Appendix A: Data and Empirical Methods

**Grocery Experiment.** The store changes product prices on Wednesday nights and leaves the prices fixed (with rare exceptions) for the following week, termed a “promotional week.” To synchronize our intervention with this pricing cycle, a team of researchers and research assistants printed tags every Wednesday night and attached them to each of the 750 products. The tags were changed between 11 pm and 2 am, which are low-traffic times at the store. The tags were printed using a template and card stock supplied by the store (often used for sales or other additional information on a product) in order to match the color scheme and layout familiar to customers. The two control stores were chosen by a minimum-distance criterion based on the characteristics listed in Appendix Table 1.

The raw scanner data provided by the grocery chain contains information on weekly revenue and quantity sold for each product (UPC id) that was sold among the 108 categories listed in Appendix Table 2 in the three stores from 2005 week 1 to 2006 week 15. The original dataset contains 331,508 product-week-store observations. The quantity and revenue variables are measured net of returns (i.e., returns count as negative sales). We exclude 1,756 observations where the weekly quantity or revenue was zero or negative, which are cases where as many or more items were returned than purchased in that week. Including these observations does not affect the results. Finally, we aggregate to the category-week-store level by summing quantity and revenue across products, setting the sum to zero if no products were sold in a given category-week-store.

The average price for each category of goods is defined as $P_{ct} = \frac{\sum_{i \in c}(p_{it}q_{it})}{\sum_{i \in c}q_{it}}$ where $c$ indexes the category, $t$ time, and $i$ products, $p_{it}$ is the price of good $i$ at time $t$, and $q_{it}$ is the average quantity sold of good $i$. This “category price” is effectively a price index for a fixed basket of products where each product’s weight in the basket is determined by its average weekly sales over the period before and during the experiment. Since the scanner data reports only items that have sold each week, we impute prices for unsold items when constructing $P_{ct}$. In particular, we use the price in the last observed transaction for unsold products; if no previous price is available, we use the next available price. Alternative imputation methods – such as using the closest observed price, or an average of previous and subsequent prices – give similar results. Varying the imputation technique has little impact on the estimates in Tables 4 and 5 because items requiring imputation have low sales volume, and therefore receive little weight in the category-level price variable.

**Grocery Store Survey.** We surveyed 91 customers entering the treatment store in August 2006 about their knowledge of sales taxes. Survey respondents were offered candy bars and sodas to spend a few minutes filling out the survey displayed in Appendix Exhibit 2. After collecting basic demographic information, the survey asked individuals to report whether each of eight goods were subject to sales tax or not. Many individuals remarked while filling out the survey that they did not think about taxes while shopping, and therefore were hesitant to report which goods were taxed. These individuals were asked to mark their best guess to avoid nonresponse bias. To assess whether knowledge of taxes is correlated with experience, we also asked whether individuals had purchased each of these goods recently. Finally, we asked questions about tax rates and bases – the sales tax rate in the city where the store is located, the state income tax rate, and the tax base for the federal estate tax.

State excise tax rates on beer are primarily obtained from the Brewer’s Almanac (various years), published annually by the Beer Institute. These rates were verified and corrected using the Tax Foundation’s State Tax Collections and Rates (various years) and the State Tax Handbook. Our measure of the excise rate includes taxes that are statutorily ‘local’ excise taxes – which are sometime excluded from state statistics available in the Brewer’s Almanac – that are applied state-wide. Specifically, in Alabama, Georgia, and Louisiana all counties or localities levy an excise tax in addition to the state excise tax.

