Who Bears the Burden of Energy Taxes?
The Role of Local Pass-Through

Samuel Stolper

MIT and Michigan

November 11th, 2016
The basic question

What are the distributional impacts of energy taxation?
The basic question

What are the distributional impacts of energy taxation?

Why do we care?
The basic question

What are the distributional impacts of energy taxation?

Why do we care?

- Energy taxes are:
  - An important type of environmental policy
The basic question

What are the distributional impacts of energy taxation?

Why do we care?

- Energy taxes are:
  - An important type of environmental policy
  - Quite common throughout the world
The basic question

What are the distributional impacts of energy taxation?

Why do we care?

- Energy taxes are:
  - An important type of environmental policy
  - Quite common throughout the world
  - Frequently criticized for disproportionately burdening the poor
This paper

What I do:

- Study the distributional equity of energy taxes in one particular context:
What I do:

- Study the distributional equity of energy taxes in one particular context:
  - The Spanish market for automotive fuel
1 Motivation

This paper

What I do:

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How I do it:

- Estimate automotive fuel tax pass-through to end consumer prices
This paper

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- Quantify not just average pass-through but also local pass-through, as a function of market conditions:
This paper

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- Quantify not just *average* pass-through but also *local* pass-through, as a function of market conditions:
  - Degree of competition
  - Wealth of local consumers
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- Estimate automotive fuel tax pass-through to end consumer prices
- Quantify not just *average* pass-through but also *local* pass-through, as a function of market conditions:
  - Degree of competition
  - Wealth of local consumers
- Link price impacts to welfare impacts, by wealth bracket
Pass-through and consumer surplus

\[ P \quad Q \quad D \quad S \quad 0 \quad S_1 \quad Q_1 \quad Q_0 \quad dt \]

\[ P_1 \quad P_0 \]

Lit Review

Overfull PT

Samuel Stolper  (MIT and Michigan)  Automotive Fuel Tax Incidence  November 11th, 2016
Geoportal

[Image of a Geoportal map with various search options and markers]

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The Geoportal on mobile

Samuel Stolper (MIT and Michigan)  Automotive Fuel Tax Incidence  November 11th, 2016
Centimo Sanitario

The graph shows the number of state-specific retail diesel tax hikes and the mean tax level from January 2007 to January 2013. The number of hikes and the mean tax level both exhibit an upward trend during this period.
Assessing price trends around tax hikes

Event study model

\[ P_{it} = \alpha + \sum_{j=a}^{b} \pi^j D_{st}^j + X_{it}' \delta + \lambda_i + \sigma_t + \varepsilon_{it} \]

- Index \( j \) denotes a time period relative to the event of interest - a tax hike
  - \( D_{st}^j \) is a binary variable equaling one if time \( t \) is \( j \) periods (where \( j \in [a, b] \)) after a tax hike in state \( s \)
  - \( [a, b] = [-12, 12] \); observation window is thus 6 months wide
Price impacts of tax hikes are mean shifts
Empirical model of tax pass-through

Main fixed effects specification

\[ P_{it} = \alpha + \beta \text{Tax}_{st} + X'_{it} \delta + \lambda_i + \sigma_t + \varepsilon_{it} \]

Adding interactions between the tax variable and local market characteristics:

\[ P_{it} = \alpha + \beta \text{Tax}_{st} + X'_{it} \delta + \sum_{k=1}^{K} (\gamma_k \text{Tax}_{st} \ast X^k_{it}) + \lambda_i + \sigma_t + \varepsilon_{it} \]
### Estimates of average and local pass-through

<table>
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<tr>
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<th>(3)</th>
<th>(4)</th>
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<td>0.845***</td>
<td>0.943***</td>
<td>0.868***</td>
<td>0.598***</td>
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<td></td>
<td>(0.036)</td>
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<td>(0.036)</td>
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<td>Ownership concentration</td>
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<td>(0.045)</td>
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<td>(0.038)</td>
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<td>0.220***</td>
<td>0.195***</td>
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<td>Avg. House Price</td>
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<td>(0.042)</td>
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</table>

