Presentation

The Efficiency Consequences of Heterogeneous Behavioral Responses to Energy Fiscal Policies

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Publication Date:
2017-11-14

PermaLink:
https://doi.org/10.3929/ethz-b-000217844

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Efficiency Consequences of Heterogeneous Behavioral Responses to Energy Fiscal Policies

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November 14, 2017
Motivation: Inside the Ivory Tower

Recent literature in behavioral public finance

1. Documented various phenomena that impact behavioral responses to taxes and subsidies
   - Salience (Chetty et al. 2009)
   - Hassle costs (Currie, 2004)
   - Information frictions (Handel and Kolstad, 2015)

2. Investigate the optimal design of policies in presence of behavioral biases
   - Allcott et al. (2014) Pigouvian policies with misperceptions
   - Farhi and Gabaix (2015), revisit most classic results in optimal tax theory with behavioral agents (sparsity-based model of bounded rationality, Gabaix 2014)
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3. Main take away: **heterogeneous biases**: combining instruments can be more efficient
Motivation: Outside the Ivory Tower

Overlapping fiscal instruments are commonly used to achieve a single policy goal in the energy context.

- e.g., Carbon tax with consumer rebates and R&D subsidies

Why Overlapping Fiscal Instruments?

1. Trade-off between economic efficiency and distributional concerns
2. Interacting market failures
3. Pre-existing tax distortions
4. Heterogeneous externalities
5. **Heterogeneous micro-frictions**
What We Do

1. Theory
   - Unifying framework to study behavioral responses to fiscal policies using the concept of **micro-frictions**.
   - Investigate the design of optimal Pigouvian policies.

2. Empirics
   - Estimate heterogeneous behavioral responses to energy fiscal instruments and quantify micro-frictions.

3. Policy Analysis
   - Use the estimated model to investigate optimal energy fiscal policies with heterogeneous micro-frictions using applied behavioral welfare economics.
Definition: Micro-Frictions

**Definition 1:**
Any phenomena impacting the response to a fiscal instrument such that a one dollar variation induced by the fiscal instrument does not have the same effect than a dollar variation in relative prices.

**Definition 2 (for our applied work):**
Any phenomena impacting the response to a (small) price change such that the marginal effect of the price change is not equal to the marginal utility of income.
Examples: Micro-Frictions

Behavioral Biases (Internalities)

- misperception
- present bias
- salience
- inattention (rational or not)

Transaction Costs

- hassle costs to claim a rebate
- time and effort to file a tax return
- cost of hiring a tax specialist
Overview of Main Results: Theory

1. Optimal Pigouvian Taxation with Micro-Frictions

1. Although behavioral biases and transaction costs can be observationally equivalent, they lead to different policy prescription:
   • Transaction cost $\rightarrow$ Pigou holds.

2. Modest behavioral biases can lead to large adjustment of a Pigouvian tax.

3. Heterogeneity across consumers and instruments matters.

4. Unobserved heterogeneity in biases complicates the design of the optimal Pigouvian tax.
Overview of Main Results: Empirics

In the U.S. appliance market:

1. Substantial heterogeneity across income groups and policy instruments.

2. Micro-frictions are important for all types of energy fiscal policies we investigate.

3. Larger behavioral biases, but smaller transaction costs for lower income households relative to higher income households.
Overview of Main Results: Policy Analysis

1. Rarely optimal to combine tax and subsidies in practice.
2. Large adjustment to the Pigouvian tax could be justified by behavioral biases.
3. Energy labels interact in perverse ways with energy fiscal policies.
4. Energy fiscal instruments should target the investment margin.
Road Map for Today

1. Optimal Pigouvian Instruments with Micro-Frictions
2. Empirical Setting and Data
3. Empirical Strategy
4. Results
5. Policy Analysis
Optimal Pigouvian Instruments with Micro-Frictions
Optimal Taxation with Behavioral Biases