Excise taxes on alcohol frequently differ by product, packaging, and whether sold for on- or off-premise consumption. In states where rates differ, our measure corresponds to the excise tax on packaged 12oz. beer, sold for off-premise consumption, with an alcohol content of 3.2 percent or more. Excise rates on other beer products are highly correlated with this measure across states, and the timing of tax changes for different categories of alcoholic beverages within a state are virtually identical. Per-gallon taxes are converted to per-case rates by multiplying by 2.25, the number of gallons in 24 12oz. cans or bottles. The excise tax rate is converted into an ad valorem rate by dividing the real CPI-adjusted beer excise tax per case in year 2000 dollars by the average cost of a case of beer in the United States in 2000, as measured by the Beer Institute. Since Alaska has a higher price level than the continental United States, we follow Census Bureau practice and adjust its price level up by 25 percent when calculating the percentage excise tax rate. None of our results are affected by this adjustment, or by excluding Alaska entirely. For a subset of years (1982-2000) and states, we have actual beer price data from the ACCRA cost of living index survey, which samples the price of a six pack of beer (Budweiser, Schlitz, or Miller Lite) in large cities. We define the ACCRA price variable as the annual average of all prices in each state.

State sales taxes are obtained primarily from the World Tax Database (2006) at the University of Michigan. These data were verified and corrected using state Department of Revenue websites and the State Tax Handbook. Four states (KS, VT, DC, MN) apply a higher sales tax rate to alcohol than other products. In those states we include the alcohol rate rather than the general sales rate when they differ. We supplement the data on state-level sales taxes with data on average local sales tax rates, which are imputed from data on local revenues from the Census Bureau’s Survey of State and Local Government Finances and a tax base defined as state revenues divided by the state rate.

Since our estimation strategy relies on the timing and magnitude of the tax changes, we evaluate the precision of the data by regressing the change in the log of state tax revenues on the change in the log of the sales tax rate, controlling for state income. In the full sample, the coefficient estimate on the sales tax rate is 0.76 (s.e. 0.03). A state-by-state analysis of changes in rates and changes in revenues also yields similarly high correlations, with the exception of West Virginia. In WV, the correlation between sales tax rates and revenues is near zero and statistically insignificant, perhaps because the tax base is often changed at the same time as the rate. Since this problem could artificially attenuate the sales tax elasticity, we exclude West Virginia from our analysis.
Appendix B: Proof of Proposition 2

We derive an expression for $EB(t^S)$ using Taylor expansions that ignore third and higher-order terms, i.e. terms proportional to $(t^S)^n$ for $n \geq 3$. Let $V^*(p, t^S, Z)$ denote the utility attained by a fully optimizing agent who consumes the optimal bundle $(x^*(p, t^S, Z), y^*(p, t^S, Z))$. Let $R^*(p, t^S, Z) = t^S x^*(p, t^S, Z)$ denote tax revenue obtained from a fully optimizing agent.

The agent’s loss from failing to optimize relative to the tax is

$$G(t^S) = e(p, 0, V^*(p, t^S)) - e(p, 0, V(p, t^S))$$

The gain in revenue due to the agent’s underreaction to the tax is

$$\Delta R(t^S) = R(p, t^S, Z) - R^*(p, t^S, Z)$$

Recall that excess burden in the full optimization case is

$$EB^*(t^S) = Z - e(p, 0, V^*(p, t^S)) - R^*(p, t^S, Z).$$

Combining these three equations, we can rewrite the formula for excess burden in (??) as

$$EB(t^S) = EB^* - \Delta R + G.$$  

We will use Taylor expansions to obtain simple expressions for each of these three terms below.

i) Auerbach (1985) shows that ignoring third-order terms, excess burden for an optimizing agent is

$$EB^* = -\frac{1}{2}(t^S)^2 \frac{\partial x^c}{\partial p}$$

ii) Ignoring third-order terms, the $\Delta R$ term can be written as:

$$\Delta R = -t^S(x^* - x) = (t^S)^2(\frac{\partial x}{\partial t^S} - \frac{\partial x}{\partial p})$$

iii) Simplifying the expression for $G$ requires more work. First recall that the expenditure function is

$$e(p, t^S, V) = (p + t^S)x^c(p, t^S, V) + y^c(p, t^S, V)$$

and hence

$$\frac{\partial e}{\partial V} = (p + t^S)\frac{\partial x^c}{\partial V} + \frac{\partial y^c}{\partial V}.$$  

The expenditure minimization problem is

$$\min(p + t^S)x^c + y^c \text{ s.t. } u(x) + v(y) = V$$

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Differentiating the utility constraint for the expenditure minimization problem (EMP) yields

\[
    u'(x^c) \frac{dx^c}{dV} + v'(y^c) \frac{dy^c}{dV} = 1
\]

