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Information strategies and energy conservation behavior: A meta-analysis of experimental studies from 1975-2012

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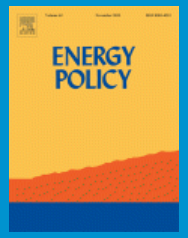
Energy Policy journal
Volume 61, Pages 729-739
October 2013



2013 BECC Conference Sacramento

http://dx.doi.org/10.1016/j.enpol.2013.05.109

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How effective are information strategies in energy conservation?

Meta-Regression Analysis

We use 156 trials of information based energy conservation experiments that were published in peer reviewed journals from 1975-2012. We use meta regression analysis to assess the effectiveness of information strategies on energy conservation.

Meta-analysis is the art of combining statistical evidence from separate studies.

Our goal in this meta analysis is to derive a common summary statistic for the effect size of an intervention spread across multiple studies.

Listing of Journals

American Journal of Community Psychology
Applied Energy
Behavior Modification
Bell Journal of Economics
Building Research and Information
Computers in Entertainment
Energy
Energy and Buildings
Energy Policy
Environment and Behavior
IEEE Transactions on Industrial Electronics
International Journal of Consumer Studies
International Journal of Sustainability in Higher Education
Journal of Applied Behavior Analysis
Journal of Applied Psychology
Journal of Applied Social Psychology
Journal of Business and Economic Statistics
Journal of Consumer Research
Journal of Design Research
Journal of Economic Psychology
Journal of Environmental Psychology
Journal of Environmental Systems
Journal of Public Economics
NBER Working Papers*
Personality and Social Psychology Bulletin
Psychological Science
RAND Journal of Economics
Resource and Energy Economics
The Energy Journal
The Review of Economics and Statistics

A complete listing of papers is available http://dx.doi.org/10.1016/j.enpol.2013.05.109

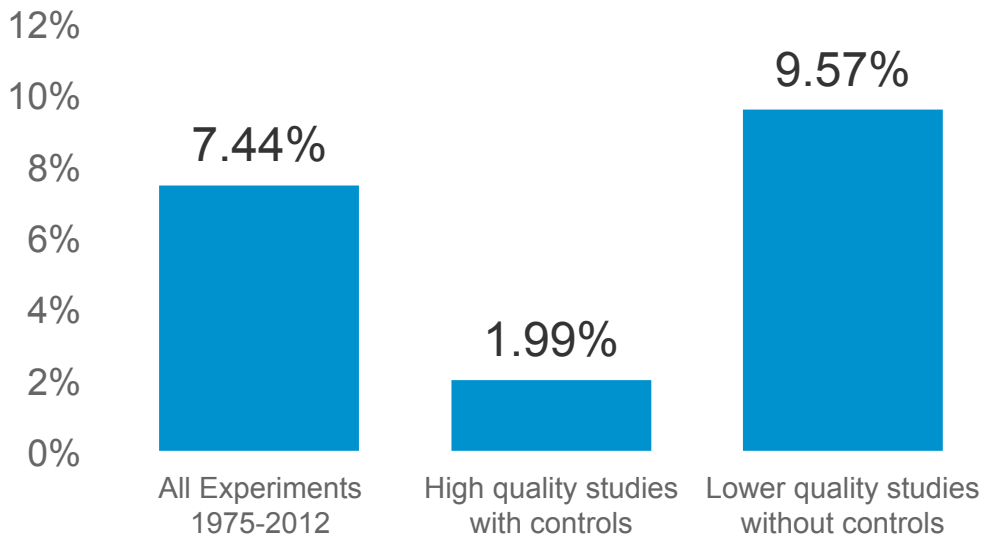
* Non peer-reviewed

Meta-Analysis
Summary of Treatment Effects

N=156 field trials
(524,479 study subjects)

