ISSN 1471-0498

DEPARTMENT OF ECONOMICS

DISCUSSION PAPER SERIES

TAX SALIENCE VS. PRICE UNCERTAINTY: DISENTANGLING THE EFECTS OF ATTENTION AND RATIONAL HABITS

K. Rebecca Scott

Number 736
December 2014

Manor Road Building, Manor Road, Oxford OX1 3UQ

Tax Salience vs. Price Uncertainty: Disentangling the Effects of Attention and Rational Habits

K. Rebecca Scott*

14 January 2014
(Revised 8 October 2014)

Key Words: gasoline demand, tax salience, rational habits, price elasticity

Abstract

A recent surge of literature on tax salience has included studies that use tax type as a proxy for salience. The relationship between tax type and salience is not always apparent, however, nor is salience the only feature by which taxes differ. In fact, taxes' behaviour over time suggests an alternative explanation for consumers' tax sensitivity: rational habits or forward-looking investment. Consumers affected by these intertemporal issues will be more responsive to price components that carry stronger signals about future prices—price components such as the specific taxes posited to be particularly salient.

This paper develops a model to disentangle and test for tax salience and rational habits effects. Differentiating the two effects is important, as they carry vastly different policy implications: tax salience implies that publicity and nominal incidence matter; rational habits imply all that matters is an instrument's effect on price behaviour. Examining the case of beer demand, I find evidence that favours a rational habits mechanism over a salience effect. Examining the case of gasoline demand, I find rational habits to be the more plausible explanation for consumers' sensitivity to specific taxes, though a salience effect cannot be ruled out definitively.

1 Introduction

Recent literature has devoted increasing attention to the concept of tax salience: the idea that consumer behaviour may be shaped not only by tax levels, but by taxes' visibility. Where visibility effects exist, they carry important policy implications; and empirical studies have documented several cases in which taxes of different salience provoke different responses.

Salience is not, however, the only way in which taxes differ from one another and from before-tax market signals. Taxes also differ in their behaviour over time: an ad valorem tax tracks a good's underlying price, for example, whereas a specific excise tax often remains nominally constant between discrete jumps. If a taxed good is durable or habit-forming, these differences in the time series properties of prices inform consumer behaviour. Indeed, a tax on such a good will provoke a stronger consumer response the more stable the price change it signals. The combination of consumer habits and taxes' time series properties should therefore yield different responses to different tax designs.

Unfortunately, the very tax design choices that influence time series properties are often plausibly correlated with, and used as proxies for, tax salience. Papers that rely on tax design as a proxy for salience may be capturing something other than salience effects—namely, rational habits.

*rebecca.scott@economics.ox.ac.uk

Distinguishing between salience and time-series phenomena is important because even when they drive observationally-equivalent behaviour, their policy implications may be at odds. If consumers are particularly sensitive to an excise tax because it is highlighted conspicuously alongside the before-tax price, then levying the tax higher up the supply chain will reduce consumers' sensitivity to it. If consumers are particularly sensitive to the tax because its changes tend to be long-lasting, by contrast, then shifting its nominal incidence should have no effect. In realms such as climate policy, where governments enjoy a large latitude in nominal incidence, not to mention the potential to manipulate tax salience and the stability of prices over time, the distinction between tax salience and rational habits may be crucial.

This paper briefly reviews some of the burgeoning literature on tax salience, then introduces an empirical model that distinguishes between tax salience and rational habits effects. This model is applied to two cases from the literature in which tax type has been used as a proxy for salience: beer demand and gasoline demand. In the case of beer demand, the data favours rational habits over tax salience as an explanation for the differentials in consumer responsiveness to different types of price changes. In the case of gasoline demand, salience's unobservability means a salience effect cannot be ruled out definitively; but rational habits appear to be the more plausible explanation.

2 Tax Salience Literature

Tax salience has been examined from a variety of angles in a variety of contexts—from theory on the desirability of salience in tax design[1] to empirical analysis of salience's relationship to political pressure[2] to empirical analysis of salience's effect on consumer behaviour, including demand.

Investigating the last of these, tax salience's effect on demand, requires some way of measuring or at least establishing differences in tax salience. Experimentation offers a relatively robust way to vary salience: Feldman and Ruffle (2012), for instance, provide subjects with an endowment and then observe their spending when prices are quoted with and without taxes. When prices are quoted without taxes, subjects purchase 30% more.

A seminar paper by Chetty, Looney, and Kroft (2009, henceforth "CLK") moves this experimental approach into a real-world setting. Taking advantage of the fact that prices in the US are quoted without sales tax, the authors temporarily alter a subset of prices in a grocery store to include sales tax. Observing purchasing behaviour before, after, and in comparison to stores where no intervention occurs, they find that the mere inclusion of tax in the posted price reduces consumption by 7.6%.

In both Feldman and Ruffle's (2012) laboratory experiment and CLK's grocery store experiment, the only variable factor is the inclusion or exclusion of taxes from the posted price. Although both papers acknowledge the possibility of other explanations for the observed behaviour—rounding and optimism in Feldman and Ruffle, the Hawthorne effect in CLK—there is absolutely no difference in the taxes themselves aside from how they are presented. These approaches therefore clearly identify and isolate a program for tax salience.

Finkelstein (2009), too, identifies a relatively clear program: looking at driving behaviour before and after the adoption of electronic toll collection, she finds that drivers become less price sensitive as they switch to electronic payment. She also finds that toll rates tend to increase more quickly after the adoption of electronic payments, which suggests another possible explanation: higher variability in post-adoption rates could reduce consumers' incentive to adapt to toll changes. This explanation seems unlikely, however, as the main result holds in a sample ending only two years after adoption, in which consumers are unlikely to have learned much about changes in toll rates' time series properties. The case

[1] See, for example, Bird (2010) and Schenk (2011).

[2] Cabral and Hoxby (2012), for example, examine the relationship between salience and property tax 'revolts'.

for a toll salience program is bolstered, moreover, by survey evidence on toll rate awareness of drivers paying electronically versus those paying by cash.

Natural experiments like Finkelstein's are rare, so some papers turn to a much less clean method of identifying of tax salience effects: comparing consumer responsiveness to excise taxes included in posted prices and sales taxes imposed at the register. Goldin and Homonoff (2013) take this approach in examining tax salience effects in cigarette demand. In a second empirical section, CLK take this approach in examining alcohol demand. There is no doubt that these excise and sales taxes differ in visibility. The problem with this identification strategy is that the excise and sales taxes differ in other ways, too. Excise taxes on tobacco and alcohol are levied per unit and with the intention of discouraging consumption of those specific goods. Sales taxes are levied ad valorem and apply to a broad range of goods. Since sales tax levels track underlying prices and excise taxes do not, the two are likely to have different time series properties; and since sales taxes affect a large set of goods, the two have different effects on relative prices. The former effect is particularly important in the case of addictive goods, where rational habits imply that consumers care about the behaviour of prices over time.

In applications to gasoline demand, several papers compare responsiveness to excise taxes and pretax prices. The first of these, Scott (2006), does not claim to identify a tax salience effect, positing that the extra sensitivity to the tax-driven price component might arise from tax changes' perceived permanence. Li et al. (2012), employing the same price decomposition in a static rather than a dynamic model, also find that tax-driven price changes have a greater effect than market-driven changes. They acknowledge the possibility of both the perceived permanence and the tax salience explanations. Rivers and Schaufele (2013), by contrast, focus on the tax salience interpretation. Looking at gasoline demand across Canadian provinces during a period in which carbon taxes were introduced in British Columbia and Quebec, they find that consumers are seven times more sensitive to carbon taxes than they are to pretax prices. The effect and the analysis thereof are very robust, but the attribution to a tax salience mechanism is more tenuous. All taxes are included in the posted gasoline price, which rules out the possibility that carbon taxes are particularly visible at the pump. Rivers and Schaufele offer a theoretical argument that carbon taxes are emotionally salient, affecting consumers' feelings of guilt and resentment of freeriders; but these two theoretical effects work against each other, and emotional salience is unobservable here. In the case of both carbon taxes in Canada and gasoline excise taxes in the US, consumers' extra sensitivity to taxes is insufficient to establish a tax salience effect. Further work is required to detangle tax saliency from an explanation based on price-component variability and rational habits.

3 Models

To build a model that nests tax salience and rational habits, it will help to first consider modelling each in turn.

3.1 Modelling Salience

Building a model of tax salience is complicated by the fuzzy and multifacted notions of 'salience' that run through the literature. To CLK (2009), salience is the 'visibility of the tax-inclusive price'; CLK (2007) tie this visibility to the cognitive cost of computing the post-tax price. To Rivers and Schaufele (2013), salience relates to the intent of a tax and is also defined, circularly, as the difference between responsiveness to 'tax-induced [and] equivalent market-determined price movements'. To others, salience is tied to misperceptions of tax rates (Congdon, Kling, and Mullainathan 2009) or to the onerousness of making tax payments (Cabral and Hoxby 2012). Closely-related literature on tax complexity and bounded rationality further muddies the term. Without a testable measure of salience or a credible a priori difference in salience levels, we can always define salience such that it explains observed differences in price responsiveness. To make progress in modelling salience effects, let us postpone the problem of identifying salience and assume for now that we observe salience directly.

Whatever notion of salience we employ, we expect consumers to pay greater heed to the more salient components of a price. A sensible demand model therefore weights price components by their salience. Dividing the total price p into components p_k, $k = 1, ..., K$, each with corresponding salience s_k, we could write a partial adjustment model of demand as

$$c_{it} = \lambda c_{i,t-1} + \beta_y y_{it} + \beta_p \sum_{k=1}^{K} f(s_k) p_{k,it} + \varepsilon_{it} \tag{1}$$

where c is (log) per-capita consumption, y is (log) per-capita income, and f is a monotonically increasing function that maps salience to its effect on consumers' price sensitivity. If $f(s_k) = s_k$ and s_k ranges from 0 (perfect non-salience) to 1 (perfect salience), then a perfectly non-salient price change will have no effect on consumption, and a perfectly-salient price change will have effect β_p. The value of $f(s_k)$ here is analogous to CLK's parameter θ, the ratio of the tax to the pretax elasticity of demand. In CLK (2007), θ is interpreted specifically as the proportion of individuals who optimise with respect to the tax-inclusive rather than the pretax price. CLK (2009) interprets θ more agnostically, allowing it to be a general 'measure of [...] inattention'. However we define and interpret $f(s_k)$ here, however, the simple upshot is that demand responsiveness increases with a price component's salience. Given observations of s_k and a functional form for f, and assuming s_k to be uncorrelated with any other influnces on price responsiveness, we could use this model to estimate the effect of salience on price elasticity.

3.2 Modelling rational habits

Modelling rational habits requires a slightly deeper dip into the literature. As used in the relevant literature, 'habits' implies simply that utility depends upon past as well as present consumption. An agent's utility for nicotine, for example, depends upon his smoking history: marginal nicotine utility drops off more quickly for a historically light smoker than a historically heavy smoker. Similarly, past alcohol consumption influences the utility derived from alcohol today. For goods that are not medically 'addictive', past consumption may shape current utility through indirect channels. Past gasoline consumption, for example, captures factors that influence current utility for gasoline, such as how far an agent commutes and whether he drives an SUV or a hybrid. The appearance of past consumption in the present utility function constitutes a habit. When this habit is held by a self-aware, forward-looking agent, it is a 'rational' habit, and the agent's expectations of the future take on particular importance.

Early work on rational habits (e.g. Becker et al. 1994, Spinnewyn 1981) concentrated on the certainty case, in which all future prices are known. The uncertain case, in which future prices are not known, is more germane to the present application, where we suspect uncertainty in future prices to play a key role in behaviour. For the uncertainty case, Browning (1991) shows that under certain assumptions, demand is a function of known current and lagged prices; expectations of one-period-ahead prices; and a term for the unobserved expected marginal utility of wealth, which mops up the effect of prices further in the future.

To deal more explicitly with prices further in the future, in Scott (2011b) I consider a two-good model in which utility for one of the goods is influenced by past consumption. Looking at a restricted case in which unknown future prices are drawn from known distributions, I show by simulation that an agent's responsiveness to a price change increases with the duration of that change's effect on the mean of future price distributions and decreases with uncertainty in the price distribution. I also show that uncertainty in the price distribution reduces the level of demand for the habit-forming good. Coppejans et al. (2007) prove this latter effect more rigorously, showing with much looser assumptions that an increase in the variance of future prices reduces demand for the habit-forming good.

Rational habits therefore imply two testable effects: price uncertainty reduces both the price responsiveness and the overall demand for a habit-forming good. To check for these effects empirically, we could introduce a measure of price uncertainty or forecastability into a demand regression, looking at a model of the form

$$c_{it} = \lambda c_{i,t-1} + \delta_1 y_{it} + \delta_2 p_{it} + \delta_3 \sigma_{it} + \delta_4 \sigma_{it} p_{it} + \mu_i + \varepsilon_{it} \tag{2}$$

where c is log consumption of the habit-forming good, p is its (log) price, y is (log) income, and σ_{it} is a measure of the price's uncertainty or unpredictability. This is the approach I take in Scott (2011a) to look for rational habits effects in gasoline demand at the international level. If rational habits are at work, we should expect to find $\delta_3 < 0$, implying that price uncertainty reduces the demand level, and $\delta_4 > 0$, implying that price uncertainty reduces the magnitude of price elasticity.

3.3 Nesting salience and rational habits

Neither (1) nor (2) offers a way to distinguish between tax salience and rational habits effects. To disentangle the two, let us suppose that p, the total price or log price of the good in question, can be divided into K components p_k, each with corresponding salience s_k and uncertainty σ_k. The demand responsiveness with respect to each component, β_k, is a function of its salience and uncertainty: $\beta_k = f(s_k, \sigma_k)$. More generally, allowing salience and price uncertainty to vary across cross-sections i,[3] we have

$$\beta_{ki} = f(s_{ki}, \sigma_{ki}) \tag{3}$$

Substituting these coefficients into a partial adjustment model of demand gives us

$$c_{it} = \lambda c_{i,t-1} + \beta_y y_{it} + \sum_{k=1}^{K} f(s_{ki}, \sigma_{ki})\, p_{k,it} + \varepsilon_{it} \tag{4}$$

where c is log per capita consumption and y is log per capita income. (For brevity, time effects are omitted from all models in this section; but depending on the situation it may be desirable to include either time dummies or a trend.)

If we assume f to be linear, then we can write β_{ki} as

$$\beta_{ki} = f(s_{ki}, \sigma_{ki}) = \alpha_0 + \alpha_\sigma \sigma_{ki} + \alpha_s s_{ki} \tag{5}$$

We expect each β_{ki} to be negative, as demand is generally a decreasing function of price. For consumers who have rational habits, price uncertainty decreases the magnitude of price responsiveness, so α_σ will be positive (that is, price uncertainty will make price responsiveness less negative). For consumers who are sensitive to salience, α_s will be negative (that is, salience will make price responsiveness more negative). Substituting (5) into (4) gives us

$$c_{it} = \lambda c_{i,t-1} + \beta_y y_{it} + \alpha_0 \sum_k p_{k,it} + \alpha_\sigma \sum_k \sigma_{ki} p_{k,it} + \alpha_s \sum_k s_{ki} p_{k,it} + \varepsilon_{it} \tag{6}$$

Provided we can divide the price of a good into components with observable, non-collinear variation in salience and uncertainty, (6) allows us to test empirically for (and between) salience and rational habits

[3] We could further allow salience and price uncertainty to vary across time, giving us $\beta_{k,it} = f(s_{k,it}, \sigma_{k,it})$. In situations with appropriate data, this might allow us to explore the reasons behind evolutions in price elasticity.

effects. A negative estimate of α_s is evidence of salience; a positive estimate of α_σ is evidence of habits.