The first-order-condition for the EMP implies

\[
    u'(x^c) = (p + t^S)v'(y^c)
\]

and hence we obtain the equation

\[
    (p + t^S) \frac{\partial x^c}{\partial V} + \frac{\partial y^c}{\partial V} = \frac{1}{v'(y^c)} = \frac{\partial e(p, t^S, V^*)}{\partial V}
\]

where all the derivatives are evaluated at \((p, t^S, V^*)\). Using a Taylor expansion, we write

\[
    G = \frac{\partial e(p, t^S, V^*)}{\partial V} [V^*(p, t^S, Z) - V(p, t^S, Z)] - \frac{1}{2} \frac{\partial^2 e(p, t^S, V^*)}{\partial V^2} [V^* - V]^2 + ...
\]

We show below that \(V^* - V\) is proportional to \((t^S)^2\); hence, the \([V^* - V]^2\) and higher-order terms in this expansion can be ignored under the second-order approximation. Hence, we can write

\[
    G = \frac{[V^*(p, t^S, Z) - V(p, t^S, Z)]}{v'(y^c(p, t^S, V^*))}
\]

Define the utility gain from choosing the optimal level \(x^*\) instead of \(x\) as

\[
    \tilde{G}(x) = V^*(p, t^S, Z) - V(p, t^S, Z) = u(x^*) - u(x) + v(y^*) - v(y)
\]

\[
    = u'(x^*)(x^* - x) - \frac{1}{2} u''(x^*)(x^* - x)^2 + O^3_u + v'(y^*)(y^* - y) - \frac{1}{2} v''(y^*)(y^* - y)^2 + O^3_v
\]

where \(O^3_u\) and \(+O^3_v\) represent the third- and higher order terms of the Taylor expansions for \(u\) and \(v\). All of the terms in \(O^3_u\) and \(+O^3_v\) turn out to be proportional to \((t^S)^n\) with \(n \geq 3\), so we ignore these terms from this point onward.

Using the first-order-condition that characterizes the choice of the fully-optimizing agent,

\[
    u'(x^*) = (p + t^S)v'(y^*)
\]

and the identity

\[
    (p + t^S)(x^* - x) = (y - y^*)
\]

we obtain

\[
    \tilde{G} = -\frac{1}{2} u''(x^*)(x^* - x)^2 - \frac{1}{2} v''(y^*)(y^* - y)^2
\]

\[
    = -\frac{1}{2} (x^* - x)^2[u''(x^*) + v''(y^*)(p + t^S)^2]
\]

\[2\]
Totally differentiating the fully-optimizing agent’s first-order-condition with respect to \( p \) yields

\[
u''(x^*) \frac{\partial x^*}{\partial p} = v'(y^*) + (p + tS)v''(y^*) \frac{\partial y^*}{\partial p} = v'(y^*) + (p + tS)[-(p + tS) \frac{\partial x^*}{\partial p} - x^*]v''(y^*)\]

It follows that

\[\left[u''(x^*) + (p + tS)^2 v''(y^*)\right] \frac{\partial x^*}{\partial p} = v'(y^*) - (p + tS)x^*v''(y^*)\]

and hence

\[(3) \quad \tilde{G} = \frac{1}{2}(x^* - x)^2 \frac{v'(y^*) - (p + tS)x^*v''(y^*)}{\partial x^*/\partial p}.
\]

Defining \( \gamma_y = -y^*v''(y^*)/v'(y^*) \) it follows that

\[(4) \quad G \approx \frac{\tilde{G}}{v'(y^*)} = -\frac{1}{2}(x^* - x)^2 \frac{1}{\partial x^*/\partial p} \left[1 + (p + tS)x^*\gamma_y\right].\]

Finally, we use a result from Chetty (2006) which relates the coefficient of relative risk aversion \( \gamma_y \) to the ratio of the income effect to the substitution effect:

\[(5) \quad \gamma_y = \frac{-y^* \frac{\partial x^*}{\partial x}}{p + tS \frac{\partial x^*}{\partial p}}.
\]

