

Supplementary Material for:
**Carbon Mitigation Costs for the Commercial Building Sector:
Discrete-Continuous Choice Analysis of Multifuel Energy Demand**

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Choice of weights for prediction

As we shift from predictions of *log* energy demand (the form in our model in (5)) to *level* energy demand we are confronted with two issues. The first issue is that mean-zero predictions of log energy demand do not translate into mean-zero predictions of level energy demand because exponentiation is a nonlinear function and nonlinear functions generally do not preserve expectations. Mathematically, we have

$$E[y] = E[\hat{y} + e] = \hat{y}$$

where y is the true log energy demand, \hat{y} is the predicted value in logs, and e is the prediction error. But,

$$E[\exp y] = E[\exp(\hat{y} + e)] = \exp \hat{y} \cdot E[\exp e] \neq \exp \hat{y}$$

because $E[\exp e] \neq 1$. Assuming a normal distribution for e , one can compute

$E[\exp e] = \exp \hat{\sigma}^2 / 2$ where $\hat{\sigma}^2 = \frac{1}{n} \sum e_i^2$ is the estimated variance of e based on observed residuals e_i (see Goldberger, A.S. 1968. The Interpretation and Estimation of Cobb-Douglas Functions *Econometrica* 35(3-4): 464–72.).

The second issue is that we want our aggregate prediction at observed prices to match actual aggregate energy use when the individual predictions are aggregated using sampling weights provided with the data. These weights indicate how many buildings each observation represents in the population; individual observations must be aggregated using these weights in order to generate aggregate U.S.-level energy estimates.

We therefore take a slightly different approach so that our aggregate prediction matches at observed prices matches actual aggregate energy use. In other words, we want to construct an estimate of $E[\exp e]$ such that

$$\sum_i w_i \cdot E[\exp e] \exp \hat{y}_i = \sum_i w_i \exp y_i,$$

where again y_i are the true log energy demands (for the observed data), \hat{y}_i are the predicted log energy demands, and w_i are the sampling weights. The following consistent estimator of $E[\exp e]$ satisfies the above condition:

$$E'[\exp e] = \frac{\sum_i w_i \exp \hat{y}_i \cdot \exp e_i}{\sum_i w_i \exp \hat{y}_i},$$

which, in effect, weights using both the sample weights and the predicted level of energy use.¹

Once we calculate our estimate of $E'[\exp e]$, we scale up all of our predictions ($\exp \hat{y}$) of levelized fuel demand by this value for each end use, fuel combination, and fuel. We compute estimates of expenditure by multiplying by price. The advantage of this approach is that we maintain the benchmark prediction of aggregate energy demand using the estimated sample when the sample is aggregated.

Once we have computed the levelized (unlogged) fuel use and expenditure predictions for each observation, end use, fuel combination, and fuel, we aggregate by computing

$$\sum_{i,j,k} w_i \hat{p}_{i,j,k} \exp \hat{y}_{i,j,k,l} E'[\exp e_{i,j,k,l} | j, k, l],$$

where w_i is the sampling weight for observation i , $\hat{p}_{i,j,k}$ is the probability of the k th fuel combination, for the j th end use, and observation i , $\hat{y}_{i,j,k,l}$ is predicted log fuel demand for observation i , end use j , fuel combination k , and fuel l , and $e_{i,j,k,l}$ is similarly the error in the prediction of log fuel demand for observation i , end use j , fuel combination k , and fuel l . This delivers estimates of aggregate fuel demand for fuel l across all commercial buildings for both the benchmark and the simulated price changes. Note that alternatively, we can also compute

$$\sum_{i,j,k} w_i 1(k = Z_{i,j}) \exp \hat{y}_{i,j,k,l} E'[\exp e_{i,j,k,l} | j, k, l],$$

where k indicates a particular fuel choice combination, and $Z_{i,j}$ is the observed fuel combination choice for observation i and end use j . This represents the predicted energy demand holding the choice of fuel combination fixed. Based on our weighting to compute $E[\exp e]$, we would exactly match the benchmark aggregate fuel use estimates for the sample *except* we do not predict energy demand for certain fuel choice combinations that are observed in the sample (see footnotes 9 and 10).

¹ Note that any weighted average of observed values of e_i would provide a consistent estimate of $E[\exp(e)]$.

