Geographical Spatial Analysis

Beyond the Indications

Geoffrey Werner, FCAS MAAA

USAA

2003 Ratemaking Seminar

Outline

- Current Procedure
- Practical Issues
  - Use of CW and state data
  - Subsidization
  - Incorporation of business concepts
  - Diagnostic tools
  - Regulatory approval
  - Zip code changes
- Summary

Current Procedure
Indicated Boundaries and Relativities

1. Develop CW GLM model to predict loss costs, excluding county/zip
   - Use of CW data

2. Calculate average residual for each county/zip in state and smooth residuals based on distance/exposures
   - Use of state data

3. Cluster residuals into <u>indicated</u> territories

4. Calculate <u>indicated</u> territorial relativities using GLM
   - Subsidization issue

Current Procedure
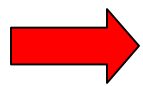## Final Boundaries and Relativities

5. Calculate <u>initial</u> boundaries and relativities
   - Incorporation of business concepts

6. Judgmentally select <u>final</u> territorial boundaries and relativities
   - Diagnostic Tools

7. Implement <u>final</u> territorial boundaries and relativities
   - Regulatory approval
   - Zip code changes

Practical Issues

- Use of CW and state data
- Subsidization
- Incorporation of business concepts
- Diagnostic tools
- Regulatory approval
- Zip code changes

ISSUE: Use of CW Data

Step 1: Develop CW GLM model to predict loss costs, excluding county/zip

- Uses all available data to determine relationships between non-geographic rating characteristics

- Overall state differences included via state independent variable

- Since CW data, do not need to repeat analysis for each territorial review. Frequency depends on materiality of changes, but annual or semi-annual should be appropriate

- Tests can validate
  - CW model for each state
 - Appropriate frequency

ISSUE: Use of State Data

Step 2: Calculate average residual for each county/zip in state and smooth residuals based on distance/exposures

- Smoothing stops at state boundaries

  - Only an issue at or near state boundaries due to distance weighting

  - Ideally, could use data from contiguous states. Regulatory hurdles make this impractical today

Practical Issues
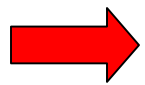
- Use of CW and state data
- **Subsidization**
- Incorporation of business concepts
- Diagnostic tools
- Regulatory approval
- Zip code changes

ISSUE: Subsidization

Step 4: Calculate <u>indicated</u> territorial relativities using GLM

- Must choose how to include non-territorial rating characteristics:

Constrained factors
- Reflect charged relativities for other factors
- Minimizes other "subsidies" at a territorial level

Indicated factors
- Reflect indicated relativities for other factors
- Retains "subsidies" within other rating structures

- Decision will vary on case-by-case basis
  - Undesirable subsidy
  - Desired subsidy

Practical Issues

- Use of CW and state data
- Subsidization
→ - **Incorporation of business concepts**
- Diagnostic tools
- Regulatory approval
- Zip code changes

ISSUE: Incorporation of Business Concepts

Step 5: Calculate <u>initial</u> boundaries and relativities

- Developing <u>indicated</u> boundaries and relativities is only a part of the task. Rates and relativities should also consider

  - Renewal constraints

  - Competitive concerns

  - Regulatory restrictions

ISSUE: Incorporation of Business Concepts
Systematic Steps to Include

- Renewal and competitive considerations can be systematically included to develop <u>initial</u> boundaries and relativities
  - Have indicated relativities by county/zip
  - Determine competitors and calculate normalized relativities by county/zip
  - Calculate normalized current relativities by county/zip
  - Combine relativities in appropriate fashion
  - Cluster relativities to form initial boundaries
  - Weight combined relativities to derive initial relativities
  - Regulatory restrictions handled on ad hoc basis

ISSUE: Incorporation of Business Concepts
Competitors

- Decide how many competitors

- Decide which competitors
  - Market share
  - Competitive information
  - Rating structure sophistication

- Determine normalized relativities
  - Weight with own distribution
  - Adjust for base rate differences or not?

ISSUE: Incorporation of Business Concepts
Systematic Steps to Include

- Renewal and competitive considerations can be systematically included to develop <u>initial</u> boundaries and relativities
  - Have indicated relativities by county/zip
  - Determine competitors and calculate normalized relativities by county/zip
  - Calculate normalized current relativities by county/zip
  - Combine relativities in appropriate fashion
  - Cluster relativities to form initial boundaries
  - Weight combined relativities to derive initial relativities
  - Regulatory restrictions handled on ad hoc basis

ISSUE: Incorporation of Business Concepts
Combining Relativities

- ## Median
  - Generally performs better if wide variances in relativities
  - Decide whether current, indicated, competitor considered equally
- ## Weighted-average
  - Allows actuary to more easily adjust emphasis
  - Can be distorted by outliers

Curr	Ind	Comp	Wtd Avg*	Median
1.00	.95	1.10	1.02	1.00
1.00	1.05	1.30	1.12	1.05
1.00	1.30	.95	1.08	1.00

*Equal weighting.