Inserting this expression into (4) yields

\[
G \approx -\frac{1}{2}(x^* - x)^2 \frac{1}{\partial x^*/\partial p} \left[1 - x^* \frac{\partial x^*}{\partial x} \frac{\partial x}{\partial p} \right] = -\frac{1}{2}(x^* - x)^2 \frac{1}{\partial x^*/\partial p} = -\frac{1}{2}(tS)^2 \frac{\partial x}{\partial p} \frac{\partial x}{\partial p}.
\]

Combining the expressions for \( G \), \( \Delta R \), and \( EB^* \) above using (1) and collecting terms yields

\[
EB(t^S) = (t^S)^2 \frac{1}{\partial x}{\partial x} \left\{ \frac{\partial x}{\partial t^S} \frac{\partial x}{\partial p} - \frac{1}{2} \frac{\partial x}{\partial p} - \frac{1}{2} \frac{\partial x}{\partial p} \right\} - \frac{1}{2} \left[ \frac{\partial x}{\partial p} - \frac{\partial x}{\partial p} \right]^2.
\]

Using the Slutsky equation and the definition \( \frac{\partial x}{\partial t^S} = \frac{\partial x}{\partial t^S} \) to simplify this expression, we obtain the formula in Proposition 2.
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<tr>
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<td>Thermometers/Covers</td>
<td>37.72</td>
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<tr>
<td>5901</td>
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<td>Acid Neutralizers</td>
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<td>Anti-diarrhea</td>
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<td>5940</td>
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<td>Laxatives</td>
<td>265.29</td>
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<td>Lactose Intolerance</td>
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<td>Rectal/Hemorrhoidal</td>
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<tr>
<td>5955</td>
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<td>31.57</td>
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<tr>
<td>6001</td>
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<td>Soft Contact Lens Care</td>
<td>155.16</td>
</tr>
<tr>
<td>6005</td>
<td>Eye/Ear Care</td>
<td>Rigid Gas Permeable Contact Lens Care</td>
<td>18.55</td>
</tr>
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<td>203.62</td>
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<tr>
<td>6042</td>
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<td>Sunglasses</td>
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</tr>
<tr>
<td>6045</td>
<td>Eye/Ear Care</td>
<td>Misc. Eye Glass Accessories</td>
<td>15.28</td>
</tr>
<tr>
<td>Code</td>
<td>Category</td>
<td>Description</td>
<td>Price</td>
</tr>
<tr>
<td>--------</td>
<td>-------------------</td>
<td>------------------------------------------------------------------</td>
<td>--------</td>
</tr>
<tr>
<td>6050</td>
<td>Eye/Ear Care</td>
<td>Ear Care/Ear Plugs</td>
<td>33.25</td>
</tr>
<tr>
<td>6101</td>
<td>Foot Care</td>
<td>Insoles/Inserts</td>
<td>75.90</td>
</tr>
<tr>
<td>6105</td>
<td>Foot Care</td>
<td>Corns/Callous/Padding/Bunion/Blister</td>
<td>28.88</td>
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<tr>
<td>6110</td>
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<td>Odor/Wetness Control</td>
<td>19.64</td>
</tr>
<tr>
<td>6115</td>
<td>Foot Care</td>
<td>Anti-Fungal/Athlete's Foot</td>
<td>107.49</td>
</tr>
<tr>
<td>6120</td>
<td>Foot Care</td>
<td>Jock Itch</td>
<td>20.22</td>
</tr>
<tr>
<td>6130</td>
<td>Foot Care</td>
<td>Wart Removers</td>
<td>37.76</td>
</tr>
<tr>
<td>6190</td>
<td>Foot Care</td>
<td>Grooming and Misc. Foot Care</td>
<td>12.70</td>
</tr>
</tbody>
</table>

Note: Weekly revenue statistics based on sales in calendar year 2005.
### APPENDIX TABLE 2
Descriptive Statistics: Grocery Stores