If consumers respond differently to two price components, (6) also allows us to separate the difference into portions attributable to salience and rational habits. First, differentiate (or refer to (5)) to recover the short-run responsiveness with respect to a price component p_k :

$$\frac{\partial c_{it}}{\partial p_{k,it}} = \beta_{ki} = \alpha_0 + \alpha_\sigma \sigma_{ki} + \alpha_s s_{ki} \tag{7}$$

The difference in responsiveness to price components m and n is therefore

$$\frac{\partial c_{it}}{\partial p_{m,it}} - \frac{\partial c_{it}}{\partial p_{n,it}} = \beta_{mi} - \beta_{ni} = \underbrace{\alpha_\sigma (\sigma_{mi} - \sigma_{ni})}_{\text{habit-driven}} + \underbrace{\alpha_s (s_{mi} - s_{ni})}_{\text{salience-driven}} \tag{8}$$

When the effects of habits and salience counteract each other, which will happen whenever price component m is both more uncertain and more salient than component n, $|\alpha_\sigma (\sigma_{mi} - \sigma_{ni})| + |\alpha_s (s_{mi} - s_{ni})| > |\beta_{mi} - \beta_{ni}|$, so it will not be sensible to attribute *proportions* of the difference $|\beta_{mi} - \beta_{ni}|$ to habits and salience.

The model above requires that prices be broken down into components. This decomposition is simple for prices in levels. For the two cases I will be considering, beer and gasoline, prices generally take the form

$$P_{it} = (1 + sales_{it})(base_{it} + exc_{it} + Ctax_{it}) \tag{9}$$

where P is the price level, *sales* is the proportional sales tax, *base* is the pretax price, *exc* is the excise tax level, and *Ctax* is the carbon tax level (which is omitted for beer). The price level can therefore be broken into additive components:

$$P_{it} = \underbrace{sales_{it}(base_{it} + exc_{it} + Ctax_{it})}_{saleslev_{it}} + base_{it} + exc_{it} + Ctax_{it}$$

More commonly, however, we model demand using log rather than level prices. To decompose the log price into additive components, first factorise (9), then take logs:

$$P_{it} = (1 + sales_{it})(base_{it})\left(1 + \frac{exc_{it}}{base_{it}}\right)\left(1 + \frac{\frac{Ctax_{it}}{base_{it}}}{\frac{base_{it}+exc_{it}}{base_{it}}}\right) \tag{10}$$

$$\ln P_{it} = p_{it} = \ln(1 + sales_{it}) + \ln(base_{it}) + \ln\left(1 + \frac{exc_{it}}{base_{it}}\right) + \ln\left(1 + \frac{Ctax_{it}}{base_{it} + exc_{it}}\right) \tag{11}$$

The carbon price component is, of course, omitted for beer.

With this decomposition of prices, the model to be estimated is

$$\begin{aligned} c_{it} \quad = \quad & \lambda c_{i,t-1} + \alpha_0 \left[\overbrace{\ln(1 + sales_{it}) + \ln(base_{it}) + \ln\left(1 + \frac{exc_{it}}{base_{it}}\right) + \ln\left(1 + \frac{Ctax_{it}}{base_{it} + exc_{it}}\right)}^{\ln P_{it}} \right] \\ & + \alpha_\sigma \left[\sigma_{sales} \ln(1 + sales_{it}) + \sigma_{base} \ln(base_{it}) + \sigma_{exc} \ln\left(1 + \frac{exc_{it}}{base_{it}}\right) + \sigma_{Ctax} \ln\left(1 + \frac{Ctax_{it}}{base_{it} + exc_{it}}\right) \right] \\ & + \alpha_s \left[s_{sales} \ln(1 + sales_{it}) + s_{base} \ln(base_{it}) + s_{exc} \ln\left(1 + \frac{exc_{it}}{base_{it}}\right) + s_{Ctax} \ln\left(1 + \frac{Ctax_{it}}{base_{it} + exc_{it}}\right) \right] \\ & + \beta_y y_{it} + \varepsilon_{it} \end{aligned} \tag{12}$$

For comparison with the literature, we may also be interested in estimating the coefficients β_k, i.e.

the responsiveness to each price component. We can either construct $\widehat{\beta}_k$ from (12) as $\widehat{\alpha}_0 + \widehat{\alpha}_\sigma \sigma_k + \widehat{\alpha}_s s_k$, or we can estimate the β_k directly by substituting (11) into a partial adjustment model:

$$\begin{aligned} c_{it} &= \lambda c_{i,t-1} + \beta_{sales} \ln\left(1 + sales_{it}\right) + \beta_{base} \ln\left(base_{it}\right) + \beta_{exc} \ln\left(1 + \frac{exc_{it}}{base_{it}}\right) \\ &\quad + \beta_{Ctax} \ln\left(1 + \frac{Ctax_{it}}{base_{it} + exc_{it}}\right) + \beta_y y_{it} + \varepsilon_{it} \end{aligned} \tag{13}$$

In order to estimate model (12) and distinguish between salience and rational habits effects, we need to know something about the salience, s_k, and uncertainty, σ_k, for each price component. I address the identification of these two properties separately for the case of beer (Section 4.2) and gasoline (Section 5.2).

4 The Case of Beer

I first look to disentangle salience and rational habits effects in US beer demand, the case considered in the second empirical section of CLK.

4.1 Beer Data

My dataset is an annual, US state-level panel, 1982-2011, very similar to that used by CLK. Consumption, available from the National Institute on Alcohol Abuse and Alcoholism (NIAAA), is measured as gallons of beer purchased per population over 21. Beer prices are taken from C2ER's (formerly ACCRA's) Cost of Living Index, which records the price of a six-pack of Heineken, Schlitz or Budweiser in several hundred cities across the US. To construct annual state-level prices, these observations are averaged first by state, then by year, and converted into real dollars per gallon beer. State sales and excise tax rates are taken from the CLK dataset and revised and updated through 2011 using a variety of sources. Details on the dataset are provided in Appendix A, with sources listed in Appendix E.

4.2 Identifying Salience

Although we cannot tap into consumers' brains to observe salience directly, we can make a reasonable argument that visible components of a price are more salient than invisible ones. Physical visibility can therefore be used as a proxy for salience. In the case of beer, the exclusion of sales tax from the posted price implies that the sales tax is less salient than the rest of the price. If consumers are sensitive to price-component salience, they should therefore be less responsive to the sales tax than to the base price or the excise tax, ceteris paribus.

Based on this physical visibility proxy, and consistent with CLK (2007), I assign a salience of 0 to sales tax ($s_{sales} = 0$) and a salience of 1 to the base price and excise tax ($s_{base} = 1, s_{exc} = 1$). The scale of the salience measure is arbitrary, but these assignments imply a convenient interpretation of $s = 1$ as fully observable and $s = 0$ as physically unobservable.

4.3 Identifying Price Component Uncertainty

The identification of rational habits effects relies on variation in time-series uncertainty across price components. Unless price components behave differently from one another over time, that is, there is no potential for rational habits to drive a differential in responsiveness to different price components.

Table 1 reports various measures of price-component stability for US beer prices. The first two columns report standard deviations of nominal and real price level components. The third column reports the standard deviation of the components of the log price (as defined in (11)), which are more akin to proportional changes. Since our chief concern is the behaviour of price components over time, columns 4 and 5 report the mean absolute value of year-to-year changes in the real and log price components. By all of these measures, the base (pretax) price is more volatile than the sales or excise tax components. The difference is considerable—in fact, the mean absolute change in the pretax log component is eight times greater than that of the excise tax component and 63 times greater than that of the sales tax component. Meanwhile, the volatility difference between sales and excise taxes is less striking, but by most measures the excise tax is more variable. If rational habits are at work, then all other things equal, this pattern in price-component variability should yield responsiveness to sales taxes>responsiveness to excise taxes>responsiveness to the base price. Conveniently, this ordering differs from that implied by tax salience.

Table 1: Measures of beer price-component variability, US, annual*

	(1) **SD, Nominal**	(2) **SD, Real**	(3) **SD, Log Component**	(4) **Mean Abs. Change, Real**	(5) **Mean Abs. Change, Log Component**
Base Price	3.702	1.157	0.217	0.241	0.0450
Sales (Level)	0.299	0.139	0.0208	0.0265	0.000712
Excise (fed. + state)	0.269	0.169	0.0421	0.0326	0.00560

Prices measured in (1982-4) USD/gallon.

Given the anticipated importance of price components' behaviour over time, I use as my main measure of uncertainty the mean absolute change in the log price component (Table 1, column 5): that is, $\sigma_{base} = 0.0450, \sigma_{sales} = 0.000712, \sigma_{exc} = 0.00560$. As a check, I estimate models that define uncertainty σ as the standard deviation of each log price component (1, column 3). I also consider state-specific versions of each of these measures.

4.4 Estimation

The main equation to be estimated is

$$\begin{aligned} c_{it} &= \lambda c_{i,t-1} + \alpha_0 \left[p_{it}\right] \\ &+\alpha_\sigma \left[\sigma_{sales} \ln\left(1 + sales_{it}\right) + \sigma_{base} \ln\left(base_{it}\right) + \sigma_{excise} \ln\left(1 + \frac{excise_{it}}{base_{it}}\right)\right] \\ &+\alpha_s \left[s_{sales} \ln\left(1 + sales_{it}\right) + s_{base} \ln\left(base_{it}\right) + s_{excise} \ln\left(1 + \frac{excise_{it}}{base_{it}}\right)\right] \\ &+\beta_y y_{it} + \beta_t t + \mu_i + v_{it} \end{aligned} \tag{14}$$

which is the same as (12) but with the omission of carbon-tax variable and the addition of a trend. (Given data constraints, it is not possible to include time period dummies in this case.) For clarity, (14) divides the error term ε_{it} into a state-specific effect μ_i and idiosyncratic error v_{it}.

For comparison with the literature, I also estimate the model

$$\begin{aligned} c_{it} &= \lambda c_{i,t-1} + \beta_{sales} \ln\left(1 + sales_{it}\right) + \beta_{base} \ln\left(base_{it}\right) + \beta_{exc} \ln\left(1 + \frac{excise_{it}}{base_{it}}\right) \\ &+\beta_y y_{it} + \beta_t t + \mu_i + v_{it} \end{aligned} \tag{15}$$

which is the same as (13) aside, again, from the omission of the carbon-tax variable and the addition of a trend term.

Estimating these models using a simple within-groups estimator would entail several problems. First, since the US beer market is dominated by just two companies,[4] before-tax base prices are likely to be endogenous. This endogeneity is particularly problematic because it threatens to bias our estimate of the base price's effect upward towards 0 in (15), with corresponding distortionary effects in (14).

To address the endogeneity, I use the market price of barley to construct instruments for regressors containing the base price. Barley is, of course, a major input to beer production. Its relevance is borne out by the first-stage F statistic when the log base price in (15) is instrumented by the log barley price ($F = 95.66$ when only $\ln base_{it}$ is instrumented). The barley price's exogeneity is plausible because its main use is not beer, which accounts for only about 20-25% of barley consumption, but animal feed (NEWCrop 1999, Schmitz and Koo 1996). Using the price of Canadian feed barley further reduces the possibility of correlation with beer demand shocks: in contrast to the US, regulations in Canada differentiate rather strictly between feed and malt barley (Schmitz and Koo 1996). Beer demand shocks should influence feed barley prices mainly through planting decisions, therefore; and those planting decisions should not affect malt barley prices until at least a season has passed. This instrumenting strategy should therefore allow us to isolate variation in the before-tax beer price driven by factors affecting the feed and malt barley crops similarly—e.g. weather. Note that since barley is a globally-traded commodity, Canadian prices are still informative about market conditions in the US. Also note that since the barley price is a single series, constant across i, we will be relying on cross-time variation to identify the effect of the base price.

For model (15), I instrument the log base price using the log barley price. Since the excise tax term, $\ln\left(1 + \frac{excise_{it}}{base_{it}}\right)$, also contains the endogenous base price, I instrument for it using $\ln\left(1 + \frac{exc_{it}}{\widehat{base}_{it}}\right)$, where $\widehat{base}_{it}$ are the fitted values from a fixed-effects regression of the base price on the barley price. In model (14), the price variables (i.e. the regressors with coefficients α_0, α_σ, and α_s) are linear combinations of the price components in model (15). I therefore instrument for this set of price variables using the log barley price, the previously-defined instrument $\ln\left(1 + \frac{exc_{it}}{\widehat{base}_{it}}\right)$, and the sales tax term $\ln(1 + sales_{it})$. As both models are exactly identified, it is not possible to use an overidentification test to check the instruments' exogeneity. (For the regressions that utilise state-specific measures of price-component uncertainty (σ_{ki}), a further set of instruments is used to prevent the loss of the cross-state variation: $\sigma_{sales_i} \ln(1 + sales_{it})$, $\sigma_{base_i} \ln(\text{barley price})$, and $\sigma_{excise_i} \ln\left(1 + \frac{exc_{it}}{\widehat{base}_{it}}\right)$.)

The second concern in estimating these models arises from the inclusion of lagged consumption as a regressor. The correlation of lagged consumption with the fixed effect μ_i biases the simple OLS estimator of λ upward and the within-groups/fixed-effects estimator of λ downwards (see, for example, Bond 2002). The bias in the within estimator increases in λ and may be exacerbated by the model's inclusion of outside regressors (Nickell 1981), though there is dissent on the latter point (Kiviet 1995, p. 61). A variety of potential remedies exists, including bias corrections (Kiviet 1995, Bun and Carree 2006) and GMM estimators built on various sets of moment conditions (Ahn and Schmidt 1995, Arellano and Bond 1991, Blundell and Bond 1998). The appropriate estimator depends on the context: for an unbalanced panel, Judson and Owen (1996) recommend GMM-type estimators when $T \leq 20$ and the simple within estimator when $T \geq 30$; for a balanced panel, they recommend Kiviet's (1995) corrected estimator regardless of T. It does not make sense to use a Kiviet-style correction here, as the panel at hand is unbalanced, and as the Kiviet correction has not been derived for the case in which we must instrument for outside variables. Difference GMM is a possible alternative, but the high autocorrelation of consumption renders twice-lagged consumption relatively uninformative about differenced consumption; and Mehrhoff's (2009) Monte Carlo simulations suggest difference GMM with relatively high T and λ

[4] As of 2012, Anheuser-Busch and MillerCoors together controlled 74% of the US market (Beer Marketer's Insights 2013).

will be more biased than fixed-effects. Indeed, difference GMM yields $\widehat{\lambda}$ well *below* the downward-biased fixed-effects estimate. System GMM has the potential to do a better job of identifying λ, but it too yields $\widehat{\lambda}$ below the fixed-effects estimate, and apparently at a considerable cost of efficiency. (For illustration purposes, difference and system GMM estimates are provided in Appendix B.)

