other 10 cities all have potential for boundary expansion and some usage of the sphere of influence legislation to extend municipal boundaries. These cities are Industry (10), Torrance (8), Irwindale (8), Long Beach (8), El Monte (7), South Gate (7), Rosemead (7), Pasadena (7), Pico Rivera (7) and Hawthorne (7). All 13 cities have been the subject matter of boundary function regulation and municipal annexation strategy to expand boundaries, to contest for county territory with contiguous cities and to sometimes fail to extend municipal boundaries by annexation campaigns and decisions.

Pasadena and Long Beach adopted and implemented successful annexation strategies producing boundary expansion. Hawthorne, Torrance and Pico Rivera maintain boundaries relatively similar to a status quo derived from municipal incorporation. El Monte and South Gate are also relatively small cities in city land area. Pasadena, Long Beach, Hawthorne and Torrance each block City of Los Angeles annexation to east Los Angeles County, south Bay town sections and west to the Pacific coastline. Rosemead and Montebello engaged in an aggressive pursuit of unincorporated eastern county areas in the San Gabriel Valley. Pasadena has successfully annexed town sections of Altadena from northeast Los Angeles County territory. Three of cities have small populations: Industry (219, 87th ranked city), Irwindale (1422, 85th ranked city) and Commerce (12823, 75th ranked city). All three cities were the target of annexation by adjacent cities because of the predominance of commercial and industrial property in what are now incorporated cities. The areas evolved under County planning, development and zoning to the point that they became desirable targets for municipal annexation. In response, incorporation was supported by the business communities, property owners and few residents in these areas.

The cities of Industry, Irwindale and Commerce join Vernon as a small city with large per-capita tax base. The cities met the minimal population requirements for the purposes of municipal incorporation. Even so, these were somewhat controversial decisions to exclude significant county property tax base from municipal annexation. Because these areas evolved under County zoning, transportation and freight industries are also relevant to some of the opposition to annexation. These areas contain large complexes of railroad tracks, warehouses and truck traffic for the purposes of transporting goods to and from Greater Los Angeles and the Los Angeles Harbor. In retrospect, the adjacent residential cities would have benefitted from annexation of tax base. Even so, there would have been changes in zoning by the transfer of these affected areas to residential-suburbs, with more restrictive zoning requirements for commercial and industrial property. Given transportation and freight was the base of the economy, the County prevented municipal annexation to residential peripheral suburbs, and instead allowed for municipal incorporation of these areas. In recent years, the State has intervened because the population decline in these cities is below the minimal requirement of what used to be at least 500 residents. At issue was the fact these at least two of these cities (Vernon and Industry), and a third, (Irwindale) are falling below the minimal population requirements for Los Angeles County to allocate at least one voting precinct. This issue is complicated by what has happened to residential property in these cities and the fact that there have been difficulties in administration of local elections. The State Legislature warnings concern the incorporation status of these minimum population requirement cities, with specific reference to the dis-incorporation of Vernon and possible dis-incorporation of Industry.

The dis-incorporation of Vernon was overturned in Court which temporarily ended the State initiative to reduce the number of cities by dis-incorporation of small cities. All of the smaller cities sitting on large tax bases were informed of these issues with suggestions to pursue consolidation with other local jurisdictions prior to any State intervention to promote dissolution and merger with adjacent, more populated cities. This initiative called into question the incorporation status of several cities, including cities incorporated prior to the 1982, 1963 and 1911 provisions. Given the demographic trends, it is not likely that this issue can be resolved in the absence of boundary regulation and local consolidation decisions.

The number of unincorporated county neighbors is not equal to the number of unincorporated areas. First, given 137 unincorporated service districts in county territory, consisting of 49 CDPs (35.8%) and 88 (or 64.2%) other unincorporated areas. Second, the number of unincorporated neighbors equals 249, averaging almost 3 county neighbors per-city. The standard deviation equals approximately a 4 neighbor variation per-city. The covariation index is greater than 1 and equal to 1.31 suggesting significant variation exists among the incorporated cities and any potential they may have to annex unincorporated areas of county territory. The median equals 2 neighbors per-city, with the skewness and kurtosis coefficients indicating an asymmetric distribution of unincorporated areas. The skewness coefficient reveals cities with larger numbers of adjacent county areas are the exceptional cities. The strongly positive kurtosis coefficient reveals 2/3 of the cities are coterminous between 0 and 3 areas of county territory. The larger numbers of county neighbors range from 4 to 27 unincorporated areas. The cities with 7 or more adjacent unincorporated areas hold greater potential for annexation of county territory than those cities near the average, ranging from 0 to 3 areas.

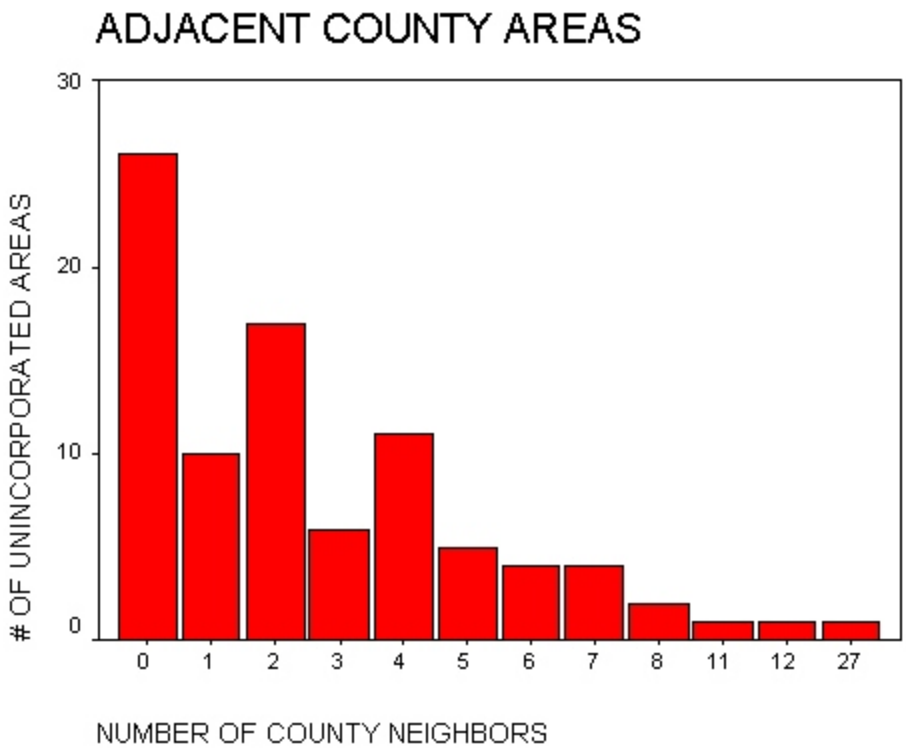
TABLE 8.0 Descriptive Statistics on Number of Adjacent County Areas

N	88
Mean	2.83
Std. Error of Mean	.39
Median	2.00
Std. Deviation	3.70
Skewness	3.611
Kurtosis	20.427
Sum	249

TABLE 9.0

Neighbor County Areas	Number of Unincorporated Areas	Percent	Cumulative Percent
0	26	29.5	29.5
1	10	11.4	40.9
2	17	19.3	60.2
3	6	6.8	67.0
4	11	12.5	79.5
5	5	5.7	85.2
6	4	4.5	89.8
7	4	4.5	94.3
8	2	2.3	96.6
11	1	1.1	97.7
12	1	1.1	98.9
27	1	1.1	100.0
Total	88	100.0	

FIGURE 17.0 Distribution of Unincorporated Neighbor Areas in Los Angeles County



The potential for municipal annexation of county territory varies by the number of adjacent unincorporated areas. The number of adjacent unincorporated areas establishes the number of county neighbors per-city. The findings indicate variation in city potential for annexation of county neighbors. The numbers of unincorporated areas are generally greater in the more peripheral cities, nearest to county boundary lines and other physical boundary delimitations on the outer ring of suburbs. These unincorporated areas tend to be larger in land area and less populated than any fringe areas adjacent to inner ring residential suburbs. The division between CDPs and unincorporated places describes some of the distinction between the more and less populated, larger and smaller county territories with potential for municipal annexation. In summary, the cities with the most county neighbors have the greatest potential for annexation to consolidate unincorporated areas into municipal territory.

As a consequence of County boundary regulation, annexation potential varies by region of Los Angeles County. The area with most potential for annexation is in the Antelope Valley, near the twin desert cities of Lancaster and Palmdale. The unincorporated areas adjacent to these two cities have been the subject of successful annexation, failed annexations, and proposals for annexation. Both Lancaster and Palmdale have service islands, fringe area donut holes and unincorporated neighboring fringe areas. The second county region with greater annexation potential are the San Gabriel Valley cities in east Los Angeles County. Independent and separate from the City of Los Angeles, these cities share many fringe areas and a spatial history of bilateral and multilateral competition for unincorporated areas. Cities such as Montebello and Rosemead annexed county territory to each others municipal boundaries. The period of 1945 to 1963 and then onwards to 1972 produced multiple annexations among the San Gabriel cities.

TABLE 10.0 Cities with Greater Annexation Potential

City	# of Adjacent Unincorporated County Areas	City	# of Adjacent Unincorporated County Areas
Los Angeles	27	Arcadia	6
Covina	12	West Covina	6
Industry	11	Inglewood	6
San Dimas	8	Palmdale	6
Santa Clarita	9	Baldwin Park	5
Hawthorne	7	San Gabriel	5
Santa Fe Springs	7	Azusa	5
Whittier	7	La Puente	5
Compton	7	Hidden Hills	5

TABLE 11.0 Number of Unincorporated Areas by County Region

Region	Number of Areas	Percent
Angeles National Forest	5	3.6
Antelope Valley	28	20.4
Central Los Angeles County	5	3.6
Northwest Los Angeles County	2	1.5
San Clemente Island	1	.7
San Fernando Valley	7	5.1
San Gabriel Valley	26	19.0
Santa Catalina Island	1	.7
Santa Clarita Valley	14	10.2
Santa Monica Mountains	12	8.8
South Bay/Port Area	9	6.6
South Los Angeles County	14	10.2
Southeast Los Angeles County	9	6.6
Verdugo Mountains	2	1.5
West Los Angeles Area	2	1.5
Total	137	100.0

In south Los Angeles County, there are three regions that taken together contain a large number of potential annexations in county territory. The first group of unincorporated areas are amongst the South Bay cities, on the western edge of Los Angeles County and the Pacific coastline. Among these cities, are many service islands, donut holes and fringe areas with some potential for annexation with existing South Bay cities.

Secondly, there are also multiple unincorporated areas, consisting of population centers (CDPs) in south Los Angeles County. In this region, the existence of failed city incorporation votes produced a patchwork quilt of intact unincorporated areas. The chances are unlikely that either city incorporation or municipal annexation is going to occur given the time elapsed, from the 1940's to 1960's, when cities were deliberated for these unincorporated areas. In most instances, the threat of annexation to the City of Los Angeles produced a response favoring municipal incorporation. Since annexation to Los Angeles is very unlikely, the threat of municipal incorporation has been greatly reduced as these areas of county territory remain unincorporated. Similar to the San Gabriel Valley and South Bay cities, there also appears to be a reduction in the chances of annexation to neighboring cities, so that the most likely outcome is that unincorporated areas remain county territory.

Thirdly, the southeast region of Los Angeles County contains unincorporated areas that have been both proposed as cities and for annexation to neighboring cities. The primary city in this region is Whittier, with multiple adjacent unincorporated areas. The combination of these three regions contains 32 unincorporated areas of county territory. After the Antelope Valley, San Gabriel Valley and south Los Angeles County, the Santa Clarita Valley is the region most likely to produce municipal annexation.

The City of Santa Clarita is the most active and it is the only city incorporated in this region. County boundary planning generally supports municipal annexation by Santa Clarita as a gradual consolidation of the population in the Santa Clarita Valley into a single local jurisdiction. Santa Clarita joins Lancaster and Palmdale as the cities most active in county boundary planning and municipal annexation campaigns and decisions. Whereas other cities may pursue specifically targeted unincorporated areas, these three cities are described as new growth areas experiencing normal boundary expansion to incorporate adjacent populations into municipal boundaries.

To some extent, the spheres of influence legislation bypasses annexation and mergers to attain consolidation of unincorporated areas into municipal territory. Because of the spatial history of failed annexations and incorporations, the San Gabriel Valley and South Bay cities are more likely to extend municipal territory through spheres of influence than by either annexation to existing cities or incorporation of affected areas as a minimum population city. The boundary extensions to cover spheres of influence prevent fragmentation of county territory by spatial competition with annexation and incorporation of new cities. Additionally, the spheres of influence boundary strategy incorporates any potential threat of annexation to the City of Los Angeles. By region, there was a significant potential for boundary expansion by the City of Los Angeles in south Los Angeles County. Some of the South Bay incorporations and failed incorporations are undoubtably the consequence of the threat of corridor expansion by the City of Los Angeles. In the San Gabriel Valley, the resulting fragmentation of cities and unincorporated areas is the direct consequence of spatial competition among the San Gabriel Valley cities.

At present, the City of Los Angeles continues to annex relatively small tracts of unincorporated areas in northwest Los Angeles County.. These areas include far edges of the San Fernando Valley near the County boundary lines. The direction of annexation is toward the Santa Clarita Valley revealing that the City of Los Angeles is annexing county territory from the south toward Santa Clarita whereas Santa Clarita is pursuing annexation from the north toward the City of Los Angeles. Some of the areas are fast growing suburbs with housing construction proceeding at a rapid growth rate. In other cases, the City of Los Angeles is annexing unpopulated areas that are along transportation, street and highway corridors. In the present, the annexation strategy of the City of Los Angeles is far more limited, by location and distance than what had been attained in city land area and boundary expansion from 1911-1971.

