Asymmetric Incidence of Sales Taxes: A Short-Run Investigation of Gasoline Prices*

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Abstract

This paper investigates the shifting of sales taxes to consumers through retail prices in the short run. Retail data on gasoline prices are used at the station level within the U.S., including observations from all fifty states and the District of Columbia. A difference-in-differences approach is employed to identify the short-run effects of the changes in state taxes as of January 1st, 2015, when five states have increased their gasoline sales taxes, while five other states have decreased theirs. States experiencing such changes in sales taxes (between December 31st, 2014 and January 1st, 2015) are analyzed as the treatment group of a natural policy experiment, where the control group consists of states with no changes in their sales taxes. The results show that both sales-tax increases and decreases are under-shifted to consumer prices, although the under-shifting of sales-tax decreases is much higher (i.e., the asymmetric incidence of sales taxes). The pass-through measures also differ significantly across states, showing the importance of having a nationwide analysis. The results are robust to the consideration of retailer characteristics, wholesale prices, retail brand effects and hourly price changes within each day.

JEL Classification: H22, H73

Key Words: Tax Incidence; Gasoline Prices; Gas-Station Level Analysis

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1 Introduction

The incidence of gasoline sales taxes is a fundamental concept in public economics, because it determines how economic welfare is distributed between gas stations and consumers due to changes in taxes. Since gasoline accounts for about 5% of consumer spending and sales taxes are determined by policy makers, the measurement of the incidence is an essential concern of politicians as well.[1] However, there are only a few studies that have attempted to measure the effects of gasoline sales taxes at the station (i.e., retail-firm*)* level.[2] Having an investigation at the retail level is especially important for the gasoline market, because each gas station can pass the effects of taxes on to consumers differently (by over-shifting or under-shifting taxes to consumer prices), which leads a distribution of tax incidence among gas stations and thus a redistribution of economic welfare even within consumers purchasing gasoline from different stations or among stations located in the same political district.

This paper achieves such an investigation at the gas-station level in the short run. Using retail prices of regular gasoline obtained from gas stations within the U.S., including observations from all fifty states and the District of Columbia, we investigate the effects of state-level sales tax changes (on retail prices) that have become effective on January 1st, 2015, when five states have increased their sales taxes, while five others have reduced theirs. Accordingly, these ten states experiencing changes in their sales taxes (between December 31st, 2014 and January 1st, 2015) are analyzed as the treatment group of a natural policy experiment, where the control group consists of states with

[1] According to the Bureau of Labor Statistics' (BLS) Consumer Price Index, gasoline accounted for 5.1% of consumer spending, as of October 2014.

[2] For other retail-firm level studies, see Poterba (1996) and Doyle and Samphantharak (2008). Although they are not comparable to this paper, there are many other studies focusing on retail level (rather than retail-firm level) analysis such as by Alm et al. (2009), Li et al. (2012), Devereux et al. (2007), Chouinard et al. (2007) and Fullerton and Metcalf (2002).

no changes in their sales taxes. Since all sales tax changes are due to earlier state laws (rather than market conditions), using a difference-in-differences approach is a compelling way to study the effects of tax changes on retail prices, and it is robust to any identification/endogeneity problem. Within this context, the main assumption is that the retailers would re-optimize their pricing decision according to changes in tax rates, since they already know the timing of such changes.

The results of a difference-in-differences approach show evidence for asymmetric incidence of sales taxes. In particular, although both sales-tax increases and decreases are under-shifted to consumer prices, the under-shifting of sales-tax decreases is much higher. In the case of sales-tax increases, the under-shifting corresponds to an increase in gasoline prices less than the increase in sales taxes due to the estimated pass-through coefficients less than one, while in the case of sales-tax decreases, it corresponds to an increase in prices despite the decrease in sales taxes due to the estimated pass-through coefficients less than zero. The latter result is interesting in an environment of gasoline prices decreasing nationwide, because it implies that retailers have either kept their prices constant or have reduced their prices less than the national average, which has potentially resulted in higher rates of return on capital (in a perfectly competitive market) or higher markups (in an environment with imperfect competition). When we further investigate the retailers facing tax reductions, we in fact observe that the average retailer have reduced its price by only 0.1% after the average tax reduction of 0.85%, while the retailers in the control group (with no tax changes) have experienced an average price reduction of 0.71%. Finally, the short-run pass-through measures differ significantly across states, showing the importance of having a nationwide analysis.