Table A1: Fuel Choice Parameter Estimates for Heating End Use

| <i>Variable</i> | <i>Electricity</i> | <i>Natural gas</i> | <i>Fuel oil</i> | <i>District heat</i> | <i>Electricity and natural gas</i> | <i>Natural gas and fuel oil</i> | <i>Electricity and district heat</i> | <i>Electricity and fuel oil</i> |
|------------------------------|--------------------|--------------------|-----------------|----------------------|------------------------------------|---------------------------------|--------------------------------------|---------------------------------|
| Electricity | -0.899** | | | | -0.396** | | -1.152** | -1.045* |
| Natural gas | | -1.662** | | | -0.747** | -1.297** | | |
| Fuel oil | | | -5.687** | | | -3.745** | | -3.539** |
| District heat | | | | -2.195** | | | -1.982** | |
| Electricity ² | -0.382 | | | | -0.461 | | 0.760 | -2.616 |
| Natural gas ² | | -0.325 | | | 0.368 | -1.196 | | |
| Fuel oil ² | | | -7.127** | | | -5.122 | | -1.753 |
| District heat ² | | | | -2.131** | | | -1.257** | |
| Electricity*size | 0.045 | | | | 0.200** | | -0.053 | -0.463* |
| Natural gas*size | | -0.152** | | | -0.154* | -0.670** | | |
| Fuel oil*size | | | -1.670** | | | -0.732* | | -0.963** |
| District heat*size | | | | 0.250 | | | 0.375 | |
| Heating deg days | -0.167** | 0.099** | 0.150** | 0.212** | 0.130** | 0.464** | 0.024 | 0.057 |
| Cooling deg days | 0.170** | 0.006 | -0.136** | 0.113* | -0.018 | -0.151** | 0.118 | -0.222** |
| Hours open | 0.197** | 0.231** | 0.263* | 0.083 | 0.313** | 1.055** | -0.341 | 0.335 |
| Owner occupied | -0.639** | -0.355** | 0.233 | 0.133 | -0.249 | -0.239 | -0.367 | -0.361 |
| Ln(sq. footage) | 0.100 | -0.057 | -0.485** | 0.570** | 0.253** | 0.287* | 0.778** | -0.079 |
| Ln(sq. footage) ² | -0.038** | -0.083** | -0.099** | -0.070 | -0.073** | -0.121** | -0.088 | -0.068 |
| >20 years old | -0.752** | 0.100 | 0.380 | 0.820** | 0.055 | 0.802** | 0.412 | -0.406 |
| >40 years old | 0.075 | 0.439** | 0.870** | 0.259 | 0.424** | 0.236 | 0.776 | 1.152** |
| >60 years old | 0.056 | 0.105 | -0.420 | 0.590 | 0.286 | 0.051 | 0.680 | -0.808 |
| >80 years old | 0.034 | 0.519 | 0.962** | 1.190 | 0.410 | 1.600** | 0.123 | 0.870 |
| MSA | 0.665** | 1.051** | -0.008 | 2.240** | 0.922** | 1.661** | 2.223** | -0.581** |
| Government own | -0.359* | -0.066 | -0.032 | 0.821** | -0.326 | 0.309 | 0.151 | 0.106 |
| North census | -0.446* | -0.278 | 3.086** | 0.793* | -0.895** | 1.869** | 0.790 | 2.125** |
| South census | -0.196 | -0.567** | 1.515** | -0.776** | -0.634** | 1.439** | -0.795* | 0.679 |
| Midwest census | -0.669** | -0.268 | 0.115 | 0.554 | -0.361* | 0.813 | 0.630 | -1.345* |
| Central phys plant | -0.921** | -0.651** | -0.095 | 2.529** | -1.000** | -0.267 | 1.117** | -0.157 |
| Multi-building | -0.546** | -0.702** | -1.143** | -0.538 | -0.718** | -1.121** | -0.054 | -0.644** |
| Restaurant | -1.313** | -1.007** | -1.692** | -2.189* | -1.592** | -0.810 | [31.424] | -1.585* |
| Warehouse | -2.961** | -1.903** | -3.379** | -3.599** | -1.973** | -2.918** | -4.916** | -2.880** |
| Foodstore | -1.238** | -0.732* | -2.557** | -0.627 | -1.582** | [30.853] | [-30.535] | -1.426 |
| Hospital | -1.937** | -0.339 | 0.070 | -0.909 | -0.394 | 0.391 | -0.461 | -0.892 |
| Vacant | -3.986** | -3.349** | -3.218** | -4.594** | -3.855** | -3.139** | -5.333** | -3.757** |
| Public services | -0.512** | 0.164 | 0.214 | -0.797* | 0.096 | -0.404 | -1.335** | -0.379 |
| Lodging | 0.108 | -0.954** | -1.496** | -0.200 | -0.076 | -0.589 | -1.413 | -0.533 |
| Retail services | -1.168** | -0.629** | -0.883** | -4.006** | -0.722** | -1.399** | -3.804** | -1.270** |
| Constant | 3.055** | 1.137** | -3.684** | -2.034 | 0.371 | -10.033** | 1.077 | -0.845 |

Asterisks denote statistical significance at various levels: ** = 95%, * = 90%. Brackets indicate building categories where all (for a positive coefficient) or none (for a negative coefficient) of the given category chose a particular fuel option; this leads to large coefficients with high standard errors.