ISSUE: Incorporation of Business Concepts
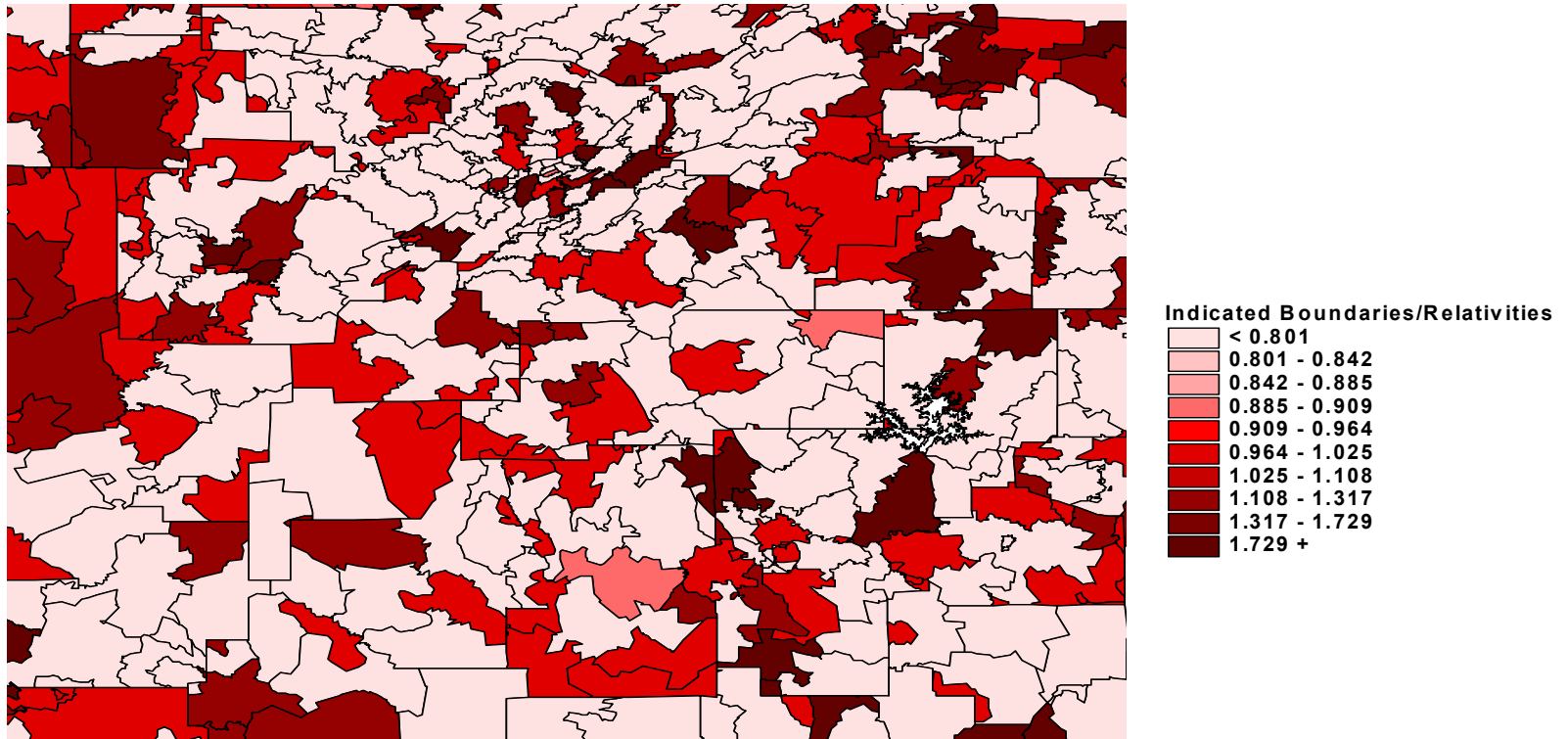## Systematic Steps to Include

- Renewal and competitive considerations can be systematically included to develop <u>initial</u> boundaries and relativities
    - Have indicated relativities by county/zip
    - Determine competitors and calculate normalized relativities by county/zip
    - Calculate normalized current relativities by county/zip
    - Combine relativities in appropriate fashion
    - Cluster relativities to form initial boundaries
    - Weight combined relativities to derive initial relativities
    - Regulatory restrictions handled on ad hoc basis

Let's look at some maps of "outdated" example to see it in action…

ISSUE: Incorporation of Business Concepts
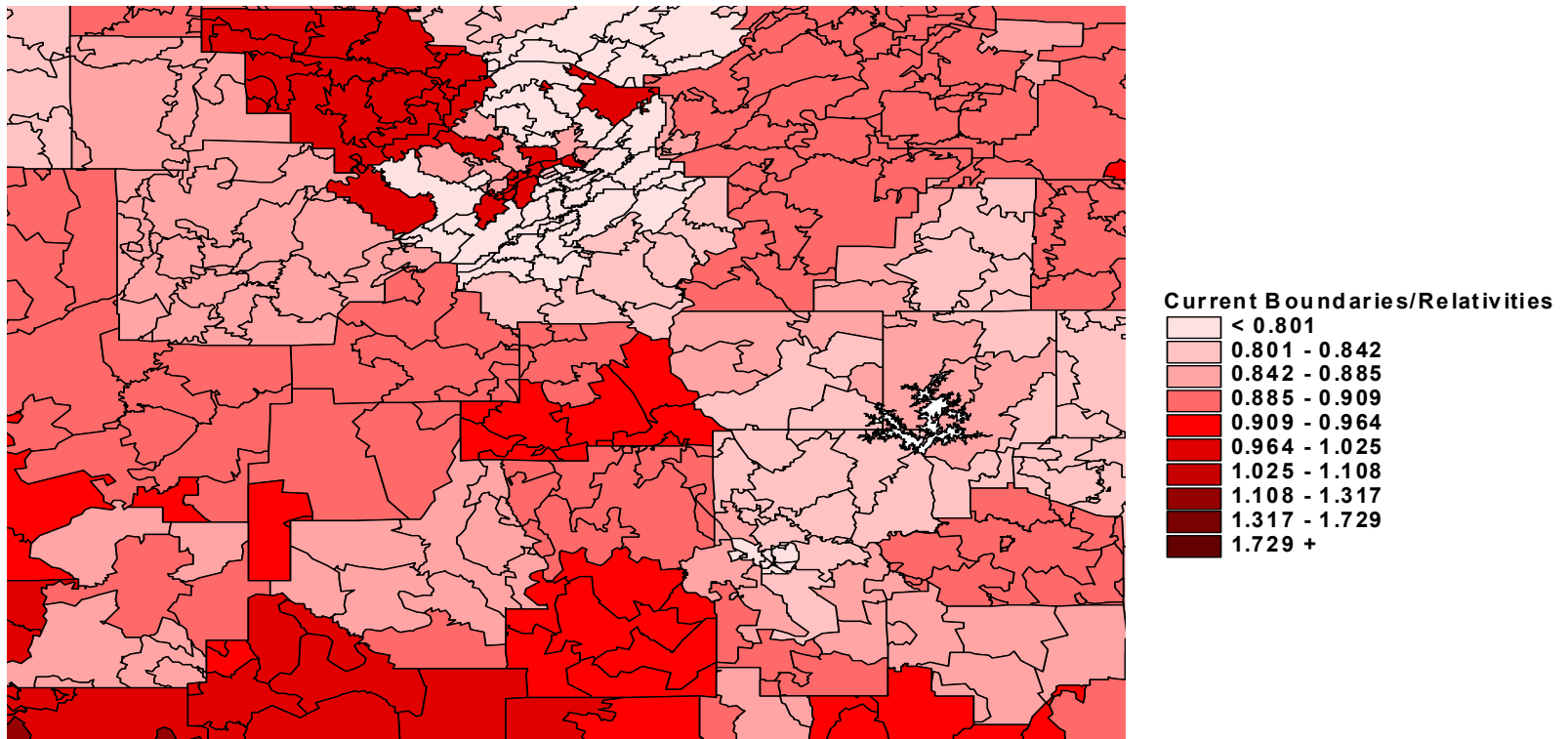## Example: Indicated Boundaries/Relativities