The existing empirical literature on sales tax incidence, mostly focusing on tax shifting, has mixed evidence in terms of under-shifting (i.e., incomplete pass-through measures of below 100%), full-shifting (i.e., full pass-through of 100%) or over-shifting of taxes (i.e., more than full pass-through measures of above 100%) on retail prices. For instance, earlier studies such as by Poterba

(1996, analyzing clothing prices) have found evidence for both over-shifting and under-shifting, while studies such as by Besley and Rosen (1999, analyzing commodities such as bananas, bread, and milk) or by Kenkel (2005, analyzing alcoholic beverages) have found evidence for full-shifting and over-shifting of sales taxes. However, almost all of these studies are subject to identification problems (i.e., their analysis potentially suffer from not distinguishing between market conditions and policy changes) due to not having a natural policy experiment as in this paper.[3]

In the context of gasoline retail prices, this paper is closest to the excellent study by Doyle and Samphantharak (2008; henceforth, DS) who have also considered a natural policy experiment using a difference-in-differences approach to investigate the short-run effects of state-level sales tax changes in the gasoline retail market. By considering the tax suspension and reinstatements in two Midwest states, Illinois and Indiana, DS have found that 70% of the tax suspension is passed on to consumers in the form of lower prices, while 80–100% of the tax reinstatements are passed on to consumers. However, one may criticize their methodology in some aspects, which may potentially result in biased measures of pass through. First, DS have considered the asymmetry when the increases and decreases happen at different times in Illinois and Indiana. Such an approach would ignore potential changes across these states over time (and thus lead to omitted variable bias); instead, this paper focuses on the effects of concurrent increases and decreases of sales taxes by using data on the very same days of December 31st, 2014 and January 1st, 2015 across all states

[3] There are also other studies in the literature that investigate tax incidence by using aggregate-level (rather than retail-level) data. For example, Devereux and Lanot (2003, analyzing mortgages) and Chouinard and Perloff (2004, investigating gasoline taxes) have depicted pass-through measures in the interior between 0% and 100%, respectively. Other studies such as by Young and Bielinska-Kwapisz (2002) have shown that excise taxes on alcohol are over-shifted. Similarly, Marion and Muehlegger (2011) have found at least full, and potentially more than full, pass-through of both federal and state diesel and gasoline taxes to consumers. Also see Eckert (2013) for an excellent survey of studies based on gasoline retailing.

for both treatment and control groups, which makes the results robust to similar issues. Second, in the formal analysis of DS, the only time-varying right-hand-side variable is the policy reform (i.e., sales tax rate), which ignores any potential change in wholesale prices or brand-specific costs over time (and thus again lead to omitted variable bias); instead, this paper considers time-varying wholesale prices and brand-specific costs to resolve such potential issues.[4] Third, since DS consider control variables at the zip-code level, they fail to capture any retailer-specific characteristics in their short-run difference-in-differences approach analyzing the tax incidence; as an alternative, this paper considers the change in retail prices which effectively eliminates such characteristics in the regression analysis. Finally, this paper takes into account potential differences between the retail prices collected at different hours of the day, while DS do not have the information on the hour of day when the data have been collected. The latter issue is important especially if retailers follow a pattern in their pricing strategy during peak versus off-peak hours within a particular day. Overall, the results in this paper are robust to many of the concerns that one would have in the literature.

The structure of the paper is as follows. Section 2 introduces data and provides descriptive statistics. Section 3 introduces the estimation methodology in the context of a difference-in-differences approach. Section 4 depicts the empirical results. Section 5 concludes by providing policy suggestions.

[4]It is important to note that DS have considered wholesale prices in a separate regression analysis where wholesale prices have been used as the dependent variable. They have found that the effects of taxes on wholesale prices were small.

