  - Duration bin
  - Numeric duration for durations between 2 and 16 hours
  - Whether there was a warning
  - Day type
  - An indicator for a momentary outage at 7 a.m. or 7 p.m.
  - An indicator for a 1 hour outage at 7 a.m. or 7 p.m.
  - An indicator for a 2-16 hour outage at 7 p.m.
- Predictors for positive costs
  - Duration bin
  - Numeric duration for durations between 2 and 16 hours
  - Whether there was a warning

The VOLL is given by:

$$\text{VOLL}^{C}(X_{ij}, Z_{ij}) \quad \Pr\left(C > 0 \mid X_{ij}; \delta_0(Z_{0i})\right) \times F\left(C \mid C > 0, X; \delta_{\mid}\left(Z_{\mid i}\right), \sigma(Z_{\sigma i})\right). \tag{5}$$

As with the residential case, this formulation makes the relationship between the VOLL and the characteristics of both the outage and the customer explicit.

3. POST-STRATIFICATION

In the preceding sections, we derived residential and C&I VOLL values that are a function of outage characteristics and customer characteristics. To calculate the overall VOLL for each customer class, we take an average over the distribution of characteristics in the customer class, yielding a VOLL only as a function of outage characteristics. This approach is called *post-stratification* weighting.

Because the re-weighting occurs at the end (*post*-stratification), rather than during estimation, we avoid the possibility that any given respondent has excessive influence over the model. The modeling approaches used to estimate the customer-level VOLLs above smooth over respondent differences and the weights applied below reflect the actual frequency of each group in the population. In this way, post-stratification yields more stable results than approaches that re-weight observations during model estimation.

Residential. The demographics that we consider for residential customers include:

- Whether the customer's income is above or below the statewide median
- Whether the customer's annual usage is above or below the ERCOT Region median for residential customers
- Whether the customer is located in a rural or urban county (defined as having a Rural-Urban Classification Code of 3 or lower)

We use US Census data to ascertain how many households fall into each combination of these categories.

Note that the VOLL is also a function of whether the customer has health needs that require electricity and whether the customer works from home daily. Because these attributes are not available in the Census data, we calculate the share of customers that have each of these characteristics according to our survey responses within each combination of the characteristics in the list above. When multiplied together, this provides population shares for each attribute.

C&I. The characteristics used for commercial customers include:

- Employee count (less than 5, 5-19, 20-49, 50-249, 250+)
- Sector
- Whether the customer is located in a rural or urban county

We begin by assuming that the other characteristics not available in the County Business Pattern data (availability of backup power, critical load designation, customer class, and transmission connection status) are distributed within these categories as observed in the survey response data. Because we have an ERCOT Region share of customers that are transmission connected, we perform a three-iteration raking procedure to re-weight large transmission-connected customers so as to better align the share of these customers implied by our sample with that found in the CBCI data.

VOLL. Given a characteristic set d and population weight for that set w_d, the VOLL becomes a weighted average for each customer class.

$$\text{VOLL}(X) = \sum_d w_d \text{VOLL}(X, Z_d).$$