Indicated relativities by county/zip normalized using current distribution

Indicated Boundaries/Relativities

- < 0.801
- 0.801 - 0.842
- 0.842 - 0.885
- 0.885 - 0.909
- 0.909 - 0.964
- 0.964 - 1.025
- 1.025 - 1.108
- 1.108 - 1.317
- 1.317 - 1.729
- 1.729 +

ISSUE: Incorporation of Business Concepts
Example: Current Boundaries/Relativities

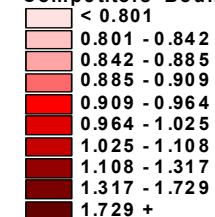**Current relativities by county/zip normalized using current distribution**

Current Boundaries/Relativities
- < 0.801
- 0.801 - 0.842
- 0.842 - 0.885
- 0.885 - 0.909
- 0.909 - 0.964
- 0.964 - 1.025
- 1.025 - 1.108
- 1.108 - 1.317
- 1.317 - 1.729
- 1.729 +

ISSUE: Incorporation of Business Concepts
Example: Competitor's Boundaries/Relativities

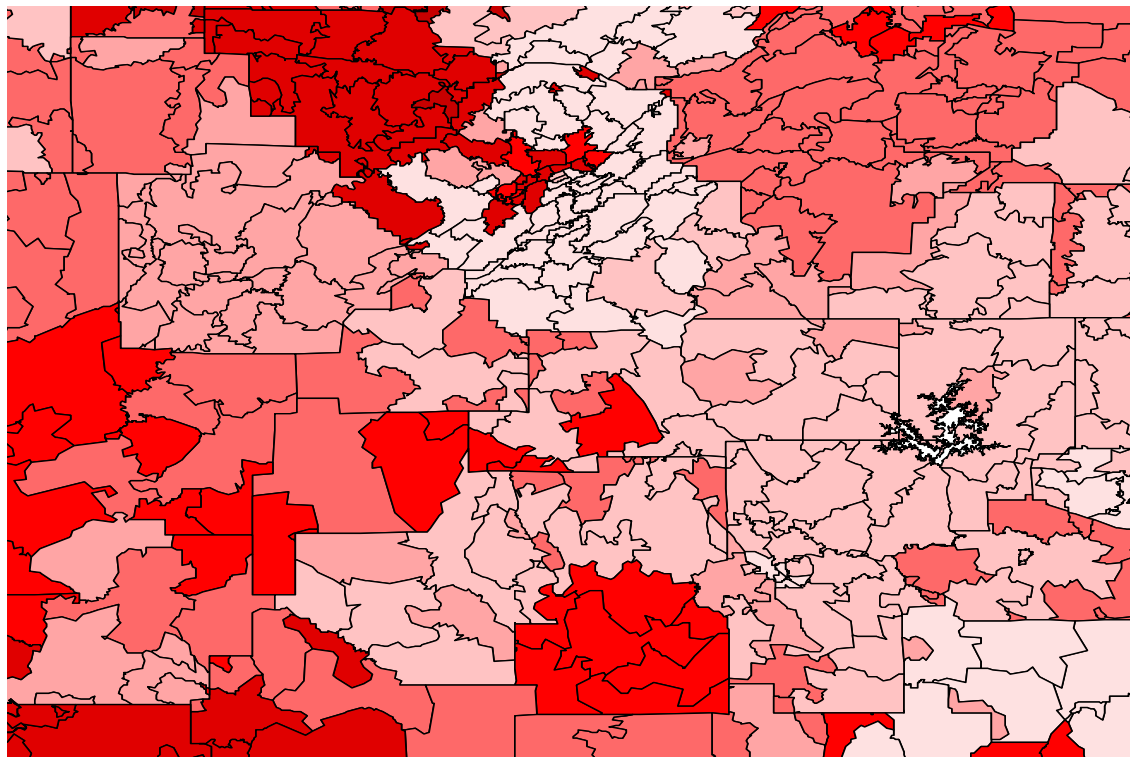**Average competitor relativities normalized using current distribution**
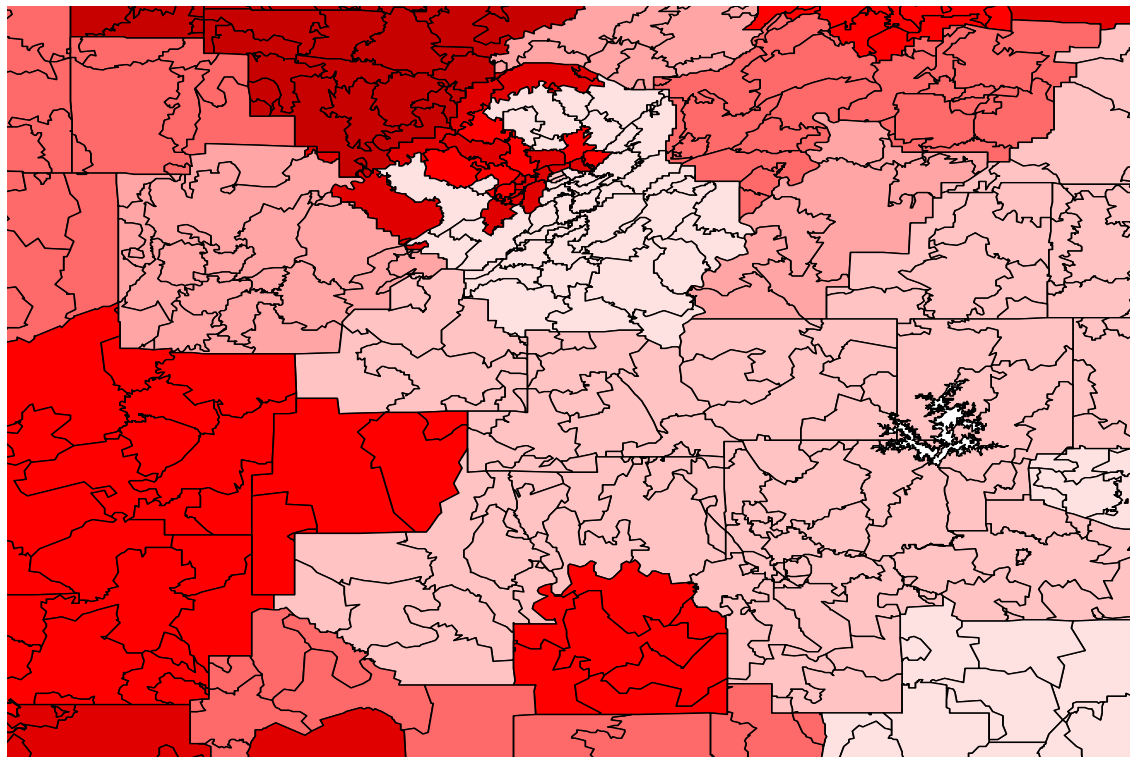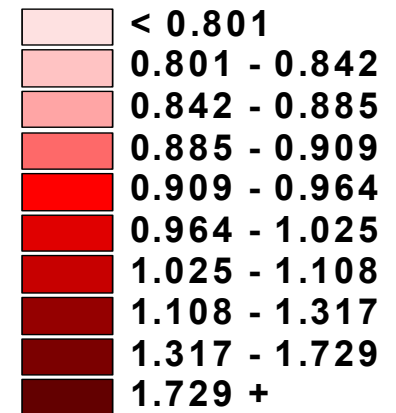