2 Data and Descriptive Statistics

Retail data on gasoline prices have been obtained from MapQuest for December 31st, 2014 and January 1st, 2015 at the gas-station level, including observations from all fifty states and the District of Columbia.[5] MapQuest receives gasoline prices from Oil Price Information Service (OPIS), a leading provider of petroleum data collecting gas price data based on fleet transaction data. The same data source has been used by many other researchers because of the fact that OPIS has the best available gasoline price data.[6] In particular, the data source of OPIS receives credit card transactions through exclusive relationships with the leading fleet card companies; although OPIS captures most prices in real-time, if there is not any transaction (using credit cards by the leading fleet card companies) achieved for a particular gas station on a particular day, then OPIS cannot receive any data. Accordingly, MapQuest gas prices are updated as qualifying transactions are processed by OPIS. Within this context, although our raw data include 74,264 price observations, they may have been obtained from different gas stations across the two days. In order to have a healthy comparison between the two days, we restricted the analysis to the gas stations for which we have retail gasoline price data for both days; such a strategy resulted in having data on 41,148 price observations (coming from 20,574 stations).[7] The approximate time of the gasoline-price update is also provided by MapQuest. The information on the location of gas stations is at the address level.

[5] We downloaded the gasoline price data at midnight of each day from http://gasprices.mapquest.com/.

[6] Focusing on other topics, earlier studies such as by Abrantes-Metz et al. (2006), Doyle and Samphantharak (2008), and Chandra and Tappata (2011) have also used this data set.

[7] Since our data set concists of credit card transactions of the leading fleet card companies, resctricting the data to the gas stations that have observations on both days may result in missing valuable information of gasoline purchases through non-credit-card transactions such as cash or debit card. Nevertheless, as shown by studies such as by Carow and Staten (1999), the majority of the gasoline purchases are achieved by credit card, even back in 1992. Accordingly, although our strategy may lead into a certain amount of bias, we don't expect it to have a large impact in our results.

In order to give the reader a better idea, a typical retailer is a BP gas station located at 11590 E 10 Mile Road, Warren, MI 48089 charging *regular* gasoline prices of \$2.06 and \$2.00 on December 31st and January 1st, respectively. During the sample period, the average gasoline prices are about \$2.28 and \$2.26 on December 31st and January 1st, respectively, with the same standard deviation of 31 cents. Average prices for states that have experienced a sales tax change (and other states) are given in Table 1, where they range between \$2.00 (for Nebraska) and \$2.76 (for New York) on December 31st and between \$2.06 (for Nebraska) and \$2.75 (for New York) on January 1st. Average price changes between the two days range between -3.18 cents (for Nebraska) and 2.10 cents (for Kentucky), suggesting a significant heterogeneity across states. This heterogeneity is also supported by the last column where average price changes are compared with the average national price decrease of 1.43 cents.

Gasoline sales taxes have been obtained from The Institute on Taxation and Economic Policy.[8] Changes in these taxes on January 1st, 2015 are given in Table 1, where Pennsylvania has experienced the highest increase (of 9.8 cents) and Kentucky has experienced the highest reduction (of 4.3 cents). The sales tax increases in Pennsylvania, Virginia and Maryland have taken place as scheduled under major transportation finance laws; retailers in North Carolina and Florida have experienced sales tax increases as a result of formulas written into state laws that update sales taxes each year alongside inflation or gasoline prices; finally, retailers in the states of New York, Nebraska, Vermont, West Virginia and Kentucky have experienced lower sales taxes, since part of the sales tax depends on the price of gasoline in these states according their law. Therefore, the sales tax changes investigated in this paper have been determined by earlier state laws rather than any market conditions, which has allowed us study the effects of tax changes on retail prices in a compelling way that is robust to any identification/endogeneity problem.

[8] www.itep.org

When the changes in sales taxes are compared with the relative average prices changes in Table 1, it is evident that retailers located in states with increased sales taxes have increased their prices, while there is mixed evidence for retailers located in states with reduced sales taxes. Such asymmetric adjustment of prices is consistent with earlier studies such as by Chouinard and Perloff (2004) who show that the gasoline tax effects vary across states based on size, and Devereux et al. (2007) who discuss tax effects near borders.[9] For sure, we need a formal analysis (as we will have, below) in order to investigate such asymmetric adjustment of prices within this paper.