Table A2: Fuel Choice Demand Estimates for Heating End Use

| Variable | | | | | Electricity and Natural Gas | | Natural Gas and Fuel Oil | | Electricity and District Heat | | Electricity and Fuel Oil | |
|------------------------------|-------------|-------------|----------|---------------|-----------------------------|-------------|--------------------------|----------|-------------------------------|---------------|--------------------------|----------|
| | Electricity | Natural gas | Fuel oil | District heat | Electricity | Natural gas | Natural gas | Fuel Oil | Electricity | District heat | Electricity | Fuel oil |
| Electricity | -1.370** | | | | -1.688** | -0.426** | | | -0.908* | 0.152 | -1.443** | 1.082 |
| Natural gas | | -1.786** | | | -0.271 | -2.121** | -2.069** | -0.010 | | | | |
| Fuel oil | | | -2.072** | | | | 1.876 | -2.827** | | | 1.085 | -4.213** |
| District heat | | | | -0.308* | | | | | 0.050 | -0.902** | | |
| Ln(probability) | -0.167 | 0.138 | 0.144 | -0.162* | -0.019 | -0.038 | 0.161 | -0.136 | 0.243 | 0.017 | 0.308 | 0.275 |
| Heating deg days | 0.047 | 0.153** | 0.184** | 0.394** | 0.040 | 0.172** | 0.297 | 0.197 | 0.255 | 0.445** | 0.055 | -0.092 |
| Cooling deg days | -0.040 | -0.108** | -0.044 | -0.080** | -0.086 | -0.138** | -0.232* | 0.110 | -0.262** | -0.125 | -0.134 | 0.000 |
| Hours open | -0.126 | -0.010 | 0.085 | -0.483** | -0.020 | 0.215* | -0.680 | -0.714 | -1.329** | -0.047 | -1.220** | 0.063 |
| Owner occupied | -0.174 | -0.002 | 0.251 | 0.235 | 0.018 | -0.119 | -0.076 | -0.724 | -0.103 | 0.210 | 0.371 | -0.059 |
| Ln(sq. footage) | 0.884** | 0.531** | 0.499** | 0.870** | -0.154 | 0.142** | 0.686** | 0.546** | 0.710** | 0.984** | 1.034** | 0.454* |
| Ln(sq. footage) ² | 0.103** | 0.011 | -0.028 | 0.019 | 0.073 | -0.049** | 0.058 | 0.067 | -0.016 | 0.062 | 0.059 | 0.037 |
| >20 years old | 0.449** | 0.187** | 0.124 | 0.195 | 0.320** | 0.348** | -0.253 | 0.890 | 0.362 | 0.975** | -0.280 | 0.238 |
| >40 years old | -0.244 | 0.000 | 0.016 | -0.032 | -0.030 | -0.107 | 0.391 | 0.051 | -0.103 | 0.022 | 0.231 | 0.117 |
| >60 years old | -0.099 | -0.082 | 0.192 | -0.086 | -0.020 | -0.014 | -0.819 | 0.507 | 0.372 | -0.282 | -1.808** | -1.171 |
| >80 years old | -0.164 | 0.002 | -0.140 | -0.200 | -0.126 | -0.043 | 0.506 | 0.406 | -0.641 | 0.676 | 0.958 | 1.399 |
| North census | 1.311** | 1.214** | -0.007 | 0.989** | 0.257 | 1.555** | 0.477 | -0.723 | 0.977 | 0.877* | 1.181 | -0.369 |
| South census | 0.128 | 0.275** | 0.237 | 0.368* | 0.030 | 0.134 | 0.627 | -1.487 | 0.319 | 0.843 | 1.206* | -0.258 |
| Midwest census | 1.150** | 0.612** | 0.086 | 0.624** | 1.329** | 0.781** | 0.451 | -0.948 | 0.556 | 1.230** | 2.823* | 0.598 |
| Central phys plant | 0.105 | 0.035 | -1.064** | 0.505* | -0.167 | 0.229 | 0.136 | -0.278 | 0.959* | -0.002 | -0.018 | 0.909 |
| Multi-building | 0.111 | 0.055 | 0.310 | -0.111 | 0.622* | 0.171 | 0.024 | 0.656 | -1.147** | 0.335 | 0.062 | -0.643 |
| Restaurant | 0.161 | -0.484** | 0.243 | -0.345 | -0.147 | 0.059 | -1.499 | -1.824 | | | -0.439 | 0.598 |
| Warehouse | -0.028 | -0.138 | -0.226 | 0.109 | -0.014 | 0.285 | -0.782 | 0.319 | -0.971 | -0.752 | -0.528 | 0.719 |
| Foodstore | 0.168 | -0.738** | 1.064 | -0.499 | -0.239 | -1.947** | | | | | 2.433 | -0.699 |
| Hospital | 0.894 | 0.596** | 0.955* | 0.922** | 0.734 | 0.716* | 0.552 | 0.288 | 2.530** | 0.656 | 1.461 | 1.335 |
| Vacant | 0.766 | 0.027 | 0.293 | -0.356 | -0.564 | -0.233 | -2.539** | 0.944 | 0.232 | -1.795 | 0.534 | 0.837 |
| Public services | 1.106** | -0.121 | -0.133 | 0.028 | 1.464** | -0.128 | -1.492** | 0.172 | 0.107 | -0.134 | -0.032 | 0.515 |
| Lodging | 0.459** | -1.187** | -1.646** | 0.157 | 0.954* | -1.139** | 0.208 | 0.028 | 1.156 | 0.496 | 1.343 | 0.139 |
| Retail services | 0.740** | -0.129 | 0.126 | 0.003 | 0.762** | -0.470** | -0.420 | -0.912 | -1.038 | 0.667 | -0.552 | 0.380 |
| Constant | 11.275** | 12.904** | 12.095** | 13.103** | 2.796 | 11.076** | 16.590** | 14.099** | 16.131** | 10.122** | 17.379** | 13.612** |