Fortunately, the within-groups estimator is consistent in T, and its bias in this case is small. According to Nickell's (1981) approximation of the bias for a model without outside regressors, given λ as high as 0.9 and an average of 28 observations per state, we might expect a downward bias of around only 0.07. My preferred estimator is therefore the within-groups/fixed-effects estimator, with its known small bias. Within-groups is also used to estimate a static version of (14), thereby sidestepping even the small Nickell bias. In both cases, errors are heteroskedasticity-robust and state-clustered, and estimation is performed using Schaffer's *xtivreg2*.

4.5 Results and Discussion

Estimation results support the hypothesis that rational habits drive at least some of the differential in responsiveness to different price components, while providing little evidence of an explanatory role for salience.

We can see evidence of a rational-habits-type effect in Table 2, which contains the preferred fixed-effects, two-stage least-squares estimates of the main model (14). The estimated coefficient on $\sum_k \sigma_k p_k$, $\widehat{\alpha}_\sigma$, is positive and strongly significant, implying that consumers' responsiveness becomes less negative (and therefore smaller in magnitude) as price-component uncertainty increases. This is the case whether uncertainty σ_k is defined as the mean absolute change or the standard deviation of price component k. The estimated coefficient on $\sum_k s_k p_k$, $\widehat{\alpha}_s$, meanwhile, is negative but not statistically significant ($p = 0.269$). This lack of statistical significance does not definitively contradict the salience hypothesis, which implies a more negative response to more salient price components; but nor does it offer evidence in its favour.

To check that the results are not distorted by the inclusion of lagged consumption, Table 3 presents fixed-effects, two-stage least-squares estimates of a static version of (14). Most coefficients in this static model fall between the short- and long-run coefficients implied by the dynamic model; the others exceed the implied long-run coefficients only slightly. The distinction between static and dynamic models has no bearing on the evidence on rational habits and salience effects.

To check that the instrumentation strategy has acted as anticipated, Table 4 presents fixed-effects estimates of (14) that do not instrument for price components. Comparing the results in Tables 2 and 4, we can see that instrumenting reduces the coefficient on $\sum_k p_k$, $\widehat{\alpha}_0$, from 0.3 or 0.4 to -0.1, which suggests that instrumenting has indeed corrected some of the suspected endogeneity in the base price. Although instrumenting makes the coefficient on $\sum_k s_k p_k$ slightly less negative, the difference is a comparatively tiny amount, and $\widehat{\alpha}_s$ is statistically insignificant before as well as after instrumenting. The sign and statistical significance of $\widehat{\alpha}_\sigma$, meanwhile, are also unaffected by instrumenting.

Turning to the case of state-specific price component uncertainty (Table 5), the instrumenting strategy is ostensibly more consequential—and potentially troubled. The use of extra instruments to estimate the state-specific models, as discussed in Section 4.4, makes it possible to run an overidentifying restrictions test. The test's low p-value (0.064) when σ is defined as state-specific mean absolute change ($\overline{|\Delta p_{k,t}|_i}$) suggests that the instruments might not all be exogenous. Suspicions about the instrument set are important to keep in mind in this case, as instrumenting makes the difference between finding no evidence of rational habits or salience effects and finding evidence (albeit at the 10% significance level) of both.

Table 2: Beer demand with uncertainty and salience effects on price-component responsiveness

Dependent: c_t	Parameter	(1) $\sigma = \overline{\lvert\Delta p_{k,t}\rvert}$	(2) $\sigma = \overline{SD\left(p_{k,t}\right)}$
c_{t-1}	λ	0.620***	0.620***
		(0.0982)	(0.0982)
y	β_y	0.489***	0.489***
		(0.149)	(0.149)
$\sum_k p_k$	α_0	-0.0929	-0.138
		(0.563)	(0.567)
$\sum_k \sigma_k p_k$	α_σ	11.37**	2.562**
		(4.635)	(1.044)
$\sum_k s_k p_k$	α_s	-0.598	-0.597
		(0.541)	(0.541)
Trend	β_t	-0.00633***	-0.00633***
		(0.00146)	(0.00146)
R^2		0.702	0.702
	Implied Coefficients		
Sales component,	β_{sales}	-0.0848	-0.0848
$\ln\left(1+sales\right)$		(0.562)	(0.562)
Base component,	β_{base}	-0.180*	-0.180*
$\ln\left(base\right)$		(0.104)	(0.104)
Excise component,	β_{exc}	-0.628**	-0.628**
$\ln\left(1+\frac{excise}{base}\right)$		(0.268)	(0.268)

Heteroskedasticity-robust, state-clustered standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
N=48, T=8-30

When σ is defined as state-specific standard deviation ($SD\left(p_{k,it}\right)$), by contrast, the overidentifying restrictions test fails to reject—and as before, instrumenting has the expected effects on the coefficients but does not alter the key results. Given the consensus of the model with state-specific standard deviation, where the instruments appear well-behaved, and the models with nationally-averaged uncertainty, I am inclined to trust the nationally-averaged models, and in particular to trust them over the specification with state-specific uncertainty $\overline{\lvert\Delta p_{k,t}\rvert}_i$.

To see how our estimates of (14) parlay into differences between price-component responsiveness, recall the breakdown in (8). Using the estimates from Table 2 for $\sigma = \overline{\lvert\Delta p_{k,t}\rvert}$, this breakdown implies that $\widehat{\beta}_{sales} - \widehat{\beta}_{exc} = 0.542$, with price-component uncertainty contributing -0.0556 to the difference and salience contributing 0.598; and $\widehat{\beta}_{sales} - \widehat{\beta}_{base} = 0.0944$, with price-component uncertainty contributing -0.504 and salience 0.598.[5] That is, the responsiveness to the sales tax component is less negative than the responsiveness to the excise tax or the base price; and, statistical (in)significance aside, price-component uncertainty increases the relative magnitude of sales-tax responsiveness, while salience reduces it. Price-component uncertainty is of course the only factor that differs between the excise tax component

[5] The breakdown is nearly identical for $\sigma = \overline{SD\left(p_{k,t}\right)}$.

Table 3: Beer demand with uncertainty and salience effects on price-component responsiveness, static model

Dependent: c_t	Parameter	(1) $\sigma = \lvert\Delta p_{k,t}\rvert$	(2) $\sigma = SD\,(p_{k,t})$
y	β_y	0.642***	0.642***
		(0.116)	(0.116)
$\sum_k p_k$	α_0	-0.370	-0.498
		(0.947)	(0.942)
$\sum_k \sigma_k p_k$	α_σ	32.08***	7.227***
		(6.420)	(1.446)
$\sum_k s_k p_k$	α_s	-1.422	-1.419
		(1.044)	(1.044)
Trend	β_t	-0.0104***	-0.0104***
		(0.00149)	(0.00149)
R^2		0.366	0.366
	Implied Coefficients		
Sales component,	β_{sales}	-0.347	-0.347
$\ln(1+sales)$		(0.948)	(0.948)
Base component,	β_{base}	-0.348***	-0.348***
$\ln(base)$		(0.0954)	(0.0954)
Excise component,	β_{exc}	-1.612***	-1.612***
$\ln\left(1+\frac{excise}{base}\right)$		(0.298)	(0.298)

Heteroskedasticity-robust, state-clustered standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
N=48, T=8-30

and the base price, and therefore the sole source of the 0.448 difference between $\widehat{\beta}_{base}$ and $\widehat{\beta}_{exc}$.

The price-component coefficients implied by model (14) are the same as those estimated directly using model (15). For a clearer comparison with the literature, direct estimates of (15) are provided in Table 6. These results provide a different telling of the same story. First, the ratio of the coefficient on the excise tax to that on the base price component is statistically-significantly greater than one. This lends credence to the rational-habits hypothesis, as the excise tax's lower uncertainty is the main way in which the price components differ. Second, the ratio of the coefficient on the sales tax to that on either the base price or the excise tax is statistically indistinguishable from one (and, similarly, we fail to reject that $\beta_{sales} = \beta_{exc}$ or $\beta_{sales} = \beta_{base}$). That is, we do not find a difference in responsiveness to the non-salient price component and either of the salient components.

This last finding contrasts with that of CLK, which is able to reject that $\beta_{sales} = \beta_{exc}$. To explore why, and to check that the reason isn't a difference in the underlying data, I estimate models that are increasingly similar to CLK's (Table 7). It appears that the CLK model's exclusion of the base price is the major factor: simply omitting it from my model (Table 7, column 1) allows us to reject $\beta_{sales} = \beta_{exc}$ at the 10% level ($p = 0.082$). Switching to a static model allows us to reject at nearly the 5% level. We can push down the p-value a bit further by estimating specifications very similar to CLK's baseline

Table 4: Beer demand with uncertainty and salience effects on price-component responsiveness, no price IVing

Dependent: c_t	Parameter	(1) $\sigma = \lvert\Delta p_{k,t}\rvert$	(2) $\sigma = SD\left(p_{k,t}\right)$
c_{t-1}	λ	0.587***	0.587***
		(0.109)	(0.109)
y	β_y	0.468***	0.468***
		(0.142)	(0.142)
$\sum_k p_k$	α_0	0.385	0.348
		(0.456)	(0.453)
$\sum_k \sigma_k p_k$	α_σ	9.341***	2.104***
		(3.346)	(0.754)
$\sum_k s_k p_k$	α_s	-0.844	-0.843
		(0.518)	(0.518)
Trend	β_t	-0.00842***	-0.00842***
		(0.00240)	(0.00240)
R^2		0.742	0.742
	Implied Coefficients		
Sales component, $\ln\left(1 + sales\right)$	β_{sales}	0.391	0.391
		(0.456)	(0.456)
Base component, $\ln\left(base\right)$	β_{base}	-0.0387**	-0.0387**
		(0.0173)	(0.0173)
Excise component, $\ln\left(1 + \frac{excise}{base}\right)$	β_{exc}	-0.407***	-0.407***
		(0.146)	(0.146)

Heteroskedasticity-robust, state-clustered standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
N=48, T=8-30

and business cycle models (Table 7, columns 4 and 5). These specifications, which omit the before-tax price and use a first-differenced estimator on a static model with year dummies,[6] allow us to reject $\beta_{sales} = \beta_{exc}$ with $p = 0.0174$ and $p = 0.0006$, respectively. The use of the first-differenced estimator is not important to the rejection of $\beta_{sales} = \beta_{exc}$ in the CLK-style specifications, though: a fixed-effects estimator of the same models will reject $\beta_{sales} = \beta_{exc}$ with $p = 0.0009$ and $p = 0.0008$, respectively. Thus it seems that CLK are able to reject $\beta_{sales} = \beta_{exc}$ largely because of the exclusion of the excise tax, and not because of a different choice of estimator or hidden differences in data.

The results thus far suggest that the difference between β_{sales} and β_{exc} observed in CLK and the differential in responsiveness to price components observed here are more likely driven by rational habits than by salience. Recall, however, that the identification of salience is based only on the unobservability

[6]For better comparability with CLK, I use nationally-averaged prices in my construction of the excise tax variable here, though similar results are achieved by both my previous instrumenting strategy and a reduced-form regression directly on the previously-defined tax instrument. The main deviation from CLK's specification is that I do not include log population as a regressor, as the rationale for including it when the dependent variable is log per capita income is unclear. (Unsurprisingly, though, its inclusion or exclusion is inconsequential.)

Table 5: Beer demand with uncertainty and salience effects on price-component responsiveness, state-specific uncertainty

Dependent: c_t		(1) $\sigma_i = \overline{\lvert\Delta p_{k,t}\rvert}_i$ IV	(2) $\sigma_i = \overline{\lvert\Delta p_{k,t}\rvert}_i$ no IV	(3) $\sigma_i = \overline{SD\left(p_{k,t}\right)}_i$ IV	(4) $\sigma_i = \overline{SD\left(p_{k,t}\right)}_i$ no IV
c_{t-1}	λ	0.578***	0.616***	0.574***	0.596***
		(0.106)	(0.106)	(0.101)	(0.109)
y	β_y	0.437***	0.469***	0.480***	0.473***
		(0.143)	(0.144)	(0.148)	(0.142)
$\sum_k p_k$	α_0	0.826	0.352	0.111	0.267
		(0.529)	(0.460)	(0.509)	(0.444)
$\sum_k \sigma_k p_k$	α_σ	6.913*	0.229	1.865***	0.806**
		(4.097)	(0.805)	(0.714)	(0.340)
$\sum_k s_k p_k$	α_s	-1.112*	-0.365	-0.578	-0.463
		(0.612)	(0.460)	(0.489)	(0.463)
Trend	β_t	-0.00901***	-0.00808***	-0.00798***	-0.00814***
		(0.00202)	(0.00237)	(0.00166)	(0.00235)
Overid. test (χ^2_3)		7.256		3.367	
		[0.0642]		[0.338]	
R^2		0.686	0.736	0.731	0.741

Heteroskedasticity-robust, state-clustered standard errors in parentheses.
P-values in brackets.
*** p<0.01, ** p<0.05, * p<0.1
N=48, T=8-30

of sales taxes. This means that if sales taxes differ from other price components in aspects besides observability and uncertainty, then our identification of salience effects may be muddied. Unfortunately, sales taxes do in fact differ from the other price components in a third aspect: their effect on relative prices. Since sales taxes apply to a wide set of goods, they affect fewer tradeoffs than either excise taxes or the base price. Fortunately, a smaller effect on relative prices is likely act in the same direction as nonsalience, reducing the magnitude of consumers' responsiveness to sales taxes; and if anything we should expect the relative-price issue to bias us *towards* finding a salience effect. Although we have not found a statistically-significant salience effect, we can explore whether the relative-price issue is important using CLK's suggestion to limit the sample to states that do not apply sales tax to food (proxied by whether sales tax was applied to food in 2002). This ensures that sales taxes have at least some effect on relative prices, and therefore reduces the difference in price components' effect on relative prices. Following this suggestion, I re-estimate model (14) on the limited sample (Table 8). The salience coefficient $\widehat{\alpha}_s$ is slightly less negative here than for the full sample, so it is possible that some of the effect ascribed to salience is actually driven by differences in effects on relative prices. Without a statistically-significant difference between $\widehat{\alpha}_s$ in the full and limited samples, however, we really can't make a statement one way or the other.

Table 6: Beer demand with separated price components

Dependent: c_t	Parameter	(1) Dynamic	(2) Static
c_{t-1}	λ	0.620***	
		(0.0982)	
y	β_y	0.489***	0.642***
		(0.149)	(0.116)
Base component,	β_{base}	-0.180*	-0.348***
$\ln base$		(0.104)	(0.0954)
Sales component,	β_{sales}	-0.0848	-0.347
$\ln(1 + sales)$		(0.562)	(0.948)
Excise component,	β_{exc}	-0.628**	-1.612***
$\ln\left(1 + \frac{exc}{base}\right)$		(0.268)	(0.298)
Trend	β_t	-0.00633***	-0.0104***
		(0.00146)	(0.00149)
R^2		0.702	0.366
	Coefficient Ratios		
Excise:Base	β_{exc}/β_{base}	3.496**	4.629***
		(0.985)	(1.0252)
Sales:Base	$\beta_{sales}/\beta_{base}$	0.472	0.998
		(2.993)	(2.678)
Sales:Excise	$\beta_{sales}/\beta_{exc}$	0.135	0.215
		(0.878)	(0.594)

Heteroskedasticity-robust, state=clustered standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1 (H_0 for coeff ratios: ratio=1)
N=48, T=8-30

There remain two further concerns about the behaviour and measurement of the price components. First, the analysis thus far has assumed that tax pass-through to consumers is 100%. If instead taxes were partially absorbed by producers, then excise taxes (and, to some extent, sales taxes) would trigger changes in the base price. The response to the excise tax component in model (15) would be partially captured by the coefficient on the before-tax price, and interpretation of model (14) would be similarly muddied. To check whether incomplete pass-through is a problem in reality, I regress changes in the real before-tax price on changes in the excise tax level. The resulting coefficient on the excise tax level is statistically indistinguishable from 0 ($p = 0.74$), so it appears that excise taxes are not cushioned by the pretax price, and pass-through is in fact complete.