In order to control for differences across brands, brand fixed effects are included in the analysis, below, using the brand information also obtained from MapQuest. In order to control for differences across time of observation/update, the corresponding hour fixed effects are also included in the analysis, below, for each day. We also control for the wholesale price effects by considering fixed effects for the nearest refiner of each gas station; this is a very similar approach as in Doyle and Samphantharak (2008) who use the rack price from the nearest refinery. The list and exact locations of gasoline-producing refiners, which have been used to find the nearest refiner for each gas station, have been obtained from Oil Change International.[10]

3 Estimation Methodology

We are interested in the pass-through of sales taxes on retail prices. In order to identify the policy change, we follow a difference-in-differences approach for which we take the gasoline sales

[9] Also see Balke et al. (1998) and Bachmeier and Griffin (2003) who discuss the relationship between crude oil and gasoline prices through an asymmetric adjustment.

[10] The web page is http://refineryreport.org/. We considered the possibility of gas stations purchasing gasoline from both U.S. and Canadian refiners due to the open nature of trade between the two countries, as stipulated by the North American Free Trade Agreement (NAFTA). There are 131 gasoline-producing refiners in this list, where 117 refiners are located in the U.S. and 14 refiners are located in Canada.

tax changes between December 31st, 2014 and January 1st, 2015 as a natural policy experiment. Effective on January 1st, five states (of Pennsylvania, Virginia, Maryland, North Carolina, and Florida) have increases their sales taxes, while five other states (of New York, Nebraska, Vermont, West Virginia, and Kentucky) have reduced theirs. We define the retailers located in these ten states as the treatment group, while the retailers in remaining states with no sales tax changes are defined as the control group.

Before moving to the technical details of the econometric model, we start with a specification check by having a graphical comparison of gasoline prices in treatment versus control groups in Figure 1. This is a before-and-after analysis for the average retail prices in the corresponding group of states covering the days between December 30th and January 1st.[11] As is evident, although there is a common trend of gasoline prices between December 30th and December 31st across all groups, the treatment groups deviate from this trend after the changes in sales taxes on January 1st, while the control group continues having the same trend. Therefore, there is evidence for a structural break in the retail price data due to policy changes on sales taxes. Although it is expected for the retailers in states with higher sales taxes to have higher prices as of January 1st, it is interesting to observe that the retailers in states with lower sales taxes have also increased their prices. Hence, *asymmetric incidence of sales taxes* is observed in the before-and-after analysis, which is the main motivation behind the following technical analysis.

In terms of the theoretical framework, we consider a flexible approach that allows for both perfect and imperfect competition. When retail prices are in a multiplicative form, the latter corresponds to the case of market power with gross markups higher than one, while the former implies gross markup of one. Within this context, following Besley and Rosen (1999), we consider the following

[11] The details of the data are the same as in the previous section for December 30th.

equilibrium price expression for tax-inclusive gasoline retail prices:

$$\text{RetailPrice}_{sbt} = \text{Markup}_{sbt} \times [\text{MarginalCost}_{sbt} \times \text{SalesTax}_{sbt}] \tag{1}$$

where s represents the station, b represents the brand, and t represents the time; Markup_{sbt} is the gross markup, $\text{MarginalCost}_{sbt}$ is the marginal cost of retailing, and SalesTax_{sbt} is the gross *ad valorem* sales tax. This is the standard expression representing gasoline retail prices as markups over marginal costs. It is important to emphasize that both Markup_{sbt} and $\text{MarginalCost}_{sbt}$ may be functions of SalesTax_{sbt}; they may also be functions of wholesale prices, brand-specific costs (e.g., Chevron including Techron into its gasoline), time-varying costs (that are common across all gas stations) as well as other characteristics of station s that are constant over time (e.g., any demand shifter across stations such as being in the treatment or the control group, the geographical characteristics, having a car wash or a convenience store, etc.).

Accordingly, after assuming that Markup_{sbt} and $\text{MarginalCost}_{sbt}$ are connected to wholesale prices, brand-specific costs, time-varying costs, and station-specific characteristics in a log-linear way, the log version of Equation 1 can be written as follows:

$$\ln(\text{RetailPrice}_{sbt}) = \beta_1 \ln(\text{SalesTax}_{sbt}) + \delta^W_{sbt} + \delta^B_{sbt} + \delta_t + \delta_s + \varepsilon_{sbt} \tag{2}$$

where δ^W_{sbt} represents wholesale prices, δ^B_{sbt} represents brand-specific costs, δ_t is time-varying costs that are common across all gas stations, and δ_s represents station-specific factors.[12] The interpretation of the coefficient β_1 in front of SalesTax_{sbt}, which also represents the elasticity of RetailPrice_{sbt} with respect to SalesTax_{sbt}, is the key in this paper. In particular, since gasoline retail price data