Robustness checks
Empirical distribution of pass-through rates

Density

Pass-Through Rate (%)

Raw St. Dev. = 13.2
Adj. St. Dev. = 12.3
Distributional welfare analysis, graphically
Heterogeneous pass-through and regressivity

Goal: estimate tax burdens on households in different wealth brackets, as a proportion of overall wealth

- Following Poterba (1991), Fullerton and West (2003), and Treasury OTA
Heterogeneous pass-through and regressivity

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  - Accurately depicts relative tax burdens only if \( \frac{dp}{dt} \) is uniform
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  - Accurately depicts relative tax burdens only if $\frac{dp}{dt}$ is uniform
- Compare to using $(\frac{Q^{fuel}}{E^{tot}}) \times \frac{dp}{dt}$, where $\frac{dp}{dt}$ is the corresponding wealth-decile specific pass-through rate
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- Collect data on household consumption of automotive fuel ($Q_{fuel}^\text{tot}$) and total expenditure ($E_{tot}$)
- Graph average ($\frac{Q_{fuel}^\text{tot}}{E_{tot}}$) by decile of $E_{tot}$
  - Accurately depicts relative tax burdens only if $\frac{dp}{dt}$ is uniform
- Compare to using ($\frac{Q_{fuel}^\text{tot}}{E_{tot}}$) $\times$ $\frac{dp}{dt}$, where $\frac{dp}{dt}$ is the corresponding wealth-decile specific pass-through rate
  - Assumes house-price decile equals expenditure decile
Is the Spanish diesel tax regressive?

![Graph showing the distributional equity of the diesel tax as a percentage of overall expenditure across different deciles of overall expenditure. The graph indicates a relatively flat distribution, suggesting that the tax burden is not highly regressive.](image)
Is the Spanish diesel tax regressive?

![Graph showing the per-unit tax burden as a percentage of overall expenditure across different expenditure deciles. The graph compares uniform and heterogeneous petrol taxes.]
Policy takeaways

Local variation in pass-through seriously changes estimates of distributional welfare impacts.
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- In Spain, accounting for heterogeneous pass-through suggests the diesel tax is *progressive*
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- In general, higher pass-through in richer areas means existing estimates may be biased towards regressivity
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Much of the world is considering some form of policy to mitigate climate change
Policy takeaways

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Much of the world is considering some form of policy to mitigate climate change

- Nearly any such policy will raise the price of energy
Local variation in pass-through seriously changes estimates of distributional welfare impacts

- In Spain, accounting for heterogeneous pass-through suggests the diesel tax is *progressive*.
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Much of the world is considering some form of policy to mitigate climate change

- Nearly any such policy will raise the price of energy.
- Optimal policy depends on an accurate picture of distributional implications.
Thank you for your time!

sstolper@mit.edu
The use of pass-through in energy tax research

Existing analyses assume uniform – and usually, full – pass-through

- Gasoline: West (2003); West and Williams (2004); Bento et al (2005, 2009)
- Carbon: Metcalf (2009); Grainger and Kolstad (2010); Metcalf, Mathur, and Hasset (2011); Mathur and Morris (2012)

Why might pass-through be non-uniform?

- Variation in supply conditions (Marion and Muehlegger 2011)
- Variation in the makeup of the demand side: preferences, budget constraints
The use of pass-through in energy tax research

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Why might pass-through be non-uniform?