Nascent, but rapidly growing literature

- Chetty, Kroft, and Looney (2009)
- Allcott, Mullainathan, Taubinsky (2014)
  - Internalities $\rightarrow$ Pigouvian tax should be above the marginal damage.
  - Internalities $\rightarrow$ Pigouvian tax with a subsidy more efficient than a tax alone.
- Farhi and Gabaix (2015)
  - Heterogeneity $\rightarrow$ the targeting principle does not hold.
  - Heterogeneity $\rightarrow$ a quantity instrument might dominate a price instrument.
  - If (endogeneous) attention costs are included in welfare $\rightarrow$ lower optimal behavioral tax.
- Taubinsky and Rees-Jones (2016)
  - The DWL of taxation is proportional to the variance of the internality in the population.
Model with misperception to tax:

**Rational consumer:**

$$\max_c U(c) - (p + \tau)c$$

**Behavioral consumer:**

$$\max_c U(c) - (p + m\tau)c$$

where $m \leq 1$ (typically)
Misperception → Pigou Doesn’t Hold

Externality: $\phi$ marginal damage of consuming $c$

Planing Problem:

$$\max_c U(c) - (p + \phi)c$$

Rational consumer:

$$\max_c U(c) - (p + \tau)c$$

$\tau = \phi$

Behavioral consumer:

$$\max_c U(c) - (p + m\tau)c$$

$\tau = \phi/m \geq \phi$ if $m \leq 1$
Consumers must pay a **true economic** cost $k$ to learn $\tau$

**Behavioral consumer:**

$$\max_{R=\{0,1\}} (1 - R) \cdot \left[ \max_c U(c) - p \cdot c \right] + R \cdot \left[ \max_c U(c) - (p + \tau) c - k \right]$$
If $k \sim F(\cdot)$: only a fraction of the consumers will respond to the tax.

**Lemma 1** The transaction cost (TC) model is observationally equivalent to a misperception (MP) model if $m < 1$.

We don’t know if only a fraction of the consumers responded to the tax, all of them responded, but misperceived the tax, or both.
Transaction Cost → Pigou Holds

**Proposition 1** *With the TC Model Pigou holds*

For any distribution $k \sim F(\cdot)$, with $F'(0) = f(0) > 0$, $
\tau = \phi$ if consumers are subject to transaction costs $k$. 
Transaction Cost → Pigou Holds

**Proof** For a given $k$: 

![Graph showing the relationship between $W$, $W(\tau)$, $W(0)$, and $W(\tau)-k$ with a vertical line at $\phi$.]
Our framework:

- Discrete choice model with several different goods where the adjustment to a Pigouvian tax is on the extensive margin (i.e., choosing among J technologies):
- Micro-frictions (behavioral biases) to process energy operating costs
- Energy tax is included in the price of energy: consumers cannot distinguish the tax in the energy prices.
Optimal Pigouvian Instruments and Observed Heterogeneity

• Suppose we can segment the population in $R$ types
• Estimate misperceptions for each type $r$: $m_r$
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• Estimate misperceptions for each type $r$: $m_r$

For each type $r$:

$$\tau_r = \frac{\phi}{m_r} + P_{\text{energy}} \frac{(1 - m_r)}{m_r}$$
Suppose we can segment the population in $R$ types

Estimate misperceptions for each type $r$: $m_r$

For each type $r$:

$$
\tau_r = \frac{\phi}{m_r} + P_{\text{energy}} \frac{(1 - m_r)}{m_r}
$$

- Internalizing the externality
- Internalizing the bias

Example:
- $\phi = 0.02 \ $/kWh
- $P_{\text{energy}} = 0.11 \ $/kWh
- $m_r = 0.5$
- $\tau_r = 0.15 \ $/kWh
Optimal Pigouvian Instruments and Observed Heterogeneity

- Suppose we can segment the population in $R$ types
- Estimate misperceptions for each type $r$: $m_r$

For each type $r$:

$$
\tau_r = \phi \frac{1}{m_r} + P_{\text{energy}} \frac{(1 - m_r)}{m_r}
$$

Internalizing the externality

Internalizing the bias

Example:

- $\phi = 0.02 \text{ \$/kWh}$
- $P_{\text{energy}} = 0.11 \text{ \$/kWh}$
- $m_r = 0.5$
- $\tau_r = 0.15 \text{ \$/kWh}$
Optimal Pigouvian Instruments and Heterogeneity Across Consumers

If no targeting possible:

$$\tau = \frac{\phi}{1 - \sum_r \alpha_r (1 - m_r) \Delta_r^{\tau,\text{energy}}} + P_{\text{energy}} \frac{\sum_r \alpha_r (1 - m_r) \Delta_r^{\tau,\text{energy}}}{\sum_r \alpha_r \Delta_r^{\tau,\text{energy}}}$$

where

- $\alpha_r$: share of consumers of type $r$
- $\Delta_r^{\tau,\text{energy}}$: net change in energy consumption due to a small $\tau$
Optimal Pigouvian Instruments and Heterogeneity Across Consumers

If no targeting possible:

\[
\tau = \frac{\phi}{1 - \sum_r \alpha_r (1 - m_r) \Delta_r^{\tau,\text{energy}}} + P_{\text{energy}} \frac{\sum_r \alpha_r (1 - m_r) \Delta_r^{\tau,\text{energy}}}{1 - \sum_r \alpha_r \Delta_r^{\tau,\text{energy}}}
\]

- The non-differentiated tax will be non-optimal (third best) to all consumers → another fiscal instrument can help.
- But the behavioral responses to the second instrument must also be heterogeneous and follow certain patterns.
- Interactive biases will ultimately determine whether we should combine instruments.
Take Aways

1. If not clearly empirically identified, need to take a stand on the source of micro-frictions.
Take Aways

1. If not clearly empirically identified, need to take a stand on the source of micro-frictions.
2. Behavioral biases in processing energy operating costs:
   - $\tau \neq$ externality cost
   - Heterogeneity across types and instruments *may* motivate overlapping instruments.
Empirical Setting and Data
U.S. Fiscal Policies to Promote Energy Efficient Durables (Appliances)

• **Subsidies**
  • Rebates
    • Utility Rebates (∼ County level)
    • Government Rebates “Cash for Appliances” (C4A), akin to “Cash for Clunkers” (C4C) (State level)
  • Sales tax holidays and exemptions (State level)
  • Manufacturers’ tax credit (Federal level)
  • Consumers’ tax credit (Federal level)

• **Pricing Externalities in the U.S. Electricity Sector**
  • Local pollutants: Acid Rain Program (1990 Clean Air Act)
  • $CO_2$: Regional cap-and-trade programs
Decision Environment: Readily Available Energy Information

(a) Energy Star

(b) EnergyGuide
Data

- Transaction-level data over 2008-2012 from a large U.S. appliance retailer
- Focus on refrigerators
  - Manufacturer model number matched to attribute information
    - kWh/year, size, ES certification, options, brand
  - Unique household identifier matched (56%) with Acxiom demographic information
    - income, education, family structure, age, homeownership, housing type, political affiliation
  - MSRP, price paid, sales tax paid
  - Location of the store
- Utility rebates at county level (DSIRE): amounts
- C4A rebates (state): amounts, timing, other parameters
- Local (state or county) average electricity prices (EIA-861)
- Sales tax rates at the zip code-week level
Identifying Source of Variation
Prices: National Pricing Strategy

Brand A: Sales Rank 1

Normalized Price ($)

2008w1 2009w1 2010w1 2011w1 2012w1

Weeks
Prices

A lot of model-specific idiosyncratic variation:
Sales Taxes

Figure: Cross Section Variation in Sales Tax Rates (Source: Einav et al., 2014)
C4A Rebates: Variation Rebate Amount
C4A Rebates: Variation Timing
Utility Rebates

- 80-150 electric utilities/year offered rebates for ES refrigerators
- Rebate coverage vary from year to year
- Rebate amount also vary over time
Electricity Costs

2010 Average County Electricity Prices
Identification

Figure: High Electricity Price State
Identification

Figure: Low Electricity Price State
Identification

**Figure:** High Electricity Price State
Identification

![Diagram showing cost against quality with points labeled ES X, State, and FE.](image)