Asterisks denote statistical significance at various levels: ** = 95%, * = 90%.

Table A3: Fuel Choice Parameter Estimates for Water Heating End Use

| <i>Variable</i> | <i>Electricity</i> | <i>Natural gas</i> | <i>Fuel oil</i> | <i>District heat</i> | <i>Electricity and natural gas</i> |
|------------------------------|--------------------|--------------------|-----------------|----------------------|------------------------------------|
| Electricity | -0.772** | | | | -0.283 |
| Natural gas | | -1.093** | | | 0.029 |
| Fuel oil | | | -4.927** | | |
| District heat | | | | -1.684** | |
| Electricity ² | -0.302 | | | | -0.912 |
| Natural gas ² | | 0.177 | | | -0.184 |
| Fuel oil ² | | | -6.193* | | |
| District heat ² | | | | -2.130** | |
| Electricity*size | -0.008 | | | | 0.034 |
| Natural gas*size | | -0.088 | | | -0.045 |
| Fuel oil*size | | | -1.031** | | |
| District heat*size | | | | 0.568** | |
| Heating deg days | 0.081** | 0.144** | 0.179** | 0.197** | 0.248** |
| Cooling deg days | 0.028 | 0.005 | -0.124** | 0.007 | 0.060 |
| Hours open | 0.172** | 0.304** | 0.350* | 0.468* | 0.441** |
| Owner occupied | -0.363** | -0.110 | 0.226 | -0.242 | -0.440** |
| Ln(sq. footage) | 0.248** | 0.044 | -0.293 | 0.700** | 0.749** |
| Ln(sq. footage) ² | -0.034** | -0.106** | -0.104** | -0.134** | -0.048* |
| >20 years old | -0.419** | 0.262** | 0.162 | 0.812** | 0.267 |
| >40 years old | 0.011 | 0.014 | 0.280 | -0.406 | 0.158 |
| >60 years old | -0.140 | 0.312 | -0.200 | 0.744* | 0.211 |
| >80 years old | 0.086 | -0.149 | 0.000 | -0.418 | 0.169 |
| MSA | 0.347** | 1.116** | 0.168 | 1.117** | 0.262 |
| Government own | -0.382** | -0.008 | 0.217 | 0.660** | 0.000 |
| North census | 0.184 | -0.765** | 2.395** | -0.143 | -0.929** |
| South census | -0.210 | -0.949** | 0.286 | -1.315** | -0.610** |
| Midwest census | -0.274* | -0.440** | -1.170 | -0.206 | -0.232 |
| Central phys plant | -0.918 | -0.905** | 0.419 | 1.176** | -1.264** |
| Multi-building | -0.492** | -0.743** | -1.630** | -0.604* | -0.039 |
| Restaurant | -0.416 | 0.964** | 0.293 | -0.794 | 1.806** |
| Warehouse | -1.734** | -1.864** | -2.988 | -4.191** | -1.217** |
| Foodstore | 0.096 | 0.866* | 0.080 | 1.057 | 1.489* |
| Hospital | -2.257** | 0.978** | 1.683** | 0.880 | -0.634 |
| Vacant | -2.703** | -2.748** | -3.403** | -2.822** | -2.823** |
| Public services | -0.605** | 0.063 | 0.170 | -0.749** | 0.587** |
| Lodging | -1.532** | 0.208 | -0.113 | 0.080 | 0.194 |
| Retail services | -0.955** | -1.006** | -1.152** | -3.147** | 0.098 |
| Constant | 2.091** | 0.203 | -4.381** | -1.583 | -3.102** |