[12]Having a log-linear expression is useful to interpret the coefficients as elasticities. Moreover, such a strategy is also consistent with studies such as Doyle and Samphantharak (2008); hence, it makes comparison with the existing literature much easier. Nevertheless, for insterested readers, it is important to emphasize that we also considered the linear version of this expression where all variables were in levels (rather than logs). The corresponding results, which are available upon request, were virtually the same.

that we have are tax-inclusive, the case of $\beta_1 = 1$ represents tax-inclusive retail prices perfectly reflecting any sales taxes levied on them (i.e., full-shifting); this is the case that one would observe when the combined effects of SalesTax_{sbt} on Markup_{sbt} and $\text{MarginalCost}_{sbt}$ are none. Within this context, the case of $\beta_1 > 1$ would mean sales taxes being over-shifted to consumer prices (i.e., consumers face changes in prices more than the change in taxes), while the case of $\beta_1 < 1$ would mean sales taxes being under-shifted to consumer prices (i.e., consumers face changes in prices less than the change in taxes).

The case of over-shifting ($\beta_1 > 1$) can occur when the combined effects of SalesTax_{sbt} on Markup_{sbt} and $\text{MarginalCost}_{sbt}$ are positive, while the case of under-shifting ($\beta_1 < 1$) can occur when such effects are negative. It is implied that over-shifting can still occur even in the case of perfect competition (where $\text{Markup}_{sbt} = 1$) if there are increasing returns to scale, since $\text{MarginalCost}_{sbt}$ would increase with SalesTax_{sbt} in such a case; similarly, under-shifting can still occur if there are decreasing returns to scale, since $\text{MarginalCost}_{sbt}$ would decrease with SalesTax_{sbt} in such a case (see McCorriston et al, 2001). Moreover, in both cases of increasing and decreasing returns to scale, if the market is imperfectly competitive, it is possible that the overall effects of SalesTax_{sbt} on RetailPrice_{sbt} may either be cancelled out or be magnified, since Markup_{sbt} may change with the quantity sold due to market power (i.e., the case of variable markups as in Amiti et al., 2014 or DeLoecker et al., 2016). In sum, the theory is silent regarding the value of β_1 (i.e., the tax incidence); it is rather an empirical question.

Compared to earlier studies employing difference-in-differences approaches, such as by Doyle and Samphantharak (2008) who only consider the change in taxes as the only time-varying factor, the price expression introduced above is richer in terms of considering time-varying wholesale prices and brand-specific costs. Such a strategy will effectively remove any potential bias in the estimated measures of pass-through simply because retail prices on a particular day may change due to these factors as well. Moreover, Doyle and Samphantharak (2008) only consider brand and zip-code level variables (that are constant over time) to measure the demand shifters in their analysis; in comparison, our analysis is again richer in terms of considering station-specific demand shifters (i.e., δ_s).

Since our analysis focuses on the pass-through of gasoline sales taxes on gasoline prices through an identification strategy of using January 1st as the time of the reform, we estimate the first-differenced version Equation 2 as follows:

$$\begin{aligned}\Delta \ln\left(\text{RetailPrice}_{sbt}\right) &= \beta_1^{+}\Delta \ln\left(\text{SalesTaxIncrease}_{sbt}\right) + \beta_1^{-}\Delta \ln\left(\text{SalesTaxReduction}_{sbt}\right) \\ &\quad + \Delta\delta_{sbt}^{W} + \Delta\delta_{sbt}^{B} + \Delta\delta_t + \varepsilon'_{sbt}\end{aligned} \tag{3}$$

where we have distinguished between the effects of tax increases (through β_1^{+}) and tax reductions (through β_1^{-}) in order to take into account the asymmetric incidence of sales taxes; hence, we totally have two treatment groups (representing the retailers located in states with tax changes) and one control group (representing the retailers located in states with no tax changes). Taking the first difference of Equation 2 has effectively removed retailer/station fixed effects δ_s. We estimate this expression by using data on station prices RetailPrice_{sbt}, data on gasoline sales taxes SalesTax_{sbt} together with closest-refiner $\Delta\delta_{sbt}^{W}$ and brand fixed effects $\Delta\delta_{sbt}^{B}$ (in order to control for wholesale price and brand-related cost changes that are unique/constant due to considering the changes between December 31st, 2014 and January 1st, 2015). Similarly, since the variables represent percentage changes between December 31st, 2014 and January 1st, 2015, $\Delta\delta_t$ is just a constant representing the average percentage change in gasoline prices within the U.S. on January 1st. Finally, we use hour fixed effects in order to control for the differences due to the approximate time of the gasoline-price update provided by MapQuest.