**Figure**: Low Electricity Price State
Identification

Figure: High Electricity Price State
Identification

Figure: Low Electricity Price State
Empirical Strategy
Preferred Specification

Conditional logit with observed heterogeneity:

\[ U_{ijtr} = - \eta_i \text{Price}_{jrt} \]
\[ - \alpha_i \text{SalesTax}_{jrt} - \beta_i \text{SalesTax}_{jrt} \times \text{DHoliday}_{rt} \]
\[ + \psi_i \text{Rebate}_{rt}^{DSM} \times \text{ES}_{jt} \]
\[ + \phi_i \text{During}_{rt}^{C4A} \times \text{ES}_{jt} + \zeta_i \text{Before}_{rt}^{C4A} \times \text{ES}_{jt} + \xi_i \text{After}_{rt}^{C4A} \times \text{ES}_{jt} \]
\[ - \theta_i \text{ElecCost}_{jrt} - \rho_i \text{ElecCost}_{jrt} \times \text{ES}_{jt} \]
\[ + \gamma_j + \text{ES}_{jt} \times \text{State}_r + \text{BrandMonthFE}_{jt} \]
\[ + \text{Demo}_i \times \text{Attributes}_j + \epsilon_{ijtr} \]

• No outside option: static model of choice in a particular store
• Consumer-specific consideration set based on size purchased.
Estimation

- Infeasible to estimate this ML model with millions of transactions
- For each of the 6 income groups, draw about 55,000 households
- Estimate the model by maximum likelihood
Results
### Table: Estimation Results: Conditional Logit

<table>
<thead>
<tr>
<th>Category</th>
<th>&lt;$30,000</th>
<th>≥$30,000</th>
<th>≥$50,000</th>
<th>≥$75,000</th>
<th>≥$100,000</th>
<th>≥$150,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price</td>
<td>-0.42***</td>
<td>-0.41***</td>
<td>-0.38***</td>
<td>-0.36***</td>
<td>-0.35***</td>
<td>-0.30***</td>
</tr>
<tr>
<td>Elec.</td>
<td>-2.68***</td>
<td>-2.68***</td>
<td>-2.69***</td>
<td>-2.65***</td>
<td>-2.72***</td>
<td>-2.34***</td>
</tr>
<tr>
<td>Elec.-ES</td>
<td>1.06***</td>
<td>0.93***</td>
<td>0.91***</td>
<td>0.78***</td>
<td>0.73***</td>
<td>0.47*</td>
</tr>
<tr>
<td>SalesTax</td>
<td>-0.30**</td>
<td>-0.23*</td>
<td>-0.25**</td>
<td>-0.21**</td>
<td>-0.15*</td>
<td>-0.25***</td>
</tr>
<tr>
<td>T-Holiday</td>
<td>-0.01</td>
<td>-0.15</td>
<td>0.002</td>
<td>-0.19</td>
<td>-0.14</td>
<td>-0.08</td>
</tr>
<tr>
<td>DSM</td>
<td>0.03</td>
<td>0.01</td>
<td>-0.01</td>
<td>0.00</td>
<td>-0.01</td>
<td>-0.03</td>
</tr>
<tr>
<td>CFA:</td>
<td>0.12***</td>
<td>0.13***</td>
<td>0.08***</td>
<td>0.06**</td>
<td>0.06**</td>
<td>0.02</td>
</tr>
<tr>
<td>During</td>
<td>0.14***</td>
<td>0.04</td>
<td>0.10***</td>
<td>0.05</td>
<td>0.01</td>
<td>0.02</td>
</tr>
<tr>
<td>CFA : Before</td>
<td>-0.05</td>
<td>-0.05</td>
<td>0.002</td>
<td>0.01</td>
<td>-0.002</td>
<td>-0.001</td>
</tr>
<tr>
<td>CFA : After</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Interpretation of Behavioral Parameters

- $\eta_i$: Marginal utility of income
  - Key parameter to interpret the relative magnitude of other behavioral parameters.
Interpretation of Behavioral Parameters

- $\eta_i$: **Marginal utility of income**
  - Key parameter to interpret the relative magnitude of other behavioral parameters.