Asterisks denote statistical significance at various levels: ** = 95%, * = 90%.

Table A4: Fuel Choice Demand Estimates for Water Heating End Use

| <i>Variable</i> | <i>Electricity and Natural Gas</i> | | | | | |
|------------------------------|------------------------------------|--------------------|-----------------|----------------------|--------------------|--------------------|
| | <i>Electricity</i> | <i>Natural gas</i> | <i>Fuel oil</i> | <i>District heat</i> | <i>Electricity</i> | <i>Natural gas</i> |
| Electricity | -1.189** | | | | -1.358** | -0.755** |
| Natural gas | | -1.236** | | | -0.142 | -1.599** |
| Fuel oil | | | -1.458* | | | |
| District heat | | | | -0.406** | | |
| Ln(probability) | -0.469** | 0.085 | -0.055 | -0.080 | 0.101 | -0.138 |
| Heating deg days | 0.035** | 0.059** | 0.054 | 0.140** | -0.147** | -0.049 |
| Cooling deg days | 0.083** | 0.011 | -0.055 | -0.005 | 0.043 | 0.023 |
| Hours open | 0.466** | 0.675** | 0.522** | 0.578** | 0.378** | 0.902** |
| Owner occupied | 0.047 | -0.025 | 0.826** | 0.072 | -0.419* | -0.487* |
| Ln(sq. footage) | 0.868** | 0.922** | 0.930** | 0.839** | 0.809** | 0.946** |
| Ln(sq. footage) ² | 0.075** | 0.055** | 0.115** | 0.001 | 0.107** | 0.026 |
| >20 years old | 0.170** | -0.061 | 0.205 | -0.331** | 0.419** | 0.362 |
| >40 years old | -0.332** | -0.046 | -0.386 | -0.080 | -0.540** | -0.305 |
| >60 years old | -0.136 | -0.147 | -0.106 | 0.147 | 0.079 | 0.030 |
| >80 years old | -0.241 | -0.122 | 0.457 | 0.098 | -0.567 | -0.857 |
| North census | 0.331** | 0.097 | -0.530 | -0.071 | 0.224 | 0.606 |
| South census | -0.133** | -0.037 | -0.166 | -0.016 | -0.329 | -0.180 |
| Midwest census | -0.457** | -0.320** | -1.317 | 0.107 | -0.038 | -0.003 |
| Central phys plant | 0.106 | 0.158 | -0.465 | -0.078 | 0.203 | -0.195 |
| Multi-building | -0.039 | 0.165** | 0.120 | 0.361* | 0.315 | 0.352 |
| Restaurant | 0.972** | 0.394** | 0.657 | 1.047** | 1.870** | 1.907** |
| Warehouse | -0.785** | -1.271** | -1.020 | 0.236 | -1.804** | -1.542** |
| Foodstore | 0.503** | -0.368** | -1.901 | -0.328 | 0.514 | -0.516 |
| Hospital | 1.745** | 0.794** | -0.090 | 0.463** | 2.437 | 0.438 |
| Vacant | -1.068** | -1.213** | 0.258 | 1.265** | -0.745 | -0.858 |
| Public services | 0.890** | -0.006 | -0.482 | 0.258** | 1.210** | 0.221 |
| Lodging | 2.196** | 1.073** | 0.110 | -0.135 | 2.784** | 1.435** |
| Retail services | -0.077 | -0.711** | -0.655 | 0.275 | -0.550 | -0.308 |
| Constant | 7.948** | 10.394** | 11.613** | 11.038** | 10.108** | 8.785** |

Asterisks denote statistical significance at various levels: ** = 95%, * = 90%.