Percentage Energy Savings
Field Experiments 1975-2012

Data from Table 3



* Controls include weather, demographics or control group

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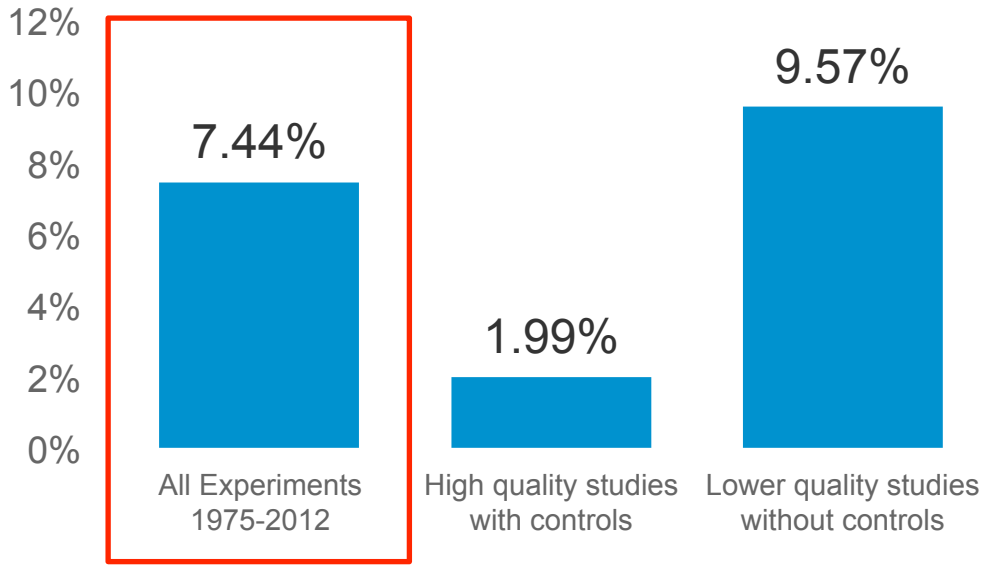

