



# Residential Energy Code: Is Compliance Equitable?

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**Research Question:** Are residential building energy codes implemented equitably across United States?

**Data:** Residential code compliance field study

- Single family: 20 states
- Multifamily: 4 states
- Data collection: 2014 - 2022

**Approach:** Exploratory & statistical analysis

Compliance rate for category  $i$ :

$$\text{Compliance rate}_i = \frac{n_{\text{compliant}_i}}{n_{\text{total}_i}}$$

$n_{\text{compliant}_i}$  = number of complaint observations for parameter  $i$

$n_{\text{total}_i}$  = total number of observations for parameter  $i$

Non-compliance rate for category  $i$ :

$$\text{Noncompliance rate}_i = 1 - \text{Compliance rate}_i$$



Single-family

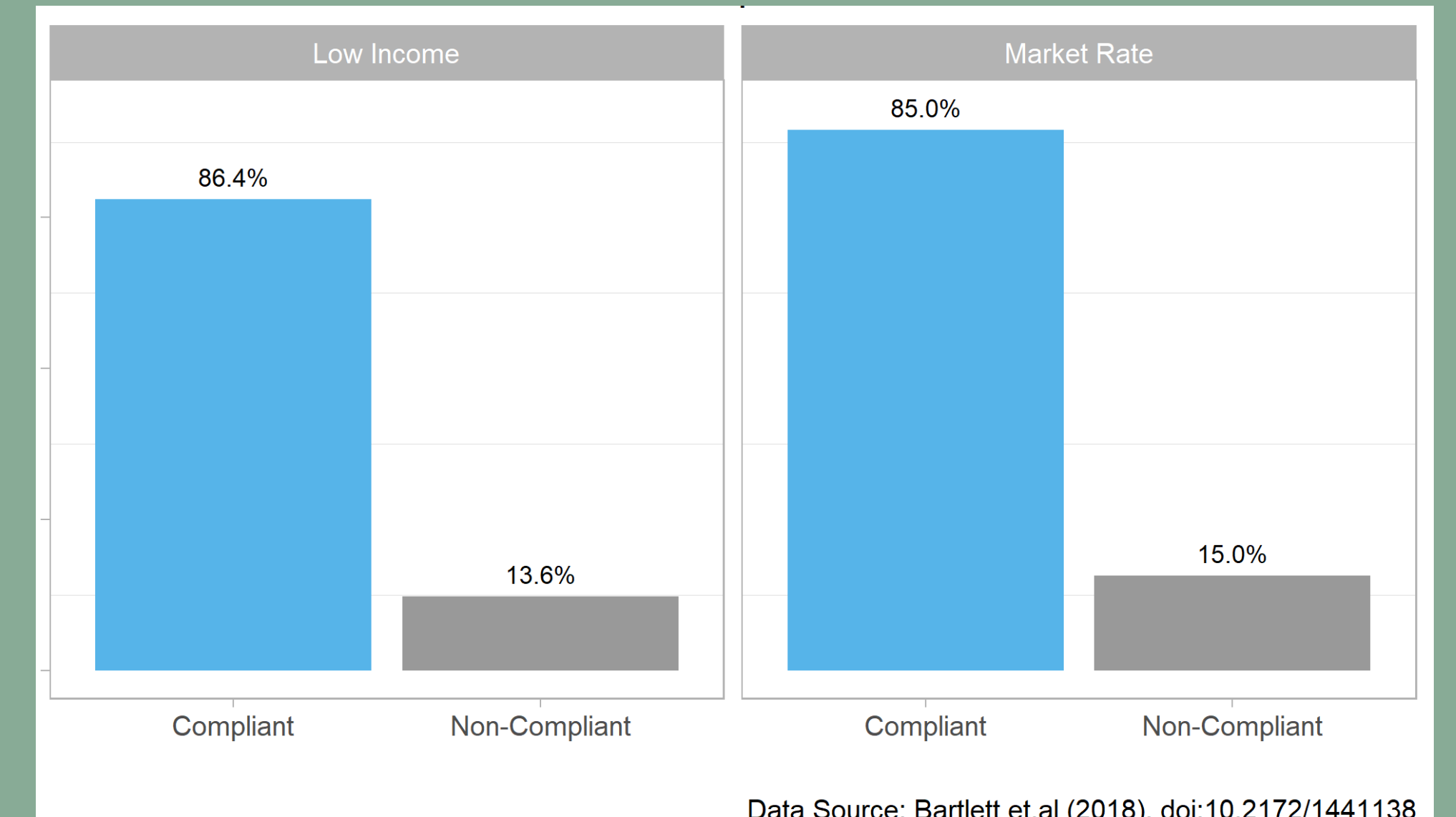


Low rise Multi-family

Energy Code Compliance  
Lower Income County vs Higher Income County