Of the 137 unincorporated areas in county territory, 26 or 19.0% are the result of failed incorporation decisions. The failed incorporations are reported in **TABLE 12.0**. Most of the 26 incorporation failures involved multiple attempts to attain municipal incorporation status. Recent failures include three attempts by Hacienda Heights that failed by referendum votes. Rowland Heights also pursued incorporation status with the result being two petition drives that failed to achieve the number of registered voters required to place this local affairs issue on the ballot. Other unincorporated areas have made multiple attempts at campaigning for municipal incorporation over a long period of time. The campaign for a City of East Los Angeles began in the 1930's with two failed referendum proposals. The first involved an incorporation vote to block annexation to the City of Los Angeles. This vote failed and a second incorporation campaign occurred two years later for the consideration of a modified and larger area to be included in a City of East Los Angeles. This campaign also failed at the ballot.

East Los Angeles remained unincorporated county territory even with a massive increase in population from the 1930's to the 1960's. In 1961 and 1965, two attempts were made to incorporate a City of East Los Angeles. Both attempts failed. One before and after the 1963 State boundary legislation. Municipal proponents made use of survey research to elicit voter's opinions on city and county services and toward the issue of municipal incorporation. The findings generally revealed plurality opposition to municipal incorporation conditional upon the category statements included in the incorporation questions. In most instances, residents did not perceive a City of East Los Angeles as something that had to be accomplished immediately, preferring instead to wait for additional study given their concerns about the financial viability, budgeting capacity and tax base of the unincorporated areas included in the City of East Los Angeles incorporation campaign. A 2012 Study by County planning determined that the area included in a City of East Los Angeles is a recipient territory and cannot sustain fiscal solvency over the long- run. This conclusion implies East Los Angeles is too poor to incorporate as a city, a concern expressed in earlier public opinion surveys of residents in the 1960's. The findings indicate financial management of the unincorporated area is too expensive to fund based on own revenues and therefore requires a redistribution of revenues from incorporated places and other unincorporated areas that are donor territories.

Altadena has had multiple attempts at municipal incorporation and annexation to adjacent Pasadena. According to historical records, the City of Pasadena has annexed portions of Altadena 4-6 times during the past 150 years. Altadena responds to the threat of Pasadena annexation with campaigns for municipal incorporation. In 1983 and 1984 Pasadena made two attempts to annex the remaining unincorporated areas of Altadena.

Both attempts failed and this produced an incorporation campaign that failed in 1985. In 2012, municipals again pursued incorporation by county planning review of the unincorporated areas potential for incorporation. The County found that the area could sustain the financial management of providing local public goods and services. Even so, this would be accomplished at a much increased cost to taxpayers well above the tax price being charged by the County for municipal services to the area. This finding suggests that it is becoming too fiscally expensive to incorporate a new city in Los Angeles County. County planning finds either a recipient area, that cannot afford incorporation, or a donor area where the costs would increase significantly above County rates. In either setting, the studies recommend remaining in county territory and if anything, contracting for additional local public goods and services to provide for unmet demands revealed by public opinion surveys. The County recommendations are consistent with an opposition to fragmentation of county territory by either municipal annexation to existing cities or municipal incorporation of a new city. Generally speaking, the findings suggest it is too expensive to incorporate any of the remaining unincorporated areas in county territory. This would seemingly imply the County prefers the current spatial configuration of unincorporated areas, allowing for as many as possible to become spheres of municipal territory.

Dating back to the 1940's, there is a period of time from the 1940's to the 1960's, with multiple incorporation failures. This began in Willowbrook and Lennox, two commercial and industrial suburbs with potential annexation by the City of Angeles. Alondra Park and El Camino Village became the subject of incorporation campaigns as the City of Moneta, Moneta Gardens and Moneta Park from 1951 to 1962. The simple majority success of Lomita (1964) and the failure of Carson-Dominguez produced an end to the cascade of city incorporations.

These latter two incorporation decisions demonstrate how incorporation campaigns evolve through multiple attempts. In both the Alondra Park and Carson cases, city boundaries changed from initial to subsequent referendum votes. Alondra Park came very close to incorporation with the Moneta Gardens attempt in 1956. The vote for incorporation remained competitive and close, but still failed in 1962. This failure occurred with State litigation of the cities of Carson and Lomita. Lomita municipals generated sufficient petition signatures to place the issue on the ballot in 1962, but State intervention blocked a vote until 1964. Given the second failure in nearby Alondra Park, the expectations were that the incorporation campaign would also fail in Lomita. It did not, but the campaign for cityhood did fail in Carson. In both Alondra Park and Carson the defeat of incorporation was explained by geographically concentrated, town sectional opposition derived from combining too large of an area into the municipal incorporation decision. Municipals alleged locals emphasized divisions between Alondra Park and El Camino Village, and Carson and Dominguez or east and west Rancho Dominguez (the current designation for this unincorporated county territory). The City of Carson incorporated in 1968 and did not include unincorporated Dominguez within municipal boundaries. Alondra Park was a commuter suburban area similar to Lawndale & Lomita among the South Bay communities. It contained county park & recreation programs, that the County preferred to exclude from any municipal incorporation. El Camino Village has a Community College that provides higher education to South Bay residents. The combination of town and gown was not popular, and there was some sentiment that the fact that one of the long standing Board of Supervisors resided in the area contributed to the ambivalence of county residents toward municipal incorporation as a new city when State elected officials opposed fragmentation.

TABLE 12.0 Failed City Incorporations

Altadena
Alondra Park & El Camino Village: Moneta, Moneta Gardens, Moneta Park
Canyon Country, Canyon Lake
Carsonlinguez-East-West Rancho Dominguez-Dominguez
Casa Verdugo
Charter Oak
Covina Highlands
East Los Angeles: City Terrace, Belvedere Gardens-Garden City, Eastmont-The Heights
East Whittier
Hacienda Heights
La Colima, Whittier area
La Crescenta-Montrose
Las Virgenes
Lennox
Monte Villa
Newhall-Valencia
Quartz Hill
Rowland Heights
San Pedro Hills, La Rambla
South San Gabriel
Sun Oaks
Topanga
Walnut Park
West Whittier
Westmont-West Athens
Willowbrook

Other failed incorporations occurred in the unincorporated county territories of Los Nietos (Township) and the Whittier Narrows surrounding the City of Whittier. These unincorporated areas included incorporation campaigns for La Colima, East and West Whittier. Whittier annexed county territory in uneven boundary expansions producing multiple fringe areas in county territory surrounding municipal boundaries. Because these annexations extended lineal corridors into county territory, it is generally difficult to tell when you are in municipal versus county territory. Some of commercial and industrial properties are excluded dis-contiguously from what was a main street town, with rectangular commercial corridors and a residential grid organization of city neighborhoods. Gasoline stations and industrial plants are located at the city entrances, on the municipal boundary points with county territory

There are four failed incorporations in the San Gabriel Valley: Hacienda Heights (1983, 1992, 2003), Covina Highlands (1958), Walnut Park (1960) and South San Gabriel (1963). Three of the incorporation failures are prior to the 1963 State legislation on boundary function regulation. As more recent cases with county planning, the Hacienda Heights and nearby Rowland Heights (1983, 1984, 1985) incorporation campaigns achieved five recommendations from County planning to gather petitions for a vote on incorporation status.

Besides Willowbrook and Lennox, other unincorporated areas were confronted with potential annexation to the City of Los Angeles. These areas included. San Pedro Hills, in the South Bay/Port Area of the Los Angeles County; Topanga and Westmont-West Athens. San Pedro Hills is in the LA Harbor Area consisting of an unincorporated municipal service area designated as La Rambla. Westmont and West Athens are areas in west Los Angeles County adjacent to the westside of the City of Los Angeles. Topanga is in the vicinity of Malibu City, unincorporated Malibu Heights, and the cities of Los Angeles and Santa Monica on the Pacific coastline. The incorporation campaigns in these areas are in response to City of Los Angeles annexation decisions and these areas are currently most likely to become spheres of influence to adjacent cities while remaining unincorporated county territory.

TABLE 13.0 Number of Neighbors by Boundary Function

	Spatial Competition	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	intact	99	15.7	16.0	16.0
	extensive	283	44.8	45.6	61.6
	failed annexation	191	30.3	30.8	92.4
	failed incorporation	47	7.4	7.6	100.0
	Total	620	98.3	100.0	
Missing	forest preserve	11	1.7		
Total		**631**	100.0		

TABLE 14.0 Equilibrium Boundary Strategy by Fragmentation Number of Cities

Boundary Strategy	Number of Cities	Percent	Cumulative Percent
Coterminous boundaries	26	29.54	29.54
Extensive/Annexation	34	38.64	68.18
Extensive/Incorporation	6	6.82	75.00
Extensive/Both	22	25.00	100.00
Total	88	100.00	

Appendix TABLE 1.0 for Individual City Results.

Coterminous boundary strategy = intact city district boundary delimitation.
Intact boundary delimitation = closed municipal boundaries = frozen city district boundaries.
Extensive boundary strategy = open municipal boundaries.
Pure city strategy = Coterminous boundaries + Extensive boundaries/annexation strategy + Extensive boundaries/incorporation strategy.
Mixed city strategy = Linear extension boundary strategy + Annexation strategy + Incorporation strategy.

TABLE 15.0 Descriptive Statistics on Number of Adjacent or Neighboring Areas

N	88
Mean	7.17
Std. Error of Mean	.69
Median	6.00
Std. Deviation	6.50
Skewness	5.386
Kurtosis	39.783
Sum	**631**

The number of neighbors equals the number of adjacent unincorporated county areas plus the number of adjacent incorporated cities. Boundary intersection among local jurisdictions, with incorporation and charter status, produces contiguous boundaries in the form of the number of neighbor cities. Unincorporated municipal services districts may also be neighboring areas and in some cases are extensions of municipal boundaries as a result of becoming spheres of influence. In Los Angeles County, the total number of neighbors equals 631 coterminous boundary intersections.

The nature of the boundary function relationship can best be described as a hierarchy derived from frozen city district boundaries to open city boundaries with adjacent spheres of influence and failed annexation and incorporation areas contiguous with municipal boundaries. The findings indicate spatial competition by neighbor communities produces 99 intact municipal boundaries. These city districts are closed because they have no adjacent spheres of influence and therefore the city district boundaries are coterminous municipal delimitation. This group constitutes 16% of the total number of neighbor areas. The other 84% provide for some interdependence and therefore openness of the city district cover. City district boundaries are extended to provide local public goods and services to both municipal areas and spheres of influence in county territory.

As neighbors, the fringe areas are broken down into three categories. The first are the extensions into county territory for single point, service islands, fringe area donut holes and contiguous fringe areas. These unincorporated areas equal 283 adjacencies and a plurality equal to 45.6% of the total number of neighbor areas. This result demonstrates the fragmentation of county territory into smaller unincorporated areas.

These areas are too small and not wealthy enough to incorporate as new cities. They have sometimes been pursued by annexation attempts to neighbor cities. In the absence of successful annexation, prior to 1972, these areas remained unincorporated areas in county territory with varying contracts for municipal-type, county services and adoption and implementation of special districts for funding additional local public goods and services. After 1972, these areas are more likely to satisfy conditions for municipal consolidation by attachment as a sphere of influence. As affected areas, this extends municipal into county territory and provides for municipal service districts for unincorporated areas.

Among these unincorporated areas, are census defined places that are population centers described by census tract boundaries. As a fringe area, these areas may remain intact and be derived from municipal annexation and incorporation campaigns. When the municipal boundary campaigns fail, the boundaries are no longer recognized but they may be used for the purposes of planning, development and zoning. County boundary recommendations are not always successful in annexation and incorporation campaigns. Municipals may fail to attain enough signatures for ballot access and they frequently are defeated by referendum vote. As a result, the failure of a boundary decision implies possibilities for future campaigns and decisions. County planning recommendations may be used as a starting point for the next attempts to reduce fragmentation by city annexation or new city incorporation, and therefore a consolidation of county into municipal territory.

County planning also rejects and modifies boundary decisions. By regulation of boundary functions, grassroots campaigns are not the only source of boundary change. As a result, planning interacts with municipals & locals during any sequence of boundary decisions.

When failed annexation and incorporation areas maintain intact boundaries from county recommendations for boundary decisions, the fringe areas tend to continue designation as those formed for the purposes of boundary decisions. These fringe areas may remain intact for lengthy periods of time, dating from a failed municipal annexation or incorporation campaign. Because some of these failures are prior to 1963 and 1972 State legislation the long-run survival of these unincorporated areas as intact communities suggests the importance of planning, development and zoning in the evolution of any spatial history of boundary decisions. The fact that these areas are intact as unincorporated municipal service areas confirms residents preferences for municipal service district status over remaining unincorporated areas with no municipal-type, county services or special district status. Because the unincorporated areas use the unincorporated municipal service area boundaries, derived from county recommendations in boundary decisions, the allocation of contracted goods and services and special district financing is provided within municipal service district boundaries established by county subdivision and boundary function.

The failed incorporation attempts are reported in **TABLE 12.0**. Failed annexation is classified as an intact area that has been designated an unincorporated municipal service area for at least 20 years (2000-2020) with the area boundaries defeated by annexation vote. In the case of Altadena, unincorporated area boundaries were used in both failed annexation and incorporation campaigns. Altadena is counted as a failed incorporation, even though both failed and successful annexation campaigns have occurred in the area. Other communities such as Avocado Heights, Bassett, Del Aire-Wiseburn, Mayflower Village, South Whittier and Valinda have been deliberated for potential annexation decisions, with the result being decisions to make these fringe areas an extension of municipal territory by sphere of influence decisions.

There are 191 combinations of failed annexations and existing cities. As a result, failed annexations comprise 30.8% of the total number of neighbors available for potential annexation. It is clear that the annexation threat varies by time period, by the City of Los Angeles annexation strategy, and bilateral and multilateral competition among cities by county region. The results demonstrate fringe areas generated by failed municipal annexation are 4:1 more likely than those derived from failed incorporation decisions. There are 47 failed incorporation adjacencies with existing cities. These boundary intersections produce 47 opportunities to expand and consolidate the municipal territory of existing cities to incorporate intact municipal service district areas. This may be accomplished by either city annexation or an extension of municipal boundaries by sphere of influence. The results demonstrate existing cities make boundary decisions concerning spheres of influence to extend territory to either failed annexation or failed incorporation areas.