Table A5: Fuel Choice Parameter Estimates for Cooking End Use

| <i>Variable</i> | <i>Electricity</i> | <i>Natural gas</i> | <i>Electricity and natural gas</i> |
|------------------------------|--------------------|--------------------|------------------------------------|
| Electricity | -0.485** | | -0.300 |
| Natural gas | | -0.346* | -0.538** |
| Electricity ² | -0.676 | | -0.890* |
| Natural gas ² | | -0.718** | -0.483 |
| Electricity*size | -0.033 | | -0.063 |
| Natural gas*size | | -0.068 | 0.024 |
| Heating deg days | 0.058 | 0.009 | 0.095** |
| Cooling deg days | -0.022 | 0.064** | 0.044 |
| Hours open | 0.198 | 0.111 | 0.406** |
| Owner occupied | -0.174* | -0.325** | -0.077 |
| Ln(sq. footage) | 0.771** | 0.857** | 1.155** |
| Ln(sq. footage) ² | 0.071** | 0.064** | 0.082** |
| >20 years old | -0.200* | 0.351** | -0.012 |
| >40 years old | -0.250 | 0.125 | 0.158 |
| >60 years old | -0.179 | 0.062 | -0.605* |
| >80 years old | 0.094 | 0.154 | 0.661 |
| MSA | -0.307** | 0.430** | 0.415** |
| Government own | 0.064 | -0.345** | 0.122 |
| North census | 0.175 | -0.203 | -0.294 |
| South census | 0.097 | -0.425** | -0.185 |
| Midwest census | -0.270* | -0.443** | -0.119 |
| Central phys plant | -0.894** | -1.263** | -1.370** |
| Multi-building | -0.447** | -0.318** | -0.067 |
| Restaurant | 3.317** | 4.500** | 6.201** |
| Warehouse | -3.006** | -2.294** | -2.215** |
| Foodstore | 2.187** | 2.387** | 3.268** |
| Hospital | 1.685** | 3.226** | 3.021** |
| Vacant | -1.769** | -1.850** | -1.380* |
| Public services | 1.349** | 2.008** | 2.333** |
| Lodging | 0.238 | 2.140** | 2.194** |
| Retail services | 0.303* | 0.906** | 1.796** |
| Constant | -1.912** | -2.526** | -5.418** |

Asterisks denote statistical significance at various levels: ** = 95%, * = 90%.

Table A6: Fuel Choice Demand Estimates for CK End Use

| <i>Variable</i> | <i>Electricity and Natural Gas</i> | | | |
|------------------------------|------------------------------------|--------------------|--------------------|--------------------|
| | <i>Electricity</i> | <i>Natural gas</i> | <i>Electricity</i> | <i>Natural gas</i> |
| Electricity | -1.072** | | -0.968** | -0.203 |
| Natural gas | | -1.510** | 0.164 | -1.293** |
| Ln(probability) | -0.239 | 0.203 | 0.235 | 0.265 |
| Heating deg days | 0.010 | -0.036 | -0.034 | -0.055 |
| Cooling deg days | 0.051** | 0.091** | 0.040 | 0.045 |
| Hours open | 0.546** | 0.654** | 0.522** | 0.486** |
| Owner occupied | 0.103 | 0.101 | 0.031 | 0.006 |
| Ln(sq. footage) | 1.062** | 0.626** | 0.692** | 0.467** |
| Ln(sq. footage) ² | 0.025* | 0.019 | 0.017 | -0.039** |
| >20 years old | -0.135 | -0.203* | -0.185* | -0.017 |
| >40 years old | -0.196 | -0.342** | -0.293** | -0.235 |
| >60 years old | 0.137 | 0.274 | 0.044 | 0.057 |
| >80 years old | -0.621** | 0.262 | -0.424 | -0.173 |
| North census | 0.080 | 0.141 | 0.091 | 0.276 |
| South census | -0.251** | -0.391** | -0.105 | -0.106 |
| Midwest census | -0.383** | -0.290* | 0.002 | -0.198 |
| Central phys plant | 0.003 | 0.445** | 0.358** | 0.495** |
| Multi-building | -0.073 | -0.049 | -0.182* | -0.178 |
| Restaurant | 3.004** | 1.805** | 1.934** | 0.849 |
| Warehouse | -4.091** | -0.657 | -2.518** | -0.814 |
| Foodstore | 1.609** | 0.985** | 0.522 | -0.621 |
| Hospital | -0.139 | 0.078 | -0.175 | -0.410 |
| Vacant | -3.182** | -0.248 | -3.565** | -0.803 |
| Public services | 0.933** | -0.157 | 0.379 | -1.256** |
| Lodging | 0.906** | 0.153 | 1.096** | -0.659** |
| Retail services | 0.255** | -0.062 | -0.131 | -1.026** |
| Constant | 7.776** | 10.208** | 8.820** | 12.309** |

Asterisks denote statistical significance at various levels: ** = 95%, * = 90%.