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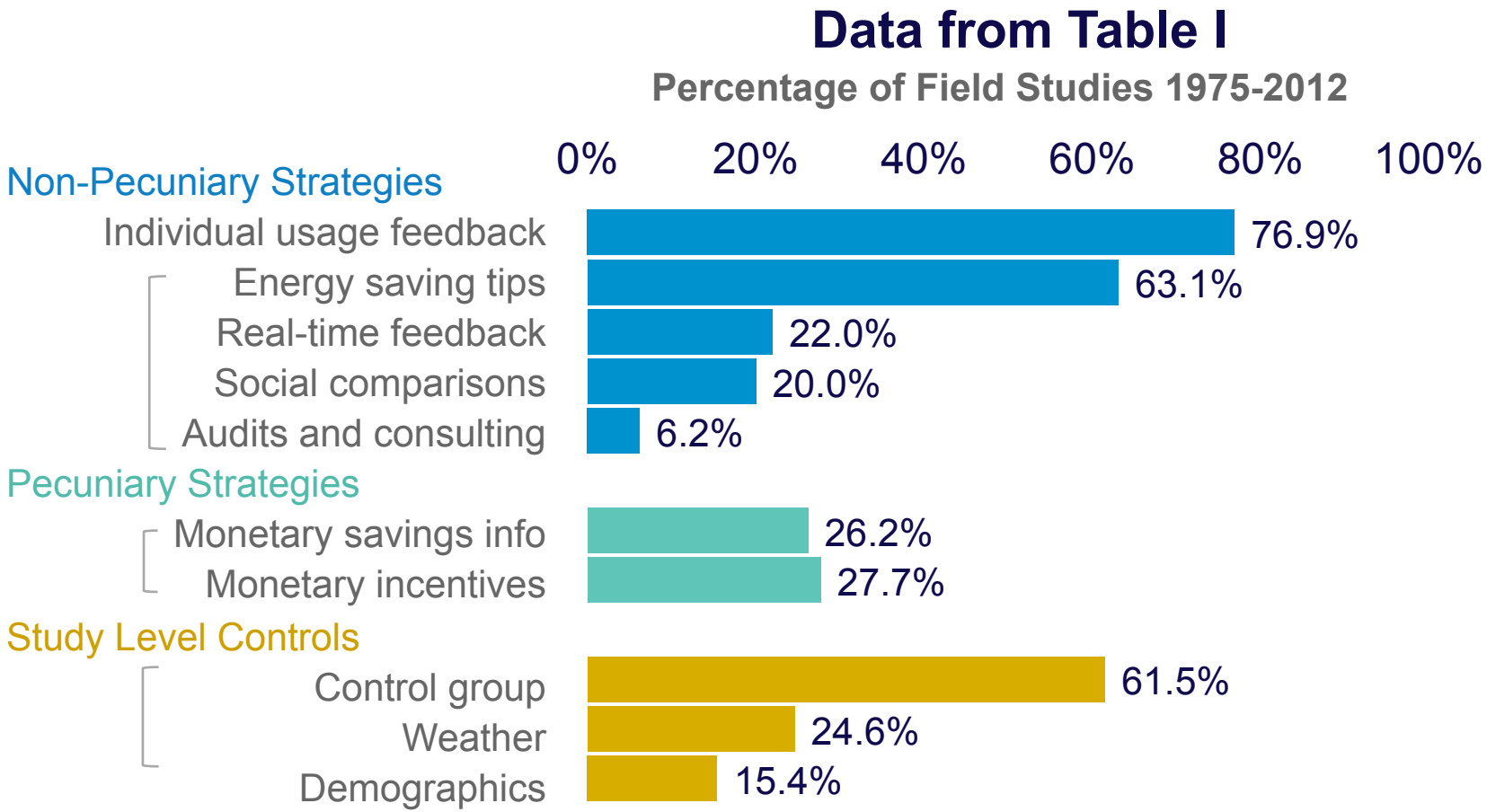