There are 97 single point, service islands in Los Angeles County: 96 of the 97 are covered by municipal adoption and implementation of an extensive boundary strategy to form spheres of influence. Only Bandini Island, surrounded by the City of Vernon remains unattached to a city district boundary. Formed in the 1920's, when the Gilmore girl descendants refused to sell their homestead property, their ownership continued into the 1960's, after State legislation on boundary functions to regulate fragmentation. Given a population less than 100, the 82 residents of the City of Vernon cannot petition for annexation because it falls below the minimum population requirements to hold a referendum vote. The City of Industry also fails to attain the petition signature requirements for annexation of contiguous service islands and fringe areas in unincorporated county territory. As reported in **TABLE 14.0**, the equilibrium boundary strategy varies by city and is equal to a fragmentation numerical solution.

In this model, the city boundary strategy is determined by the number of cities adopting and implementing an intact versus extensive boundary strategy, a closed/open boundary function correspondence, frozen city districts versus a potential municipal boundary change, an annexation versus an incorporation strategy, and pure versus mixed city boundary strategies. The findings reveal a coterminous boundary strategy is adopted by 26 or less than1/3 of the cities resulting in the implementation of frozen city district boundaries. The boundary function is a closed correspondence for this set of cities.

Given 62 cities or more than 2/3 of the cities adopt an extensive boundary strategy, this is the evolutionary stable strategy and it allows for potential boundary changes in the long-run. An extensive boundary strategy with annexation is adopted in a 4:1 ratio to linear extension of municipal boundaries and annexation of failed incorporation municipal service district areas. On this basis, cities prefer to annex smaller town sectional areas or provide for spheres of influence to single point, service islands and fringe areas derived from failed annexation boundaries. The results indicate 75% of the cities adopt a pure to mixed boundary strategy by a 3:1 ratio, with either intact boundaries or annexation of failed annexation areas and extension into service islands and fringe areas preferred among the boundary strategy alternatives.

As reported in **TABLE 15.0**, the results describe the distribution of the number of neighbors constructed by adding the number of county adjacent areas to the number of contiguous cities for each of the 88 cities. The cities in Los Angeles County average 7 neighbors per-city, with a median number equal to 6 neighbors per-city. There exists significant variation among the cities and positive skewness and kurtosis implying a non-normal distribution of neighbors. As a result, the cities with the largest number of neighbors are the exceptional cases.

FIGURE 18.0 Number of Neighbors = County + City Adjacent Areas

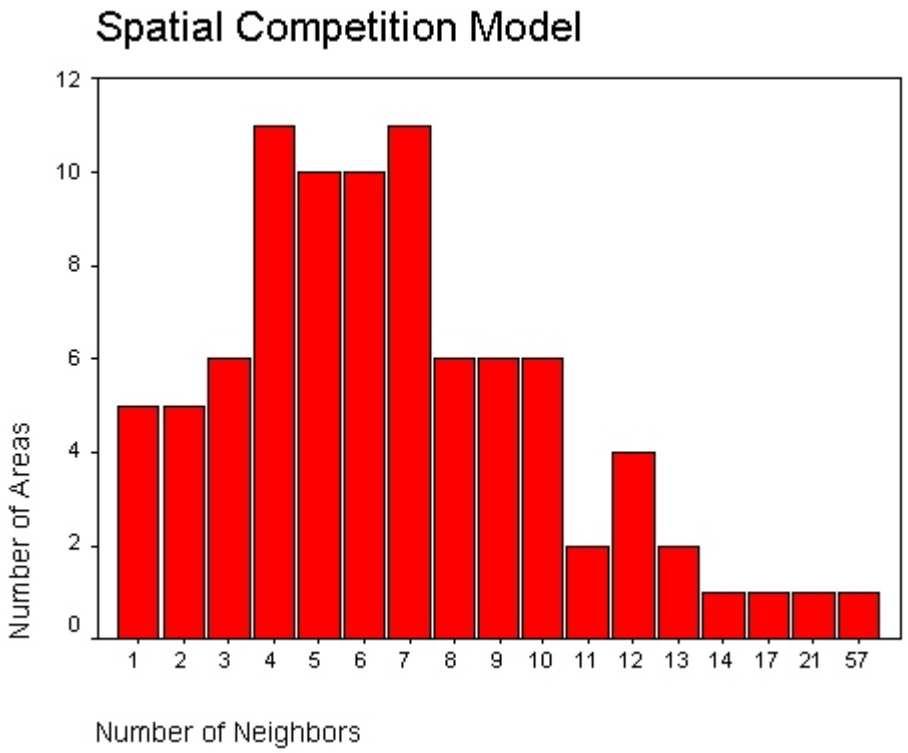


TABLE 16.0 Imperfect Competition by Number of Neighbors and Number of Cities

# of Neighbors	# of Cities	Percent	Cumulative Percent
1	5	5.7	5.7
2	5	5.7	11.4
3	6	6.8	18.2
4	11	12.5	30.7
5	10	11.4	42.0
6	10	11.4	53.4
7	11	12.5	65.9
8	6	6.8	72.7
9	6	6.8	79.5
10	6	6.8	86.4
11	2	2.3	88.6
12	4	4.5	93.2
13	2	2.3	95.5
14	1	1.1	96.6
17	1	1.1	97.7
21	1	1.1	98.9
57	1	1.1	100.0
Total	88	100.0	

The distribution of the number of county and city neighbors is summarized by **FIGURE 18.0**. The results indicate three cities with the largest number of neighboring county and municipal territories. The central core city of Los Angeles is by far the most exceptional case with 57 neighbors contiguous with municipal boundaries. The City of Los Angeles maintains 15 spheres of influence derived from the 27 adjacent unincorporated county areas. There are 30 cities having contiguous boundaries with the City of Los Angeles. The large number of adjacent county and city areas indicate the complicated evolution of local boundary division even with a linear extension boundary strategy. The lineal extension strategy produced boundary expansion in corridors derived from the status quo, town square, downtown core area. Additionally the adoption and implementation of Los Angeles annexation and merger strategy produced corridor planning, development and zoning variance within the City of Los Angeles. The threat of Los Angeles annexation produced expanded core city boundaries, failed Los Angeles annexations, new city incorporations, failed city incorporations, peripheral city annexations, unincorporated municipal services districts in county territory and spheres of influence.

Besides the City of Los Angeles, there are three other cities with substantially larger numbers of adjacent neighboring areas. The City of Industry has 21 neighbors in county and municipal territory. Covina is next with 17 neighbors, with the results for Industry and Covina revealing the failure of city annexation strategies in the 1940's through 1960's and State legislation. Both cities are located in the San Gabriel Valley and suggest that peripheral city annexation failure was greatest in this region of Los Angeles County. The combination of a fragmentation of cities and thereafter competition among these cities to annex produced greater fragmentation of county territory than in other unincorporated areas of Los Angeles County.

As the county region with the most city annexation activity, the San Gabriel Valley exceeds other county regions in fragmentation of county territory. Incorporation of the South Bay cities, in response to the potential for annexation to the City of Los Angeles, also produced a fragmentation of county territory. The fourth ranked city, in terms of numbers of neighbors s Hawthorne located in the South Bay/Port Area of Los Angeles County. Hawthorne has many surrounding fringe areas revealing the failure of municipal annexation. Industry and Hawthorne have 5 and 6 spheres of influence, but this lags behind Covina with 12 spheres of influence. The predominance of fringe areas around Hawthorne is a good indication of the potential for municipal annexation and construction of spheres of influence among South Bay cities. This potential also exists in the San Gabriel Valley among cities located in this region of Los Angeles County. As a result, the large number of neighboring unincorporated areas demonstrates the combinations of 1) potential Los Angeles annexation, 2) Hawthorne annexation strategy, 3) failure of Hawthorne annexation, 4) new city incorporations in the South Bay/Port Area region, 5) failures of new city incorporations in South Bay, 6) the formation of unincorporated municipal service district areas, 7) the extensive boundary strategy by cities in the South Bay region, and 8) extension of municipal territory by Hawthorne to form spheres of influence in county territory. The results indicate 2/3 of the cities have 7 or fewer adjacent neighboring areas sharing contiguous boundaries with municipal territory. This result is consistent with the strongly positive kurtosis coefficient measuring the concentration of cities near the average of 7 neighbors per-city. The exceptional cities with a large number of neighbors describe the asymmetry among cities in the distribution of the number of neighbor areas. The cities with the largest number of neighbors skew the mean equal to 7 above the median of 6 neighbors per-city.

This result is also consistent with the strongly positive skewness coefficient suggesting the importance of the City of Los Angeles and both the San Gabriel Valley and South Bay/Port Area to the fragmentation of county territory. The distribution of neighbors provides evidence of spatial competition among cities. Using boundary strategies, spatial competition among cities produces fragmentation of county territory in numbers of neighbors or adjacent areas with contiguous boundaries. By doing so, fragmentation of cities produces a large number of small unincorporated areas in county territory. The core and peripheral city boundary strategies describe imperfect competition among local jurisdictions to provide local public goods and services. This imperfect competition includes county contracting to provide goods and services. It also includes unincorporated areas established as municipal service districts to contract for and provide funding for additional municipal-type services. By extension of municipal boundaries, the sphere of influence initiatives allows for an additional option, with the transfer of the affected areas from county to municipal territory. Because these areas correspond by location and distance to existing cities, the sphere of influence areas are generally unincorporated areas with the greatest potential for peripheral city annexation. By adoption and implementation of a sphere of influence boundary strategy, this enables these areas to provide municipal goods and services while remaining unincorporated areas in county territory. The sphere of influence areas frequently hold county contracts for additional goods and services and enact multiple special districts to fund local public goods and services. By establishing this form of a municipal service district, the areas maintain both their incorporation status and boundaries intact reducing the potential for consolidation with municipal territory. In summary, the essence of this imperfect competition is a spatial competition among neighbor areas sharing contiguous boundaries.

Models of Fragmentation and Spatial Competition

Generally speaking, zero spheres of influence implies coterminous city district boundaries. Having zero unincorporated county neighbors adjacent also implies closed or intact municipal boundaries. Given these conditions, having only city neighbors adjacent implies frozen city district boundaries. The term frozen city district is location fixed in municipal boundaries. As an evolutionary stable boundary strategy, frozen city district boundaries are durable and therefore sustainable over long time horizons. As a local jurisdictional equilibrium (LJE), location fixed implies zero spatial elasticity that is equivalent to no potential for municipal boundary expansion.

In comparison, one or more spheres of influence implies spatial elasticity and therefore extensive boundaries. The boundary strategy is to change municipal boundaries by linear extension. This boundary strategy extends municipal territory to neighboring and adjacent county territory. By doing so, *linear extension boundary strategies imply open city district boundary lines for the general purposes of providing m-dimensional, local public goods and services.* City district boundaries are open to annex failed annexation or incorporation areas of county territory. By adding spheres of influence to municipal territory, this increases the potential for unincorporated municipal district formation in failed annexation and incorporation areas. As a result, the existence of spheres of influence implies positive spatial elasticity in municipal boundaries, with varying complexity in m-dimensional allocations to affected unincorporated areas. The previous section specifies two models for empirical analysis of spatial and imperfect neighbor city competition in location and distance. The first model is a model of the number of spheres of influence. The second models the number of contiguous cities.

In the first model, the number of spheres of influence are determined by the number of adjacent unincorporated county areas. This specification allows for the fact that most adjacent unincorporated areas are not spheres of influence. These areas remain county territory by contracting for municipal-type services and funding additional local public goods and services by formation of multiple special districts.

The second model equates the number of adjacent cities to the total number of city plus county neighbors. Given the fact there are more incorporated city neighbors than unincorporated county neighbors, the distribution adjacent cities is a measure of spatial competition derived from neighbor areas. Because there is city variation in the number of adjacent areas, the amount of spatial competition varies with the fragmentation number of neighbor areas. On this basis, spatial competition becomes a fragmentation numerical solution and therefore a local jurisdictional equilibrium. The fragmentation number equals the amount of imperfect competition and this number equals a locally finite, integer set of numbers. As an integer set, imperfect competition forms a closed and bounded set of location and distance alternatives by the number of neighbor cities condition.

The 2010 Census data is used to specify log rank rule models. The first variable is city population size in the 2010 Census. Population ranking is established in descending order, from the top ranked, largest city (Los Angeles) to the bottom ranked, smallest city (Vernon). The correspondence between city population size and city population rank is termed the log rank size rule. This equation exhibits a negative correspondence between city size and ranking, such that increasing population rankings, in a range from 1 to 88 cities, correspond with decreases in population size.

The second variable is city land area in the 2010 Census. City land area rankings are also established in descending order, from the 1st to 88th sized city in land area. The correspondence between city land area and city land area rankings is termed a log area rank rule. The equation exhibits a negative correspondence between city land area and city land area ranking. As a spatial model, the log area rank rule generally fits the data better than the log rank size rule. The results for the log area rank rule equation demonstrate significant quadrature and provide evidence of a non-linear functional form.

Given the significant asymmetry in the distributions of city population size and city land areas, the city averages generally exceed the median city by large amounts. The distributions of population size and land areas generate significantly positive skewness and kurtosis coefficients. These results indicate a concentration of local areas around the median, instead of the mean. The results also indicate the largest cities are the exceptional cases. The results for the two log rank rules produce similar error structures to the findings for the number of spheres of influence and number of neighbor cities. The results for the four equations imply a structural model, consisting of a four equation model by simultaneous estimation.

The tests of normality reveal a non-normal distribution for all four variables. All four variables exhibit significant positive skewness and kurtosis and therefore indicate a non-normal distribution of cities. Additionally the existence of city variation suggests complications in the choice of functional form for estimation purposes. Even so, the simultaneous four equation model produces consistent results using linear estimation. The significant skewness and kurtosis coefficients describe significant asymmetries in the distribution of city population and land area. Some transformation of the variables is suggested given asymmetric distributions of cities.

A log transform is used to normalize the distributions of city population size and land area. The log transform data more closely approximates a normal distribution. Even so, tests of normality reveal the log transformed measures are also not normally distributed.

The city orderings are equal to rankings from first to last place in city population size and city land area. The rankings are congruent with a uniform or rectangular distribution. The correspondence between the log transforms and rankings is generally nonlinear and exhibits a degree of quadrature in the functional form. The results demonstrate the importance of linear estimation, for the purposes of explaining variation in the distribution of cities and building a structural model based on these equations. The results also demonstrate that any interpretation of the error structure of the simultaneous equation estimation requires choices of the functional form for estimation of individual equations.