Competitors' Boundaries/Relativities
- < 0.801
- 0.801 - 0.842
- 0.842 - 0.885
- 0.885 - 0.909
- 0.909 - 0.964
- 0.964 - 1.025
- 1.025 - 1.108
- 1.108 - 1.317
- 1.317 - 1.729
- 1.729 +

ISSUE: Incorporation of Business Concepts
Example: Median Relativities by County/Zip

**Median of current, competitor, indicated relativity selected for each county/zip**

Median Relativities
- < 0.801
- 0.801 - 0.842
- 0.842 - 0.885
- 0.885 - 0.909
- 0.909 - 0.964
- 0.964 - 1.025
- 1.025 - 1.108
- 1.108 - 1.317
- 1.317 - 1.729
- 1.729 +

ISSUE: Incorporation of Business Concepts
Example: Initial Boundaries/Relativities by County/Zip

Median relativities clustered and re-weighted to form <u>initial</u> boundaries/relativities
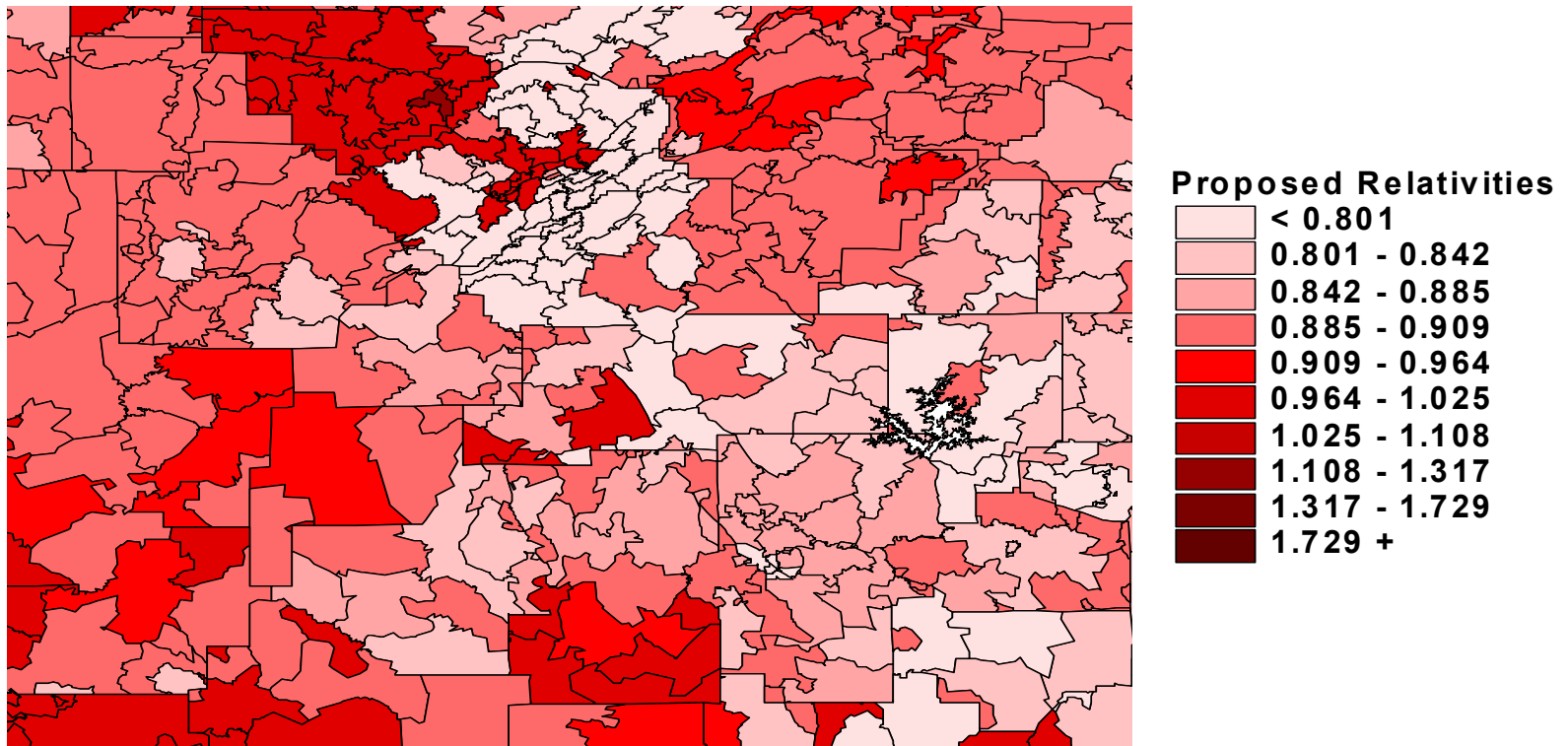
Practical Issues