In order to measure state-specific tax shifting, as an alternative estimation strategy, we also estimate the following version of Equation 3:

$$\Delta \ln(\text{RetailPrice}_{sbt}) = \beta_1^{state} \Delta \ln(\text{SalesTax}_{sbt}) + \Delta\delta_{sbt}^{W} + \Delta\delta_{sbt}^{B} + \Delta\delta_t + \varepsilon'_{sbt} \tag{4}$$

where we consider state-specific pass-through of gasoline sales taxes through state-specific β_1^{state} estimates. Such an empirical strategy will show whether there is any heterogeneity across states that have experienced sales tax changes.

4 Estimation Results

The estimation results using Equation 3 are given in Table 2. As is evident in columns (1) and (2), both sales tax increases and decreases are under-shifted to consumer prices, on average across states. While under-shifting represented by the coefficient of 0.09 in the case of a sales-tax increase corresponds to an increase in prices less than the increase in sales taxes, under-shifting represented by the coefficient of -0.97 in the case of a sales-tax reduction corresponds to an increase in prices despite the decrease in sales taxes. These results are robust to the consideration of all fixed effects. The pass-through of sales tax increases (of about 0.09) is much lower compared to the existing literature, potentially due to the reasons discussed in detail in the introduction section. Nevertheless, we should mention one more time that the results of this paper corresponds to the short-run tax shifting, while the existing studies have mostly considered long-run analyses, with the exception by Doyle and Samphantharak (2008). Nevertheless, the pass-through of sales tax reductions, which is -0.97, is interesting in an environment of gasoline prices decreasing nationwide, because it implies that retailers have either kept their prices constant or have reduced their prices less than the national average, which has potentially resulted in higher rates of return on capital (in a perfectly competitive market) or higher markups (in an environment with imperfect competition). When we further investigate the retailers facing tax reductions, we in fact observe that the average retailer has reduced its price by only 0.1% after the average tax reduction of 0.85%, while the retailers in the control group (with no tax changes) have experienced an average price reduction of 0.71%.

Since the average sales tax increase (reduction) is about 1.49% (0.85%), it is implied that gas stations facing a sales tax increase (reduction) have increased their prices by about 0.13% (0.82%) on average, compared to the nationwide reduction in gasoline prices (measured by the constant of $\Delta\delta_t$ in the regressions) which is about 0.19%, after controlling for wholesale prices, brand-specific costs and the hour of data collection within each day.

State-specific elasticities (due to the estimation of Equation 4) are also given in Table 2 where pass-through measures range between 0.32 (for North Carolina) and -1.09 (for Vermont), when all control variables are considered in column (3); they range between 0.94 (for Nebraska) and -0.41 (for Kentucky) when fixed effects are excluded in column (4). When all control variables are considered in column (3), it is evident that sales-tax increases are under-shifted to consumer prices across all states, except for Florida (which has the lowest rate of increase in sales taxes) with a statistically zero pass-through of taxes. The highest tax pass-through in the case of a sales-tax increase belongs to North Carolina with a significant coefficient of 0.32, while the lowest pass-through belongs to Pennsylvania with a significant coefficient of 0.04. It is also evident in column (3) that sales-tax reductions are highly under-shifted to consumer prices across all states, except for Nebraska and New York (which have the two lowest rates of sales-tax reductions) with a statistically zero pass-through of taxes. The highest tax pass-through in the case of a sales-tax decrease belongs to Kentucky with a significant coefficient of -0.42, while the lowest pass-through belongs to Vermont with a significant coefficient of -1.09. Hence, rather than focusing on a specific state/region, a nationwide analysis with the appropriate control variables is essential to measure the asymmetric tax incidence within the U.S..