<table>
<thead>
<tr>
<th></th>
<th>Treatment Store</th>
<th>Control Store #1</th>
<th>Control Store #2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. Store Characteristics</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean Weekly Revenue ($)</td>
<td>307,297</td>
<td>268,193</td>
<td>375,114</td>
</tr>
<tr>
<td>Total Floor Space (sq ft)</td>
<td>41,609</td>
<td>34,187</td>
<td>37,251</td>
</tr>
<tr>
<td>Store Opening Year</td>
<td>1992</td>
<td>1992</td>
<td>1990</td>
</tr>
<tr>
<td><strong>B. City Characteristics (in 1999)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population</td>
<td>88,625</td>
<td>96,178</td>
<td>90,532</td>
</tr>
<tr>
<td>Median Age (years)</td>
<td>33.9</td>
<td>31.1</td>
<td>32.3</td>
</tr>
<tr>
<td>Median Household Income ($)</td>
<td>57,667</td>
<td>51,151</td>
<td>60,359</td>
</tr>
<tr>
<td>Mean Household Size</td>
<td>2.8</td>
<td>2.9</td>
<td>3.1</td>
</tr>
<tr>
<td>Percent bachelor's degree or higher</td>
<td>19.4</td>
<td>20.4</td>
<td>18.2</td>
</tr>
<tr>
<td>Percent Married</td>
<td>60.2</td>
<td>56.9</td>
<td>58.1</td>
</tr>
<tr>
<td>Percent White</td>
<td>72.1</td>
<td>56.2</td>
<td>65.3</td>
</tr>
<tr>
<td>Distance to Treatment Store (miles)</td>
<td>7.7</td>
<td></td>
<td>27.4</td>
</tr>
</tbody>
</table>

Notes: Data on store characteristics obtained from grocery chain. Weekly revenue statistics based on sales in calendar year 2005. Data for city characteristics are obtained from the U.S. Census Bureau, Census 2000. Control stores were chosen using a least-squares minimum-distance criterion based on this set of variables.
APPENDIX EXHIBIT 1: CLASSROOM SURVEY

Short survey on spending patterns

Major: _____________
Year: _____________
Gender: _____________

Choose two items from the image projected on the screen.

Number of item #1: ___________
Number of item #2: ___________

Total bill due at the register for these two items:
$_________
This survey is part of a project about taxes being conducted by researchers at UC Berkeley. Your identity will be kept strictly confidential and will not be used in the research. If you have any questions about your rights or treatment as a participant in this research project, please contact UC-Berkeley’s Committee for Protection of Human Subjects at (510) 642-7461, or e-mail: subjects@berkeley.edu.

### Gender:  
- [ ] Male  
- [ ] Female

### Age:  

### Marital Status:  
- [ ] Married  
- [ ] Unmarried

### Education:  
- [ ] High School  
- [ ] College Degree  
- [ ] Graduate Degree

### Years You Have Lived in California:

<table>
<thead>
<tr>
<th>Is tax added at the register (in addition to the price posted on the shelf) for each of the following items?</th>
<th>Have you purchased these items within the last month?</th>
</tr>
</thead>
<tbody>
<tr>
<td>milk          Y   N                  toothpaste       Y   N</td>
<td>milk          Y   N                  toothpaste       Y   N</td>
</tr>
<tr>
<td>magazines     Y   N                  soda             Y   N</td>
<td>magazines     Y   N                  soda             Y   N</td>
</tr>
<tr>
<td>beer          Y   N                  cookies           Y   N</td>
<td>beer          Y   N                  cookies           Y   N</td>
</tr>
<tr>
<td>potatoes      Y   N                  cigarettes        Y   N</td>
<td>potatoes      Y   N                  cigarettes        Y   N</td>
</tr>
</tbody>
</table>

What is the sales tax rate in [city]? ___________%

What is the California state income tax rate in the highest tax bracket? _____________ %

What percentage of families in the US do you think pay the federal estate tax when someone dies?  
- [ ] < 2%  
- [ ] 2-10%  
- [ ] 10-25%  
- [ ] 25-50%  
- [ ] > 50%

Thank you for your time!