In summary, the formal model describes local boundary division as a finite cover. The finite number associated with this covering is equal to a fragmentation numerical solution. The fragmentation number equals the total number of local jurisdictions constituting an integer set of local jurisdictions. The integer set defines both the fragmentation number solution (n) and the choice of local jurisdiction.(m) . The integer set also forms an integer sequence in rank orderings. The integer set of local jurisdiction is closed and bounded, and therefore a compact set of location alternatives. The integer set of local jurisdictions is finite and therefore imperfectly competitive in the number of local jurisdictions. The integer set of local jurisdictions is also locally finite and therefore equals spatial competition in location and distance, by neighboring or adjacency correspondence and therefore contiguous boundaries among the total number of jacknife combination solutions for any fragmentation number.

As reported in **TABLE 17.0**, the simultaneous estimation of the four-equation structural model explains significant amounts of city variation in the number of spheres of influence, the number of neighbor cities, the log of city population size and the log of city land area. The goodness of fit statistics range from 77% to 86% predictions in the distributions of 88 cities for these four variables. The chi-square tests reveals the $p < .0001$ of the goodness of fit statistics being equal to zero for any random sampling of the number or combination of cities.

The individual equation findings reveal the log area rank rule fits the distribution of cities better than the log rank size rule. The findings indicate the spheres of influence model explains 86% of the city variation in the number of spheres of influence. The 81% goodness of fit statistic for the number of neighbor cities explains a 4:1 ratio in systematic to random variation in fragmentation-induced spatial and imperfect competition among cities. The explanatory power of the spheres of influence and number of neighbor cities results verify the importance of spatial competition and imperfect competition by fragmentation in the number of cities.

The linear regression estimation of the individual equation coefficients produces results describing the rates of substitution in each of the four equations. The coefficient equals .635 or 64% for the model of the numbers of city spheres of influence. This finding indicates that as the number of adjacent unincorporated county areas increases, the number of spheres of influence increase proportionally at a .635 rate. This finding suggests that it takes approximately two neighboring unincorporated areas to produce a single sphere of influence. As a result, spheres of influence occur at a stability number of 1.57 in the ratio of the number of adjacent unincorporated areas to city spheres of influence. This basic result explains the spatial configuration of single point, service islands and fringe areas.

The coefficient equals approximately a ½ rate of substitution between the total number of adjacent areas and the number of neighbor cities. At this rate, the number of neighbor cities varies at a 2:1 ratio to the total number of adjacent areas. This finding indicates a balanced effect in the influence of the number of adjacent city and county areas on the number of city neighbors. This basic result implies that fragmentation is determined by the total number of contiguous areas and not only the number of cities. This adjacency condition implies the reduction to a locally finite fragmentation number describes spatial competition, in location and distance, by neighboring areas with contiguous boundaries.

There are two coefficients estimated for log rank rules. The first, estimates the log rank size rule. The second provides an estimate of the log area rank rule. The first coefficient equals a -.05 rate of substitution in the log transform of city population size by city population ranking. This result is consistent with a uniform distribution of 88 city populations. As an integer sequence, the log of city population size decreases by -5% for each change in city population rankings, in descending order, from 1 to 88. The coefficient for the log area rank rule estimates between a -3.5% to -4% change for each in city land area rankings. The log area rank rule generates a smaller coefficient standard error than the log rank size rule. The log rank size rule confidence interval is approximately (2:1) twice the size of the confidence interval estimated for the log area rank rule. The results reveal greater precision in the log area rank rule estimates. This basic result verifies the importance of the pursuit of municipal territory by cities in a spatial competition with other cities and unincorporated county areas. The z-tests for all four of the equations in the structural model are significant at the .001 probability level. This result indicates all four of the coefficients are unlikely to equal zero or a random rate of substitution.

The correlation matrix of residuals describes inter-equation correlations. The findings reveal a 30% correlation in the residuals for the spheres of influence and number of neighbor cities models. This result suggests a common factor, such as spatial competition explains both imperfect and fragmentation-induced competition variables. Any reduction in the 70% unexplained variation produces multi-collinearity between equations and therefore less reliable coefficient estimates. On this basis, the linear estimation of the spheres of influence and number of neighbor cities models is preferred to other choices of functional form. The findings also reveal a 30% inter-equation correlation for the log rank rule models of city population size and city land area. This result suggests two pairings of the four-equation structural model, with the log rank rule and spatial competition models paired for explanations of the error structure by simultaneous estimate. The Breusch-Pagan test of independence reveals a .01 probability level that residuals of the four-equation model are independent and therefore generate zero correlations among the model estimation errors. The result indicates significant inter-correlation exists in the error structure generated from the simultaneous estimation of the four-equation structural model. This result is consistent with a local jurisdictional equilibrium determined by minimal federalism and decentralization, choice of local jurisdiction, governmental fragmentation, imperfect competition, and spatial competition among local jurisdictions in a greater metropolitan area.

The next set of results elaborate the bivariate correlations among the variables in the structural model and a measure of city hood. The cityhood variable is a durational measure equal to the number of years since municipal incorporation. The distribution of cityhood describes the evolution of municipal incorporation decisions with the largest number of new cities incorporated during the 1950's and 1960's prior to the 1972 spheres of influence initiative.

TABLE 17.0 Simultaneous Estimation of the Four-Equation Structural Model

```
. sureg (spheres = adjcty) (adjcity = neighbors) (lnpop = poprank) (lnarea = arearank), corr

Seemingly unrelated regression
------------------------------------------------------------------------------
Equation        Obs  Parms       RMSE    "R-sq"      chi2       P
------------------------------------------------------------------------------
spheres          88      1     .9767556   0.8562    531.19   0.0000
adjcity          88      1    1.533773    0.8058    379.74   0.0000
lnpop            88      1     .7056922   0.7666    294.10   0.0000
lnarea           88      1     .3854332   0.8613    602.68   0.0000
------------------------------------------------------------------------------

------------------------------------------------------------------------------
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
spheres      |
      adjcty |   .6352382   .0275621    23.05   0.000     .5812176    .6892589
       _cons |   .1798373   .1299914     1.38   0.167    -.0749412    .4346158
-------------+----------------------------------------------------------------
adjcity      |
   neighbors |   .4875748   .0250206    19.49   0.000     .4385353    .5366143
       _cons |    .844776   .2427148     3.48   0.001     .3690638    1.320488
-------------+----------------------------------------------------------------
lnpop        |
     poprank |  -.0491601   .0028666   -17.15   0.000    -.0547785   -.0435416
       _cons |   12.61342   .1480577    85.19   0.000     12.32323    12.90361
-------------+----------------------------------------------------------------
lnarea       |
    arearank |  -.037935   .0015452   -24.55   0.000    -.0409636   -.0349064
       _cons |   3.682425   .080103     45.97   0.000     3.525426    3.839424
------------------------------------------------------------------------------

Correlation matrix of residuals:
             spheres  adjcity   lnpop   lnarea
spheres       1.0000
adjcity      -0.2981   1.0000
lnpop         0.0505  -0.0040   1.0000
lnarea       -0.1661  -0.0447   0.2840   1.0000

Breusch-Pagan test of independence: chi2(6) =    17.748, Pr = 0.0069
```

The bivariate correlation analysis reveals that the number of spheres of influence are significantly related to all of the other variables. The numbers of spheres of influence are strongly and positively related to the number adjacent county areas, the number of adjacent cities, the total number of neighbors, the log transformations of city population size and city land area, and the duration of municipal incorporation status or cityhood. The linear correlations indicate the potential for additional structural equation modeling to estimate the unexplained variation in the error structure of the four-equation model.

The number of spheres of influence generate a near one-to-one correspondence with the number adjacent unincorporated county areas. Because the spheres of influence areas remain in county territory, this accounts for the strong correspondence between numbers of spheres of influence and unincorporated county areas. The correlation results reveal a 50% correlation between the number of adjacent cities and the number of spheres of influence. As the number of neighbor cities increases by 2 cities, the number of spheres of influences increases by 1. As a result, the linear bivariate correlation indicates a 2:1 ratio in fragmentation numbers of adjacent cities and numbers of spheres of influence. The correlation results also reveal the number of spheres of influence increases determined by city population size, city land area, and duration of city incorporation. Which cities are most likely to adopt and implement spheres of influence? The results demonstrate the cities with spheres of influence are older cities, with larger populations and greater land area.

The number of adjacent cities measures spatial competition among local jurisdictions. Given the small numbers of adjacent cities, it is a measure of imperfect competition. As a result, neighbor cities equal a finite cover derived from fragmentation of county territory into new cities.

TABLE 18.0 Bivariate Correlation Analysis

Correlations

		SPHERES	ADJCTY	ADJCITY	NEIGHBOR	LNPOP	LNAREA	CITYHOOD
SPHERES	Pearson Correlation	1.000	.926	.489	.789	.259	.480	.234
	Sig. (2-tailed)	.	.000	.000	.000	.015	.000	.028
	N	88	88	88	88	88	88	88
ADJCTY	Pearson Correlation	.926**	1.000	.632	.909	.285	.558	.230
	Sig. (2-tailed)	.000	.	.000	.000	.007	.000	.031
	N	88	88	88	88	88	88	88
ADJCITY	Pearson Correlation	.489**	.632**	1.000	.898	.342	.427	.329
	Sig. (2-tailed)	.000	.000	.	.000	.001	.000	.002
	N	88	88	88	88	88	88	88
NEIGHBOR	Pearson Correlation	.789**	.909**	.898**	1.000	.347	.547	.308
	Sig. (2-tailed)	.000	.000	.000	.	.001	.000	.004
	N	88	88	88	88	88	88	88
LNPOP	Pearson Correlation	.259*	.285**	.342**	.347**	1.000	.537	.294
	Sig. (2-tailed)	.015	.007	.001	.001	.	.000	.005
	N	88	88	88	88	88	88	88
LNAREA	Pearson Correlation	.480**	.558**	.427**	.547**	.537**	1.000	.142
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.	.186
	N	88	88	88	88	88	88	88
CITYHOOD	Pearson Correlation	.234*	.230*	.329**	.308**	.294**	.142	1.000
	Sig. (2-tailed)	.028	.031	.002	.004	.005	.186	.
	N	88	88	88	88	88	88	88

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

CITYHOOD = Number of Years Since Municipal Incorporation Date

The number of adjacent cities is strongly and positively correlated with the fragmentation numbers of spheres of influence and adjacent county areas. The correlation between numbers of adjacent incorporated and unincorporated areas is 63% or between 3/5 and 2/3 ratios of correspondence. Which cities have more adjacent cities as neighboring local jurisdictions with contiguous boundaries? The correlation results demonstrate the cities with greater numbers of neighbor cities are older cities, with larger populations and more land area.

In summary, city hood is a measure of both the evolution of municipal boundary decisions and the dynamics of incorporation status. The results indicate city hood is strongly and positive correlated with the number of spheres of influence, the number of adjacent unincorporated county areas, the number of adjacent incorporated cities, the number of neighboring areas sharing contiguous boundaries and city population size. City hood is not related to city land area verifying the importance of a spatial history of boundary decisions, versus grassroots campaigns, in determining the evolution of metropolitan fragmentation into a spatial configuration of cities. The existence of a local boundary division has proven to be stable in the long-run implying that fragmentation numbers of cities produce evolutionary stable boundary strategies in long-run division of county territory. The existence of boundary strategies implies a stable local boundary division into cities, spheres of influence and unincorporated municipal service areas. Boundary strategies are adopted and implemented by fragmentation numbers of local jurisdictions to produce a finite cover of county territory. A finite cover is stable under the conditions for closed and intact municipal boundaries, producing frozen city district boundaries that are location fixed. As a consequence, the stability of boundary strategies are consistent with long-run incorporation and charter status.

Municipal Governance, Urban Planning, Metropolitan Government

Local government fragmentation is more complicated than the number of cities (= 88). Fragmentation corresponds with local jurisdiction and therefore both minimal federalism and decentralization of organizational structure. Fragmentation numerical solutions are determined by the number of local jurisdictions and the choice of local jurisdiction. Local jurisdictional fragmentation corresponds with the existence of a boundary function and the choice of local jurisdiction by home rule doctrine. As a result, local jurisdictional fragmentation produces a finite cover of county partitioned territory by local boundary division. Local boundary division evolves from boundary strategies and is therefore derived from boundary function (regulation) and a spatial history of boundary decisions. The spatial history of boundary decisions are the collective outcomes of boundary campaigns and decisions. What is important is incorporation and charter status, determined by home rule doctrine and boundary function.

The finite cover of county territory is subdivided by the number of local jurisdictions and the choice of local jurisdiction. The fragmentation of cities forms a finite open cover of county territory. The existence of fragmentation produces a combination of incorporated and unincorporated areas. As a result of this division, areas are divided between municipal and unincorporated county territory. In all county territory, the choice of local jurisdiction produces a combination of local jurisdiction consisting of cities, villages, towns, boroughs and townships. The very elements of a locally finite number of general purpose, minor civil districts units of local government. In this setting, the choice of local jurisdiction determines both incorporation and charter status. Incorporation and charter status are the result of a long run-evolution of local jurisdiction through the adoption and implementation of stable boundary strategies.

Incorporation and charter status establish local boundary division by function into a spatial configuration of local jurisdictional boundaries. These configurations vary and therefore produce varying levels of spatial competition among local jurisdictions. As a result, spatial competition varies by location and distance, so that competition is related to both boundary contiguity and the number of adjacent-neighboring local jurisdictions.

In the absence of incorporation status, adjacent unincorporated areas vary in land area, population size and by numbers of neighboring areas. Unincorporated areas may be separated into CDP-population centers and far less populated, fringe land areas. Unincorporated area population centers tend to establish unincorporated municipal service areas based on county contracting for provision of local public goods and services. Populations centers may also adopt and implement special purpose districts in the provision of additional local public goods and services. As a result, unincorporated area CDPs organize municipal service districts to provide municipal type local public goods and services to county unincorporated area residents.