Energy Code Compliance  
Low Income Rate vs Market Rate Development



## Findings

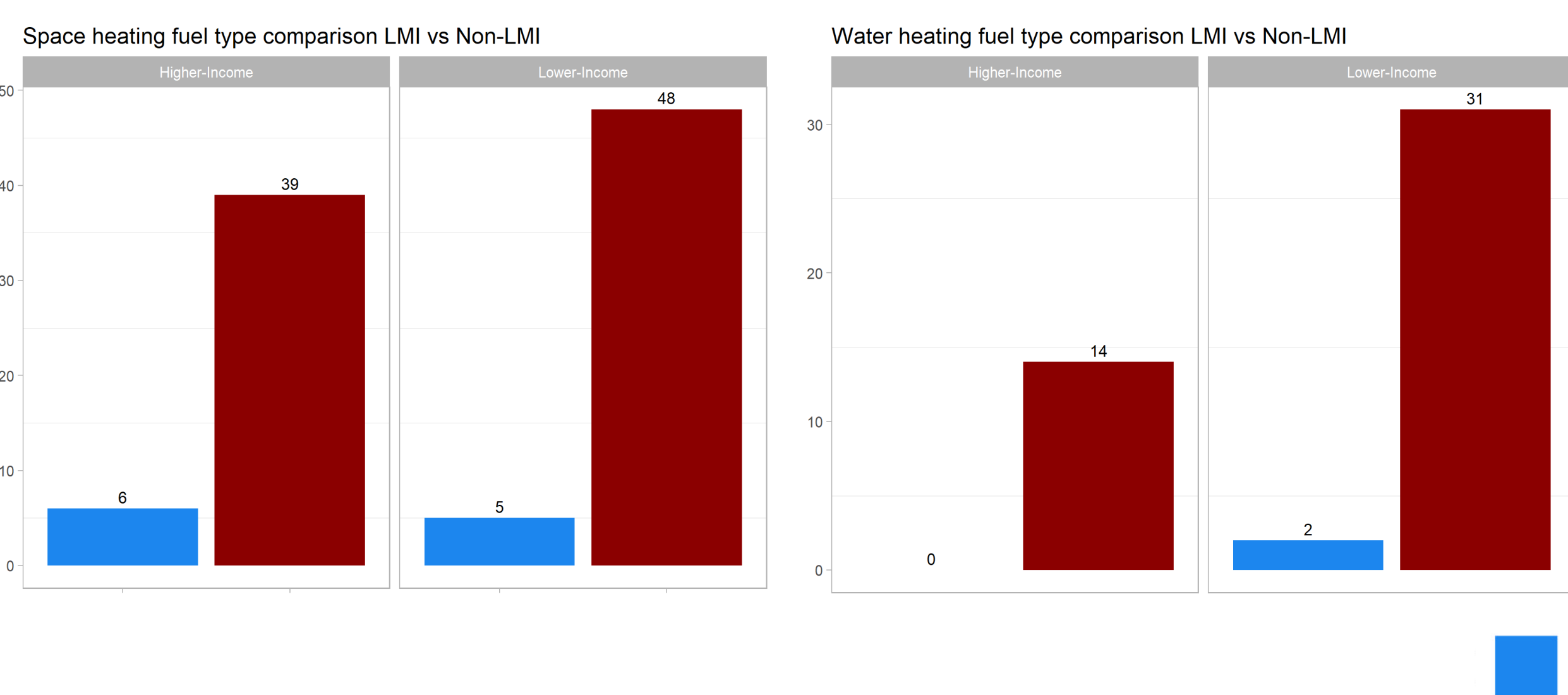


Single-family

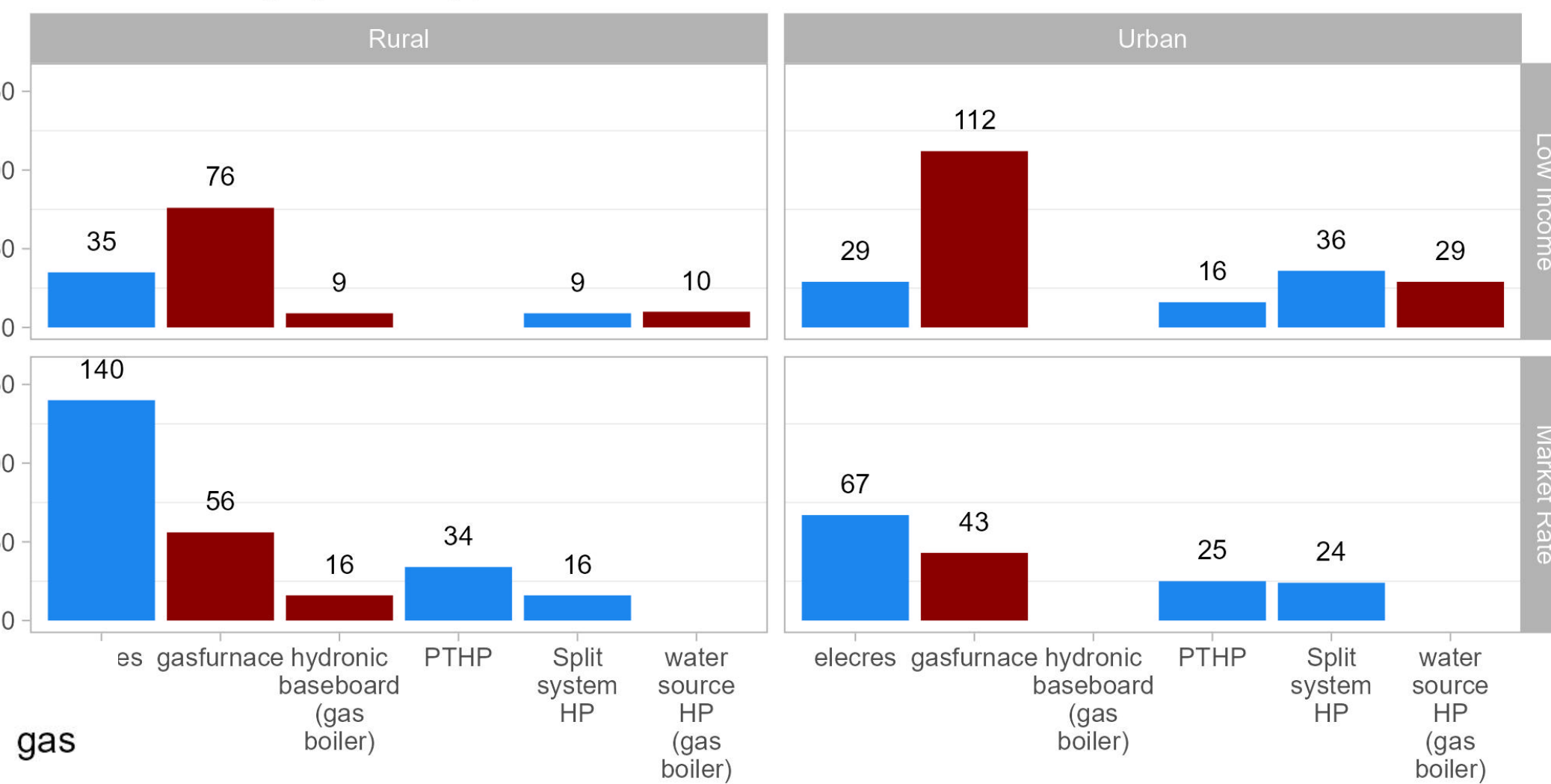


Low rise Multi-family

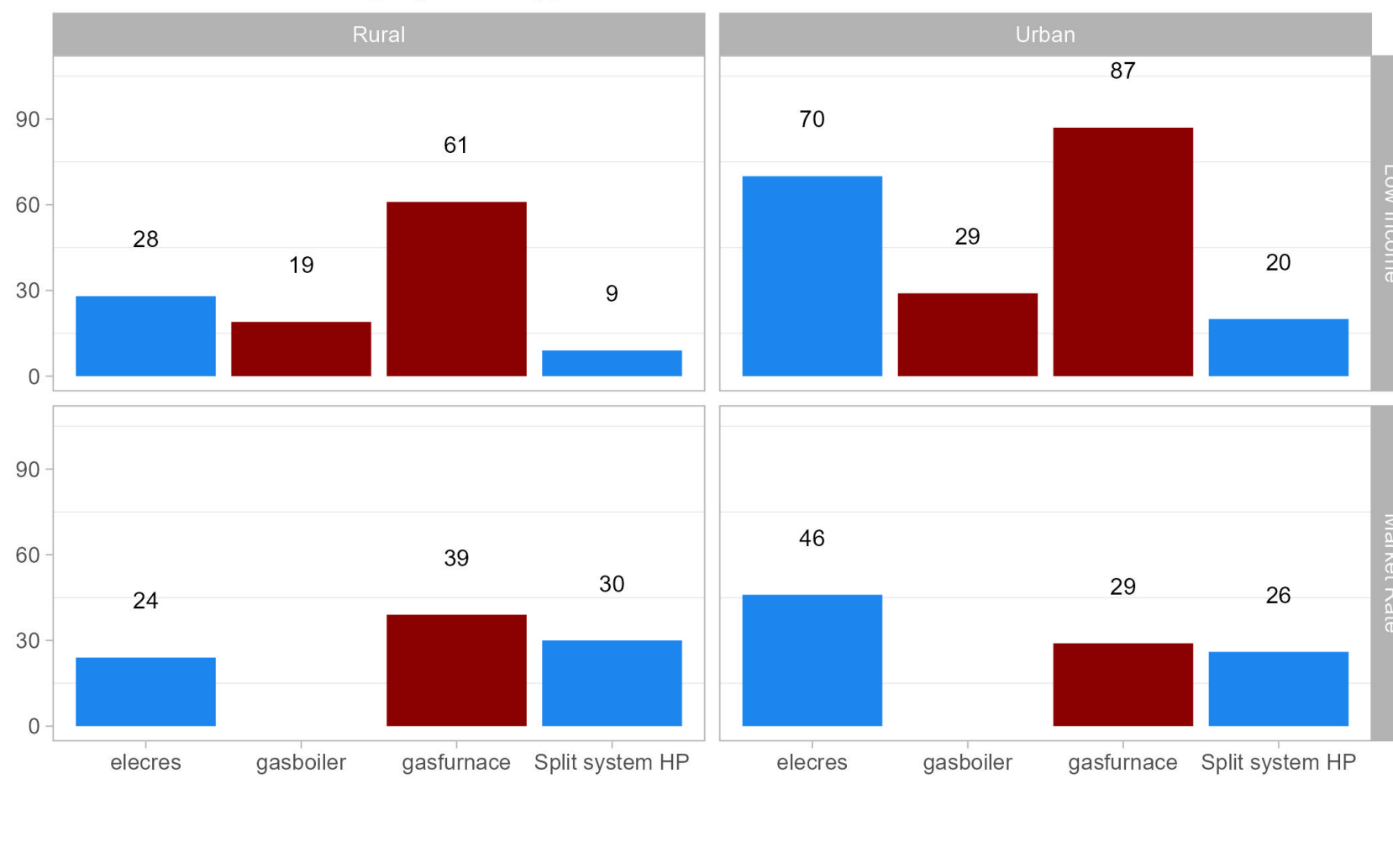
### 1. Gas heating dominates in lower income houses