Second, it is possible that the pretax price is measured less accurately than the tax rates. Pretax price measurements are based on observations of a single brand per shop, so they do not reflect the range of beers consumed. More importantly, observations are sparse in some states, and so some of the variation in state-averaged prices may reflect random sampling variation rather than true variation in the prices faced by the bulk of consumers. If we did not instrument for prices, classical measurement error might bias $\widehat{\beta}_{base}$ in model (15) towards 0, with analogous problems in model (14), and with further complications arising in both models from the use of the base price to construct the excise tax component $\ln\left(1 + \frac{exc}{base}\right)$. As long as measurement error in beer prices is independent of the barley price, however,

Table 7: Beer demand with separated price components, omitting before-tax price

Dependent: c_t	(1) Dynamic, FE IV	(2) Static, FE IV	(3) CLK Baseline Model, FD	(4) CLK Business Cycle Model, FD
c_{t-1}	0.573***			
	(0.111)			
y	0.462***	0.571***		0.881***
	(0.141)	(0.119)		(0.0849)
$\ln(unemployment)$				0.0120
				(0.00863)
Excise component,	-0.391***	-1.049***	-1.060***	-0.830***
$\ln\left(1+\frac{exc}{base}\right)$	(0.137)	(0.187)	(0.234)	(0.226)
Sales component,	0.545	0.829	-0.261	0.366
$\ln(1+sales)$	(0.479)	(0.911)	(0.239)	(0.273)
Trend	-0.00911***	-0.0149***		
	(0.00257)	(0.00149)		
Year dummies			X	X
Constant			-0.0204***	-0.0293***
			(0.00497)	(0.00498)
Test: $\beta_{sales}=\beta_{exc}$ (χ^2_1)	3.02	3.84	5.66	11.77
	[0.0821]	[0.0501]	[0.0174]	[0.0006]

Heteroskedasticity-robust, state-clustered standard errors in parentheses.
P-values in brackets.
N=48; T=8-30.
*** p<0.01, ** p<0.05, * p<0.1

the IV estimators described above avoid this bias.

After considerable scrutiny, the main results in Table 2 stand: the effect predicted by a rational habits model is present and statistically significant, and the effect predicted by the salience model is not statistically significant. In the case of beer demand, the evidence favours uncertainty over salience as the driver of differences between price-component responsiveness.

Table 8: Beer demand with uncertainty and salience effects on price-component responsiveness, states that exempt food from sales tax

Dependent: c_t	Parameter	(1) $\sigma = \overline{\lvert\Delta p_{k,t}\rvert}$	(2) $\sigma = SD\left(p_{k,t}\right)$
c_{t-1}	λ	0.781***	0.781***
		(0.0544)	(0.0544)
y	β_y	0.137***	0.137***
		(0.0324)	(0.0324)
$\sum_k p_k$	α_0	0.156	0.139
		(0.282)	(0.284)
$\sum_k \sigma_k p_k$	α_σ	4.366**	0.984**
		(2.189)	(0.493)
$\sum_k s_k p_k$	α_s	-0.312	-0.312
		(0.279)	(0.279)
Trend	β_t	-0.00412***	-0.00412***
		(0.00104)	(0.00104)
R^2		0.880	0.880
	Implied Coefficients		
Sales component,		0.159	0.159
$\ln\left(1+sales\right)$		(0.282)	(0.282)
Base component,		0.0405	0.0405
$\ln\left(base\right)$		(0.0557)	(0.0557)
Excise component,		-0.132	-0.132
$\ln\left(1+\frac{exc}{base}\right)$		(0.103)	(0.103)

Heteroskedasticity-robust, state-clustered standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

N=33, T=8-30

5 The Case of Gasoline

Next I turn to gasoline demand, applying my model to distinguish between salience and rational habits effects in the case considered by Rivers and Schaufele (2013).

5.1 Gasoline Data

My data is a monthly, Canadian province-level panel, 1990 through 2011. It is very similar to the dataset of Rivers and Schaufele (2013), whose lead I follow in drawing prices and excise taxes from Kent Marketing Services (2013), and from whose data I draw carbon tax levels. Provincial retail gasoline sales, GDP, and population—used to construct consumption and income per capita—are from Statistics Canada. Although some provinces' series are abbreviated, in all cases at least 176 months (or 54 quarters) are available for estimation. Details of the dataset's construction are provided in Appendix C, and a full list of data sources is included as Appendix F.

5.2 Identifying Salience

Identifying salience is problematic in the case of gasoline. Indeed, it is difficult even to make the argument that salience differs across price components. Since gasoline prices are posted including all applicable taxes, we cannot make inferences about salience based upon the relative visibility of the price components. Moreover, we cannot directly observe consumers' thoughts: we cannot see whether their attention lingers longer on some price components than on others, nor whether they resent paying the government more than they resent paying oil producers.

It might be possible to infer something about consumers' thoughts from public discourse. If newspapers devote more attention to carbon taxes than to the base gasoline price, for example, then we might believe that readers and consumers are also devoting more of their attention to carbon taxes. To check whether newspaper coverage supports the hypothesis of carbon and/or excise tax salience, I tally the number of articles in leading Canadian newspapers that mentioned gasoline taxes and prices over the sample period. The methodology for this tally is detailed in Appendix D. Table 9 reports the ratio of articles mentioning various price components to articles mentioning gasoline prices. By this metric, there appears no evidence of a program for excise tax salience: over a large sample of Canadian newspapers, the ratio of gas tax to gas price mentions is about 1:10.[7] Mentions of carbon taxes are somewhat higher, particularly in British Columbia; but carbon taxes still receive only a quarter the attention of gas prices overall. If we attribute all mentions of the carbon tax to the years 2008 through 2011, during which carbon taxes were in effect in British Columbia, the implied ratio of carbon tax to gasoline price mentions for that period rises to 1.69 for Canadian newspapers overall, 4.57 for the Vancouver Sun, and 2.80 for the Vancouver Province. It is therefore possible that carbon taxes are more salient than gasoline prices overall—though this metric probably overstates the salience of carbon taxes, inasmuch as they are mentioned in broad discussions of global climate policy as well as specifically in the gasoline context.

Whatever the tallies show, they cannot provide definitive evidence for or against differences in price-component salience: it is possible that salience is not accurately reflected in news coverage. But while newspaper coverage leaves open the possibility of carbon tax salience, the failure of excise taxes to garner much coverage weakens the case that excise taxes are particularly salient, and it should increase our skepticism that salience could explain consumers' high responsiveness to excise taxes.

[7] Mentions of sales tax keywords appear more frequently, but consumers' concern about sales tax is presumably spread across all the goods to which it applies. If sales taxes are in fact particularly salient in the context of gasoline, this would not help to explain the behaviour we eventually observe.

Regardless of our inability to measure salience, and indeed regardless of our skepticism that a program of price-component salience exists, we can test whether the existence of such a program *would* explain the consumer behaviour we observe. Giving the benefit of the doubt to Rivers and Schaufele's (2013) claim that carbon taxes are more salient than the rest of the gasoline price, let us assign the carbon-tax price component a salience of 1 and all other price components a salience of 0. To check whether our results are robust to this salience assumption, we can also consider a scenario in which carbon and excise taxes are more salient than the rest of the price ($s_C = s_{exc} = 1; s_{sales} = s_{base} = 0$), or even a scenario in which all taxes are more salient than the base price ($s_C = s_{exc} = s_{sales} = 1; s_{base} = 0$).

5.3 Identifying Price Component Uncertainty

Uncertainty in gasoline price components can be approximated using the same approach that was applied to beer. The measures calculated for beer in Section 4.3 are now reported in Table 10 for the Canadian gasoline dataset. The first two columns report standard deviations in nominal and real price components; by this measure there is a clear hierarchy in variability, stepping down from high-variation base prices and sales taxes to lower-variation excise taxes to lowest-variation carbon taxes. Column 3 reports the standard deviations of the components of the log price. The previous hierarchy in variability persists except for sales taxes, which now appear less variable because, whereas the sales tax *level* moves with the base price, changes in the sales tax *rate* are infrequent.

To check how the price components behave over time, columns 4 and 5 report the mean absolute value of month-to-month changes in the real and log price components. By these measures, the base price and the sales tax appear less stable than either of the specific taxes. In contrast to the standard deviation measures, the mean absolute real change measure finds excise and carbon taxes to be about equally variable; but according to the mean absolute log-component change, excise taxes are once again more variable than carbon taxes.

Although we don't know which measure of stability is most relevant to consumers, and although perceived variability may be changing over time, these measures are unanimous that excise and carbon taxes are more stable than the base gasoline price. The measures are also largely in agreement that excise taxes are more variable than carbon taxes. This suggests a program of price-component-variability with the potential to drive differences in responsiveness to the base price, the excise tax, and the carbon tax.

5.4 Estimation

The main model to be estimated for gasoline is a version of (12) augmented with month dummies to control for seasonality and year dummies to allow for general tendencies over time. For comparison with the literature, I also consider a version of model (13) augmented with month and year dummies. These month and year dummies are partialled out and not reflected in reported R^2s. Unless otherwise noted, all standard errors are heteroskedasticity-robust and province-clustered, and estimation is performed using Schaffer's (2010) *xtiveg2*.

As it was for beer, estimation is complicated by the endogeneity of price components and lagged consumption.

5.4.1 Price Component Endogeneity

Estimation of the gasoline demand models relies on the assumption that all specific taxes are strongly exogenous. It is possible for this assumption to be violated if current demand shocks put pressure on politicians to adjust future tax levels, but fortunately this would induce only a second-order correlation between the within-groups transformations of the specific taxes and the error term in (13), with analagous

Table 9: Ratio of price component to gasoline price keywords, Canadian newspapers

	Ratio of price component to gasoline price keywords, Canadian newspapers							
	Canadian Newspapers	Vancouver Sun (BC)	[Vancouver] Province (BC)	Toronto Star (ON)	Globe and Mail (ON)	The Gazette (QC)	Calgary Herald (AB)	Edmonton Journal (AB)
Gasoline tax keywords	0.09	0.18	0.09	0.24	0.09	0.14	0.05	0.10
Carbon tax	0.23	0.62	0.38	0.16	0.18	0.16	0.10	0.18
Oil price keywords	2.15	2.03	1.56	1.97	2.93	2.22	2.15	2.31
Sales tax keywords	2.06	5.01	1.38	4.57	2.02	2.06	1.47	1.34

Table 10: Measures of gasoline price-component variability, Canadian provinces, monthly*

	(1)	(2)	(3)	(4)	(5)
	SD, Nominal	**SD, Real**	**SD, Log Component**	**Mean Abs. Change, Real**	**Mean Abs. Change, Log Component**
Base	22.847	14.159	0.310	2.124	0.0487
Sales (Level)	25.264	13.583	0.0380	2.377	0.0258
Excise	3.981	3.362	0.135	0.0883	0.0166
Carbon	0.811	0.547	0.00567	0.0726	0.00184

*Observations for which price component is 0 (e.g. carbon tax for most provinces, carbon tax in BC pre-implementation) are excluded from calculations.
Prices measured in (1997) Can. cents/gallon.

behaviour in (12). The inertia and complexity of the legislative process imply, moreover, that it is difficult to re-legislate tax levels on a demand-driven whim.

Given that we are working with province-aggregated data, the potential endogeneity of the before-tax price (and the implied sales tax level) is more worrisome: price and consumption are determined jointly. To address this, I use the crude oil price as an instrument for the before-tax price. As the major input into gasoline, the crude price is clearly relevant. Whether it is exogenous is less clear-cut. Oil is a global commodity; and insofar as Canadian provinces comprise only a small portion of worldwide demand, local demand shocks should not be too correlated to the crude price. A correlation cannot be ruled out entirely, however: demand shocks may be correlated across provinces and/or correlated to US demand shocks, so an individual province may act econometrically as if it were a much larger player in the market. Transport bottlenecks, meanwhile, mean that in the very short run the oil market may be local rather than global. Using the West Texas Intermediate price rather than local Canadian streams mitigates the latter problem. Although we can run an overidentifying restrictions test after estimating (12), this merely compares different instruments based on the crude oil price, and so we cannot take the uniform failure to reject as solid evidence of the crude price's exogeneity. To check whether the crude oil price at least has the effect expected of a valid instrument, I report non-instrumented estimates of both (12) and (13). These non-instrumented results may indeed be preferable, as in most cases we cannot reject the exogeneity of the instrumented variables.

The instrumenting approach used for beer can now be applied to construct instruments for each of the gasoline price components. For model (13), the log crude oil price is used as an instrument for the log base price. Instruments for the excise and carbon tax terms are constructed as $\ln\left(1+\frac{exc_{it}}{\widehat{base}_{it}}\right)$ and $\ln\left(1+\frac{Ctax_{it}}{\widehat{base}_{it}+exc_{it}}\right)$, where $\widehat{base}_{it}$ are the fitted values from a fixed-effects regression of real before-tax prices on the crude oil price. For model (12), where the price variables are again linear combinations of the price components in (13), I add the sales tax component to the instrument set. (For the regressions that utilise province-specific measures of price-component uncertainty, I further augment the instrument set with the interaction between each price component's instrument and province-specific σ.)

5.4.2 Endogeneity of lagged consumption

The lagged dependent variable in the dynamic models presents a familiar problem, namely that the within-groups estimator will be biased downward. Given the length of the sample, however, the problem is negligible. With $T \geq 175$ months for each province, Nickell's (1981) approximation of the bias for a model without outside regressors, $\frac{-(1+\lambda)}{T-1}$, implies a downward bias of less than 0.012 for all $\lambda < 1$. For $\lambda = 0.6$, the implied bias in $\widehat{\lambda}_{FE}$ is only 1.5%. In light of the tiny size of this bias and the previously-discussed limitations of alternative estimators, the simple fixed-effects two-stage least-squares estimator is appropriate here.

5.5 Results and Discussion

The main estimates of model (12) are reported in Tables 11 and 12. Table 11 reports the case where uncertainty σ is measured as the mean absolute change in log price component; Table 12, the case where uncertainty is the standard deviation of the log price component.

