State-level Food Waste Policies In the U.S.: A Predictive Modelling

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Purpose/Objective

The purpose of the initial stage of this research is to predict the relationship between rigidity of the food waste policies and demographic, political, economic, food safety, and environmental factors at state level.

Research questions include:
- Which policy category (prevention, recycling, recovery, and/or all) has the best performance in predicting regulatory stringency in food waste policies across states?
- Which model has the best performance metrics in predicting regulatory stringency in food waste policies across states?
- Which variables have the highest importance in predicting regulatory stringency in food waste policies across states?

Methodology

Generalized Linear Model Elastic Net (GLMNET) is a type of regularized linear regression model that incorporates tuning parameters for variable selection and shrinkage. The paper compares 5 levels of k-fold cross validation models to select the best model with optimal performance metrics. Too high penalty levels lead to simple model and underfitting.

\[
\sum_{i=1}^{n} \left( y_i - \hat{y}_i \right)^2 + \lambda \left[ \frac{1}{2} \alpha \sum_{j=1}^{p} \beta_j^2 + \alpha \sum_{j=1}^{p} \beta_j \right]
\]

- Alpha: convexity (0.0 - 1.0)
- Lambda: degree of penalty (0.0 - 1.0)

Model Selection
- Prevention, recovery, recycling, all categories
- 5, 10, LOOCV k-fold, repeated 10x

Findings

Figure 9. The R2 and RMSE Results of the k-Fold Methods in Predicting State-level Food Waste Policies

<table>
<thead>
<tr>
<th>K-Fold</th>
<th>All</th>
<th>Prevention</th>
<th>Recovery</th>
<th>Recycling</th>
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<tbody>
<tr>
<td>R2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M0</td>
<td>0.819 (0.821)</td>
<td>0.812 (0.820)</td>
<td>0.743 (0.752)</td>
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<td>M1</td>
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<td>M2</td>
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<tr>
<td>M3</td>
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- M0: k=10-fold, M1: LOOCV (50 k-fold), M2: 5 k-fold
- Policy categories are denoted as i, for i = 1, 2, 3, and 4, which respectively represent sum of all categories, prevention, recovery, and recycling policy categories

Model Selection
- Prevention, recovery, recycling, all categories
- 5, 10, LOOCV k-fold, repeated 10x

Performance metrics, iteration 100x [3,4,6]
- RMSE
- R-square

Wilcoxon Sum Rank Test [8,9,10]
- Non-parametric version of the two-sample t-test
- Ordinal level
- Normal distribution not required

Hypothesis 1: \( M_0 \leq M_3 \)
Hypothesis 2: \( M_3 = M_0 \)
Hypothesis 3: \( M_3 > M_0 \)

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Significant difference between performances of two models if \( p < 0.05 \) [8,9,10].

Findings

Figure 10. Distribution of RMSE Results in Predicting State-level Food Waste Policies

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Results

Figure 11. Polynomial Relative Importance of Variables Extracted from M0, M1, and M2

- Higher environmental score
- Higher financial constraint to state finances
- Higher salary per employee
- Higher total salary and larger size opportunities for innovation
- Opportunity for investing
- Less food waste
- Food education
- Additional state level food waste policies
- Higher African American population
- Foodborne illness concerns
- Stricter food standardization and food label regulations
- The perception of state government is parallel to the perception consumers
- Food education that drive consumers to throw away food
- Nutritional knowledge is a good proxy for foodborne (bacterial)
- Businesses hesitant to donate food due to liability concerns

Figure 12. Polynomial Relative Importance of Variables Extracted from M0, M1, and M2

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