Table A7: Fuel Choice Parameter Estimates for Miscellaneous End Use

| <i>Variable</i> | <i>Electricity</i> | <i>Electricity and natural gas</i> | <i>Electricity and fuel oil</i> |
|------------------------------|--------------------|------------------------------------|---------------------------------|
| Electricity | 1.389* | 0.761 | 1.272 |
| Natural gas | | 0.010 | |
| Fuel oil | | | 0.151 |
| Electricity ² | 1.268 | 0.591 | 0.735 |
| Natural gas ² | | 0.482* | |
| Fuel oil ² | | | 0.256 |
| Electricity*size | 0.294 | 0.147 | 0.326 |
| Natural gas*size | | 0.138 | |
| Fuel oil*size | | | 0.433* |
| Heating deg days | -0.013 | 0.021 | 0.018 |
| Cooling deg days | 0.000 | 0.024 | -0.050 |
| Hours open | 0.298** | 0.667** | 0.634** |
| Owner occupied | -0.101 | 0.311 | 0.469 |
| Ln(sq. footage) | 0.141 | 0.364** | 0.963** |
| Ln(sq. footage) ² | -0.082* | -0.136** | -0.121** |
| >20 years old | 0.526* | 0.823** | 0.018 |
| >40 years old | 0.003 | -0.331 | -0.584 |
| >60 years old | -0.180 | 0.024 | -0.052 |
| >80 years old | 0.153 | 0.043 | -0.192 |
| MSA | 0.570** | 0.650** | 0.082 |
| Government own | -0.623* | -0.479 | -0.722* |
| North census | -0.817** | -0.201 | -0.389 |
| South census | 0.080 | -0.066 | 0.448 |
| Midwest census | 0.107 | 0.128 | -0.487 |
| Central phys plant | 0.994* | 1.117* | 0.895 |
| Multi-building | -0.534** | -0.512* | -0.522* |
| Restaurant | 20.613** | [19.218] | 20.456** |
| Warehouse | -2.832** | -3.565* | -4.592** |
| Foodstore | 20.290** | 21.103** | [18.799] |
| Hospital | 15.871** | 17.795** | [16.891] |
| Vacant | -5.015** | -6.065** | -6.044** |
| Public services | 0.431 | 0.111 | -0.539 |
| Lodging | -1.379* | -1.356* | -2.169** |
| Retail services | -0.549 | -0.650 | -2.051** |
| Constant | 4.947** | 0.553 | 2.511** |

Asterisks denote statistical significance at various levels: ** = 95%, * = 90%. Brackets indicate building categories where all (for a positive coefficient) or none (for a negative coefficient) of the given category chose a particular fuel option; this leads to large coefficients with high standard errors.