5 Conclusion and Policy Implications

Policy makers determine sales taxes based on measures of pass-through (i.e., shifting of the tax), because the distribution of economic welfare among consumers and producers/retailers in an economy, the so called tax incidence, is determined through such measures. Therefore, there is no debate on how important these measures are. However, when it comes to the actual measurement, only few studies have achieved an investigation at the level of the retailer, which is essential to understand how economic welfare is distributed within consumers shopping from alternative retailers or within producers/retailers even located in the same political district.

This paper has shown that both gasoline sales-tax increases and decreases are under-shifted to consumer gasoline prices. While this under-shifting corresponds to an increase in gasoline prices less than the increase in sales taxes due to the estimated pass-through coefficients less than one, it corresponds to an increase in prices despite the decrease in sales taxes due to the estimated pass-through coefficients less than zero. Based on our discussion in the methodology section regarding the linkage among retail prices, marginal costs and markups, it is implied that the combined effects of sales taxes on marginal costs and markups are negative, although it is not possible to distinguish between the pure effects of sales taxes on marginal costs versus markups due to the lack of quantity data on gasoline retail market. When consumers optimize, for the case of sales-tax increases (decreases), the under-shifting can be explained by either decreasing (increasing) returns to scale or variable markups increasing (decreasing) with quantities sold or a combination of the two. However, when there are consumer optimization failures as in Chetty et al. (2009), the difference between the effects of sales-tax increases and decreases on retail prices can also be explained by such failures; we need more search along these lines in order to understand such linkages.

Regarding robustness, the results in this paper are immune to any identification/endogeneity issues, since a difference-in-differences approach is employed to investigate the effects of the changes in state taxes as of January 1st, 2015, when five states have increased their gasoline sales taxes, while five other states have decreased theirs. Since these tax changes have been achieved due to earlier state laws rather than market conditions, states experiencing such changes in sales taxes are considered as the treatment group of a natural policy experiment, where the control group consists of states with no changes in their sales taxes. Such a strategy corresponds to a compelling way to study the effects of tax changes on retail prices. Finally, controlling for retailer characteristics, wholesale prices, retail brand effects, and the hour of the day when retail price data are collected has resulted in a robust set of results for policy makers.

The main policy suggestion of this paper is that there is significant heterogeneity across retailers in different U.S. states in terms of how they shift sales taxes, supporting the investigation strategy in this paper at the national level. Therefore, a policy maker cannot simply work with a single set of numbers provided in the literature, which potentially suffer from problems such as not properly considering retailer data/characteristics; having regional (rather than nationwide) analyses; or not properly controlling for wholesale prices, retail brand effects or the hour of the data collection within each day. Although this paper has achieved an analysis by taking into account all of these dimensions in the short-run, more needs to be done in future research, including an analysis of tax incidence at the retail level in the long-run that is important for individual welfare and long-term budget planning. In particular, with longer periods of data, the limitations that we have (e.g., having data for only two days or January 1st being a major holiday) can be removed by considering longer pre- and post-treatment periods that would result in further support to the results in this paper.

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Table 1 - Descriptive Statistics

	Changes in Sales Taxes (cents)	Average Price on December 31st (dollars per gallon)	Average Price on January 1st (dollars per gallon)	Average Change in Prices (cents)	Relative Average Change in Prices (cents)
Pennsylvania (+)	9.8	2.57	2.54	-1.40	0.03
Virginia (+)	5.1	2.10	2.12	-1.21	0.22
Maryland (+)	2.9	2.40	2.40	-0.82	0.61
North Carolina (+)	1.0	2.30	2.29	-1.08	0.35
Florida (+)	0.3	2.30	2.31	-1.43	0.00
New York (-)	-0.6	2.76	2.75	-1.70	-0.27
Nebraska (-)	-0.8	2.00	2.06	-3.18	-1.75
Vermont (-)	-0.8	2.68	2.65	-1.06	0.37
West Virginia (-)	-0.9	2.50	2.41	-1.08	0.35
Kentucky (-)	-4.3	2.16	2.15	2.10	3.53
Remaining States	0.0	2.24	2.22	-1.54	-0.11