The less populated unincorporated areas may be described as fringe areas of county territory or single point, service islands in urbanized-municipal areas. These unincorporated areas also contract for county services and they may be included in special districts organized by town sections and townships in county territory. In some settings, the unincorporated areas are excluded from urbanized areas of county territory and in other settings may exist beyond urban development boundaries and therefore subject to physical boundary delimitation of township areas by forest preserve areas, mountain range, coastline and river valleys. Unincorporated town sections also exist coterminous with county boundary lines that produce intact fringe areas adjacent to existing cities.

The spheres of influence legislation allows cities to linearly extend municipal boundaries to cover adjacent unincorporated areas. The areas remain unincorporated so that the spheres of influence legislation does not change the incorporation and charter status of existing cities. In some cases, this encourages cities to annex county territory and provide municipal services to county residents adjacent to municipal boundaries. In other cases, this legislation corrects for the failures of municipal annexation and incorporation. By boundary function, these failures allow for greater fragmentation than what would be the case in the absence of making an affected area a sphere of influence. In some cases, these areas have waited for a long time, as intact unincorporated places, for annexation to a specific city or successful incorporation as a new city. These town sections of county territory remain unincorporated areas under the spheres of influence legislation even though local public goods and services are allocated to the areas by municipal government.

The number of unincorporated areas [(147, 2000), (137, 2020)] produces fragmentation of county territory by subdivision. The distinction can be made between unincorporated municipal service areas and unincorporated municipal service districts. Service areas are an open cover of county territory by general purpose, multi-dimensional local public good and service allocations. These distinct areas are described as unincorporated municipal service areas (or UMSAs). An UMSA is usually an intact fringe area and it may have boundaries contiguous with existing cities. An UMSA may also involve CDP, population centers in unincorporated county territory. An unincorporated municipal service district has some functional responsibility for the provision of local public goods and services. The functional responsibilities may be attained by county contracting, special purpose district adoption/implementation, or municipal contracting.

A municipal service district holds functional responsibilities for provision of local public goods and services. Oftentimes these service districts serve special purposes and therefore involve the provision of single local public good or service. More generally, county service districts provide local public goods and services through the adoption and implementation of multiple special purpose districts. By doing so, allocation decisions are made one dimension at a time, with contracting and funding decisions determined by special district. Residents in a municipal service district area receive tax bills charging for multiple local public goods and services, each provided by an independent and separate special district in their area. As a result, municipal service districts provide municipal type services by adopting and implementing fiscal policies and contracting for county, municipal and special district goods and services. Municipal service districts have no incorporation status and remain county territory. Unincorporated municipal service districts are not considered a general purpose local jurisdiction, even though they offer an accumulation of individual goods and services rather than a package of local public goods and services by general funding.

The organization of county territory varies across metropolitan areas. In Los Angeles, there are spheres of municipal influence, UMSAs and unincorporated areas with uniform county services. Similar spheres of influence exist in Seattle-King County, San Diego County, Phoenix-Maricopa and Las Vegas-Clark County. The unincorporated areas are scattered throughout King County, with the County Home Rule Charter—Metropolitan County Government providing for many municipal type-services. The emphasis in Seattle-King County is on county planning, development and zoning in the unincorporated areas. Some new cities have been incorporated and the priority is to reduce fragmentation of county territory by municipal annexation.

The Greater Portland area is a three county metropolis with an urban development boundary. The urban development boundary is for the purposes of land use regulation and regional, multi-county control over planning, development and zoning issues. The primary division is between urbanized areas and areas set aside for agriculture and green space. The incorporated cities in San Diego County are contained within a rectangular corridor along the coastline from North County to the United States border with Mexico. San Diego County is functionally responsible for the eastern 4/5 of the county territory. The boundary division is distinct between the eastern and western-coastline regions of San Diego County separating unincorporated and incorporated areas. This division is also between rural and urbanized areas, although there were important agricultural lands along the Pacific Ocean coastline. Today, San Diego County has shifted priorities toward urban services, providing, for example, housing assistance programs throughout the unincorporated areas of county territory.

Like the other metropolitan areas, Phoenix-Maricopa County has experienced large scale population and housing growth in the unincorporated areas. New CDPs emerge by the decade and these are sometimes transformed into municipal territory by either municipal annexation or by becoming a sphere of influence with an existing city. Maricopa County maintains an active planning function that encourages development and annexation of growth areas to existing cities. As the spatial history of boundary decisions evolves, both single point, service islands and donut hole-fringe areas exist as municipal annexation surrounds county territory. Municipal annexation to the core city of Phoenix and peripheral suburban cities continues to the present with support derived from County planning, development and zoning. The existence of housing additions in the desert has increased the unincorporated population in Maricopa County.

Spheres of influence exist in San Antonio-Bexar County, with theses areas connected to the central core city of San Antonio. San Antonio has pursued municipal annexation of Bexar County territory, producing 2 suburban cities surrounded by core city boundaries. The spheres of influence extend from the City of San Antonio throughout Bexar County and are primarily for water management and flood control. The unincorporated areas of Bexar County include UMSA districts and flood control areas that are managed for the purposes of planning, development and zoning of residential and commercial property. Town sections of Bexar County have incorporation status, but these adjacent cities are small cities in population size and land area. Town incorporation produced some fragmentation of Bexar County into cities, unincorporated areas, and unincorporated area municipal spheres of influence. Even so, San Antonio continues to annex unincorporated areas, such that sphere of influence status appears to be a transition state for some unincorporated areas from county to municipal territory.

In Las Vegas-Clark County, the unincorporated areas are scattered throughout county territory. Clark County planning has promoted the adoption and implementation of special districts in these unincorporated areas. The priorities have been to establish fire districts for the protection of Clark County residences and commercial property. Most of the unincorporated areas contain small populations, no CDPs and are therefore unincorporated municipal service districts for the purposes of providing fire protection and emergency services. Closed boundary delimitations exists for each of these unincorporated municipal service districts. In the other unincorporated areas, with population centers and CDPs, Clark County government provides municipal-type services. These unincorporated areas form an open cover of county territory with no subdivision into unincorporated municipal service areas.

Two greater metropolitan areas have established elective community council districts to organize unincorporated areas in county territory. These metropolitan areas both have county home rule, charter status and use this delegated state authority to regulate local boundary functions. In the consolidated city and county of Honolulu, there are 33 organized community council districts with some local autonomy to deliberate county planning, development and zoning decisions. The State of Hawaii partitions counties by consolidated island districts, such that Oahu County consists of the consolidated City and County of Honolulu plus the Northwest Islands surrounding Oahu and scattered over a wide territory. In 1898, Oahu was subdivided and organized into 7 townships. From east to west Oahu, these townships are Honolulu, Midway, Ewa and Waianae on the south shore, and Wahiawa, Koolaupoho and Koolauloa on the north shore. Honolulu City and County is a single entity unit of local government and therefore a closed and totally complete cover of the Island of Oahu.

Miami-Dade County has also established 16 elected community council districts to organize what are termed enclave areas of unincorporated county territory. The enclaves form both unincorporated municipal service areas and organized unincorporated municipal service districts. Some of the enclaves are population centers and defined as Census Defined Places (CDPs). Others are described as service islands, consisting of single point, service islands, donut hole fringe areas, adjacent town sectional fringe areas and township areas delimited by the urban development boundary. Issues exist over the designation of urbanized areas, with concerns about the protection of agricultural lands from transfer to residential, industrial and commercial use. Additional issues concern water management for the protection of clear water and water flow pressure in agricultural and urbanized areas.

As a boundary function, Miami-Dade County formed Municipal Advisory Committees (MACs) in each of the 16 Community Council Districts. Members of the committees were selected from those elected to serve on the Community Councils. MACs engaged in strategic planning, holding public hearings and presenting reports with statistics on municipal incorporation. At the end of the 6 to 8 meeting schedule, the County made recommendations on forming new cities. In several instances, the MACs became new cities collecting petition signatures, and voting on incorporation status, electing officials and then voting on a city charter. The incorporation campaigns averaged between 6 to 8 months in duration and this followed the County Municipal Advisory Committee agenda for strategic planning. Altogether, there was an approximately a 2 to 3 year duration in the incorporation process for successful new cities. This duration included situations with changes made to city boundaries during the process causing re-calibration of the models for potential new city fiscal policy, employment levels and regulatory authority.

The community council districts also facilitate contracting with county services and any study of annexation to existing cities. Even so, the community council districts do not generally organize annexation campaigns, special districts or promote the formation of spheres of influence and therefore contracting with existing cities to provide municipal services. In the unincorporated areas of Miami-Dade County, the community council districts allocate functional responsibilities to organize a general purpose unincorporated municipal service district in enclave areas of county territory. The creation of community council districts is to allow for metropolitan federalism and decentralization of what is otherwise a single county territorial entity by subdivision into unincorporated areas defined by county planning, development and zoning.

The charter status of Honolulu and Miami-Dade allocate the functional responsibilities for local affairs derived from county government. This covers the m-dimensional provision of local public goods and services, including municipal type functions, to county areas. It also covers boundary functions for regulating local boundary line division by municipal incorporation and charter status. In the campaigns for local government, residents choose an organizational structure to elect officials and allocate public goods and services. Because these campaigns are regulated by boundary function, in Los Angeles and Miami-Dade County, any vote choice of local jurisdiction is derived from a set of county recommendations. The alternative adopted and implemented is therefore a product of county planning, development and zoning.

In both Los Angeles and Miami-Dade counties there are unincorporated areas and the difficulty has been on how to organize individual areas. Both of these counties are in states with strong county government and incomplete town and township organization. In the States with county-township organization, the townships subdivide county territory and form a closed cover of organized town and township sections. In the absence of complete township subdivision, county government may organize unincorporated areas as a single entity and this was the case in Miami-Dade County until there was litigation to create new cities.

Core city annexation and formation of spheres of influence also serve to organize unincorporated county areas. City annexation has been very important in the transfer of county to municipal territory in greater Los Angeles, San Antonio, Phoenix, Las Vegas, Portland, Seattle, San Diego and Miami. The first five cities continue to pursue annexation, whereas the last three cities appear to have established a status quo with no changes in local boundary division. Even so, the cessation of core expansion does not rule out peripheral city annexation.

The organic act incorporating the City of Honolulu was enacted after township organization and revised by the Territorial Legislature (in 1898, 1903 & 1910). At issue was the fragmentation of Island Districts by multiple towns derived from land consolidation and boundary division. The existence of property rights and diffuse settlements implied the possibility of fragmentation by numbers of incorporated cities. As a result, the Territorial Legislature permitted the incorporation of at most 1 city: the City of Honolulu. The City was formed from Honolulu Township, in a rectangular corridor on the south shore of Oahu from the China Town section to the Waikikki Improvement District and Diamond Head. This area extended inland through the Beretania corridor, from West Oahu (areas west of Chinatown) to East Oahu (areas east of Waikikki District). The City of Honolulu did not extend to the north shore of Oahu, and either West or East Oahu. The City was divided into ward-districts, and the number and a linear extension of these district boundaries expanded with increasing population. Currently, the City and County of Honolulu is the only incorporated city in the State of Hawaii and all county territory is incorporated by city-county consolidation. As a result, Oahu County only exists as an independent and separable entity in the Northwest Islands and in a few areas not included in the organic act of city incorporation.

Other city-county consolidation decisions have also produced municipal incorporation for all county territory. The consolidation of a single city with a single county reduces fragmentation of local government and produces a large scale boundary expansion in the core city and municipal territory. The incorporation status of the consolidated city and county is determined by the home rule charter status of the new metropolitan county government under state home rule doctrine. In the limit, city-county consolidation produces a single and unified local government.

The Lexington-Fayette County consolidation decision produced a single, consolidated city and county with all areas of county territory incorporated into the City of Lexington. The core city expanded city boundaries to incorporate all county territory into a single city. The Nashville-Davidson County consolidation combined city and county administration, with the county government generally absorbing all municipal functions. This consolidation dissolved the City of Nashville administration and boundaries producing a single consolidated county and city government. All Davidson County territory became incorporated territory as either part of the core City of Nashville or a peripheral city. Six peripheral cities maintained incorporation status: Belle Meade, Berry Hill, Forest Hills, Goodlettsville, Oak Hill, and Ridgetop. These cities have functional responsibility for providing local public goods and services. Even so, these suburban cities have contracted with the consolidated metropolitan government to provide selected municipal-type services. The Jacksonville-Duval County consolidations allows for four independent and separable cities to maintain incorporation status: Jacksonville Beach, Atlantic Beach, Neptune Beach and Baldwin. Three of these four cities are beach towns with a distinct economy and housing markets. Under this consolidation, the City of Jacksonville dissolved and all of the Duval County territory holds incorporation status by metropolitan county charter. In these three cases, there is some minor fragmentation of cities and a large scale increase in incorporation status and core annexation of county territory. With this boundary strategy, the core city administration and boundaries dis-incorporate and thereafter expand to incorporate all county territory with the exception of excluded municipal territories. The Indianapolis-Marion County consolidation produced four excluded cities, Beech Grove, Lawrence, Southport and Speedway, by Indianapolis annexation of Marion County and merger with 12 cities.

The UNIGOV of Indianapolis-Marion County is a more complicated government than a city and county consolidation. The consolidated city-county provides municipal services throughout county territory with the exception of the excluded cities. These cities maintain independent and separate incorporation status. The consolidation by dis-incorporation of the City of Indianapolis and then incorporation of a new city of Indianapolis consisting of the dissolved core city boundaries, the merger of 12 incorporated cities and the remainder of Marion County not included in the 4 remaining incorporated cities. The UNIGOV also allows for a metropolitan federal structure with 9 organized townships. These 9 townships provide selected county and municipal services throughout Marion County, including what were the City of Indianapolis boundaries, 16 cities and the unincorporated (township) areas of Marion County. The two-tiered structure, of city and township government is an incorporated, minimally federal and decentralized charter organization for the allocation of local public goods and services.

A more recent decision, consolidated neighborhoods of Louisville and Jefferson County CDPs and UMSA territory. The existence of some townships in Jefferson County produced a similar situation to Indianapolis-Marion County. Even so, city-county consolidation involved the dis-incorporation of the City of Louisville, and the re-incorporation of a City of Louisville consisting of borough-ward districts throughout Jefferson County. Because of the incomplete township organization, townships are not used as a second-tier for local public good and service allocation. Inasmuch city and county consolidation produced core annexation of county territory by the City of Louisville and merger with all incorporated peripheral or suburban cities in Jefferson County. All areas of Jefferson County are incorporated places and these borough-ward districts exist within the City of Louisville boundaries.