- $\alpha_i/\eta_i$: **Sales tax salience and lack of information about local taxes**
  - $\alpha_i/\eta_i < 1$: Behavioral biases play a role.
Interpretation: Sales Tax

![Graph showing the normalized coefficient for different income groups.](image)
Interpretation of Behavioral Parameters, Contd.

- $\psi_i/\eta_i$: Probability to Claim Utility Rebates
- $\phi_i/\eta_i$: Probability to Claim C4A Rebates
• $\psi_i/\eta_i$: Probability to Claim Utility Rebates
• $\phi_i/\eta_i$: Probability to Claim C4A Rebates

• $\psi_i/\eta_i < 1$, $\phi_i/\eta_i < 1$: “Transaction/Hassle costs” to claim rebates play a role.
Interpretation: Utility Rebates
Interpretation: CFA Rebates

![Graph showing normalized coefficients for different income groups](image-url)
Interpretation of Behavioral Parameters, Contd.

- With $\theta_i$ and $\eta_i$ we can solve for an \textbf{implied discount rate}
Interpretation of Behavioral Parameters, Contd.

• With $\theta_i$ and $\eta_i$ we can solve for an **implied discount rate**

• If consumers form time-invariant expectations about the yearly operating electricity cost

• No depreciation

Lifetime energy operating cost ($L C_j$) for the durable $j$ is given by

$$L C_{ij} = \sum_{t=1}^{L} \rho_i^t C_{ij} = \rho_i \cdot \frac{1 - \rho_i^L}{1 - \rho_i} \cdot C_j,$$

Therefore, we have:

$$\theta_i = \eta_i \cdot \rho_i \cdot \frac{1 - \rho_i^L}{1 - \rho_i},$$

where $\rho_i = 1/(1 + r_i)$.

$\theta_i/ \left( \eta_i \cdot \rho_i(5\%) \cdot \frac{1 - \rho_i(5\%)^L}{1 - \rho_i(5\%)} \right) < 1$ Behavioral biases play a role.
Interpretation: Elec. Costs at $r = 5\%$
Interpretation: Elec. Costs X ES at $r = 5\%$
Take Aways Empirics

- For all energy fiscal instruments, large micro-frictions
- Low income HDs subject to larger behavioral biases (energy costs, sales taxes)
- Higher income HDs subject to larger transaction costs (rebates)
- Energy Star magnifies the biases on the perception of energy costs
Policy Analysis
Welfare Measure

- We have a model of decision utility
- We have to take a stand and interpret the discrepancy between the coefficient on price and the other coefficients capturing the behavioral responses to costs and subsidies
Welfare Measure

- We have a model of decision utility
- We have to take a stand and interpret the discrepancy between the coefficient on price and the other coefficients capturing the behavioral responses to costs and subsidies

- Is there a discrepancy between decision and experienced utility?
  - All consumers ultimately pay the sales tax and future electricity costs. Do the “muted” behavioral responses reflect a lack of information?
  - Not all consumers take advantage of rebates. The coefficient on rebates reflects the fact that the probability of taking rebates is less than one due to various hassle costs.
Our Assumptions

Assumption 1:  
Under perfect information, the behavioral responses to sales taxes and sales tax holidays should be the same as for prices.

Assumption 2:  
Under perfect information, the coefficient on electricity cost should imply a discount rate in line with other investment/borrowing decisions. We assume $r = 5\%$.