Table A8: Fuel Choice Demand Estimates for Miscellaneous End Use

| <i>Variable</i> | <i>Electricity and Natural Gas</i> | | | <i>Electricity and Fuel Oil</i> | |
|------------------------------|------------------------------------|--------------------|--------------------|---------------------------------|-----------------|
| | <i>Electricity</i> | <i>Electricity</i> | <i>Natural gas</i> | <i>Electricity</i> | <i>Fuel oil</i> |
| Electricity | -1.034** | -0.815** | -0.925** | -1.064** | -0.120 |
| Natural gas | | 0.031 | -1.886** | | |
| Fuel oil | | | | 0.006 | -2.540** |
| Ln(probability) | -0.086 | -0.009 | -1.787** | 0.034 | -1.140** |
| Heating deg days | 0.022** | -0.001 | 0.093 | 0.005 | 0.004 |
| Cooling deg days | 0.061** | 0.099** | -0.019 | 0.039 | -0.030 |
| Hours open | 0.306** | 0.358** | 1.240** | -0.002 | 0.603** |
| Owner occupied | -0.097** | 0.046 | 0.686** | 0.129 | 0.020 |
| Ln(sq. footage) | 1.014** | 0.914** | 0.690** | 0.878** | 0.885** |
| Ln(sq. footage) ² | 0.014** | -0.061** | -0.107** | -0.053** | -0.058* |
| >20 years old | -0.158** | -0.006 | 0.218 | -0.102 | -0.381* |
| >40 years old | -0.132** | -0.356** | -0.392 | -0.276 | -0.883** |
| >60 years old | -0.055 | 0.046 | 0.438 | -0.028 | 0.297 |
| >80 years old | -0.216** | -0.439 | -0.820* | 0.818* | 0.280 |
| North census | 0.167** | 0.109 | 0.812** | -0.037 | 0.365 |
| South census | -0.248** | -0.160 | -0.401* | -0.166 | 0.032 |
| Midwest census | -0.268** | -0.129 | -0.570** | -0.457** | -0.776** |
| Central phys plant | 0.182** | 0.128 | 0.851** | 0.462** | 0.430** |
| Multi-building | -0.046 | -0.109 | 0.041 | -0.109 | 0.060 |
| Restaurant | 1.165** | 1.384* | -2.323* | 0.902* | -0.889 |
| Warehouse | -0.243** | -0.503* | -0.698* | 0.099 | -1.192** |
| Foodstore | 0.332** | -0.854** | -0.063 | -0.526 | -0.979 |
| Hospital | 0.536** | 0.184 | 1.737** | 0.762** | -0.445 |
| Vacant | -0.103 | -0.419 | -2.245** | 0.995** | -1.644** |
| Public services | -0.792** | -1.430** | -1.154** | -1.050** | -1.003** |
| Lodging | 0.002 | -0.270 | -0.497* | 0.162 | -1.521** |
| Retail services | -0.921** | -0.894** | -0.514** | -0.434 | -0.746* |
| Constant | 11.272** | 11.510** | 2.505 | 13.128** | 7.255** |

Asterisks denote statistical significance at various levels: ** = 95%, * = 90%.

**Table A9: Fuel Choice Parameter
Estimates for Other Electricity End Use**

| <i>Variable</i> | <i>Electricity</i> |
|------------------------------|--------------------|
| Electricity | 1.920** |
| Electricity ² | 1.014 |
| Electricity*size | 0.449* |
| Percent Lighted | -0.376 |
| Heating deg days | -0.015 |
| Cooling deg days | -0.003 |
| Hours open | 0.324** |
| Owner occupied | -0.278 |
| Ln(sq. footage) | 0.361** |
| Ln(sq. footage) ² | -0.027 |
| >20 years old | 0.220 |
| >40 years old | -0.114 |
| >60 years old | 0.104 |
| >80 years old | -0.206 |
| MSA | 0.548** |
| Government own | -0.737** |
| North census | -0.776** |
| South census | 0.143 |
| Midwest census | 0.145 |
| Central phys plant | 1.124** |
| Multi-building | -0.371* |
| Restaurant | [33.398] |
| Warehouse | -2.143** |
| Foodstore | — |
| Hospital | — |
| Vacant | -4.188** |
| Public services | 0.952 |
| Lodging | -0.280 |
| Retail services | 0.159 |
| Constant | 4.676 |

Asterisks denote statistical significance at various levels: ** = 95%, * = 90%. Brackets indicate building categories where all (for a positive coefficient) or none (for a negative coefficient) of the given category chose a particular fuel option; this leads to large coefficients with high standard errors.

**Table A10: Fuel Choice Demand Estimates
for Other Electricity End Use**

| <i>Variable</i> | <i>Electricity</i> |
|------------------------------|--------------------|
| Electricity | -1.136** |
| Ln(probability) | -1.429** |
| Percent Lighted | 1.027** |
| Heating deg days | 0.007 |
| Cooling deg days | 0.078** |
| Hours open | 0.493** |
| Owner occupied | -0.057* |
| Ln(sq. footage) | 0.966** |
| Ln(sq. footage) ² | 0.027** |
| >20 years old | -0.083** |
| >40 years old | -0.168** |
| >60 years old | 0.017 |
| >80 years old | -0.278** |
| North census | 0.200** |
| South census | -0.229** |
| Midwest census | -0.274** |
| Central phys plant | 0.183** |
| Multi-building | -0.057* |
| Restaurant | 0.285** |
| Warehouse | -0.934** |
| Foodstore | 0.655** |
| Hospital | -0.276** |
| Vacant | -2.051** |
| Public services | -0.496** |
| Lodging | -0.591** |
| Retail services | -0.421** |
| Constant | 11.951** |

Asterisks denote statistical significance at various levels: ** = 95%, * = 90%.