Table 11: Gasoline demand with uncertainty and salience effects on price-component responsiveness, uncertainty=mean absolute change

Dependent: c_t	Parameter	(1) $s_k = 0\ \forall\ k$	(2) $s_C = 1$	(3) $s_c = s_{exc} = 1$	(4) $s_c = s_{exc} = s_{sales} = 1$
c_{t-1}	λ	0.559***	0.559***	0.555***	0.556***
		(0.0513)	(0.0514)	(0.0536)	(0.0522)
y	β_y	0.163***	0.164***	0.174***	0.168***
		(0.0441)	(0.0416)	(0.0430)	(0.0463)
$\sum_k p_k$	α_0	-0.403**	-0.408**	0.0825	-1.582**
		(0.126)	(0.142)	(0.265)	(0.676)
$\sum_k \sigma_k p_k$	α_σ	5.337**	5.419**	-5.197	29.47*
		(1.984)	(2.289)	(5.559)	(13.51)
$\sum_k s_k p_k$	α_s		0.0438	-0.397	0.759
			(0.524)	(0.222)	(0.419)
R^2		0.498	0.498	0.499	0.498
Overid. test, $\chi^2(df)$		1.845 (2)	1.727 (1)	0.200 (1)	0.503 (1)
		[0.398]	[0.189]	[0.654]	[0.478]
Endog. test, $\chi^2(df)$		0.157 (2)	0.665 (3)	1.414 (3)	1.171 (3)
		[0.924]	[0.881]	[0.702]	[0.760]
		Implied Coefficients			
Sales component, $\ln(1+sales)$	β_{sales}	-0.265***	-0.269**	-0.0516	-0.0624
		(0.0761)	(0.0835)	(0.125)	(0.117)
Base component, $\ln(base)$	β_{base}	-0.143***	-0.144***	-0.171***	-0.147***
		(0.0342)	(0.0337)	(0.0405)	(0.0308)
Excise component, $\ln\left(1+\frac{excise}{base}\right)$	β_{exc}	-0.314***	-0.318**	-0.401***	-0.334***
		(0.0938)	(0.104)	(0.120)	(0.0865)
Carbon tax component, $\ln\left(1+\frac{Ctax_{it}}{base_{it}+exc_{it}}\right)$	β_C	-0.393**	-0.355	-0.324**	-0.768**
		(0.123)	(0.480)	(0.122)	(0.249)

Heteroskedasticity-robust, province-clustered standard errors in parentheses. P-values in brackets.
N=10, T=175-259.
*** p<0.01, ** p<0.05, * p<0.1

In both cases, we see evidence of a rational-habits-type effect when we assume either no program of salience differences (column 1, $s_k = 0\ \forall\ k$) or salience of carbon taxes (column 2, $s_C = 1$). That is, the coefficient on $\sum_k \sigma_k p_k$ is positive and statistically significant, implying that higher price uncertainty is associated with less-negative price responsiveness. The coefficient on the salience term, meanwhile, is statistically insignificant. If it is the case that carbon taxes are particularly salient, their salience does not appear to have an impact on consumers' behaviour.

If we assume that both carbon and excise taxes are salient (column 3, $s_C = s_{exc} = 1$), however, the evidence for a rational-habits effect dissolves: $\widehat{\alpha}_\sigma$ becomes statistically insigificant. The coefficient on the salience term, meanwhile, becomes more negative; and in the case where $\sigma_k \equiv SD_k$ (Table 12), it is statistically significant. *If* there is a program of carbon and excise tax salience, therefore, and *if* price-component uncertainty is better proxied by standard deviation than by mean absolute change, then it appears salience and not price uncertainty drives consumer behaviour.

If all taxes are salient (column 4, $s_c = s_{exc} = s_{sales} = 1$), finally, then evidence of a salience effect once again disappears, and evidence of rational habits is mixed and weak: $\widehat{\alpha}_\sigma$ is significant at the 10% level in Table 11, negative and statistically insignificant in Table 12.

Given the failure of endogeneity tests to reject the exogeneity of the price variables, Tables 13 and 14 report estimates of (12) without instrumenting for prices. There is very little difference between the instrumented and un-instrumented results, which may call into question the value of the instrumenting. The previously-discussed findings all continue to hold for the un-instrumented estimates, which at least confirms that the instrumenting was not masking any salience or habits effects.

To check whether the results are robust to choice of a dynamic model, Tables 15 and 16 report estimates of static versions of (12). The pattern of evidence is precisely the same as for the dynamic model, with the exception that salience now appears to *reduce* the magnitude of price responsiveness in the version of the model where uncertainty is measured as the mean absolute change in log price component and all taxes are salient (Table 15, column 4).

Tables 17 and 18 turn to the case that allows for province-specific uncertainty in price components. Using province-specific measures of price-component uncertainty, we no longer find a statistically-significant habits effect in any of the cases. We do find a statistically-significant salience effect in the case where uncertainty is measured as mean absolute change and both carbon and excise taxes are salient, and in the cases where uncertainty is measured as standard deviation and carbon and excise or all taxes are salient. The lack of a habits-type effect even when there is no allowance for a salience effect (column 1), which contrasts with the strongly-significant effect when uncertainty is measured nationally, suggests that the province-specific uncertainty measures may be noisy. We may therefore prefer to the nationally-measured uncertainty.

Along with the main estimates of model (12), Tables 11 and 12 report the implied coefficient on each price component k, $\widehat{\beta}_k$, calculated as $\widehat{\alpha}_0 + \widehat{\alpha}_\sigma \sigma_k + \widehat{\alpha}_s s_k$. These coefficients are also estimated directly using model (13), with results reported in Table 19. The implied and directly-estimated $\widehat{\beta}_k$s are no longer identical, as they were in the case of beer, because with the carbon tax there are now more price components in (13) than determinants of price-component responsiveness in (12). That is, there are now four price components but still only uncertainty, salience, and an intercept to explain differences in responsiveness to those price components: the models no longer contain the same information.

According to the directly-estimated model, demand is more than twice as responsive to the excise component than to the base price. Although the coefficient on the carbon tax component is not statistically significant, it is slightly greater in magnitude than that on the excise tax. (The coefficient on the sales tax component, meanwhile, is negligible.) The model with price-uncertainty effects mimics this pattern: even without any differences in price-component salience, model (12) predicts $\widehat{\beta}_{base} < \widehat{\beta}_{exc} < \widehat{\beta}_C$, with a twofold difference between $\widehat{\beta}_{base}$ and $\widehat{\beta}_{exc}$ and a smaller difference between $\widehat{\beta}_{exc}$ and $\widehat{\beta}_{C}$ (Tables 11 and 12, column 1). Allowing for carbon-tax salience (Tables 11 and 12, column 2), the same pattern holds. Allowing for salience of both carbon and excise taxes, however (Tables 11 and 12, column 3), the implied responsiveness to carbon taxes dips below the implied responsiveness to excise taxes. Salience effects are not necessary to explain the pattern of differences we observe in price-component responsiveness, nor, ignoring the sales tax component, do they appear to improve the match between implied and directly-estimated price-component responsiveness.

Overall, given the unobservability of salience, it is not possible to definitively rule out salience effects in the case of gasoline. If excise and carbon taxes are more salient than the rest of the price, and if standard deviation is an appropriate measure of price-component uncertainty, then the evidence points to salience rather than rational habits as the driver of differences in price-component responsiveness. But that finding is vulnerable to the choice of uncertainty measure—switch to mean absolute change, and the salience effect is no longer statistically significant. The finding of a salience effect is, moreover, completely dependent on both carbon and excise taxes being particularly salient. If there is a program of carbon but not excise tax salience, or if all taxes are equally salient, then variation in price-component responsiveness appears to be driven by price uncertainty rather than salience. Indeed, price uncertainty alone is sufficient to explain much of the observed pattern in price-component responsiveness. In the end, our conclusions about the roles of salience and rational habits mechanisms depend upon our beliefs about what sort of salience differences exist. Absent a strong argument that carbon *and* excise taxes—but not just carbon taxes—are more salient than the rest of the gasoline price, it appears rational habits are the more likely driver of consumers' behaviour.

6 Conclusions

The recent literature on tax salience and related concepts has highlighted the importance of consumers' perceptions, which are not always perfect. Studies that vary taxes' visibility while controlling for other tax characteristics suggest, indeed, that the salience of price components may shape demand in some circumstances. But controlling for those other characteristics is key. Failing to control for them may lead us to attribute to salience behaviour that is driven by something else. In particular, studies that use tax type as a proxy for salience may falsely conflate a salience effect and the combined effect of rational habits and price uncertainty.

The model in this paper encompasses both the salience and the rational-habits mechanisms, offering a way to distinguish empirically between the two. Applying this model to two cases previously considered in the literature, US beer demand (CLK) and Canadian gasoline demand (Rivers and Schaufele 2013), yields evidence that consumers' intense responsiveness to certain types of taxes is indeed driven by rational habits rather than tax salience.

It is important to examine the reasons behind a differential in consumers' responsiveness to different price components because different reasons carry different policy implications. Extra sensitivity to a tax because it is salient implies that we can tweak a policy's effect by manipulating its conspicuousness. Extra sensitivity to a tax because of rational habits implies that we can amplify a policy's effect by designing it with stability and long-run credibility in mind. In many instances we may be able to use both salience and uncertainty as levers. The results here, however, suggest that we should lean more than previously believed on the latter.

Table 12: Gasoline demand with uncertainty and salience effects on price-component responsiveness, uncertainty=SD

Dependent: c_t	Parameter	(1) $s_k = 0 \ \forall \ k$	(2) $s_C = 1$	(3) $s_c = s_{exc} = 1$	(4) $s_c = s_{exc} = s_{sales} = 1$
c_{t-1}	λ	0.563***	0.563***	0.555***	0.557***
		(0.0500)	(0.0500)	(0.0535)	(0.0531)
y	β_y	0.162***	0.162***	0.174***	0.173***
		(0.0449)	(0.0429)	(0.0432)	(0.0417)
$\sum_k p_k$	α_0	-0.333**	-0.332**	-0.0264	0.599
		(0.125)	(0.124)	(0.140)	(0.543)
$\sum_k \sigma_k p_k$	α_σ	0.660*	0.659*	-0.465	-2.481
		(0.313)	(0.323)	(0.459)	(1.808)
$\sum_k s_k p_k$	α_s		-0.00341	-0.311**	-0.653
			(0.544)	(0.133)	(0.383)
R^2		0.496	0.496	0.499	0.498
Overid. test, $\chi^2(df)$		2.479 (2)	2.348 (1)	0.158 (1)	1.216 (1)
		[0.290]	[0.125]	[0.691]	[0.270]
Endog. test, $\chi^2(df)$		0.165 (2)	0.488 (3)	1.474 (3)	0.526 (3)
		[0.921]	[0.922]	[0.688]	[0.913]
		Implied Coefficients			
Sales component,	β_{sales}	-0.308**	-0.307**	-0.0440	-0.148
$\ln(1 + sales)$		(0.113)	(0.112)	(0.123)	(0.138)
Base component,	β_{base}	-0.128**	-0.128***	-0.170***	-0.170***
$\ln(base)$		(0.0326)	(0.0287)	(0.0404)	(0.0425)
Excise component,	β_{exc}	-0.244**	-0.243**	-0.401***	-0.388**
$\ln\left(1 + \frac{excise}{base}\right)$		(0.0832)	(0.0811)	(0.119)	(0.128)
Carbon tax component,	β_C	-0.329**	-0.332*	-0.340**	-0.0676
$\ln\left(1 + \frac{Ctax_{it}}{base_{it} + exc_{it}}\right)$		(0.123)	(0.523)	(0.115)	(0.183)

Heteroskedasticity-robust, province-clustered standard errors in parentheses. P-values in brackets.

N=10, T=175-259.

*** p<0.01, ** p<0.05, * p<0.1

Table 13: Gasoline demand with uncertainty and salience effects on price-component responsiveness, uncertainty=mean absolute change, no IVing

Dependent: c_t	Parameter	(1) $s_k = 0\ \forall\ k$	(2) $s_C = 1$	(3) $s_c = s_{exc} = 1$	(4) $s_c = s_{exc} = s_{sales} = 1$
c_{t-1}	λ	0.559***	0.559***	0.556***	0.557***
		(0.0517)	(0.0518)	(0.0536)	(0.0526)
y	β_y	0.164***	0.164***	0.174***	0.168***
		(0.0437)	(0.0413)	(0.0433)	(0.0459)
$\sum_k p_k$	α_0	-0.393***	-0.402***	0.0784	-1.471*
		(0.104)	(0.108)	(0.267)	(0.705)
$\sum_k \sigma_k p_k$	α_σ	5.106***	5.239***	-5.057	27.15*
		(1.487)	(1.484)	(5.702)	(14.21)
$\sum_k s_k p_k$	α_s		0.0809	-0.371	0.697
			(0.491)	(0.212)	(0.432)
R^2		0.498	0.498	0.499	0.498
		Implied Coefficients			
Sales component,	β_{sales}	-0.261***	-0.266***	-0.0520	-0.0728
$\ln(1 + sales)$		(0.0676)	(0.0713)	(0.125)	(0.114)
Base component,	β_{base}	-0.144***	-0.146***	-0.168***	-0.148***
$\ln(base)$		(0.0386)	(0.0415)	(0.0458)	(0.0373)
Excise component,	β_{exc}	-0.308***	-0.315***	-0.377***	-0.323***
$\ln\left(1 + \frac{excise}{base}\right)$		(0.0804)	(0.0842)	(0.1000)	(0.0768)
Carbon tax component,	β_C	-0.383***	-0.311	-0.302**	-0.723**
$\ln\left(1 + \frac{Ctax_{it}}{base_{it}+exc_{it}}\right)$		(0.101)	(0.473)	(0.105)	(0.256)

Heteroskedasticity-robust, province-clustered standard errors in parentheses.
N=10, T=175-259.
*** p<0.01, ** p<0.05, * p<0.1

Table 14: Gasoline demand with uncertainty and salience effects on price-component responsiveness, uncertainty=SD, no IVing

Dependent: c_t	Parameter	(1) $s_k = 0\ \forall\ k$	(2) $s_C = 1$	(3) $s_c = s_{exc} = 1$	(4) $s_c = s_{exc} = s_{sales} = 1$
c_{t-1}	λ	0.563***	0.563***	0.556***	0.558***
		(0.0503)	(0.0503)	(0.0536)	(0.0531)
y	β_y	0.161***	0.162***	0.174***	0.173***
		(0.0442)	(0.0423)	(0.0435)	(0.0422)
$\sum_k p_k$	α_0	-0.340**	-0.347***	-0.0280	0.564
		(0.108)	(0.0989)	(0.139)	(0.494)
$\sum_k \sigma_k p_k$	α_σ	0.692**	0.709**	-0.451	-2.354
		(0.260)	(0.224)	(0.472)	(1.657)
$\sum_k s_k p_k$	α_s		0.0580	-0.288**	-0.615*
			(0.504)	(0.118)	(0.329)
R^2		0.497	0.497	0.499	0.498
		Implied Coefficients			
Sales component, $\ln(1 + sales)$	β_{sales}	-0.314**	-0.320***	-0.0451	-0.140
		(0.0983)	(0.0907)	(0.123)	(0.135)
Base component, $\ln(base)$	β_{base}	-0.125***	-0.127***	-0.168***	-0.166***
		(0.0359)	(0.0371)	(0.0456)	(0.0472)
Excise component, $\ln\left(1 + \frac{excise}{base}\right)$	β_{exc}	-0.246***	-0.251***	-0.376***	-0.369***
		(0.0744)	(0.0702)	(0.0993)	(0.103)
Carbon tax component, $\ln\left(1 + \frac{Ctax_{it}}{base_{it} + exc_{it}}\right)$	β_C	-0.336**	-0.285	-0.318***	-0.0642
		(0.106)	(0.502)	(0.0961)	(0.179)

Heteroskedasticity-robust, province-clustered standard errors in parentheses.
N=10, T=175-259.
*** p<0.01, ** p<0.05, * p<0.1

Table 15: Gasoline demand with uncertainty and salience effects on price-component responsiveness, uncertainty=mean absolute change, static model