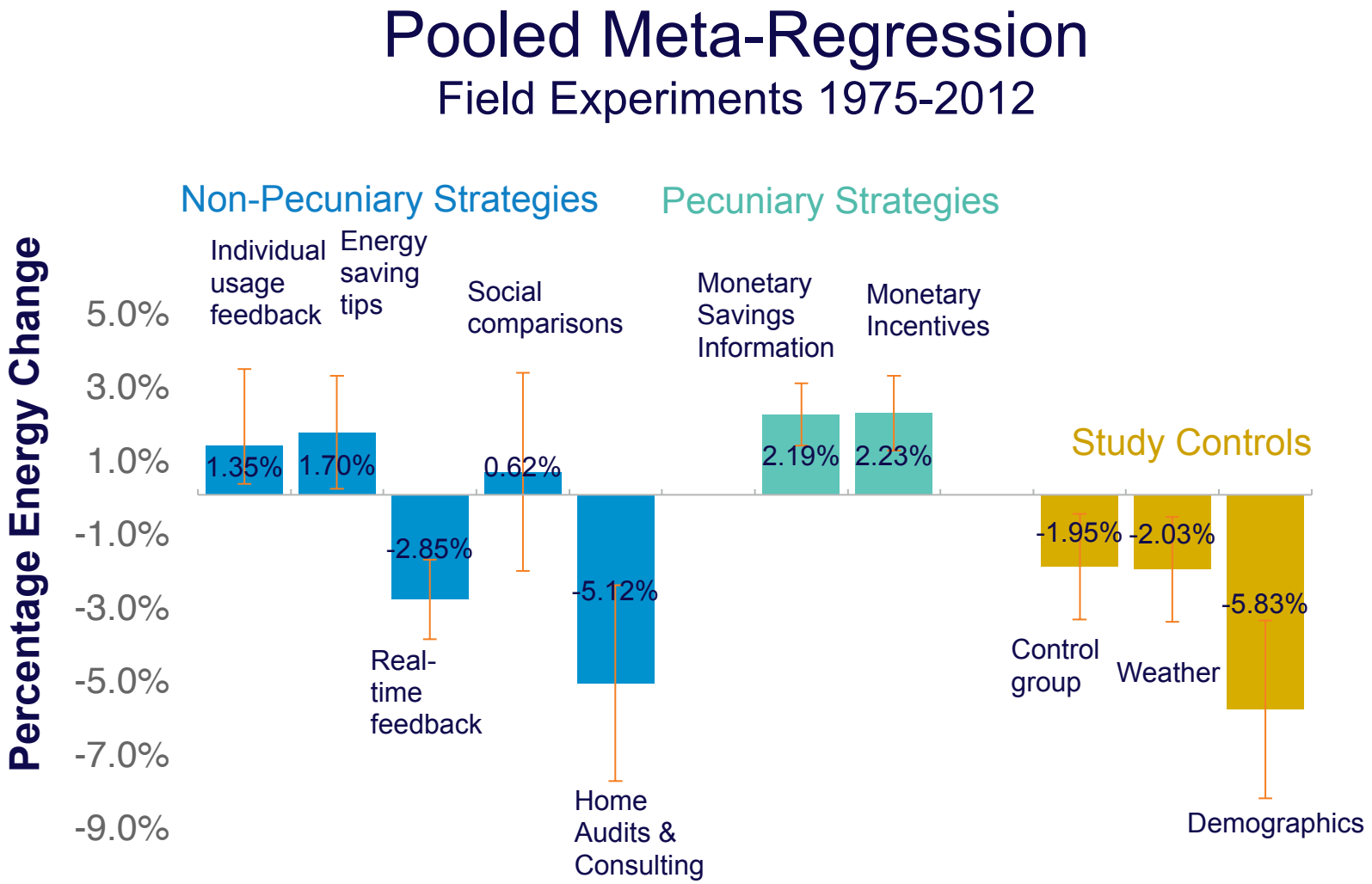
Meta-Analysis
Information Strategies