- Variation in supply conditions (Marion and Muehlegger 2011)
- Variation in the makeup of the demand side: preferences, budget constraints
- Variation in competition (Doyle and Samphantharak 2008)
The possibility of > 100% pass-through

A. Perfect Competition

B. Monopoly
Other data details

Demand-side variables

- Population density: municipal-year
- Education levels: cross-sectional, 1x1-km grid with incomplete coverage
- House prices per unit area: municipal-quarter (only if ≥25,000 residents)

In main analysis, I use only the stations with demand-side data

- Cuts sample from 9,457 to 2,553
- I show results with the national sample as well, for comparison
Geography of selected stations
## Characteristics of stations and their surroundings

<table>
<thead>
<tr>
<th>Panel A. Characteristics of stations</th>
<th>Mean</th>
<th>St. Dev.</th>
<th>Min</th>
<th>Max</th>
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<tbody>
<tr>
<td>Retail price (c/L)</td>
<td>98.59</td>
<td>4.84</td>
<td>73.54</td>
<td>117.64</td>
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<tr>
<td>1[Refiner branded]</td>
<td>0.58</td>
<td>0.49</td>
<td>0</td>
<td>1</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Panel B. Characteristics of stations’ surroundings</th>
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<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td># of rival stations, weighted by inverse travel time</td>
<td>0.47</td>
<td>0.14</td>
<td>0</td>
<td>2.13</td>
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<tr>
<td>Own-firm proportion</td>
<td>0.40</td>
<td>0.26</td>
<td>0.07</td>
<td>1</td>
</tr>
<tr>
<td>Municipal mean house price (1000s of /m²)</td>
<td>1.99</td>
<td>0.64</td>
<td>0.83</td>
<td>3.86</td>
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<tr>
<td>N</td>
<td>2,553</td>
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</tbody>
</table>
County-level price differences are negligible

Most and Least Expensive Counties in Andalucia

- **Malaga Avg**
- **Almeria Avg**
Municipality-level differences are not negligible
Is pass-through heterogeneous?

Weighted count of stations w/in 5 minutes drive

Own-Firm Proportion

Samuel Stolper (MIT and Michigan)  Automotive Fuel Tax Incidence  November 11th, 2016 8 / 9
## Checks on robustness of estimates

<table>
<thead>
<tr>
<th></th>
<th>(1) County clusters</th>
<th>(2) State-year FE</th>
<th>(3) Post-2010</th>
<th>(4) Full sample</th>
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</thead>
<tbody>
<tr>
<td>Mean Tax Level</td>
<td>0.231*</td>
<td>0.532***</td>
<td>0.826***</td>
<td>0.766***</td>
</tr>
<tr>
<td></td>
<td>(0.136)</td>
<td>(0.144)</td>
<td>(0.054)</td>
<td>(0.054)</td>
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<tr>
<td>Mean Tax Level X</td>
<td>0.095***</td>
<td>0.100***</td>
<td>0.134***</td>
<td>0.109***</td>
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<tr>
<td>1[Refiner brand]</td>
<td>(0.023)</td>
<td>(0.021)</td>
<td>(0.029)</td>
<td>(0.015)</td>
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<tr>
<td>Mean Tax Level X</td>
<td>-0.090***</td>
<td>-0.054***</td>
<td>-0.098***</td>
<td>-0.039*</td>
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<tr>
<td># of stations w/in 5 min</td>
<td>(0.030)</td>
<td>(0.019)</td>
<td>(0.030)</td>
<td>(0.019)</td>
</tr>
<tr>
<td>Mean Tax Level X</td>
<td>0.090***</td>
<td>0.085***</td>
<td>0.094**</td>
<td>0.058*</td>
</tr>
<tr>
<td>Own-firm proportion</td>
<td>(0.033)</td>
<td>(0.028)</td>
<td>(0.040)</td>
<td>(0.03)</td>
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<tr>
<td>Mean Tax Level X</td>
<td>0.195***</td>
<td>0.124***</td>
<td>0.124***</td>
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</tr>
<tr>
<td>Avg. House Price</td>
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<td>(0.036)</td>
<td>(0.036)</td>
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<tr>
<td>Demand-side interactions</td>
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