Dependent: c_t	Parameter	(1) $s_k = 0 \ \forall \ k$	(2) $s_C = 1$	(3) $s_c = s_{exc} = 1$	(4) $s_c = s_{exc} = s_{sales} = 1$
y	β_y	0.364***	0.364***	0.385***	0.372***
		(0.0977)	(0.0916)	(0.0913)	(0.0996)
$\sum_k p_k$	α_0	-0.884**	-0.881**	0.186	-3.689**
		(0.278)	(0.314)	(0.700)	(1.515)
$\sum_k \sigma_k p_k$	α_σ	12.65**	12.60**	-10.50	70.12**
		(4.142)	(4.817)	(14.60)	(30.40)
$\sum_k s_k p_k$	α_s		-0.0288	-0.869	1.810*
			(1.260)	(0.548)	(0.953)
R^2		0.258	0.258	0.263	0.262
Overid. test, $\chi^2(df)$		1.809 (2)	1.581 (1)	0.297 (1)	0.347 (1)
		[0.405]	[0.209]	[0.586]	[0.556]
Endog. test, $\chi^2(df)$		0.405 (2)	0.755 (3)	1.848 (3)	1.622 (3)
		[0.817]	[0.860]	[0.605]	[0.655]
		Implied Coefficients			
Sales component,	β_{sales}	-0.558**	-0.555**	-0.0846	-0.0701
$\ln(1+sales)$		(0.173)	(0.190)	(0.330)	(0.280)
Base component,	β_{base}	-0.268***	-0.267**	-0.325***	-0.274***
$\ln(base)$		(0.0819)	(0.0834)	(0.0926)	(0.0731)
Excise component,	β_{exc}	-0.674**	-0.671**	-0.857***	-0.715***
$\ln\left(1+\frac{excise}{base}\right)$		(0.210)	(0.234)	(0.252)	(0.187)
Carbon tax component,	β_C	-0.861**	-0.886	-0.702**	-1.749**
$\ln\left(1+\frac{Ctax_{it}}{base_{it}+exc_{it}}\right)$		(0.271)	(1.150)	(0.278)	(0.540)

Heteroskedasticity-robust, province-clustered standard errors in parentheses. P-values in brackets.
N=10, T=175-259.
*** p<0.01, ** p<0.05, * p<0.1

Table 16: Gasoline demand with uncertainty and salience effects on price-component responsiveness, uncertainty=SD, static model

Dependent: c_t	Parameter	(1) $s_k = 0\ \forall\ k$	(2) $s_C = 1$	(3) $s_c = s_{exc} = 1$	(4) $s_c = s_{exc} = s_{sales} = 1$
y	β_y	0.363***	0.362***	0.385***	0.383***
		(0.101)	(0.0963)	(0.0919)	(0.0900)
$\sum_k p_k$	α_0	-0.729**	-0.712**	-0.0297	1.331
		(0.295)	(0.291)	(0.370)	(1.319)
$\sum_k \sigma_k p_k$	α_σ	1.590*	1.547*	-0.952	-5.337
		(0.724)	(0.727)	(1.209)	(4.381)
$\sum_k s_k p_k$	α_s		-0.135	-0.698**	-1.436
			(1.299)	(0.306)	(0.891)
R^2		0.252	0.252	0.263	0.260
Overid. test, $\chi^2(df)$		2.577 (2)	2.292 (1)	0.248 (1)	1.371 (1)
		[0.276]	[0.130]	[0.618]	[0.242]
Endog. test, $\chi^2(df)$		0.0582 (2)	0.389 (3)	1.892 (3)	1.063 (3)
		[0.971]	[0.943]	[0.595]	[0.786]
		Implied Coefficients			
Sales component,	β_{sales}	-0.669**	-0.653**	-0.0659	-0.308
$\ln(1 + sales)$		(0.268)	(0.263)	(0.326)	(0.351)
Base component,	β_{base}	-0.237**	-0.232**	-0.325***	-0.324***
$\ln(base)$		(0.0789)	(0.0734)	(0.0922)	(0.0984)
Excise component,	β_{exc}	-0.515**	-0.503**	-0.856***	-0.826**
$\ln\left(1 + \frac{excise}{base}\right)$		(0.199)	(0.194)	(0.249)	(0.273)
Carbon tax component,	β_C	-0.720**	-0.838	-0.733**	-0.135
$\ln\left(1 + \frac{Ctax_{it}}{base_{it} + exc_{it}}\right)$		(0.291)	(1.245)	(0.255)	(0.469)

Heteroskedasticity-robust, province-clustered standard errors in parentheses. P-values in brackets.
N=10, T=175-259.
*** p<0.01, ** p<0.05, * p<0.1

Table 17: Gasoline demand with uncertainty and salience effects on price-component responsiveness, uncertainty=province-specific mean absolute change

Dependent: c_t	Parameter	(1) $s_k = 0 \; \forall \; k$	(2) $s_C = 1$	(3) $s_c = s_{exc} = 1$	(4) $s_c = s_{exc} = s_{sales} = 1$
c_{t-1}	λ	0.564***	0.563***	0.555***	0.559***
		(0.0511)	(0.0513)	(0.0527)	(0.0509)
y	β_y	0.181***	0.177***	0.167**	0.164**
		(0.0507)	(0.0482)	(0.0523)	(0.0557)
$\sum_k p_k$	α_0	-0.197***	-0.189***	-0.151**	-0.148**
		(0.0474)	(0.0391)	(0.0570)	(0.0616)
$\sum_k \sigma_k p_k$	α_σ	1.460	1.454	-0.250	0.161
		(0.837)	(0.832)	(1.577)	(1.649)
$\sum_k s_k p_k$	α_s		-0.318	-0.260*	-0.170
			(0.623)	(0.118)	(0.119)
R^2		0.495	0.495	0.498	0.497

Heteroskedasticity-robust, province-clustered standard errors in parentheses.
N=10, T=175-259.
*** p<0.01, ** p<0.05, * p<0.1

Table 18: Gasoline demand with uncertainty and salience effects on price-component responsiveness, uncertainty=province-specific SD

Dependent: c_t	Parameter	(1) $s_k = 0 \; \forall \; k$	(2) $s_C = 1$	(3) $s_c = s_{exc} = 1$	(4) $s_c = s_{exc} = s_{sales} = 1$
c_{t-1}	λ	0.571***	0.570***	0.548***	0.553***
		(0.0489)	(0.0489)	(0.0541)	(0.0520)
y	β_y	0.171***	0.169***	0.171***	0.157***
		(0.0461)	(0.0442)	(0.0414)	(0.0449)
$\sum_k p_k$	α_0	-0.188**	-0.170***	0.0489	0.117
		(0.0824)	(0.0467)	(0.109)	(0.161)
$\sum_k \sigma_k p_k$	α_σ	0.298	0.264	-0.707	-0.817
		(0.241)	(0.199)	(0.479)	(0.623)
$\sum_k s_k p_k$	α_s		-0.247	-0.429***	-0.377**
			(0.607)	(0.121)	(0.142)
R^2		0.494	0.494	0.497	0.496

Heteroskedasticity-robust, province-clustered standard errors in parentheses.
N=10, T=175-259.
*** p<0.01, ** p<0.05, * p<0.1

Table 19: Gasoline demand with separated price components

Dependent: c_t	Dynamic (1)	Dynamic (2) IV	Static (4)	Static (5) IV
c_{t-1}	0.555***	0.553***		
	(0.0549)	(0.0550)		
y	0.173***	0.173***	0.383***	0.383***
	(0.0434)	(0.0430)	(0.0908)	(0.0892)
$\ln BT$	-0.167***	-0.172***	-0.317**	-0.311***
	(0.0479)	(0.0412)	(0.101)	(0.0935)
Sales component, $\ln(1+ST)$	-0.00364	0.000868	0.00720	0.0285
	(0.109)	(0.107)	(0.264)	(0.274)
Excise component, $\ln\left(1+\frac{exc}{BT}\right)$	-0.379***	-0.402**	-0.773***	-0.823**
	(0.104)	(0.129)	(0.213)	(0.269)
Carbon tax component, $\ln\left(1+\frac{Ctax}{BT+exc}\right)$	-0.467	-0.513	-1.088	-1.220
	(0.461)	(0.457)	(1.102)	(1.090)
Controls: month and year dummies				
R^2	0.6792	0.6791	0.5302	0.5295
Endogeneity test, BT, excise, and C		1.696		2.227
		[0.638]		[0.527]
Underidentification test		9.091		9.090
		[0.00257]		[0.00257]
	Coefficient Ratios			
Excise : BT	2.28***	2.35***	2.44***	2.65***
	(0.217)	(0.269)	(0.275)	(0.202)
C : BT	2.802	2.992	3.426	3.926
	(2.997)	(2.812)	(3.853)	(3.879)
C : Excise	1.230	1.276	1.406	1.483
	(1.315)	(1.304)	(1.559)	(1.554)

*** p<0.01, ** p<0.05, * p<0.1
Heteroskedasticity-robust, province-clustered std errors in parentheses;
P-values in brackets.
$N = 10$; $T = 175 - 260$ (dynamic), $177 - 262$ (static)
Endogeneity test: Durbin-Wu-Hausman test of endogeneity of before-tax, excise tax, and carbon tax variables; H0: exogenous.
Underidentification test: Kleibergen-Paap rk LM statistic.

References

[1] Ahn, Seung C., and Peter Schmidt. 1995. Efficient estimation of models for dynamic panel data. Journal of Econometrics 68: 5-27.

[2] Arellano, Manuel, and Stephen Bond. 1991. Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations. Review of Economic Studies 58: 277-297.

[3] Becker, Gary S., Michael Grossman, and Kevin M. Murphy. 1994. An empirical analysis of cigarette addiction. Am. Econ. Rev. 84(3): 396–418.

[4] Beer Marketer's Insights. 2013. The US Beer Industry: Key Shipments Data - Brands. http://beerinsights.com/index.php?option=com_k2&view=item&id=19562:top-brands-shipments-and-shar Accessed 1 April 2014.

[5] Bird, Richard M. 2010. Visibility and Accountability: Is Tax-Inclusive Pricing a Good Thing? Canadian Tax Journal 58(1): 63 -76.

[6] Blundell, Richard, and Stephen Bond. 1998. Initial conditions and moment restrictions in dynamic panel data models. Journal of Econometrics 87: 115—143.

[7] Bond, Stephen R. 2002. Dynamic panel data models: A guide to micro data methods and practice. Portuguese Economic Journal 1(2): 141-162.

[8] Browning, Martin, 1991. A simple nonadditive preference structure for models of household behavior over time. J. Polit. Econ. 99(3), 607-637.

[9] Bruno, Giovanni S. F. 2005. Estimation and inference in dynamic unbalanced panel-data models with a small number of individuals. The Stata Journal 5(4): 473–500.

[10] Bun, Maurice J.G., and Martin A. Carree. 2006. Bias-corrected estimation in dynamic panel data models with heteroscedasticity. Economics Letters 92: 220–227.

[11] Cabral, Marika, and Caroline Hoxby. Nov. 2012. The Hated Property Tax: Salience, Tax Rates, and Tax Revolts. NBER Working Paper 18514.

[12] Chetty, Raj, Adam Looney, and Kory Kroft. 2009. Salience and Taxation:Theory and Evidence. AER 99:4 (1145-1177).

[13] Congdon, William, Jeffrey R. Kling, and Sendhil Mullainathan. 2009. Behavioral Economics and Tax Policy. NBER Working Paper 15328. http://www.nber.org/papers/w15328

[14] Coppejans, Mark, Donna Gilleskie, Holger Sieg, and Koleman Strumpf. 2007. Consumer demand under price uncertainty: Empirical evidence from the market for cigarettes. The Review of Economics and Statistics 89(3): 510-521.

[15] Feldman, Naomi E., and Bradley J. Ruffle. August 2012. The Impact of Tax Exclusive and Inclusive Prices on Demand. FEDS Working Paper No. 2012-50.

[16] Finkelstein, Amy. 2009. E-ZTax: Tax Salience and Tax Rates. Quarterly Journal of Economics 124(3): 969-1010.

[17] Goldin, Jacob, and Tatiana Homonoff. 2013. Smoke Gets in Your Eyes: Cigarette Tax Salience and Regressivity. American Economic Journal: Economic Policy 5(1): 302–336.

[18] Judson, Ruth A., and Ann L. Owen. 1999. Estimating dynamic panel data models: a guide for macroeconomists. Economics Letters 65: 9–15.

[19] Kiviet, Jan F. 1995. On bias, inconsistency, and efficiency of various estimators in dynamic panel data models. Journal of Econometrics 68: 53-78

[20] Li, Shanjun, Joshua Linn, and Erich Muellegger. March 2012. Gasoline taxes and consumer behavior. NBER Working Paper 17891.

[21] Mehrhoff, Jens. 2009. A solution to the problem of too many instruments in dynamic panel data GMM. Deutsche Bundesbank Discussion Paper Series 1: Economic Studies, No. 31/2009. 21 March 2014 <https://www.econstor.eu/dspace/bitstream/10419/28620/1/612354555.pdf>.

[22] NewCROP. Purdue University. 1999. "Barley: Gramineae Hordeum sp." 21 March 2014 <http://www.hort.purdue.edu/newcrop/Crops/Barley.html>

[23] Nickell, Stephen. 1981. Biases in dynamic models with fixed effects. Econometrica 49(6): 1417–1426.

[24] Rivers, Nicholas, and Brandon Schaufele. June 2013. Salience of Carbon Taxes in the Gasoline Market. Working Paper. Available at SSRN: `http://ssrn.com/abstract=2131468`.

[25] Roodman, David. 2011 (first version 2003). XTABOND2: Stata module to extend xtabond dynamic panel data estimator. Center for Global Development, Washington. http://econpapers.repec.org/software/bocbocode/s435901.htm.

[26] Schaffer, Mark E. 2010. xtivreg2: Stata module to perform extended IV/2SLS, GMM and AC/HAC, LIML and k-class regression for panel data models. `http://ideas.repec.org/c/boc/bocode/s456501.html`.

[27] Schenk, Deborah H. 2011. Exploiting the Salience Bias in Designing Taxes. Yale Journal on Regulation 28: 253-311.

[28] Schmitz, Troy G., and Won W. Koo. Sep. 1996. An Economic Analysis of International Feed and Malting Barley Markets: An Econometric Spatial Oligopolistic Approach. Agricultural Economics Report No. 357, Department of Agricultural Economics, North Dakota State University. 21 March 2014 <http://ageconsearch.umn.edu/bitstream/23286/1/aer357.pdf>.

[29] Scott, K. Rebecca. 2006. U.S. Gasoline Demand Responsiveness to Tax- and Non-Tax Components of Price. Senior Thesis, A.B., Princeton University.

[30] Scott, K. Rebecca. 2011a. Demand and Price Volatility/Forecastability: Rational Habits in International Gasoline Demand. UC-Berkeley Dept. of Agricultural & Resource Economics, CUDARE Working Papers Series #1122.

[31] Scott, K. Rebecca. 2011b. Rational Habits and Uncertain Prices: Simulating Gasoline Consumption Behavior. University of Oxford Dept. of Economics Discussion Paper Series #596. `http://www.economics.ox.ac.uk/materials/working_papers/paper596.pdf`.

[32] Scott, K. Rebecca. 2012. Rational habits in gasoline demand. Energy Economics 34(5): 1713–1723.

