3.3.0 Overview

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As discussed in Section 3.1, companies that successfully determine and apply equitable rates can profitably insure a broader range of risks, thereby gaining a competitive advantage. Companies that choose not to do so may face adverse selection.

Sections 3.1 and 3.2 then covered both traditional (univariate) and multivariate methods for determining the indicated relativities across levels of specific rating variables. Some rating variables and risk characteristics have unique features that lead actuaries to develop specialized ratemaking procedures.

In this section, we will examine several specialized ratemaking procedures used in pricing the following:

1. Territories
2. Increased limits
3. Deductibles
4. Workers' compensation by size of risk
5. Insurance to value/coinsurance

3.3.1 Territorial Ratemaking

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As a main driver of claims experience, geography is one of the most commonly used and well-established rating variables. Insurers typically define territory rating variables at the zip code level, county level, or census block level. The territorial boundaries and corresponding rate relativities can differ greatly between insurers.

Determining the indicated territorial rate relativities presents the following challenges:

1. Geographic location is often **highly correlated** with other rating variables, making traditional univariate analysis prone to distortions. For instance, high-value homes are frequently concentrated in specific areas.
2. When territories are analyzed as a collection of smaller units, the data within each territory becomes **limited**. This high-dimensionality requires special multivariate techniques to effectively address the issue.

Territorial ratemaking typically consists of two main phases:

1. Establishing territorial boundaries
2. Determining rate relativities for the territories

Phase 2 can be accomplished using the univariate or multivariate methods covered in the previous sections. Because location often correlates strongly with other variables (e.g., high- or low-value homes are commonly concentrated in specific areas), it is advisable to conduct this analysis using multivariate classification techniques. For instance, new territorial boundaries could be modeled alongside various explanatory variables within a GLM.

In the rest of this subsection, we will focus on Phase 1, which is establishing territorial boundaries.

Establishing Territorial Boundaries

Historically, insurers used few rating territories, often relying on common boundaries defined by third-party entities like ISO or NCCI using industry data. To gain a competitive edge, companies later customized these territories, often based on local operational insights. Today, actuaries refine territorial boundaries with advanced techniques, utilizing both internal and external data sources for more precise analysis.

The first step in establishing territorial boundaries is to **determine the basic geographic unit**. The units should strike a balance between including only risks that are relatively homogeneous

with respect to geographical characteristics and having a sufficient number of observations in most units.
The table below shows some common units along with their advantages and disadvantages.

Unit	Advantage	Disadvantage
Postal/Zip codes	Readily available	Prone to change over time
Counties	Static, readily available	Contain very heterogeneous risks due to their large sizes
Census blocks	Relatively stable over time	Require a process to map insurance policies to census blocks

Then, the second step is to **estimate the geographic risk associated with each unit**. Actual loss data consists of both signal and noise, and the signal is driven by both geographic and non-geographic rating variables. The key here is to isolate the geographic signal within the data. Traditional univariate techniques are not well-suited for this purpose because they fail to differentiate noise from the signal and do not properly adjust for the high correlations between location and other rating variables.

Multivariate methods (e.g., a GLM), on the other hand, are effective in isolating the signal from the noise in the data. The GLMs can be built to incorporate a variety of non-geographic (e.g., age of insured, claim history) and geographic explanatory variables. Geographic explanatory variables include geo-demographic variables (e.g., population density) and geo-physical variables (e.g., average rainfall). While these explanatory variables explain a part of variation in loss experience, there may be unexplained signal in the model residuals. Given geography is a good basis, it is often used to examine the residuals. A predictor variable can be created to account for the geographic signal in the model residuals.

Smoothing

Geographic risk is typically similar for units located near each other.

The ***spatial smoothing*** techniques can be applied to improve the accuracy of estimates by incorporating information from neighboring geographical units. There are two basic spatial smoothing techniques: distance-based and adjacency-based.

1. The ***distance-based*** technique combines data from a primary geographic unit with data from neighboring units, using weights determined by distance from the primary unit. The weights decrease as the distance from the primary unit increases, and this approach is straightforward to understand and implement.

   The disadvantages of this technique include:

- It assumes distance has the same impact on urban and rural risks
- It fails to consider natural or artificial boundaries, like rivers or highways, when determining distance

Due to these limitations, the distance-based technique is **most appropriate for weather-related perils**, where the influence of physical boundaries is less pronounced.

2. The ***adjacency-based*** technique combines data from a primary geographic unit with data from rings of adjacent units, with closer adjacent rings having more weights. The adjacency-based technique outperforms the distance-based technique in accounting for the differences between urban and rural risks and considering physical boundaries. As a result, this technique is **most appropriate for perils driven by socio-demographic characteristics**, such as thefts.

Regardless of the technique used, the actuary should be cautious not to over- or under-smooth. Over-smoothing, such as incorporating unrelated data from a distant area, can obscure the real spatial variation among the risks. Conversely, under-smoothing may result in significant noise remaining in the estimator.

Clustering

Once the geographic estimators are calculated for each unit, the next step is to **group the units into territories** with some ***clustering*** techniques. There are two categories of clustering techniques:

1. ***Quantile methods***: Clusters are created based on equal numbers of observations or weights.

2. ***Similarity methods***: Clusters are created based on the closeness of the estimators. Similarity methods can be subdivided into the following:

    - The average linkage similarity method tends to join clusters with lower variances.
    - The centroid similarity method tends to be more responsive to outliers.
    - Ward's clustering method tends to produce clusters with equal numbers of observations.

It’s important to note that these clustering methods do not inherently create contiguous groupings, meaning they may include non-adjacent geographic units within the same group. Therefore, a contiguity constraint has to be added if contiguous territorial boundaries are desired.

Geographic risk tends to vary gradually unless there is a natural or artificial boundary. However, distinct boundaries can create abrupt risk differences. Too few clusters may lead to large, undesirable jumps in estimated risk between adjacent clusters, so the actuary should choose a cluster count that minimizes noise without causing sharp discontinuities.

Many companies now avoid traditional territorial groupings, instead calculating rate relativities for each geographic unit individually. This approach, effectively creating numerous small territories, helps smooth transitions between units. By geo-coding each risk and using its latitude and longitude to determine rate relativity, companies achieve gradual rate changes across locations rather than defined territory boundaries.