Assumption 3:  
Under perfect information, the ES certification should not impact how consumers perceive electricity costs.
Welfare Measure

• Leggett (2002) developed a framework to compute welfare with uninformed consumers in a discrete choice setting.
• Allcott (2013), Kuminoff et al. (2015), and Dubois et al. (2016) rediscovered and applied it.
• Other recent applications: Houde (2017), Kuminoff et al. (2016), Reynaert and Sallee (2016), and Allcott and Knittle (2017).
Welfare Measure with Leggett’s Correction

CS for a policy change \( \mathcal{P} \rightarrow \tilde{\mathcal{P}} \):

\[
CS_{itr} = \frac{1}{\eta_i} \cdot \left[ \ln \sum_j \exp(\tilde{U}_{ijtr}) + \sum_j \tilde{P}_{ijtr}(\tilde{U}_{ijtr}^E - \tilde{U}_{ijtr}) \right] - \\
\frac{1}{\eta_i} \cdot \left[ \ln \sum_j \exp(U_{ijtr}) + \sum_j P_{ijtr}(U_{ijtr}^E - U_{ijtr}) \right]
\]

where

\[
U_{ijtr}^E = -\eta_i P_{jrt} - \eta_i \text{Tax}_{jrt} - \eta_i \rho_i \frac{1 - \rho_i^L}{1 - \rho_i} \text{Elec}_{jrt} \]

\[
+ \psi_i R_{rt}^{\text{Utility}} \times ES_{jt} + \phi_i R_{rt}^{\text{CFA}} \times ES_{jt} + \gamma_{ij} + \tau_i ES_{jt} + \epsilon_{ijtr}
\]
Welfare Measure with Leggett’s Correction

Standard welfare measure:

\[ CS_{itr} = \frac{1}{\eta_i} \cdot \left[ \ln \sum_j \exp(\tilde{U}_{ijtr}) - \ln \sum_j \exp(U_{ijtr}) \right] \]

Leggett’s correction:

\[ CS_{itr} = \frac{1}{\eta_i} \cdot \left[ \sum_j \tilde{P}_{ijtr} (\tilde{U}_{ijtr}^E - \tilde{U}_{ijtr}) - \sum_j P_{ijtr} (U_{ijtr}^E - U_{ijtr}) \right] \]
Optimal Pigouvian Tax

- Externality cost: $\phi = 0.02 \$/kWh (\approx $100 carbon tax)
- Electricity price: 0.11 \$/kWh
- No rebates and sales tax
Optimal Pigouvian Tax

- Externality cost: $\phi = 0.02$ $$/kWh$ ($\approx$ $100$ carbon tax)
- Electricity price: 0.11 $$/kWh$
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- Transaction cost model:
  $\tau = 0.02$ $$/kWh$
Optimal Pigouvian Tax

- Externality cost: $\phi = 0.02 \text{ $/kWh (}$\approx$ 100 \text{ carbon tax)$
- Electricity price: 0.11 \text{ $/kWh}
- No rebates and sales tax

- Transaction cost model:
  $\tau = 0.02 \text{ $/kWh}

- Behavioral bias energy costs:
  $\tau = 0.104 \text{ $/kWh}$
Optimal Pigouvian Tax

- Externality cost: $\phi = 0.02 \text{$/kWh} \approx $100 \text{ carbon tax}$
- Electricity price: $0.11 \text{$/kWh}$
- No rebates and sales tax

- Transaction cost model: $\tau = 0.02 \text{$/kWh}$
- Behavioral bias energy costs: $\tau = 0.104 \text{$/kWh}$
- Differentiated bias-adjusted tax: $\tau_k = [0.129, 0.124, 0.106, 0.095, 0.083, 0.085] \text{$/kWh}$
## Comparison of Energy Fiscal Instruments