[33] Spinnewyn, Frans. 1981. Rational habit formation. Eur. Econ. Rev. 15, 91–109

A Beer Data

The dataset used to examine beer demand is an annual, state-level panel, 1982-2011, constructed similarly to CLK's. The panel's starting date is limited by the availability of price data, and its end date is limited by the availability of consumption data. The availability of price data limits the series length for some states: an average of 28.1 observations is available per state, and Maine has the shortest series, with eight years. Insufficient price data forces the exclusion of Hawaii (three years) and Rhode Island (four years) altogether. Washington, DC is excluded because of a concern that some price observations may have been taken in Virginia or Maryland, and West Virginia is included despite its exclusion from the CLK data; but neither of these choices has a meaningful impact on the results. Overall, the data consists of 1350 observations across 48 states.

Annual, state-aggregated beer consumption, in gallons, is taken from the National Institute on Alcohol Abuse and Alcoholism (NIAAA). This is transformed into log consumption per capita over 21, the legal drinking age for the vast majority of the period. Population data is taken from the same NIAAA source.

Price data is derived from the Council for Community and Economic Research (C2ER, formerly ACCRA) Cost of Living Index (COLI). Since 1982, the COLI has recorded the price of a six-pack of Heineken, Schlitz or Budweiser in several hundred cities across the US. State-level prices are constructed using a simple average of price observations within a state in a given period. COLI provides annual prices beginning in 2007, and prior to that I average quarterly state prices to arrive at an annual price. When fewer than four quarters are available, which happens in only a handful of cases, I simply average over the available quarters. Because the sampled locations are not constant over time, averaging over state before time sometimes has a small effect on the weighting of individual locations' observations. Prices are converted from price per sixpack to price per gallon. Excise (but not sales) taxes are included in COLI price measurements, so before-tax price levels are caclulated by subtracting the excise tax level from the COLI price.

For state excise and sales taxes, I take the data published by CLK as a starting point, update it through 2011 and in some cases make corrections. Tables from the NIAAA's Alcohol Policy Information System and the Tax Foundation serve as the primary indicators of whether and when rates have changed. Where changes or conflicts are apparent, rates and dates of change are confirmed using a variety of sources. Annual rates are defined as the time-weighted average of rates prevailing throughout the year. All specific excise taxes are converted to dollars per gallon. Sales taxes are defined as the state ad valorem rate applying to beer. In most states this is the same as the standard sales tax rate, but in others beer is exempt from sales tax or a different rate is applied to beer. The use of local taxes in some states complicates matters. I include them in the state rate when they are applied nearly uniformly and/or at a minimum rate across a state. In addition to the state excise tax, there is a federal tax on beer (currently 58 nominal cents per gallon; rates taken from the US Alcohol and Tobacco Tax and Trade Bureau), and this is added to the state rate to form the overall excise tax.

The barley price used as an instrument for before-tax prices is the Winnipeg Commodity Exchange feed barley spot price, USD per tonne, from the World Bank.

Annual personal income is taken from the Bureau of Economic Analysis (BEA) and converted to log income per capita over 21. Using log income per capita (with total population taken from the same BEA source) makes no meaningful difference to the results. State unemployment levels are taken from the Bureau of Labor Statistics.

All price and income variables, finally, are converted to real terms using the national CPI, all items, from the Bureau of Labor Statistics.

B Difference and System GMM Estimates of Beer Demand

Difference and system GMM estimates of model 14 are presented in Table 20. The difference GMM estimator instruments the model in differences using lags two through four of consumption, with all exogenous regressors and the price instruments used as "IV-style" instruments. The system GMM estimator augments this with moment conditions for the model in levels, using as instruments the first lagged difference of consumption and the exogenous regressors and price instruments. The two-step estimator is used, with Windmeijer's correction applied to correct the standard errors. Estimation is performed using Roodman's (2011) *xtabond2*.

Table 20: Difference and system GMM estimates of beer demand

		(1)	(2)	(3)	(4)
		Diff. GMM	Sys. GMM	Diff. GMM	Sys. GMM
Dependent: c_t		$\sigma = \overline{\lvert\Delta p_{k,t}\rvert}$	$\sigma = \overline{\lvert\Delta p_{k,t}\rvert}$	$\sigma = SD\,(p_{k,t})$	$\sigma = SD\,(p_{k,t})$
c_{t-1}	λ	0.162*	0.598***	0.162*	0.598***
		(0.0849)	(0.136)	(0.0849)	(0.136)
y	β_y	0.795***	0.113	0.795***	0.113
		(0.113)	(0.0970)	(0.113)	(0.0970)
$\sum_k p_k$	α_0	-1.569*	-0.602	-1.567*	-0.621
		(0.913)	(0.523)	(0.910)	(0.527)
$\sum_k \sigma_k p_k$	α_σ	-0.596	4.682	-0.134	1.055
		(4.559)	(3.880)	(1.027)	(0.874)
$\sum_k s_k p_k$	α_s	1.586	0.368	1.586	0.368
		(0.981)	(0.513)	(0.981)	(0.513)
Trend	β_t	-0.0137***	-0.00339*	-0.0137***	-0.00339*
		(0.00158)	(0.00175)	(0.00158)	(0.00175)
R^2		0.742	0.742	0.736	0.741
Instrument Count		92	123	92	123

Standard errors with Windmeijer correction in parentheses.
*** p<0.01, ** p<0.05, * p<0.1
N=48, T=8-30

C Canadian Gasoline Data

The Canadian gasoline dataset used here is a monthly, province-level panel, 1990 through 2011. Some provinces' series are abbreviated, but in all cases at least 176 months (or 54 quarters, or 12 years) are available for estimation. For comparability with the Rivers and Schaufele (2013) study, I omit the Northwest and Yukon Territories.

Following Rivers and Schaufele, I draw my data on prices and excise taxes from Kent Marketing Services (2013), proxying the provincial price by the price in the province's most populous city. An exception occurs in Saskatchewan, where I use the long series available for Regina rather than the short series available for Saskatoon. Price data are available for regular unleaded, mid, and premium grades, and I use the mean of these. I define excise taxes as the sum of local, provincial and federal gasoline excise taxes. Rather than taking total prices directly from Kent Marketing Services (2013), I construct them from their constituent parts. Sales taxes—provincial sales taxes and the federal Good and Services Tax (GST) or a Harmonized Sales Tax (HST)—are compiled from a variety of sources. Carbon taxes I take from the data set made available by Rivers and Schaufele. In contrast to Rivers and Schaufele, I deflate all monetary variables using national rather than provincial monthly CPI.

As my measure of consumption, I use retail sales of motor gasoline divided by the population over 18. Both of these are available at the province level from Statistics Canada, though population must be interpolated linearly between Julys. My income measure is expenditure-based GDP interpolated between Julys and divided by total (interpolated) province population. Crude oil prices I get from the Canadian Association of Petroleum Producers, converting the West Texas Intermediate stream price from USD to CAN using exchange rates from the same source.

Details of data sources are provided in Appendix F.

D Newspaper coverage methodology

To gauge news coverage, I searched LexisNexis newspaper archives using the following search terms:

	Search Terms
Gasoline tax keywords	"gasoline tax" OR "gasoline excise tax" OR "gas tax"
Carbon tax	"carbon tax"
Gasoline price keywords	"gasoline price" OR "price of gasoline"
Oil price keywords	"oil price" OR "price of oil" OR "price of crude oil"
Sales tax keywords	"Goods and Services Tax" OR GST OR "Harmonized Sales Tax"
	OR "HST" or "sales tax" OR PST OR "Manufacturers' Sales Tax" OR MST

These search terms are constructed in a way that should bias us, if anything, *towards* evidence of a program for tax salience, with "gas tax" included among gasoline tax keywords but "gas price" excluded from price keywords. Mentions are tallied by the number of articles including any of these search terms rather than by the number of times the search terms appeared. These tallies are provided in Table 21.

The search period coincides with the sample period of 1990-2011. I searched all Canadian newspapers available in LexisNexis that are among both the top two circulation in the newspaper headquarter's province and the top 25 circulation nationally. No French Canadian newspapers were available in LexisNexis, so the analysis may not be representative of Quebec. The "Canadian Newspapers" aggregate includes all 45 Canadian newspapers covered by LexisNexis.

E Beer Data Sources

Income, Total Population, and Unemployment

- Bureau of Labor Statistics (BEA). Local Area Unemployment Statistics. `http://data.bls.gov`. Accessed 22 March 2014.
- Bureau of Economic Analysis (BEA). Population. SA1-3 Personal income summary, SA51-53 - Disposable personal income summary. `bea.gov`. Accessed 3 Sep 2013.

Table 21: Count of price component keywords, Canadadian newspapers

Count of price component keywords, Canada

	Canadian Newspapers	Vancouver Sun (BC)	[Vancouver] Province (BC)	Toronto Star (ON)	Globe and Mail (ON)	The Gazette (QC)	Calgary Herald (AB)	Edmonton) Journal (AB
Gasoline tax keywords	4801	334	145	1082	536	366	388	288
Carbon tax	11948	1180	602	711	1087	421	762	513
Gasoline price keywords	51887	1895	1578	4422	5876	2614	7490	2885
Oil price keywords	111590	3840	2465	8713	17241	5793	16093	6656
Sales tax keywords	106752	9491	2173	20214	11891	5396	11042	3866

Barley Price

- World Bank Data. Global Economic Monitor (GEM) Commodities. Barley. http://databank.worldbank.org. Accessed 18 March 2014.

Federal Excise Tax

- Alcohol and Tobacco Tax and Trade Bureau, U.S. Dept. of the Treasury. Historical Tax Rates. http://www.ttb.gov/tobacco/94a01_4.shtm. Accessed 28 Feb 2014.

State Excise and Sales Taxes - Main Sources

- National Institute on Alcohol Abuse and Alcoholism (NIAAA). Alcohol Policy Information System (APIS). Alcohol Beverage Taxes: Beer. http://alcoholpolicy.niaaa.nih.gov/Taxes_Beer.htm. Accessed 28 Feb 2014.

- Tax Foundation. State Beer Excise Tax Rates, 2009-2013. 8 April 2013. http://taxfoundation.org/sites/taxfou Accessed 27 Feb. 2014.

- Tax Foundation. 1 April 2010. State Sales, Gasoline, Cigarette, and Alcohol Tax Rates by State, 2000-2010. http://taxfoundation.org/article/state-sales-gasoline-cigarette-and-alcohol-tax-rates- Accessed 3 March 2014.

- Tax Foundation. State and Local Sales Tax Rates, 2011 - 2013. 14 March 2013. http://taxfoundation.org/articl Accessed 3 March 2014.

- Tax Foundation. State Sales, Gasoline, Cigarette, and Alcohol Tax Rates by State: As of January 1, 2002. http://taxfoundation.org/sites/taxfoundation.org/files/docs/state_various_sales_rates_2000- Accessed 27 Feb. 2014.

Prices

- Council for Community and Economic Research (C2ER). June 2012. Cost of Living Index Manual. https://www.coli.org/surveyforms/colimanual.pdf. Accessed 26 February 2014.

- Council for Community and Economic Research (C2ER), formerly American Chamber of Commerce Researchers Association (ACCRA). Inter-City Cost of Living Index. Individual years, 1982-1989, and 1990-2013 dataset for beer and wine.

Consumption and Population over 21

- National Institute on Alcohol Abuse and Alcoholism (NIAAA). July 2013. Data for Surveillance Report #97, "Apparent per capita alcohol consumption: National, state, and regional trends, 1977-2011" by Robin A. LaVallee, Heather A. LeMay, and Hsiao-ye Yi. http://pubs.niaaa.nih.gov/publications/sur Accessed 26 Feb. 2014.

CPI and Total Population

- Bureau of Labor Statistics (BLS). CPI: Consumer Price Index - All Urban Consumers, U.S. city average, All items, Not Seasonally Adjusted. Series Id: CUUR0000SA0,CUUS0000SA0. Base Period: 1982-84=100. http://www.bls.gov/cpi/data.htm. Accessed 3 Sep 2013.

State Excise and Sales Taxes - Supplementary Sources

- Advisory Commission on Intergovernmental Relations. February 1962. "Major State Tax Changes Enacted in 1961." http://www.library.unt.edu/gpo/acir/Reports/information/M-13.pdf.
- Advisory Commission on Intergovernmental Relations. January 1968. "State and Local Taxes: Significant Features, 1968." http://www.library.unt.edu/gpo/acir/Reports/information/m-37.pdf. Accessed 5 March 2014.
- Advisory Commission on Intergovernmental Relations. November 1968. "State and Local Finances: Significant Features, 1966 to 1969." http://www.library.unt.edu/gpo/acir/Reports/information/m-43.pdf. Accessed 5 March 2014.
- Alaska Dept. of Revenue, Tax Division. Alcoholic Beverage Excise Tax Increase. http://www.tax.alaska.gov/pro Accessed 27 Feb 2014.
- Arkansas Game & Fish Commission. 2011. "Amendments 35 and 75." http://www.agfc.com/aboutagfc/pages/ab Accessed 4 March 2014.
- Arkansas Game and Fish Commission. Arkansas 1/8th-Cent Conservation Sales Tax 10-Year Report. http://www.agfc.com/aboutagfc/Documents/consvtax_tenyr_report.pdf. Accessed 4 March 2014.
- Comptroller of Maryland. 2013. "FAQs - Sales and Use Tax on Sales of Alcoholic Beverages." http://taxes.marylandtaxes.com/Resource_Library/Taxpayer_Assistance/Frequently_Asked_Questions/F Accessed 5 March 2014.
- Comptroller of Maryland. 2013. "Frequently Asked Questions About Sales of Alcoholic Beverages." http://taxes.marylandtaxes.com/Resource_Library/Taxpayer_Assistance/Frequently_Asked_Questions/F Accessed 3 March 2014.
- Rucker, Philip. 1 Jan 2008. "Many of Md. Tax Increases Will Go Into Effect Today." Washington Post. http://www.washingtonpost.com/wp-dyn/content/article/2007/12/31/AR2007123102213.html. Accessed 3 March 2014.
- California State Board of Equalization. History of Statewide Sales and Use Tax Rate. https://www.boe.ca.gov/su Accessed 3 March 2014.
- Bureau of Legislative Research, Arkansas Legislative Council. Arkansas Legislative Handbook 2010. Oct. 2010. http://www.arkleg.state.ar.us/assembly/2011/Summary%20Budget%20Manuals/2010TaxHandbook Accessed 4 March 2014
- Bureau of Legislative Research, Arkansas Legislative Council. Arkansas Legislative Handbook 2012. Oct. 2012. http://www.arkleg.state.ar.us/bureau/fiscal/Publications/2013-2015%20Budget%20Request% Accessed 4 March 2014.
- CCH Tax Law Editors. 2008. U.S. Master Sales and Use Tax Guide. Chicago, IL: CCH. pp. 1272, 1144-1145. http://books.google.co.uk/books?id=wu2AUcM7h9AC&lpg=PA39&ots=KcFfI6npxf&dq=U.S.%20Mast
- Connecticut General Assembly, Office of Legislative Research. 13 June 2011. "2011 Sales Tax Increases." 2011-R-0238. http://www.cga.ct.gov/2011/rpt/2011-R-0238.htm. Accessed 4 March 2014.

- Dalton, Pat. August 2010. "Minnesota Sales Tax Rate." [Minnesota] House Research. http://www.house.leg.stat Accessed 5 March 2014.