- Use of CW and state data
- Subsidization
- Incorporation of business concepts
- **Diagnostic tools**
- Regulatory approval
- Zip code changes

ISSUE: Diagnostic Tools

Step 6: Judgmentally select <u>final</u> territorial boundaries and relativities

- The <u>initial</u> boundaries and relativities produced by the procedure are a starting point. The Actuary should review them and make appropriate judgmental adjustments

- Information can be put into mapping software and charts to help expedite analysis:
  - Renewal impacts
  - Current and Proposed Equity Position
  - Current and Proposed Competitive Position

ISSUE: Diagnostic Tools
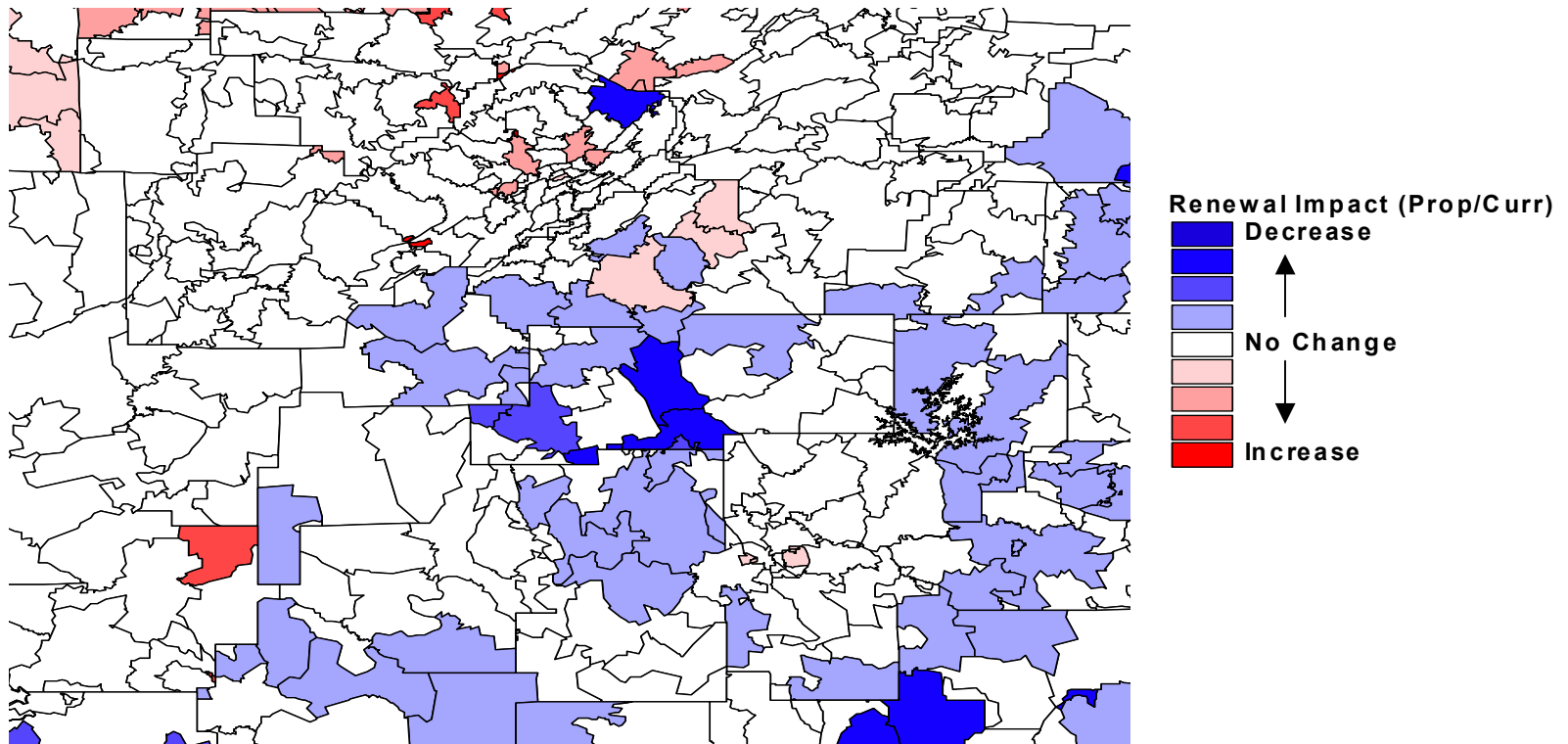## Renewal Impact of Initial Boundaries/Relativities