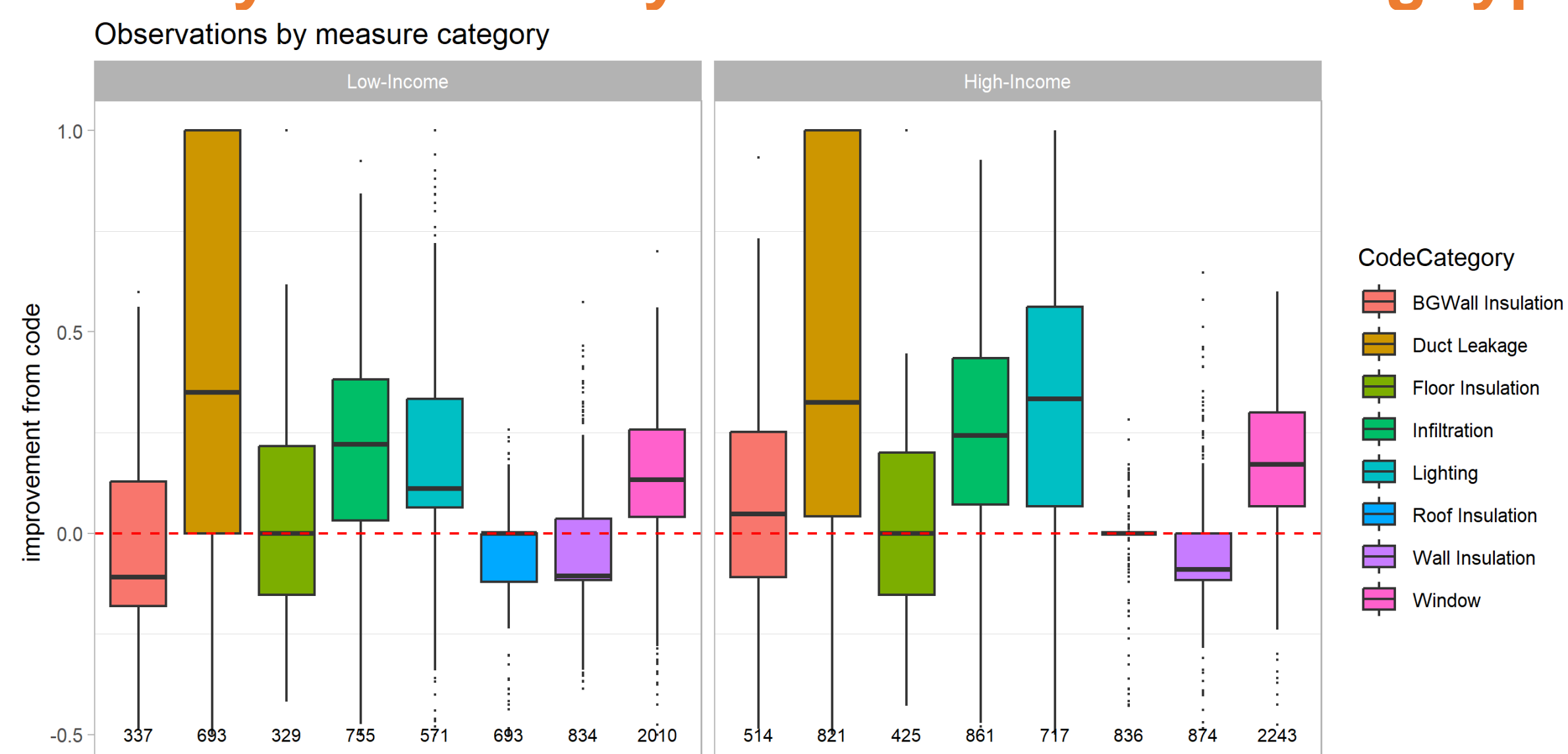
In-unit Heating by Fuel Type: Low-income rate vs Market rate in Rural and Urban



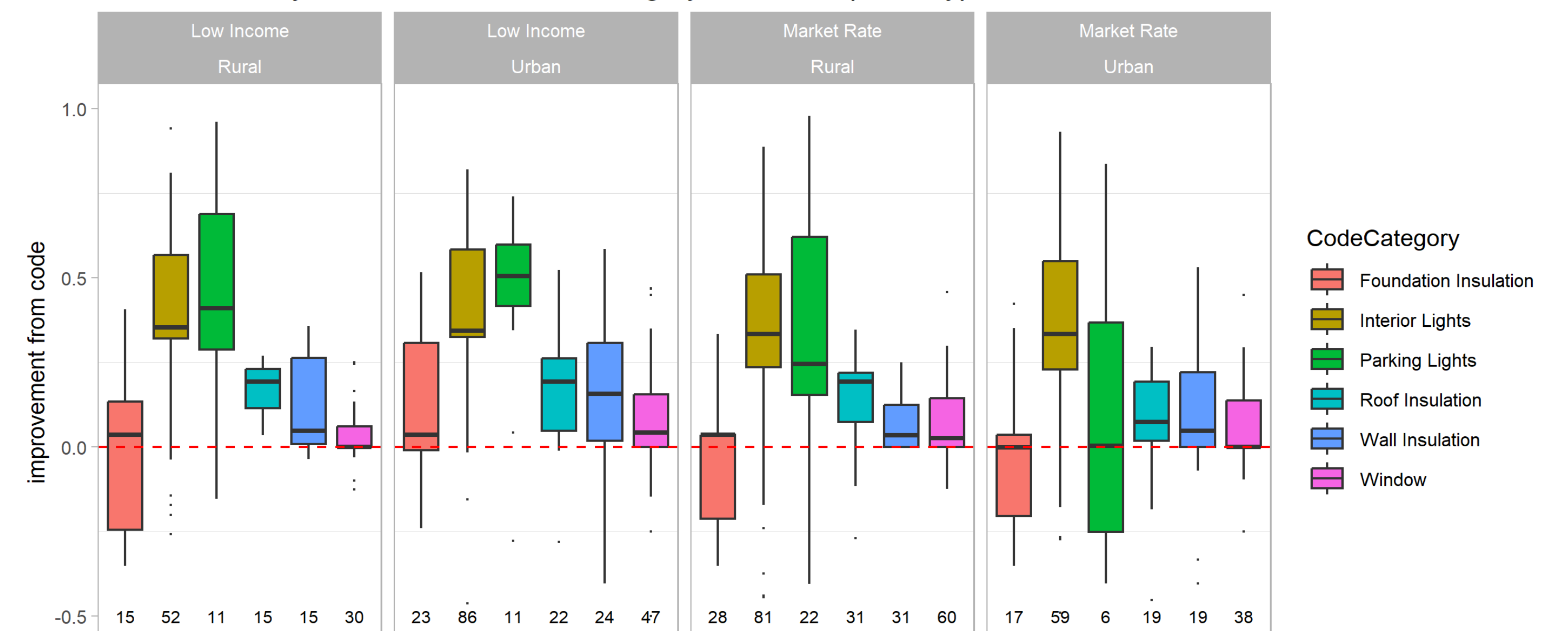
Common Area Heating by Fuel Type: Low-income rate vs Market rate in Rural and Urban