* Published studies sometimes include multiple treatments so they do not add up to 100%

Meta-Regression Estimates

N=156 field trials
(524,479 study subjects)



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* Negative values mean energy savings

Meta-Regression Estimates

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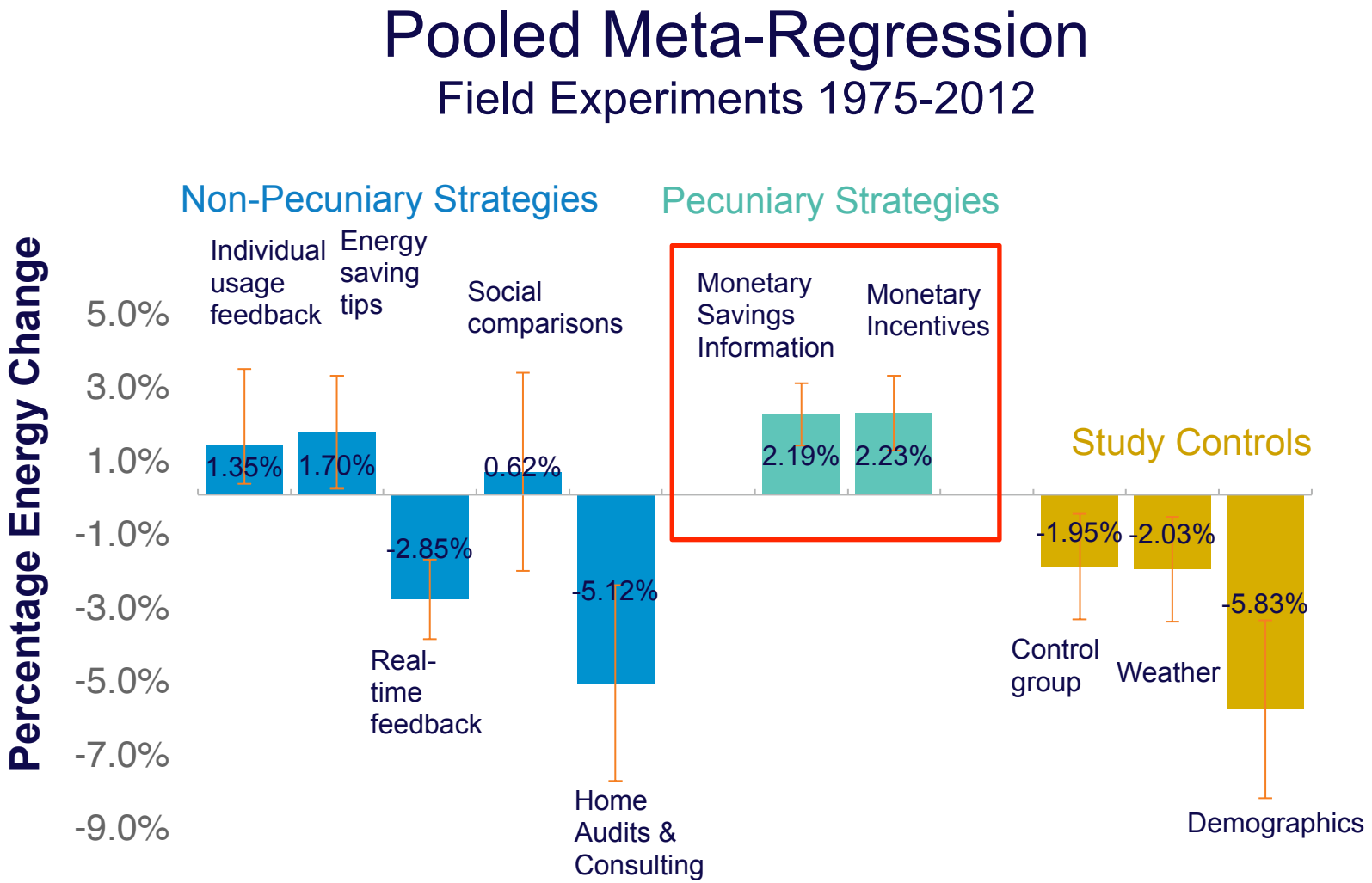

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Highlights

- We conduct a meta-analysis of information based energy conservation experiments.
- We analyze 156 published trials and 524,479 study subjects from 1975-2012.
- On average, individuals in the experiments reduced electricity consumption by 7.4%.
- Individualized feedback via audits and consulting results in the largest reductions.
- Pecuniary feedback and incentives lead to a relative increase in energy usage.

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Thank you for listening !

For more information visit
www.environment.ucla.edu/ccep

Meta-Analysis Funnel Plot

Information Treatments
1975-2012

- Heterogeneous responses (range from -55% to +18.5%)
- Social comparisons also backfire
- Larger studies near the average treatment effects