Highlights number of insureds receiving a particular change if the <u>initial</u> boundaries/relativities are implemented without adjustment
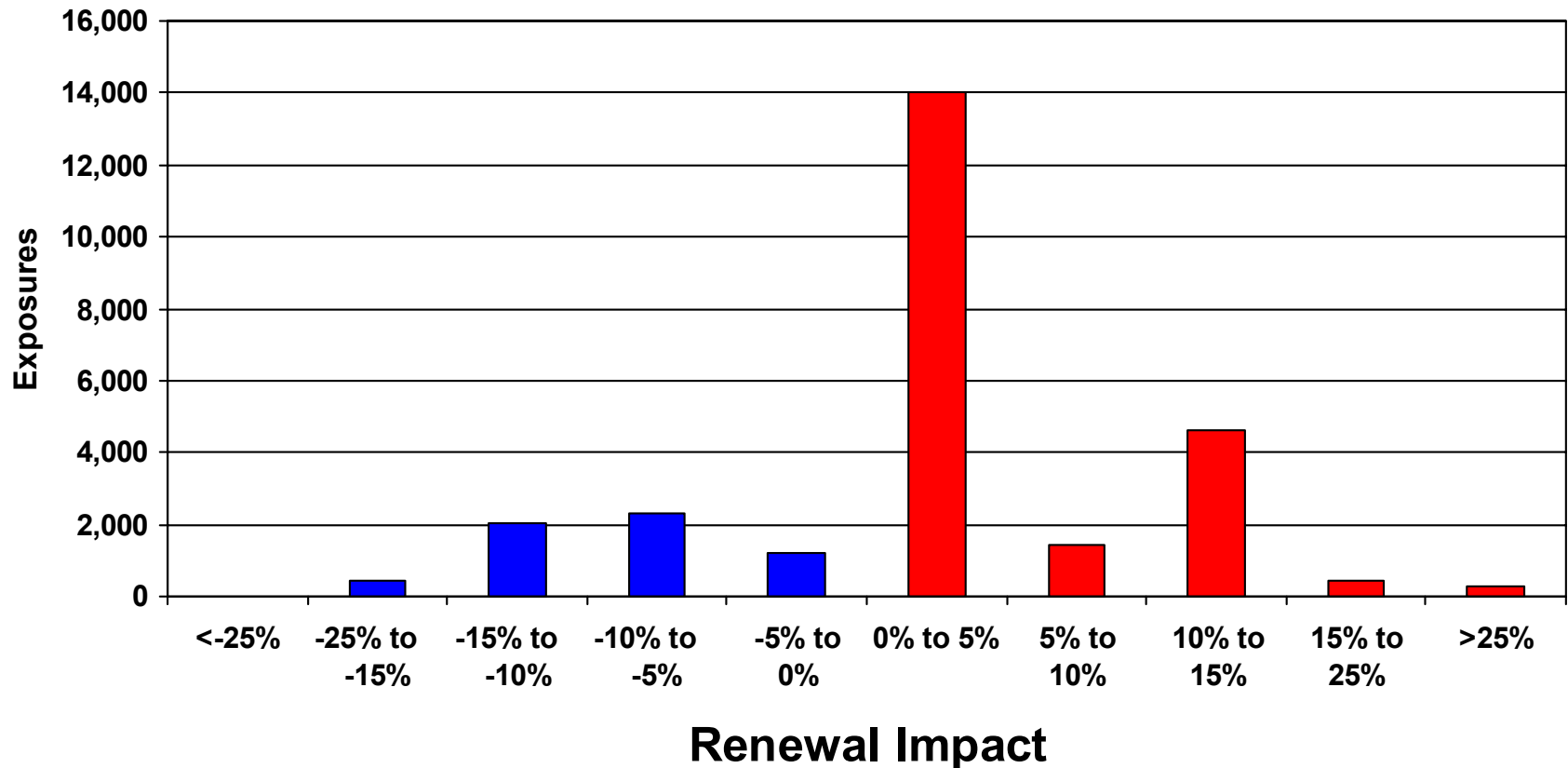
ISSUE: Diagnostic Tools
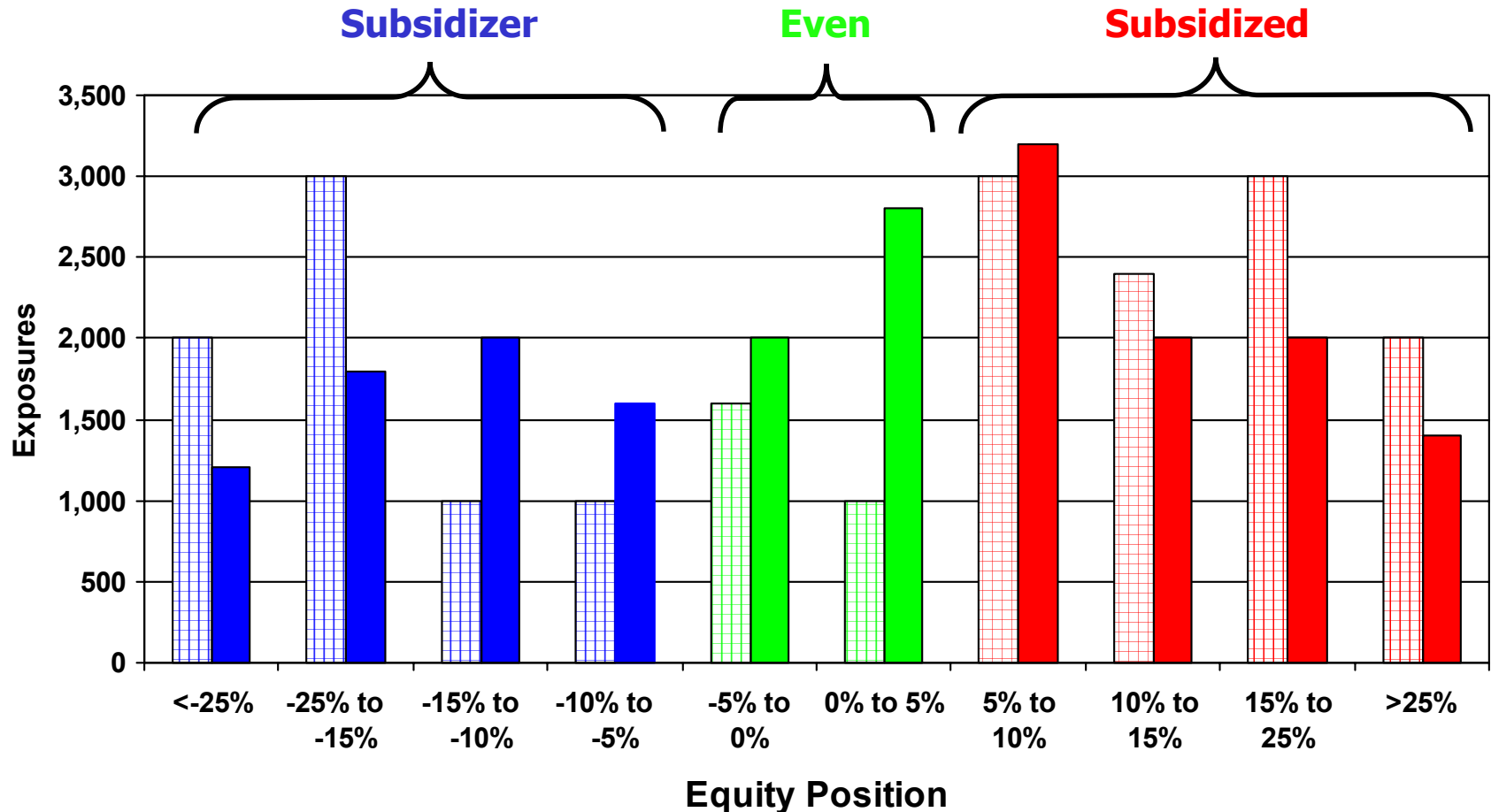## Renewal Impact of Initial Boundaries/Relativities