New Orleans City and Orleans Parish consolidation was completed in 1919. The City of New Orleans was formed from 7 municipal charter cities and unincorporated territory in Orleans Parish. The consolidation decisions produced a single incorporated city with 17 ward-Parish districts. The ward districts were used for election administration and legislative apportionment. The ward districts also served as special property tax districts until Parish reorganization.

A single consolidation decision produced Metropolitan Toronto City in 1998. The amalgamation decision combined the City of Toronto, 5 townships and several counties into a single metropolitan city-county. The 5 townships of Etobicoke, York, North York, East York and Scarborough were incorporated, general purpose local jurisdictions with functional responsibilities for municipal services. The elimination of townships dissolved town incorporation status and produced a reduction in the fragmentation of local government. The amalgamation decision resulted in Toronto incorporation, annexation and boundary change to a rectangular corridor along the southern shore of the Province of Ontario.

County reorganization decisions reduce the number of local jurisdictions and change fragmented local jurisdictional boundary division. Over a long-run spatial history of boundary decisions, the Greater Boston Area reorganized Suffolk County. Because Massachusetts county partitions are derived from town incorporation, any county reorganization involves the transfer of (incorporated and unincorporated) towns among independent and separate counties. Boston-Suffolk County contains 3 excluded towns, Chelsea, Revere and Winthrop in the North Boston area. These 3 towns maintain incorporation status as cities independent and separate from the City of Boston. Even so, extensive city and county consolidation of functional responsibilities exists with some exceptions for the excluded cities.

Reorganization of Philadelphia County allowed for the consolidation of the City of Philadelphia with a fragmented set of unincorporated liberty areas and incorporated towns, villages and townships. The consolidation of Philadelphia City and County caused a reduction in the fragmentation numbers of local jurisdictions and incorporation status for all areas in Philadelphia County. A single consolidation decision permitted core annexation and merger of territory to greatly expand the City of Philadelphia beyond the original city plan. The combined Philadelphia City and County produced an extensive consolidation of local jurisdiction. Inasmuch this consolidation decision led to the formation of metropolitan districts, including a metropolitan water district that served as a model for other greater metropolitan areas.

County separation decisions are used to reorganize city and county local jurisdiction. The county separation decisions also reorganize functional responsibility for municipal-type services. Virginia cities and counties separate urbanized from rural areas, by giving independent and separable status to cities. The cities remain in county territory, but organize to provide city and county services inside municipal boundaries. Municipal boundaries generally form donut hole service islands within county territory. County separation decisions were used to form San Francisco City and County, Baltimore City and County and Saint Louis City and County. The San Francisco decision partitioned urban from rural areas, producing an expanded City of San Francisco County and an independent and separate San Mateo County. As a result, the county separation decision produced a city county consolidation decision and a county reorganization decision to produce two counties from a single county. In Baltimore, 6 magistrate districts were consolidated to form the City of Baltimore. The remainder areas of Baltimore County contain no incorporated cities.

The consolidated city and county of Baltimore is independent and separable from Baltimore County and is usually not counted as the 24th county government in Maryland. The separation of Saint Louis City and County jurisdiction also generated a consolidated city-county and home rule charter county government. In these two cities of Saint Louis, the city performs county functions and the county provides municipal services. Saint Louis County contains spheres of influence, township organization, incorporated cities and unincorporated municipal service areas (UMSAs). There are 28 townships in Saint Louis County used for special purposes and election administration: Airport, Bonhomme, Chesterfield, Clayton, Concord, Creve Coeur, Ferguson, Florissant, Gravois, Hadley, Jefferson, Lafayette, Lemay, Lewis and Clark, Maryland Heights, Meramec, Midland, Missouri River, Normandy, Northwest, Norwood, Oakville, Queeny, Spanish Lake, St. Ferdinand. Tesson Ferry. University and Wild Horse. The fragmentation of townships organizes a two-tiered metropolitan federalism and decentralization of Saint Louis County provision of local public goods and services.

The presence of township organization complicates the incorporation status of local jurisdiction to form major and minor civil districts. Township organization exists in Tri-County Detroit Area, Chicagoland, Greater Milwaukee, Cincinnati and Hamilton County and under the UNIGOV in Indianapolis, Marion County. The large number of townships produces fragmentation of local jurisdiction and choice of local jurisdiction, with county-township organization a viable alternative to municipal incorporation. The choice of local jurisdiction allows for city, town, village and township provision of local public goods and services. The State of Michigan enacted charter townships in local affairs to permit the adoption and implementation of incorporation and charter status for township government by general law.

The Chicagoland Metropolitan Area contains a large number of incorporated local jurisdictions and unincorporated county areas. Incorporation status allows for a range in the choice of local jurisdiction, among the set of town, township, village and city governance options. County-township organization is the status quo alternative, with township government serving as a second-tier of federated and decentralized local government throughout the metropolitan area. Cook County contains unincorporated municipal service areas that are sometimes connected to municipal territory as spheres of influence. There are a large number of unincorporated areas in Cook County and the greater Chicagoland metropolitan area. Special water districts predominate for the purposes of flood control and protection of clean water.

During the 1920's, there were two attempts at metropolitan district formation in the Tri-County Detroit Area. The second attempt involved the formation a metropolitan district consisting of Wayne, Oakland and Macomb Counties. This referendum failed by statewide vote in 1925, so that there was no amalgamation decision to form a regional, metropolitan federal and decentralized local government organizational structure. The first attempt enacted a Tri-County Water District that continues to this day and has sold water to other cities and counties outside of the Greater Metropolitan Detroit Area.

The existence of township government increases fragmentation of the functional responsibilities for service delivery and the choice of organizational structure for local jurisdictions. In Milwaukee County there are 10 cities and 9 villages with incorporation status. There were 7 original townships, Granville, Wauwatosa, Greenfield, Franklin, Oak Creek, Lake and Milwaukee (2). The Hamilton County, Cincinnati Area contains 19 villages and 12 townships outside the boundaries of core city annexation to the City of Cincinnati.

Townships were abolished with total annexation to municipal territory in Detroit, Chicago, Milwaukee and Cincinnati, but they continue as a second-tier of local government for county territory in the Greater Chicagoland Area and under the Indianapolis-Marion County UNIGOV. The incorporation status of city, town and village governments guarantee the existence of enclaves in counties with and without township organization. In the counties with township government, townships may be used as a second tier of metropolitan federalism and decentralized organization to provide municipal services to unincorporated areas. In the counties with incomplete or no township organization, other alternatives are created for the allocation of local public goods and services to unincorporated areas of county territory. These alternatives structure the organization of local public goods and services, assigning functional responsibilities to affected areas, county and city government. The alternatives provide for a range of district options to unincorporated municipal service areas. Becoming a municipal sphere of influence is one option that allows city government to extend municipal allocations of public goods and services to county territory. The other options describe mechanisms derived from county-township organization such as targeted county contracting and the adoption and implementation of multiple special districts in county territory.

More generally, as the population of unincorporated areas increases, there are greater requirements for urban and municipal type services. These public goods and services frequently exceed the benefits of municipal incorporation by annexation to an existing city or the formation of a new city. The provision of emergency services is increasingly becoming an urban area priority for county government. In unincorporated areas, county emergency services provide fire, police and health care and these services are sometimes provided by township organization.

Given widespread and destructive natural events, county governments also handle responses to environmental damage by emergency management. The increasing responses of county governments describes the importance of a two-tiered metropolitan federal and decentralized State-County structure to govern in unincorporated areas. As these areas are affected by Hurricanes, Tornadoes, Wildfires, Inland and Coastal Flooding, Earthquakes and Severe Weather, the counties responsibilities increase for coordinating Federal, State, and Private Sector programs for recovery. Because unincorporated areas are frequently more diffusely located and less populated, these have become areas of origination for some of the natural events, such as Wildfires, Flooding and damage to Clean Water. *As a consequence, these place some of the most severe environmental damage in unincorporated areas with the least organized local jurisdiction.* This study analyzes what structure we do have and suggests that environmental damage requires well organized and funded county responses to natural events and disasters. In this setting, combinations of county-township and municipal organization may be necessary to sustain emergency services and management responses to environmental damage in the long-run of recovery.

The issues of climate change in unincorporated areas is targeted by insurance as a primary form of zonal regulation. As a result, unincorporated areas are covered by fire protection and flood insurance districts. If these areas are increasingly the areas of origination, for wildfires or floods, the threat of environmental damage extends beyond less populated areas of county territory to residents with incorporation status. The spread of environmental damage derived from unincorporated areas to adjacent cities is an issue that is increasingly related to any "thinking locally" deliberation of climate change.

APPENDIX I **TABLE 1.0** CITY * BOUNDARY STRATEGY Crosstabulation

City		BOUNDARY intact	extensive	annexation	incorporation	Total
Agoura Hills	Count		**2**	**4**		6
	% within CITY		**33.3%**	**66.7%**		100.0%
Alhambra	Count	**6**				6
	% within CITY	**100.0%**				100.0%
Arcadia	Count		**6**	**5**		11
	% within CITY		**54.5%**	**45.5%**		100.0%
Artesia	Count	**2**				2
	% within CITY	**100.0%**				100.0%
Avalon	Count			**1**		1
	% within CITY			**100.0%**		100.0%
Azusa	Count		**4**	**4**		8
	% within CITY		**50.0%**	**50.0%**		100.0%
Baldwin Park	Count		**5**	**5**		10
	% within CITY		**50.0%**	**50.0%**		100.0%
Bell	Count	**6**				6
	% within CITY	**100.0%**				100.0%
Bell Gardens	Count	**5**				5
	% within CITY	**100.0%**				100.0%
Bellflower	Count	**6**				6
	% within CITY	**100.0%**				100.0%
Beverly Hills	Count	**2**				2
	% within CITY	**100.0%**				100.0%
Bradbury	Count		**2**	**1**		3
	% within CITY		**66.7%**	**33.3%**		100.0%
Burbank	Count		**2**	**2**		4
	% within CITY		**50.0%**	**50.0%**		100.0%
Calabasas	Count		**3**	**4**		7
	% within CITY		**42.9%**	**57.1%**		100.0%
Carson	Count		3	1	1	5
	% within CITY		60.0%	20.0%	20.0%	100.0%
Cerritos	Count		**6**	**1**		7
	% within CITY		**85.7%**	**14.3%**		100.0%
Claremont	Count		**2**	**2**		4
	% within CITY		**50.0%**	**50.0%**		100.0%
Commerce	Count	**7**				7
	% within CITY	**100.0%**				100.0%
Compton	Count		5	5	2	12
	% within CITY		41.7%	41.7%	16.7%	100.0%
Covina	Count		5	11	1	17
	% within CITY		29.4%	64.7%	5.9%	100.0%
Cudahy	Count	**4**				4
	% within CITY	**100.0%**				100.0%
Culver City	Count		**1**	**2**		3
	% within CITY		**33.3%**	**66.7%**		100.0%
Diamond Bar	Count		2	1	1	4
	% within CITY		50.0%	25.0%	25.0%	100.0%
Downey	Count	**9**				9
	% within CITY	**100.0%**				100.0%
Duarte	Count		**4**	**1**		5

	% within CITY		**80.0%**	**20.0%**		100.0%
El Monte	Count		**7**	**2**		9
	% within CITY		**77.8%**	**22.2%**		100.0%
El Segundo	Count		**3**	**1**		4
	% within CITY		**75.0%**	**25.0%**		100.0%
Gardena	Count		**3**		**2**	5
	% within CITY		**60.0%**		**40.0%**	100.0%
Glendale	Count		**4**		**1**	5
	% within CITY		**80.0%**		**20.0%**	100.0%
Glendora	Count		**3**	**2**		5
	% within CITY		**60.0%**	**40.0%**		100.0%
Hawaiian Gardens	Count	**2**				2
	% within CITY	**100.0%**				100.0%
Hawthorne	Count		7	4	3	14
	% within CITY		50.0%	28.6%	21.4%	100.0%
Hermosa Beach	Count		**2**	**1**		3
	% within CITY		**66.7%**	**33.3%**		100.0%
Hidden Hills	Count		**2**	**5**		7
	% within CITY		**28.6%**	**71.4%**		100.0%
Huntington Park	Count		6	1	1	8
	% within CITY		75.0%	12.5%	12.5%	100.0%
Industry	Count		10	9	2	21
	% within CITY		47.6%	42.9%	9.5%	100.0%
Inglewood	Count		2	5	1	8
	% within CITY		25.0%	62.5%	12.5%	100.0%
Irwindale	Count		**8**	**2**		10
	% within CITY		**80.0%**	**20.0%**		100.0%
La Canada Flintridge	Count		**2**		**2**	4
	% within CITY		**50.0%**		**50.0%**	100.0%
La Habra Heights	Count		1	2	2	5
	% within CITY		20.0%	40.0%	40.0%	100.0%
La Mirada	Count		**3**	**4**		7
	% within CITY		**42.9%**	**57.1%**		100.0%
La Puente	Count		**3**	**5**		8
	% within CITY		**37.5%**	**62.5%**		100.0%
La Verne	Count		**3**	**3**		6
	% within CITY		**50.0%**	**50.0%**		100.0%
Lakewood	Count		**4**			4
	% within CITY		**100.0%**			100.0%
Lancaster	Count		1	3	1	5
	% within CITY		20.0%	60.0%	20.0%	100.0%
Lawndale	Count		**3**		**1**	4
	% within CITY		**75.0%**		**25.0%**	100.0%
Lomita	Count	**4**				4
	% within CITY	**100.0%**				100.0%
Long Beach	Count		8	1	1	10
	% within CITY		80.0%	10.0%	10.0%	100.0%
Los Angeles	Count		30	20	7	57
	% within CITY		52.6%	35.1%	12.3%	100.0%
Lynwood	Count		4	1	1	6
	% within CITY		66.7%	16.7%	16.7%	100.0%
Malibu	Count		**1**	**1**		2
	% within CITY		**50.0%**	**50.0%**		100.0%