### 2. EEM efficiency: variable by measure and building type



Observations by measure, urban-rural category and development type



### 3. Lower income county compliance rate lower in Single-family.

No difference in compliance rate between low income and market-rate development type in multi-family

|                               | Energy Code Compliance (95% confidence) |         |                           |           |
|-------------------------------|---|---------|---------------------------|-----------|
|                               | Difference                              | p-value | Estimated compliance rate |           |
| <b>Single family</b>          |   |         |                           |           |
| <b>Compliance rate</b>        | Lower in LMI county                     | 0       | Non-LMI: 0.73             | LMI: 0.67 |
| <b>Duct-tightness</b>         | Lower in LMI county                     | 0       | Non-LMI: 0.67             | LMI: 0.59 |
| <b>Infiltration</b>           | Lower in LMI county                     | 0       | Non-LMI: 0.84             | LMI: 0.76 |
| <b>Below Grade Insulation</b> | Lower in LMI county                     | 0       | Non-LMI: 0.60             | LMI: 0.36 |
| <b>Floor Insulation</b>       | No difference                           | 0.5     | Non-LMI: 0.74             | LMI: 0.76 |
| <b>Roof Insulation</b>        | Lower in LMI county                     | 0       | Non-LMI: 0.60             | LMI: 0.52 |
| <b>Wall Insulation</b>        | No difference                           | 0.6     | Non-LMI: 0.40             | LMI: 0.39 |
| <b>Lighting</b>               | Lower in LMI county                     | 0       | Non-LMI: 0.72             | LMI: 0.65 |
| <b>Window</b>                 | Lower in LMI county                     | 0       | Non-LMI: 0.94             | LMI: 0.90 |

|   | Energy Code Compliance (95% confidence) |         |                           |                   |
|---|---|---------|---------------------------|-------------------|
|   | Difference                              | p-value | Estimated compliance rate |                   |
| <b>Multi family</b>                       |   |         |                           |                   |
| <b>Low income vs Market rate</b>          | No difference                           | 0.2     | Low Income: 0.86          | Market rate: 0.85 |
| <b>Rural vs Urban</b>                     | No difference                           | 0.2     | Rural: 0.87               | Urban: 0.83       |
| <b>Low income: Rural vs Urban</b>         | No difference                           | 1       | Rural: 0.87               | Urban: 0.86       |
| <b>Market rate: Rural vs Urban</b>        | No difference                           | 0.2     | Rural: 0.87               | Urban: 0.82       |
| <b>Low income: Prescriptive vs other</b>  | No difference                           | 0.8     | Prescriptive: 0.86        | Other: 0.88       |
| <b>Market rate: Prescriptive vs other</b> | No difference                           | 0.5     | Prescriptive: 0.84        | Other: 0.87       |
| <b>Foundation Insulation</b>              | No difference                           | 0.3     | Low Income: 0.68          | Market rate: 0.54 |
| <b>Lighting</b>                           | No difference                           | 0.4     | Low Income: 0.94          | Market rate: 0.90 |
| <b>Window</b>                             | No difference                           | 0.2     | Low Income: 0.63          | Market rate: 0.86 |

**Study Limitations:** Data does not cover all U.S. states; hence results cannot be generalized.