Highlights geographic areas receiving large changes if the <u>initial</u> boundaries/relativities are implemented without adjustment

ISSUE: Diagnostic Tools
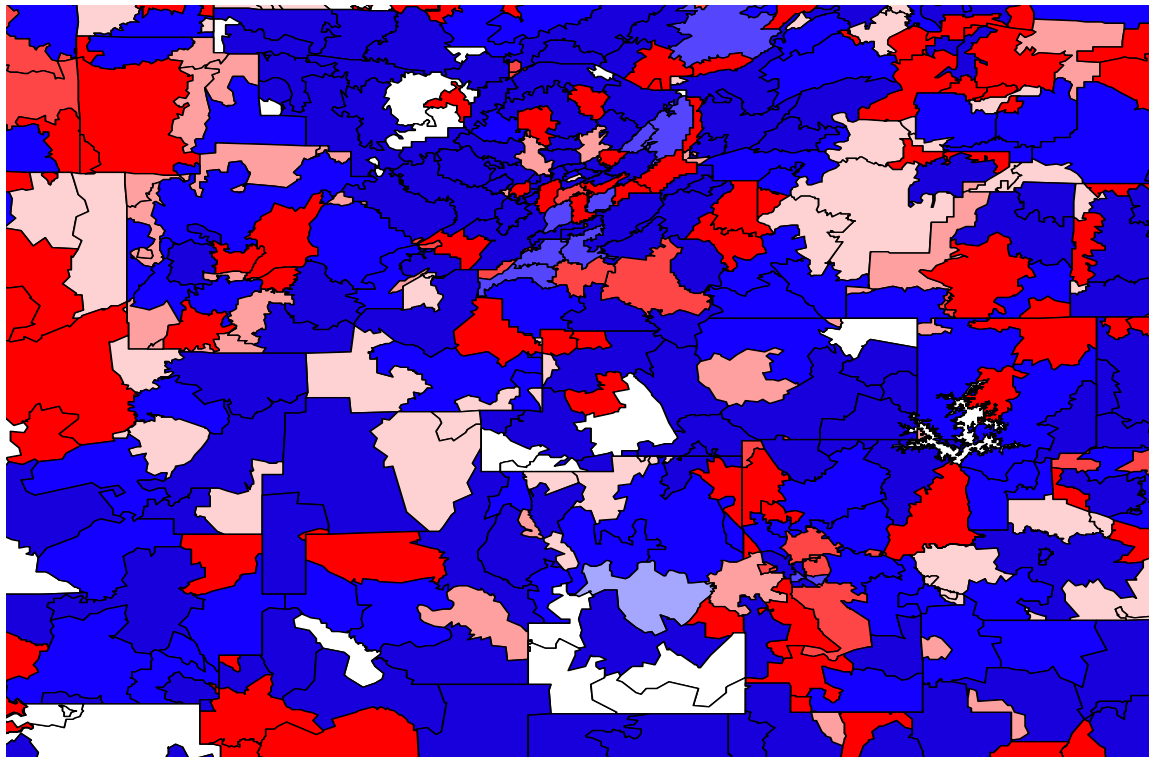## Overall Change in Equity Position

Depicts whether <u>initial</u> boundaries/relativities improve the equity situation overall

ISSUE: Diagnostic Tools
Current Equity Position

**Highlights geographic areas where there are equity mismatches today**

Current Subsidy Position (Indicated/Current)
- Subsidizer
- Even
- Subsidized

ISSUE: Diagnostic Tools
Equity Position of Initial Boundaries/Relativities

Highlights geographic areas where there will be equity mismatches, if the <u>initial</u> boundaries/relativities are implemented without adjustment
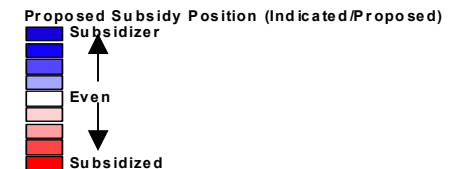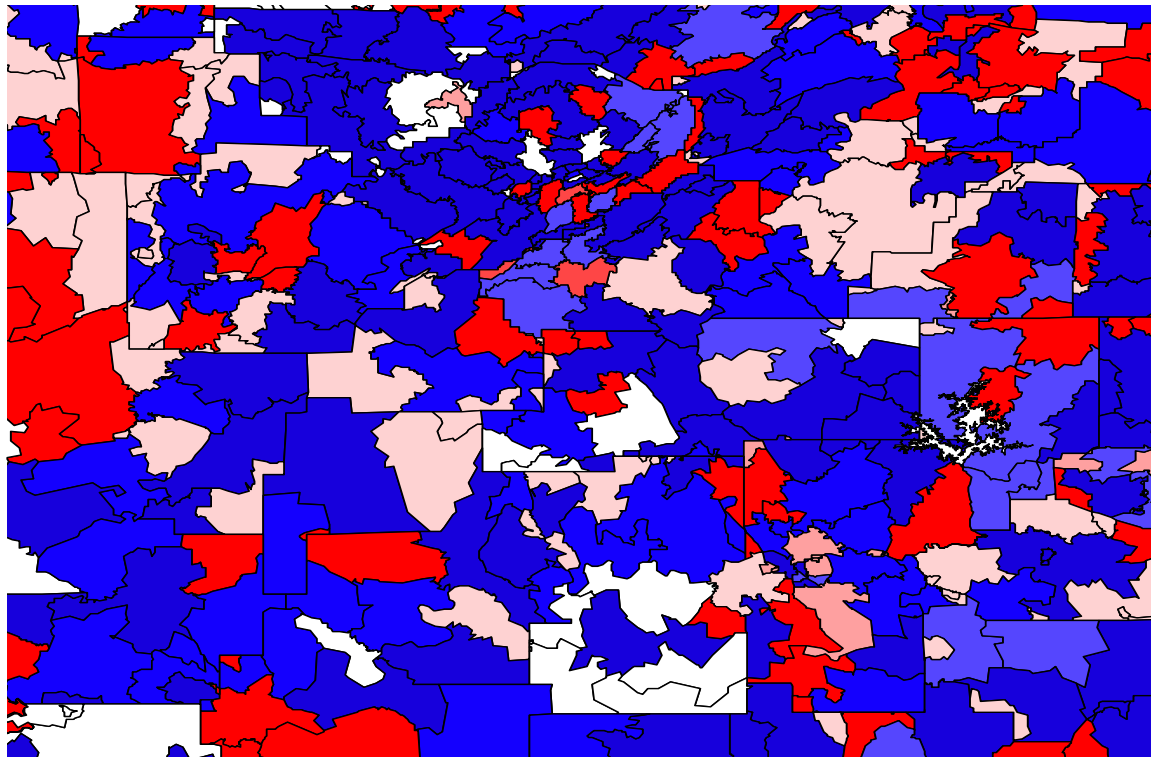
ISSUE: Diagnostic Tools
Equity Position Change Analysis