Manhattan Beach	Count	**4**				4
	% within CITY	**100.0%**				100.0%
Maywood	Count	**3**				3
	% within CITY	**100.0%**				100.0%
Monrovia	Count		**4**	**3**		7
	% within CITY		**57.1%**	**42.9%**		100.0%
Montebello	Count		5	1	1	7
	% within CITY		71.4%	14.3%	14.3%	100.0%
Monterey Park	Count		**5**		**2**	7
	% within CITY		**71.4%**		**28.6%**	100.0%
Norwalk	Count	**5**				5
	% within CITY	**100.0%**				100.0%
Palmdale	Count		**1**	**6**		7
	% within CITY		**14.3%**	**85.7%**		100.0%
Palos Verdes Estates	Count	**3**				3
	% within CITY	**100.0%**				100.0%
Paramount	Count	**6**				6
	% within CITY	**100.0%**				100.0%
Pasadena	Count		7	3	1	11
	% within CITY		63.6%	27.3%	9.1%	100.0%
Pico Rivera	Count		7	2	2	11
	% within CITY		63.6%	18.2%	18.2%	100.0%
Pomona	Count		**6**	**3**		9
	% within CITY		**66.7%**	**33.3%**		100.0%
Rancho Palos Verdes	Count		**5**	**1**		6
	% within CITY		**83.3%**	**16.7%**		100.0%
Redondo Beach	Count	**5**				5
	% within CITY	**100.0%**				100.0%
Rolling Hills	Count	**3**				3
	% within CITY	**100.0%**				100.0%
Rolling Hills Estates	Count		**5**	**2**		7
	% within CITY		**71.4%**	**28.6%**		100.0%
Rosemead	Count		7	2	1	10
	% within CITY		70.0%	20.0%	10.0%	100.0%
San Dimas	Count		5	6	1	12
	% within CITY		41.7%	50.0%	8.3%	100.0%
San Fernando	Count	**1**				1
	% within CITY	**100.0%**				100.0%
San Gabriel	Count		**5**	**5**		10
	% within CITY		**50.0%**	**50.0%**		100.0%
San Marino	Count		**4**	**4**		8
	% within CITY		**50.0%**	**50.0%**		100.0%
Santa Clarita	Count		1	5	3	9
	% within CITY		11.1%	55.6%	33.3%	100.0%
Santa Fe Springs	Count		6	6	1	13
	% within CITY		46.2%	46.2%	7.7%	100.0%
Santa Monica	Count	**1**				1
	% within CITY	**100.0%**				100.0%
Sierra Madre	Count	**2**				2
	% within CITY	**100.0%**				100.0%
Signal Hill	Count	**1**				1
	% within CITY	**100.0%**				100.0%

South El Monte	Count		**4**	**4**		8
	% within CITY		**50.0%**	**50.0%**		100.0%
South Gate	Count		7	2	1	10
	% within CITY		70.0%	20.0%	10.0%	100.0%
South Pasadena	Count	**4**				4
	% within CITY	**100.0%**				100.0%
Temple City	Count		**4**	**3**		7
	% within CITY		**57.1%**	**42.9%**		100.0%
Torrance	Count		**8**		**1**	9
	% within CITY		**88.9%**		**11.1%**	100.0%
Vernon	Count	**5**				5
	% within CITY	**100.0%**				100.0%
Walnut	Count		**4**	**1**		5
	% within CITY		**80.0%**	**20.0%**		100.0%
West Covina	Count		**6**	**6**		12
	% within CITY		**50.0%**	**50.0%**		100.0%
West Hollywood	Count	**2**				2
	% within CITY	**100.0%**				100.0%
Westlake Village	Count	**1**				1
	% within CITY	**100.0%**				100.0%
Whittier	Count		5	4	3	12
	% within CITY		41.7%	33.3%	25.0%	100.0%
Total	Count	99	283	191	47	620
	% within CITY	16.0%	45.6%	30.8%	7.6%	100.0%

Appendix II Measures of Asymmetry in Distributions of Cities and Tests of Normality of the Distributions of Cities

TABLE 1.0 Measures of Asymmetry

Inequality measures of spheres

relative mean deviation	.45911701
coefficient of variation	1.3102776
standard deviation of logs	.72551083
Gini coefficient	.61742424
Mehran measure	.80786015
Piesch measure	.52220629
Kakwani measure	.332009
Theil entropy measure	.72999625
Theil mean log deviation measure	-.11430536

Inequality measures of adjcty

relative mean deviation	.42556591
coefficient of variation	1.3073083
standard deviation of logs	.72680675
Gini coefficient	.57744615
Mehran measure	.7639385
Piesch measure	.48419997
Kakwani measure	.2896717
Theil entropy measure	.6487073
Theil mean log deviation measure	-.05082508

Inequality measures of adjcity

relative mean deviation	.23923131
coefficient of variation	.80629132
standard deviation of logs	.65854299
Gini coefficient	.3394812
Mehran measure	.47163215
Piesch measure	.27340572
Kakwani measure	.10928825
Theil entropy measure	.22524045
Theil mean log deviation measure	.19565151

Inequality measures of neighbors

relative mean deviation	.2407074
coefficient of variation	.90707614
standard deviation of logs	.69829837
Gini coefficient	.35025573
Mehran measure	.47212852
Piesch measure	.28931933
Kakwani measure	.11408222
Theil entropy measure	.24929029
Theil mean log deviation measure	.23560199

Inequality measures of lnpop

relative mean deviation	.04793927
coefficient of variation	.14089599
standard deviation of logs	.16297722
Gini coefficient	.07083103
Mehran measure	.11227699
Piesch measure	.05010804
Kakwani measure	.0065201
Theil entropy measure	.01059334
Theil mean log deviation measure	.01177048

Inequality measures of lnarea

relative mean deviation	.1899469
coefficient of variation	.52187525
standard deviation of logs	.62448074
Gini coefficient	.2779811
Mehran measure	.40461636
Piesch measure	.21466347
Kakwani measure	.07654164
Theil entropy measure	.13800658
Theil mean log deviation measure	.14090455

.

TABLE 2.0 Tests for Normality in the Distribution of Cities

. sktest spheres adjcty adjcity neighbors lnpop lnarea

Skewness/Kurtosis tests for Normality

Variable	Obs	Pr(Skewness)	Pr(Kurtosis)	joint adj chi2(2)	joint Prob>chi2
spheres	88	0.0000	0.0000	45.38	0.0000
adjcty	88	0.0000	0.0000	69.08	0.0000
adjcity	88	0.0000	0.0000	.	0.0000
neighbors	88	0.0000	0.0000	.	0.0000
lnpop	88	0.0002	0.0002	21.66	0.0000
lnarea	88	0.0006	0.0027	16.50	0.0003

. swilk spheres adjcty adjcity neighbors lnpop lnarea

Shapiro-Wilk W test for normal data

Variable	Obs	W	V	z-test	Prob>z
spheres	88	0.79336	15.342	6.015	0.00000
adjcty	88	0.71176	21.400	6.748	0.00000
adjcity	88	0.65312	25.754	7.156	0.00000
neighbors	88	0.57005	31.922	7.629	0.00000
lnpop	88	0.89313	7.935	4.563	0.00000
lnarea	88	0.94504	4.081	3.098	0.00098

. sfrancia spheres adjcty adjcity neighbors lnpop lnarea

Shapiro-Francia W' test for normal data

Variable	Obs	W'	V'	z-test	Prob>z
spheres	88	0.84087	13.039	5.034	0.00001
adjcty	88	0.73962	21.335	5.999	0.00001
adjcity	88	0.64152	29.374	6.626	0.00001
neighbors	88	0.56091	35.979	7.023	0.00001
lnpop	88	0.88148	9.712	4.456	0.00001
lnarea	88	0.94082	4.849	3.095	0.00099

Appendix III Regression Analysis of Individual Equations

Equation 1: Number of Spheres of Influence Model

Model Summary

Model	R	R Square	Std. Error of the Estimate	Durbin-Watson
1	.926	.857	.99	1.585

a Predictors: (Constant), ADJCTY
b Dependent Variable: SPHERES

ANOVA

Model		Sum of Squares	df	Mean Square	F-test	Sig.
1	Regression	500.198	1	500.198	513.599	.000
	Residual	83.756	86	.974		
	Total	583.955	87			

a Predictors: (Constant), ADJCTY
b Dependent Variable: SPHERES

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t-test	Sig.	95% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	.143	.133		1.078	.284	-.121	.407
	ADJCTY	.648	.029	.926	22.663	.000	.591	.705

a Dependent Variable: SPHERES

Casewise Diagnostics

City	Std. Residual	SPHERES	Predicted Value	Residual	Prediction Error
Compton	2.350	7	4.68	2.32	+2
Covina	4.133	12	7.92	4.08	+4
Hidden Hills	1.637	5	3.38	1.62	+2
Industry	-2.304	5	7.27	-2.27	-2
Inglewood	-3.073	1	4.03	-3.03	-3
Los Angeles	-2.680	15	17.64	-2.64	-3
Palmdale	1.994	6	4.03	1.97	+2

a Dependent Variable: SPHERES

MODEL: MODEL 1.

Dependent variable.. SPHERES Method.. LINEAR

Listwise Deletion of Missing Data

Multiple R .92551
R Square .85657
Adjusted R Square .85490
Standard Error .98687

Analysis of Variance:

	DF	Sum of Squares	Mean Square
Regression	1	500.19838	500.19838
Residuals	86	83.75616	.97391

F = 513.59874 Signif F = .0000

---------- Variables in the Equation ----------

Variable	B	SE B	Beta	T	Sig T
ADJCTY	.648212	.028603	.925511	22.663	.0000
(Constant)	.143129	.132730		1.078	.2839

Dependent variable.. SPHERES Method.. QUADRATIC

Listwise Deletion of Missing Data

Multiple R .93673
R Square .87745
Adjusted R Square .87457
Standard Error .91755

Analysis of Variance:

	DF	Sum of Squares	Mean Square
Regression	2	512.39347	256.19673
Residuals	85	71.56108	.84190

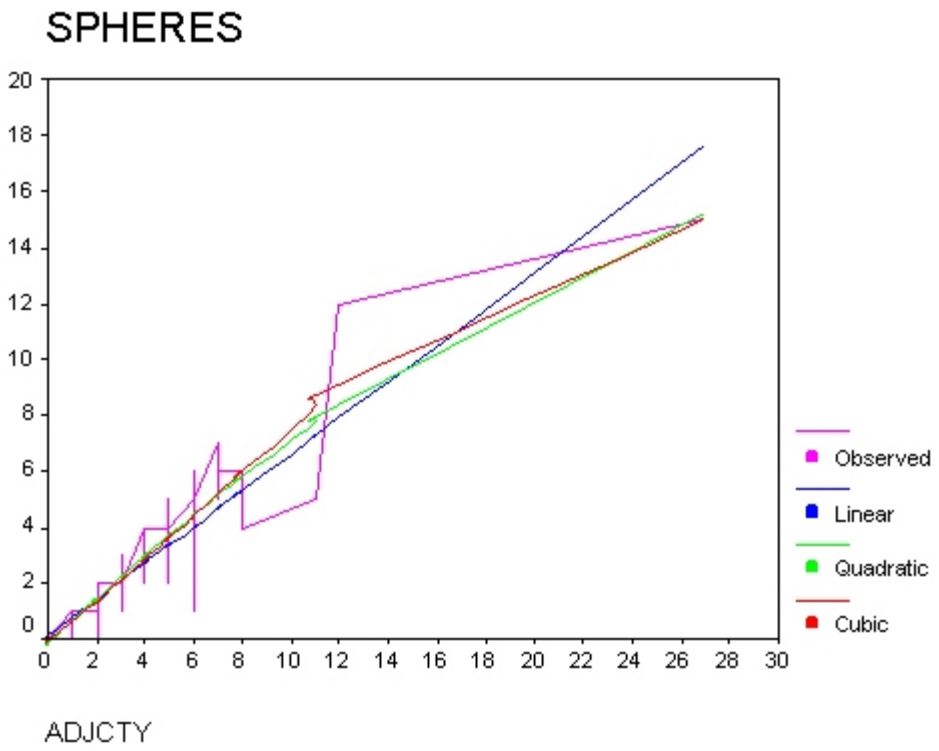
F = 304.30958 Signif F = .0000

---------- Variables in the Equation ----------

Variable	B	SE B	Beta	T	Sig T
ADJCTY	.823602	.053206	1.175932	15.480	.0000
ADJCTY**2	-.009373	.002463	-.289127	-3.806	.0003
(Constant)	-.151317	.145652		-1.039	.3018

```
Dependent variable.. SPHERES           Method.. CUBIC

Listwise Deletion of Missing Data

Multiple R           .93853
R Square             .88084
Adjusted R Square    .87658
Standard Error       .91016

            Analysis of Variance:

                DF   Sum of Squares      Mean Square

Regression       3        514.37000        171.45667
Residuals       84         69.58455           .82839

F =     206.97641       Signif F =  .0000

-------------------- Variables in the Equation --------------------

Variable                    B        SE B       Beta          T  Sig T

ADJCTY                .664878     .115518    .949307      5.756  .0000
ADJCTY**2             .018303     .018083    .564616      1.012  .3144
ADJCTY**3            -.000825     .000534   -.669675     -1.545  .1262
(Constant)           -.039065     .161725                 -.242  .8097
```

FIGURE 1.0 NUMBER OF SPHERES OF INFLUENCE



Equation 2: Number of Adjacent Cities-Neighbor Model

Model Summary

Model	R	R Square	Std. Error of the Estimate	Durbin-Watson
2	.898	.806	1.55	1.829

a Predictors: (Constant), NEIGHBORS
b Dependent Variable: ADJCITY

ANOVA

Model		Sum of Squares	df	Mean Square	F-test	Sig.
2	Regression	858.831	1	858.831	356.910	.000
	Residual	206.941	86	2.406		
	Total	1065.773	87			

a Predictors: (Constant), NEIGHBORS
b Dependent Variable: ADJCITY

Coefficients

		Unstandardized Coefficients		Standardized Coefficients	t-test	Sig.	95% Confidence Interval for B	
Model		B	Std. Error	Beta			Lower Bound	Upper Bound
2	(Constant)	.877	.247		3.553	.001	.386	1.368
	NEIGHBORS	.483	.026	.898	18.892	.000	.432	.534

a Dependent Variable: ADJCITY

Casewise Diagnostics

City	Std. Residual	ADJCITY	Predicted Value	Residual	Prediction Error
Commerce	1.767	7	4.26	2.74	+3
Covina	-2.636	5	9.09	-4.09	-4
Downey	2.434	9	5.22	3.78	+4
Inglewood	-1.767	2	4.74	-2.74	-3
Palmdale	-2.101	1	4.26	-3.26	-3
Santa Clarita	-2.723	1	5.22	-4.22	-4
Torrance	1.789	8	5.22	2.78	+3

a Dependent Variable: ADJCITY

MODEL: MODEL 2.