- Governments Division, Bureau of the Census. 1986. Governments Quarterly Report: Quarterly summary of federal, state, and local tax revenue. http://books.google.co.uk/books?id=V28rLBPZMvwC&pg=PA1# Accessed 5 March 2014.

- Governments Division, Bureau of the Census. 1990. Governments Quarterly Report: Quarterly summary of federal, state, and local tax revenue. http://books.google.co.uk/books?id=POjfDvabbpwC&lpg=PA1 Accessed 5 March 2014.

- Holbein, John, Andre Baksh, and Jin Dai. Economic & Statistical Unit, Utah State Tax Commission. June 2011. "History of the Utah Tax Structure." 2014 http://tax.utah.gov/esu/history/history.pdf. Accessed 5 March 2014.

- Idaho State Tax Commission. 29 November 2013. "Sales/Use Tax." http://tax.idaho.gov/i-1023.cfm. Accessed 4 March 2014.

- Indiana Department of Revenue. "Indiana Sales Tax Changed to 7 Percent – Effective April 1, 2008." http://www.in.gov/dor/3885.htm. 4 March 2014.

- Iowa Department of Revenue. "Iowa Sales Tax FAQs." http://www.iowa.gov/tax/educate/faqsales.html. Accessed 4 March 2014.

- Kansas Department of Revenue. 2013. "Selected Kansas Tax Rates with Statutory Citation." http://www.ksrevenue.org/taxrates.html. Accessed 4 March 2014.

- Lawhorn, Chad. 9 July 2010. "Sales tax exceeds liquor tax in Lawrence after statewide increase." Lawrence Journal-World. http://www2.ljworld.com/news/2010/jul/09/state-sales-tax-outweighs-liquor- Accessed 4 March 2014.

- Levenson, Michael. 19 May 2009. "Mass. Senate approves sales-tax increase." Boston.com. http://www.boston.com/news/local/breaking_news/2009/05/mass_senate_app.html. Accessed 4 March 2014.

- Massachusetts Department of Revenue. 14 December 2010. "TIR 10-24: Repeal of Sales Tax on Alcoholic Beverages." http://www.mass.gov/dor/businesses/help-and-resources/legal-library/tirs/tirs-b Accessed 4 March 2014.

- Minnesota Revenue, Tax Research Division. December 2010. Minnesota Tax Handbook, 2010 Edition. http://archive.leg.state.mn.us/docs/2011/other/110250.pdf. Accessed 5 March 2014 .

- Nebraska Dept. of Revenue. 2006. "Alcoholic Beverages Tax," 2006 Nebraska Department of Revenue Annual Report, p. 69. http://www.revenue.nebraska.gov/ann_rept/06an_rep/Misc2.pdf. Accessed 27 Feb. 2014.

- Nebraska Department of Revenue. History of Nebraska Income Tax and Sales Tax Rates Through 1992. http://www.revenue.nebraska.gov/research/history.pdf. Accessed 5 March 2014.

- Nebraska Department of Revenue. "Nebraska Tax Rate Chronologies. Table 1 - Income Tax and Sales Tax Rates." http://www.revenue.nebraska.gov/research/4-607table1.pdf. 5 March 2014.

- New Mexico Taxation and Revenue Department. Various Years. Forms: Gross Receipts. http://old.tax.newmexic
Accessed 5 March 2014.

- [New York] Assembly Ways and Means Committee. Feb. 2001. New York State Revenue Report, 2000-2001 & 2001-2002. http://assembly.state.ny.us/comm/WAM/20010201/. Accessed 27 Feb. 2014.

- New York State Division of the Budget. Tax Cuts Under Governor Pataki. https://www.budget.ny.gov/pubs/arc
Accessed 27 Feb. 2014.

- North Carolina Department of Revenue. November 2006. "Important Notice: Decrease in State Sales and User Tax Rate." http://www.dor.state.nc.us/taxes/sales/ImpNoticeTaxDecrease1106.pdf. Accessed 5 March 2014.

- North Carolina Department of Revenue. Aug. 2009. "Important Notice: Sales and Use Tax Rate Change." http://www.dornc.com/taxes/sales/impnotice0809_2.pdf. Accessed 5 March 2014.

- North Carolina Department of Revenue. "Permanent Extension of General State Rate of Sales and Use Tax." http://www.dornc.com/taxes/sales/rate_extension.html. Accessed 5 March 2014.

- North Carolina Department of Revenue. Various Years. "Tax Rates." http://www.dornc.com/taxes/sales/taxra
5 March 2014.

- [North Carolina] Office of State Budget and Management. North Carolina Tax Guide 2007. http://www.osbm.state.nc.us/files/pdf_files/2007TaxGuide.pdf. Accessed 5 March 2014.

- Ohio Department of Taxation. "Sales & Use Tax: History of Major Changes." http://www.tax.ohio.gov/portals/
Accessed 5 March 2014.

- State of Arkansas, 86th General Assembly. 2007. Act 869 of the Regular Session. http://www.arkleg.state.ar.us
Accessed 4 March 2014.

- State of New Jersey Department of the Treasury, Division of Taxation. 21 July 2006. Information for All Sales and Use Tax Vendors. http://www.state.nj.us/treasury/taxation/vendors.shtml. Accessed 5 March 2014.

- Statewide Accounting Division of the North Carolina Office of the State Controller. North Carolina Comprehensive Annual Financial Report for the Fiscal Year Ended June 30, 2012. http://www.osc.nc.gov/financ
Accessed 5 March 2014. pp. 268-269.

- "Taxes about to increase." 30 June 2009. Las Vegas Review. http://www.reviewjournal.com/news/nevada-legis
5 March 2014.

- Tennessee Advisory Commission on Intergovernmental Relations and the University of Tennessee Center for Business and Economic Research. February 2003. "The Structure of State Taxes in Tennessee: A Fiscal Primer." p. 46. http://www.state.tn.us/tacir/PDF_FILES/Taxes/primer.pdf. Accessed 5 March 2014.

- U.S. Department of Commerce, Bureau of the Census. June 1982. Quarterly Summary of State and Local Tax Revenue, January-March 1982. http://books.google.co.uk/books?id=3W-Tg33bbtsC&pg=PA10#v=one
Accessed 5 March 2014.

- U.S. Department of Commerce, Bureau of the Census. 1993. Statistical Abstract of the United States, 1993. p. 305. http://books.google.co.uk/books?id=YKYYAAAAIAAJ&pg=PR3#v=onepage&q&f=false. Accessed 5 March 2014.
- US Department of Commerce, Economics & Statistics Administration, Bureau of the Census. August 1994. Quarterly Summary of Federal, State, and Local Tax Revenue. July-September 1993. http://books.google.co.uk/books?id=5wr6Rfy7FwIC&pg=PA1#v=onepage&q&f=false. Accessed 5 March 2014.
- U.S. Department of Commerce, Social and Economic Statistics Administration, Bureau of the Census. November 1974. State Tax Collections in 1974. p. 11. http://books.google.co.uk/books?id=R4kBhIHoT2IC
Accessed 5 March 2014.
- [Utah] Office of Legislative Research and General Counsel. September 2011. "Utah's General Sales & Use Tax." http://le.utah.gov/lrgc/briefings/SalesTaxBriefingPaper.Sept11.pdf. Accessed 5 March 2014.
- Utah State Tax Commission. 26 March 2013. Utah Sales & Use Tax Rates. http://www.tax.utah.gov/sales/rate
Accessed 5 March 2014.
- Vermont Department of Taxes. "Highlights of 2003 Tax Legislation." http://www.state.vt.us/tax/pdf.word.exc
Accessed 5 March 2014.
- Virginia Department of Taxation. 1 August 2004. 2004 Legislative Summary. Doc. Number 04-40. http://www.policylibrary.tax.virginia.gov/OTP/Policy.nsf/72ecd7668f3940d2852569910070c1d2/4cdba0
Accessed 5 March 2014.

F Canadian Gasoline Data Sources

Carbon taxes

- Rivers, Nicholas, and Brandon Schaufele. "Data and Code for "Salience of Carbon Taxes in the Gasoline Market." http://www.brandonschaufele.com/data-and-code. Accessed 23 Sep. 2013.

Consumption

- Statistics Canada. CANSIM (database), Table134-0004 - Supply and disposition of refined petroleum products, monthly (cubic metres). Accessed 9 Sep. 2013.

Crude oil prices and exchange rates

- Canadian Association of Petroleum Producers (CAPP). Statistical Handbook. Table 05-05A, 05-05B, 05-05C, 05-05D, 05-05E, 05-05F, 05-05G. http://www.capp.ca/library/statistics/handbook/pages/statisticalTables.aspx?sectionNo=5. Accessed 17 Sep. 2013.
- Canadian Association of Petroleum Producers (CAPP). Statistical Handbook. http://membernet.capp.ca/SHB/MakeSpreadsheet.asp?Docid=96. Accessed 17 Sep. 2013.

Income

- Statistics Canada. 13-018-X. Table 2: Gross Domestic Product, Expenditure-Based. http://www.statcan.gc.ca/pub/13-018-x/2011001/tab-eng.htm. Accessed 25 Sept 2013.
- Statistics Canada. CANSIM (database), Table384-0038 - Gross domestic product, expenditure-based, provincial and territorial, annual. Accessed 24 Sep. 2013.

Population

- Statistics Canada. CANSIM (database), Table051-0001 - Estimates of population, by age group and sex for July 1, Canada, provinces and territories, annual. http://www5.statcan.gc.ca/cansim/a47. Accessed 25 Sep. 2013.

Prices and excise taxes

- Kent Marketing Services. 2013. Petroleum Price Data. http://www.kentmarketingservices.com/dnn/PetroleumPriceData.aspx. Accessed 16 Sep. 2013.

CPI

- Statistics Canada. CANSIM (database), Table326-0020 - Consumer Price Index (CPI), 2011 basket, monthly. http://www5.statcan.gc.ca/cansim/a47. Accessed: 23 Sep. 2013.

Sales tax rates - federal

- Amantea, Lindsay. 16 May 2011. "A Brief History of Sales Taxes in Canada." Politonomist. http://www.politonomist.com/a-brief-history-of-sales-taxes-in-canada-002459/. Accessed 25 Sep 2013.
- Office of the Auditor General of Canada. 1989. Report of the Auditor General of Canada, Chapter 18—Department of National Revenue—Customs and Excise—Excise. http://www.oag-bvg.gc.ca/internet/English/parl_oag_198911_18_e_4267.html. Accessed 25 Sep 2013.
- Bird, Richard M. March 2012. The GST/HST: Creating an Integrated Sales Tax in a Federal Country. SPP Research Papers, School of Public Policy, University of Calgary, 5(12). http://www.policyschool.ucalgary.ca/sites/default/files/research/bird-gst-hst.pdf. Accessed 25 Sep 2013.
- "Harmonized Sales Tax." Wikipedia. http://en.wikipedia.org/wiki/Harmonized_Sales_Tax. Accessed 25 Sep 2013.
- Canadian Sales Tax Calculator (GST - HST - PST). HelpSME.com. http://helpsme.com/tools/free-gst-hst-pst-sales-tax-calculator-canada. Accessed 25 Sep 2013.

Sales tax rates - provincial

- Canada Revenue Agency. "GST/HST Rates." http://www.cra-arc.gc.ca/tx/bsnss/tpcs/gst-tps/rts-eng.html. Accessed 19 Sep 2013.
- Continuing Legal Education Society of British Columbia. Oct. 2012. "Overview of the New Provincial Sales Tax". http://www.cle.bc.ca/PracticePoints/TAX/12-OverviewofNewSalesTax.pdf. Accessed 19 Sep 2013.

- British Columbia. "Motor Fuel Tax and Carbon Tax". http://www2.gov.bc.ca/gov/topic.page?id=1A80D78D2FC440ECB036B9EDE1EA7771&title=Motor%20Fuel%20and%20Carbon%20Ta. Accessed 19 Sep 2013.
- British Columbia Ministry of Finance. Apr 1999/Revised June 2013. "Tax Rates on Fuels: Motor Fuel Tax Act and Carbon Tax Act." Tax Bulletin. http://www.sbr.gov.bc.ca/documents_library/bulletins/mft-ct_005.pdf. Accessed 19 Sep 2013.
- BC Stats. Sep 1996. "The Hotel Room Tax Act – A Brief History." Tourism Sector Monitor. http://www.bcstats.gov.bc.ca/Files/e106df91-2e45-4a11-85fc-2be172d79128/TheHotelRoomTaxAct--ABriefHistory.pdf. Accessed 19 Sep. 2013.
- Revenu Québec. "Tables of GST and QST Rates." 31 Dec 2012. http://www.revenuquebec.ca/en/entreprise/taxes/tvq_tps/historique-taux-tps-tvq.aspx. Accessed 19 Sep. 2013.
- TaxTips.ca. "2013 Sales Tax Rates in Canadian Provinces and Territories." 11 Aug 2013. http://www.taxtips.ca/salestaxes/sales-tax-rates-2013.htm. Accessed 19 Sep. 2013.
- Dept. of Finance, Canada. "Memorandum of Agreement Regarding Sales Tax Harmonization with a View to Concluding a Canada-Quebec Comprehensive Integrated Tax Coordination Agreement." Sep. 2011. http://www.fin.gc.ca/access/tt-it/quebec-tax-2011-eng.asp. Accessed 19 Sep. 2013.
- Vander Ploeg, Casey, and Jack Vicq. Oct 2010. A Tax Framework for Saskatchewan's Continuing Prosperity, Appendix A. Canada West Foundation. http://cwf.ca/pdf-docs/publications/sk-tax-low.pdf. Accessed 25 Sep 2013.
- Government of Saskatchewan. 27 Oct 2006. "Government cuts PST from 7 to 5 per cent." News release. http://www.gov.sk.ca/news?newsId=33ed45c5-22ef-449d-8da2-039d8c72d3e4. Accessed 25 Sep 2013.
- Government of Saskatchewan. "Provincial Sales Tax." http://www.finance.gov.sk.ca/taxes/pst/. Accessed 25 Sep 2013.
- Government of Saskatchewan. 31 March 2004. "2004/05 Budget faces fiscal realities head on." News Release. http://gov.sk.ca/news?newsId=a98ca8d4-ff11-4fd9-90ae-2d4d0bb6b533. Accessed 25 Sep 2013.
- Elliott, Doug. Aug 2003. "Demographic Trends in Saskatchewan: A Statistical Analysis of Population, Migration, and Immigration." Sask Trends Monitor. http://www.saskatoon.ca/DEPARTMENTS/Community%20Services/Communitydevelopment/Documents/demographic_trends_sk.pdf. Accessed 25 Sep 2013.
- Manitoba Tax Division. "Retail Sales Tax." http://www.gov.mb.ca/finance/taxation/taxes/retail.html. Accessed 25 Sep 2013.
- Ontario Ministry of Finance. "Retail Sales Tax." http://www.fin.gov.on.ca/en/tax/rst/rates.html. Accessed 25 Sep 2013.
- Harmonized Sales Tax. "What's Taxable Under the HST and What's Not?" http://www.hst.ca/whats-taxable-under-the-hst-and-whats-not/. Accessed 25 Sep 2013.
- The Government of Prince Edward Island. "Harmonized Sales Tax (HST)." http://www.gov.pe.ca/photos/original/fema_hstback.pdf. Accessed 25 Sep 2013.]