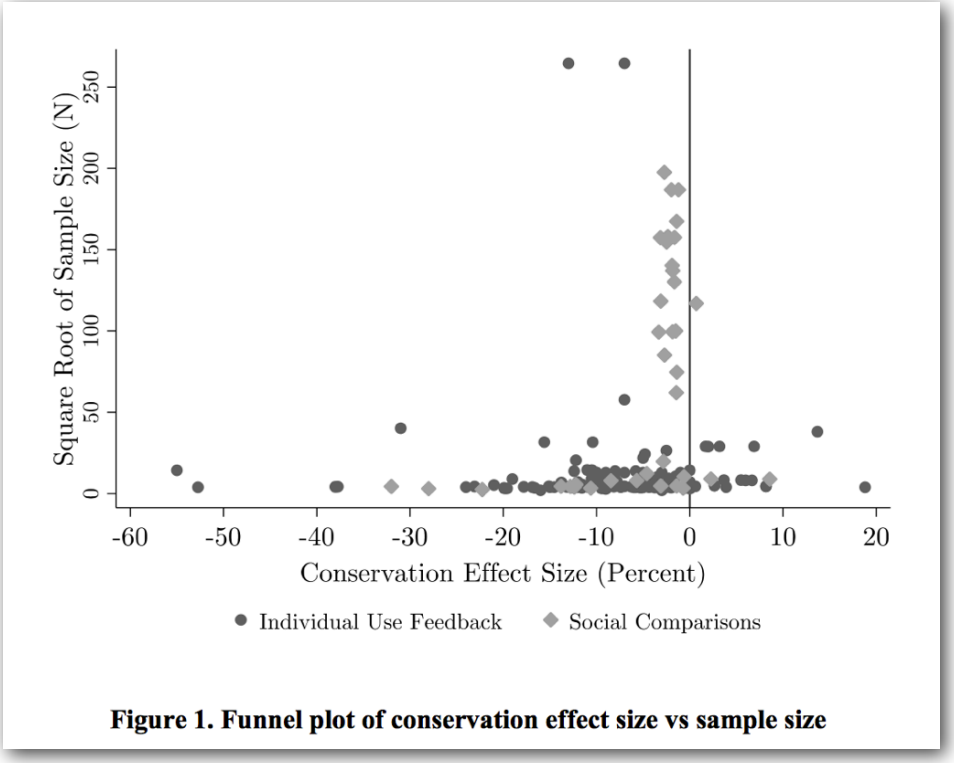

Figure 1. Funnel plot of conservation effect size vs sample size

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A large number of experiments report energy increases versus control.

Meta-Analysis
Moderator (Independent) variables

Information Strategies

- Feedback type (individual or social comparisons)
- Frequency of Feedback (residential billing or in-home displays)
- Consumer education (home audits and consulting, energy saving tips)
- Public/private information (conservation advertising campaigns)
- Goal setting (self-chosen, assigned commitments)
- Technology (real-time displays or alerts)
- Competitions (non-pecuniary rewards)

Duration

- Duration of treatment
- Duration of baseline period
- Long-term persistence monitoring
- Year published

Methodological

- Sample size, control group, weather or seasonality

Meta-Analysis
Inclusion and Exclusion of Data

Target: Peer-reviewed experimental papers in energy conservation behavior

Screen in if…

- Study includes field experiments in electricity
- Any region/geography
- Any time period

Screen out if…

- Study is not about electricity (gas or water conservation out of scope)
- Not individual level
- Not residential or household consumption (commercial buildings out of scope)
- Not peer-reviewed

Meta-Regression General Model

For the *jth* study and L number of studies in the analysis,

$$b_j = \beta + \sum_{k=1}^{K} \alpha_k \cdot Z_{jk} + e_j \qquad (1)$$

Meta-regression coefficient

- b_j: *Reported estimates of β for jth study (typically OLS estimates)*
- β: *'True' empirical effect*
- α_k: *Biasing effect*
- Z_{jk}: *Study characteristics (Dummy variables or indicators) (Meta-independent variables)*

$$j \in (1, 2, \ldots L)$$

Normalizing, we divide by standard errors (S_{bj})
if reported, or alternatively the square root of sample size as proxy

$$t_j = \frac{b_j}{S_{b_j}} = \frac{\beta_j}{S_{b_j}} + \sum_{k=1}^{K} \alpha_k \frac{Z_{jk}}{S_{b_j}} + \frac{u_j}{S_{b_j}} \qquad (2)$$

Meta-regression coefficient

- t_j: *Reported t-statistics for jth study*
- $\frac{b_j}{S_{b_j}}$: *Scaled estimates of β for the jth study*
- $\frac{\beta_j}{S_{b_j}}$: *'True' empirical effect*
- α_k: *Biasing effect*
- $\frac{Z_{jk}}{S_{b_j}}$: *Scaled study characteristics (Meta-independent variables)*

$$j \in (1, 2, \ldots L)$$