<table>
<thead>
<tr>
<th>Policy Scenario</th>
<th>Optimal Policy</th>
<th>Social Welfare ($/consumer)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pigou tax: no adjustment</td>
<td>$\tau = 0.020 \ $/kWh</td>
<td>1.791</td>
</tr>
<tr>
<td>Bias-adjusted Pigou tax</td>
<td>$\tau = 0.104 \ $/kWh</td>
<td>5.049</td>
</tr>
<tr>
<td>CFA rebate</td>
<td>$S^{CFA} = $50</td>
<td>0.047</td>
</tr>
<tr>
<td>Mean-tested CFA rebate</td>
<td>$S^{CFA} = [$32, $42, $61, $74, $57, $36]</td>
<td>0.050</td>
</tr>
<tr>
<td>ES Sales tax</td>
<td>$T_{ES}^s = 4.62%, \ T_{nonES}^s = 6.43%</td>
<td>0.575</td>
</tr>
<tr>
<td>Pigouvian tax with CFA rebate</td>
<td>$\tau = 0.104 \ $/kWh, \ S^{CFA} = $1</td>
<td>5.049</td>
</tr>
<tr>
<td>Pigou tax with ES sales tax</td>
<td>$\tau = 0.104 \ $/kWh, \ T_{ES}^s \approx 0%, \ T_{nonES}^s \approx 0%</td>
<td>5.049</td>
</tr>
</tbody>
</table>
When Should We Combine an Energy Tax with Subsidies?

- The ‘gradient’ of the behavioral responses to energy costs is increasing with income.
- The bias-adjusted tax is too low for lower income HDs and too high for higher income HDs.
- Subsidies are not socially desirable for high income HDs.
- Here the trade-off between low and high income implies that no subsidy is optimal.
When Should We Combine an Energy Tax with Subsidies?

- The ‘gradient’ of the behavioral responses to energy costs is increasing with income.
- The bias-adjusted tax is too low for lower income HDs and too high for higher income HDs.
- Subsidies are not socially desirable for high income HDs.
- Here the trade-off between low and high income implies that no subsidy is optimal.

What if the level and gradient of the behavioral responses to subsidies were different?
When Should We Combine an Energy Tax with Subsidies?

**Figure:** Varying the Gradient and Level of the Behavioral Responses to CFA rebate
When Should We Combine an Energy Tax with Subsidies?

**Figure:** Sensitivity with Respect to Behavioral Responses to CFA rebate
The Unintended Effect of the Energy Star (ES) Certification

Remember

- The interaction of ES and energy costs leads to a lower behavioral response
- We have also find a large WTP for the ES label: $101, $103, $131, $168, $174, $136,
- Are those behavioral responses to the label preferences or biases?
- Adjustment cost model:
  \[ \tau = 0.02 \ $/kWh \]
- Behavioral bias energy costs and no Energy Star bias:
  \[ \tau = 0.104 \ $/kWh \]
- Behavioral bias energy costs and with Energy Star bias:
  \[ \tau = -0.004 \ $/kWh \]
If Energy Star (ES) Acts as a Bias

<table>
<thead>
<tr>
<th>Policy Scenario</th>
<th>Optimal Policy</th>
<th>Social Welfare ($/consumer)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Welfare definition: ES \times \text{ElecCost} \neq 0 and WTP for ES acts as a bias</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pigou tax: no adjustment</td>
<td>\tau = 0.020 $/kWh</td>
<td>-2.513</td>
</tr>
<tr>
<td>Bias-adjusted Pigou tax</td>
<td>\tau = -0.072 $/kWh</td>
<td>4.483</td>
</tr>
<tr>
<td>CFA rebate</td>
<td>\text{S}^{\text{CFA}} = 0</td>
<td>0</td>
</tr>
<tr>
<td>ES Sales tax</td>
<td>\text{T}^s_{\text{ES}} = 25.15%, \text{T}^s_{\text{nonES}} = -1.41%</td>
<td>19.044</td>
</tr>
<tr>
<td>Pigouian tax with CFA rebate</td>
<td>\tau = -0.072$/kWh, \text{S}^{\text{CFA}} = 0</td>
<td>4.483</td>
</tr>
<tr>
<td>Pigou tax with ES sales tax</td>
<td>\tau = 0.033, \text{T}^s_{\text{ES}} = 27.08%, \text{T}^s_{\text{nonES}} = -4.12%</td>
<td>19.606</td>
</tr>
</tbody>
</table>
Conclusions

- Propose the concept of micro-frictions to study the behavioral responses to fiscal instruments
- Heterogeneity in behavioral biases may motivate overlapping fiscal instruments.
- We found substantial heterogeneity, but the patterns are such that they don’t motivate combining a Pigouvian tax with subsidies.
Thank you!

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