Quickly identifies the impact of the <u>initial</u> boundaries/relativities on the equity position for each area

	Change	Equity Position Under Initial Boundaries/Relativities*
Green	Any change	Moved toward Even
Yellow	Increase	Moved away from Even (Subsidizer)
Orange	Small Decrease	Moved away from Even (Subsidized)
Red	Large Decrease	Moved away from Even (Subsidized)
White	None	--

*Company must determine thresholds for "Even"

ISSUE: Diagnostic Tools
Equity Position Change Analysis

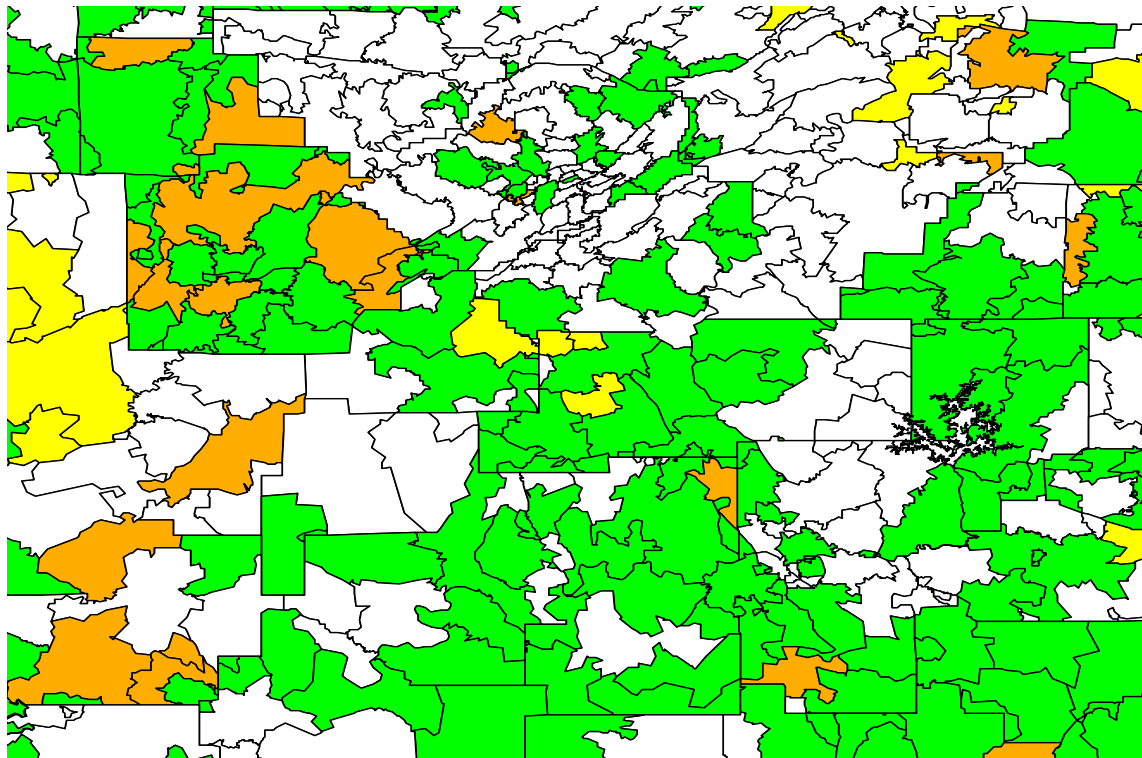**Quickly identifies the impact of the <u>initial</u> boundaries/relativities on the equity position for each area**

Subsidy Change Analysis
- green
- white
- yellow
- orange
- red

ISSUE: Diagnostic Tools
Competitive Analysis

- Similar charts/maps should be used for competitive analysis

  - Histogram of Current and "Proposed" Competitive Position by Range
    (Current and Initial Boundaries/Relativities)

  - Map of Current Competitive Position
    (Competitor rel/Current rel-1.00)

  - Map of Competitive Position assuming Initial Boundaries/Relativities
    (Competitor rel/Initial rel-1.00)

  - Map of Changes in Competitive Position
    (Green, Yellow, Orange, Red, White)

- Note, charts should be reviewed with and without base rate advantage

Practical Issues

- Use of CW and state data
- Subsidization
- Incorporation of business concepts
- Diagnostic tools
- **Regulatory approval**
- Zip code changes

ISSUE: Regulatory Support

Step 7: Implement <u>final</u> territorial boundaries and relativities

- After decisions are made, the actuary must obtain approval from the state DOI

- Complexity will likely generate some additional questions

- Ultimately, expect regulators will embrace the procedure
    - Multivariate residual approach eliminates some of the biases inherent in the current procedures
    - Smoothing/clustering techniques have been commonly used in personal lines since the mid-90's

Practical Issues

- Use of CW and state data
- Subsidization
- Incorporation of business concepts
- Diagnostic tools
- Regulatory approval
- Zip code changes

ISSUE: Zip Code Changes

Step 7: Implement <u>final</u> territorial boundaries and relativities

- Once approved, the <u>final</u> boundaries definitions and relativities remain in place until the next change

- If boundaries include references to zip codes, filed boundaries can change and cause unintended premium changes

  <u>http://www.casact.org/pubs/forum/99wforum/wf99287.pdf</u>

- Can "fix" boundaries to a zip code map at some point in time and geocode boundaries

Summary

- Described procedure eliminates some of the problems inherent in traditional procedures based on one-way analysis

- Use of countrywide data and diagnostic tools can greatly reduce the time of the reviews

- Multiple issues must be addressed to ensure desired outcome