Dependent variable.. ADJCITY Method.. LINEAR

Listwise Deletion of Missing Data

Multiple R	.89768
R Square	.80583
Adjusted R Square	.80357
Standard Error	1.55122

Analysis of Variance:

	DF	Sum of Squares	Mean Square
Regression	1	858.83133	858.83133
Residuals	86	206.94139	2.40630

F = 356.91020 Signif F = .0000

---------- Variables in the Equation ----------

Variable	B	SE B	Beta	T	Sig T
NEIGHBORS	.483063	.025570	.897680	18.892	.0000
(Constant)	.877127	.246901		3.553	.0006

Dependent variable.. ADJCITY Method.. QUADRATIC

Listwise Deletion of Missing Data

Multiple R	.90055
R Square	.81099
Adjusted R Square	.80654
Standard Error	1.53945

Analysis of Variance:

	DF	Sum of Squares	Mean Square
Regression	2	864.33021	432.16510
Residuals	85	201.44252	2.36991

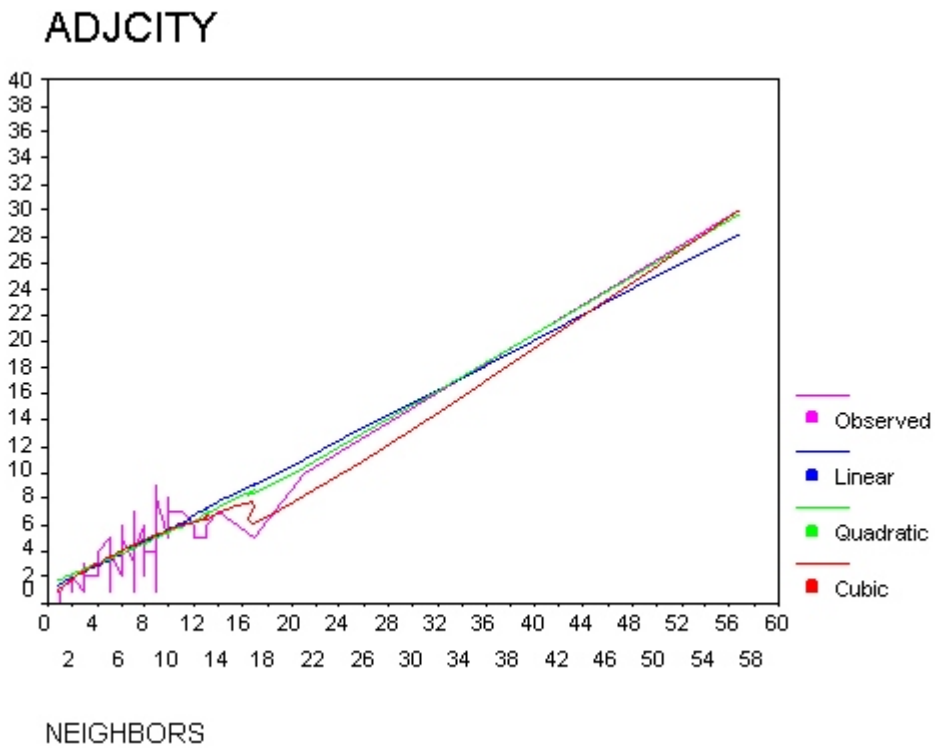
F = 182.35491 Signif F = .0000

---------- Variables in the Equation ----------

Variable	B	SE B	Beta	T	Sig T
NEIGHBOR	.397316	.061747	.738335	6.435	.0000
NEIGHBORS**2	.001765	.001159	.174786	1.523	.1314
(Constant)	1.327391	.383946		3.457	.0009

```
Dependent variable.. ADJCITY           Method.. CUBIC

Listwise Deletion of Missing Data

Multiple R           .90712
R Square             .82287
Adjusted R Square    .81655
Standard Error      1.49912

            Analysis of Variance:

                DF    Sum of Squares      Mean Square

Regression       3         876.99513        292.33171
Residuals       84         188.77760          2.24735

F =     130.07827       Signif F =  .0000

-------------------- Variables in the Equation --------------------

Variable                    B         SE B        Beta          T  Sig T

NEIGHBORS            .758750     .163696   1.409991     4.635  .0000
NEIGHBORS**2        -.026714     .012050  -2.645196    -2.217  .0293
NEIGHBORS**3         .000395     .000167   2.227522     2.374  .0199
(Constant)           .323204     .564559                .572  .5685
```

FIGURE 2.0 NUMBER OF ADJACENT CITIES



MODEL: MODEL 3.

Model Summary

Model	R	R Square	Std. Error of the Estimate	Durbin-Watson
3	.876	.767	.7130	2.012

a Predictors: (Constant), RANK of POP2010
b Dependent Variable: LNPOP

ANOVA

Model		Sum of Squares	df	Mean Square	F-test	Sig.
3	Regression	144.062	1	144.062	283.383	.000
	Residual	43.719	86	.508		
	Total	187.781	87			

a Predictors: (Constant), RANK of POP2010
b Dependent Variable: LNPOP

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t-test	Sig.	95% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
3	(Constant)	12.667	.153		82.619	.000	12.362	12.972
	RANK of POP2010	-.05037	.003	-.876	-16.834	.000	-.056	-.044

a Dependent Variable: LNPOP

Casewise Diagnostics

City	Std. Residual	LNPOP	Predicted Value	Residual	City Population Size
Bradbury	-1.936	6.95	8.3351	-1.3805	1,048
Industry	-4.061	5.39	8.2847	-2.8957	219
Irwindale	-1.579	7.26	8.3855	-1.1257	1,422
Los Angeles	3.551	15.15	12.6165	2.5320	3,792,621
Vernon	-4.931	4.72	8.2344	-3.5159	112

a Dependent Variable: LNPOP

MODEL: MODEL 3.

Dependent variable.. LNPOP Method.. LINEAR

Listwise Deletion of Missing Data

Multiple R	.87589
R Square	.76718
Adjusted R Square	.76447
Standard Error	.71300

Analysis of Variance:

	DF	Sum of Squares	Mean Square
Regression	1	144.06198	144.06198
Residuals	86	43.71943	.50837

F = 283.38273 Signif F = .0000

---------- Variables in the Equation ----------

Variable	B	SE B	Beta	T	Sig T
RPOP2010	-.050370	.002992	-.875888	-16.834	.0000
(Constant)	12.666906	.153316		82.619	.0000

Dependent variable.. LNPOP Method.. QUADRATIC

Listwise Deletion of Missing Data

Multiple R	.89679
R Square	.80423
Adjusted R Square	.79962
Standard Error	.65764

Analysis of Variance:

	DF	Sum of Squares	Mean Square
Regression	2	151.01952	75.509762
Residuals	85	36.76189	.432493

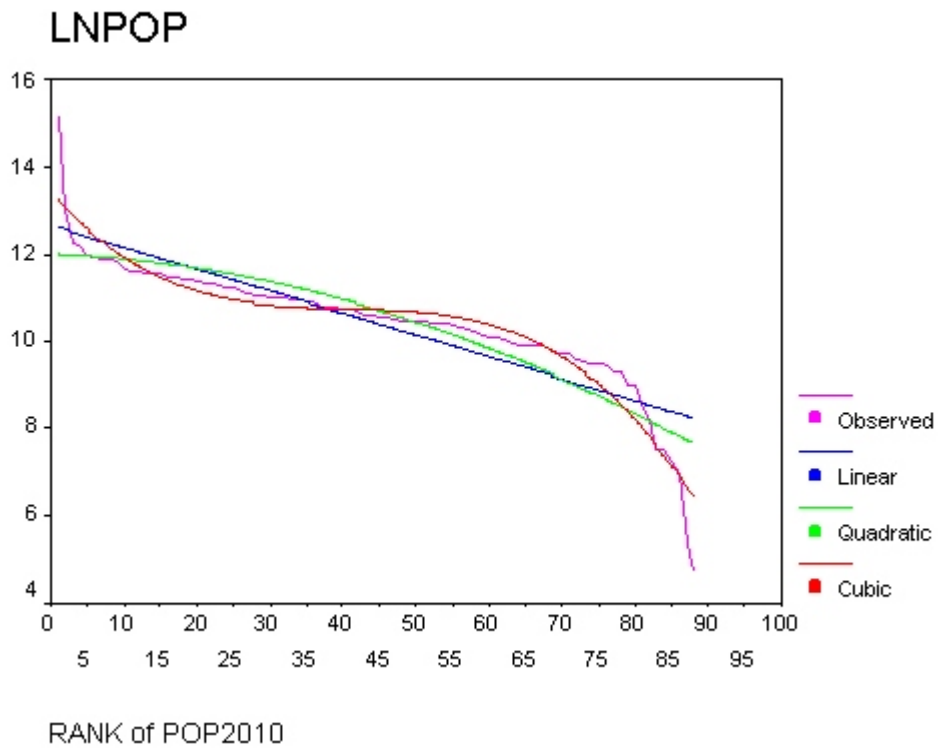
F = 174.59197 Signif F = .0000

---------- Variables in the Equation ----------

Variable	B	SE B	Beta	T	Sig T
RPOP2010	-.007000	.011160	-.121722	-.627	.5322
RPOP2010**2	-.000487	.000121	-.778343	-4.011	.0001
(Constant)	12.016358	.215187		55.842	.0000

```
Dependent variable.. LNPOP              Method.. CUBIC

Listwise Deletion of Missing Data

Multiple R           .95944
R Square             .92052
Adjusted R Square    .91769
Standard Error       .42151

            Analysis of Variance:

               DF   Sum of Squares      Mean Square

Regression      3        172.85734        57.619113
Residuals      84         14.92407          .177668

F =     324.30865       Signif F =  .0000

-------------------- Variables in the Equation --------------------

Variable                   B        SE B        Beta         T  Sig T

RPOP2010            -.192042     .018159  -3.339444   -10.576  .0000
RPOP2010**2          .004681     .000473   7.477118     9.904  .0000
RPOP2010**3 -3.87156888E-05  3.4921E-06  -5.210121   -11.087  .0000
(Constant)         13.427371     .187670                71.548  .0000
```

FIGURE 3.0 LOG RANK SIZE RULE



MODEL: MODEL 4.

Model Summary

Model	R	R Square	Std. Error of the Estimate	Durbin-Watson
4	.928	.861	.3899	1.732

a Predictors: (Constant), RANK of LANDAREA
b Dependent Variable: LNAREA

ANOVA

Model		Sum of Squares	df	Mean Square	F-test	Sig.
4	Regression	81.169	1	81.169	533.888	.000
	Residual	13.075	86	.152		
	Total	94.243	87			

a Predictors: (Constant), RANK of LANDAREA
b Dependent Variable: LNAREA

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t-test	Sig.	95% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
4	(Constant)	3.677	.084		43.851	.000	3.510	3.844
	RANK of LANDAREA	-.03781	.002	-.928	-23.106	.000	-.041	-.035

a Dependent Variable: LNAREA

Casewise Diagnostics

City	Std. Residual	LNAREA	Predicted Value	Residual	City Land Area Square Miles
Lancaster	2.732	4.63	3.5635	1.0654	102.4
Los Angeles	6.439	6.15	3.6391	2.5108	468.7
Palmdale	3.333	4.90	3.6013	1.2995	134.4

a Dependent Variable: LNAREA

MODEL: MODEL 4.

Dependent variable.. LNAREA Method.. LINEAR

Listwise Deletion of Missing Data

Multiple R	.92804
R Square	.86127
Adjusted R Square	.85965
Standard Error	.38991

Analysis of Variance:

	DF	Sum of Squares	Mean Square
Regression	1	81.168538	81.168538
Residuals	86	13.074832	.152033

F = 533.88789 Signif F = .0000

---------- Variables in the Equation ----------

Variable	B	SE B	Beta	T	Sig T
RLANDAREA	-.037813	.001637	-.928044	-23.106	.0000
(Constant)	3.676958	.083852		43.851	.0000

Dependent variable.. LNAREA Method.. QUADRATIC

Listwise Deletion of Missing Data

Multiple R	.93410
R Square	.87255
Adjusted R Square	.86955
Standard Error	.37591

Analysis of Variance:

	DF	Sum of Squares	Mean Square
Regression	2	82.231936	41.115968
Residuals	85	12.011434	.141311

F = 290.96086 Signif F = .0000

---------- Variables in the Equation ----------

Variable	B	SE B	Beta	T	Sig T
RLANDAREA	-.054771	.006380	-1.344223	-8.585	.0000
RLANDAREA**2	.000191	6.9463E-05	.429521	2.743	.0074
(Constant)	3.931297	.123010		31.959	.0000

```
Dependent variable.. LNAREA           Method.. CUBIC

Listwise Deletion of Missing Data

Multiple R           .97279
R Square             .94632
Adjusted R Square    .94440
Standard Error       .24542

            Analysis of Variance:

               DF   Sum of Squares      Mean Square

Regression      3        89.183943        29.727981
Residuals      84         5.059427          .060231

F =     493.56385       Signif F =  .0000

-------------------- Variables in the Equation --------------------

Variable                    B        SE B       Beta         T  Sig T

RLANDAREA           -.159253     .010580  -3.908517   -15.053  .0000
RLANDAREA**2         .003110     .000275   7.009184    11.289  .0000
RLANDAREA**3 -2.18686468E-05  2.0355E-06 -4.152728   -10.743  .0000
(Constant)          4.727764     .109296               43.257  .0000
```

FIGURE 4.0 LOG AREA RANK RULE