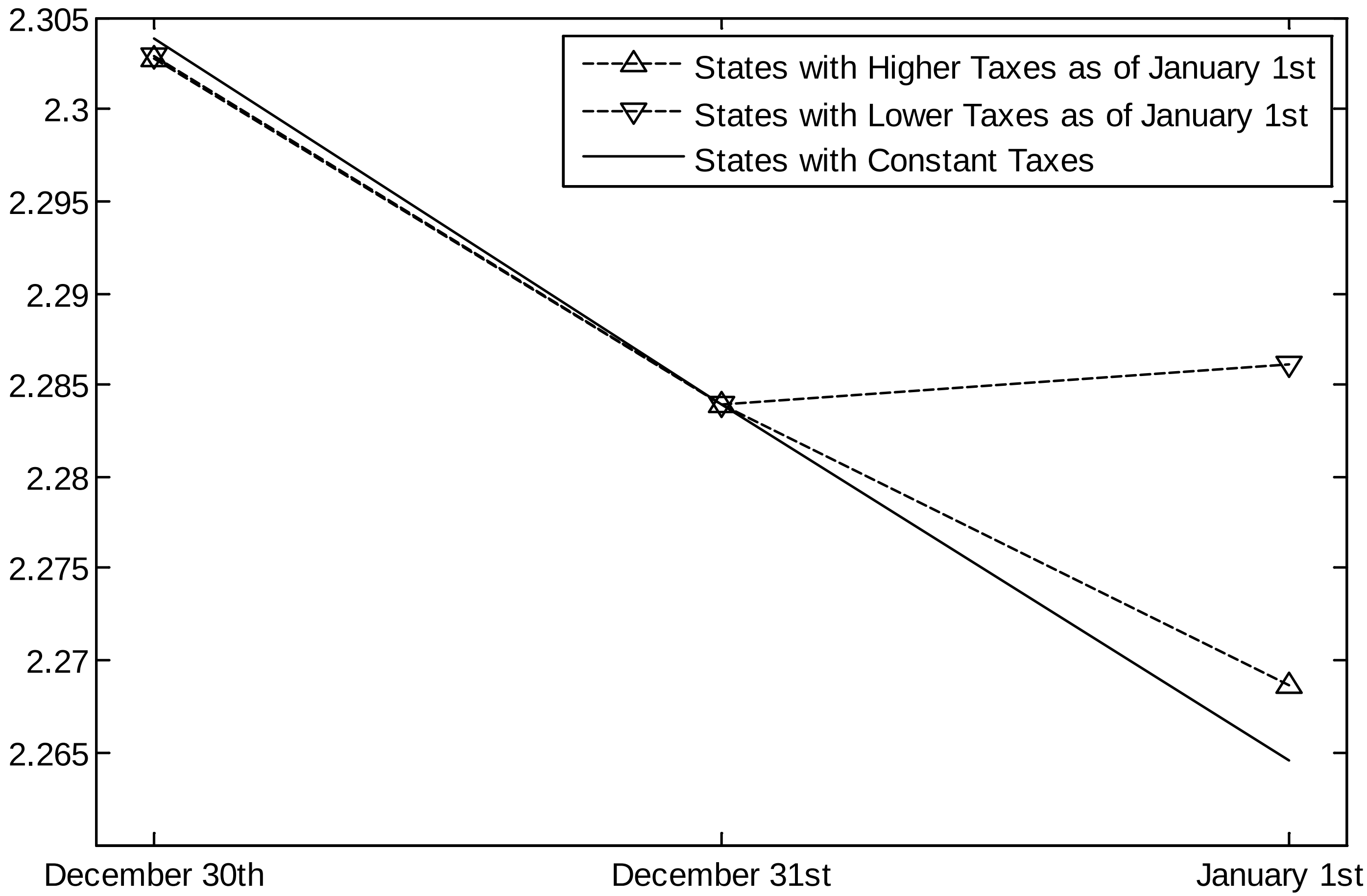
Notes: (+) represents states with a sales tax increase, while (-) represents states with a sales tax reduction. The national average decrease on January 1st was 1.43 cents which have been used to calculate relative average change in prices in the last column.

Table 2 – Estimation Results

	Pass-through of Sales Taxes (β_1)			
	(1)	(2)	(3)	(4)
Sales Tax Increases	**0.09****** (0.02)	**0.06*** (0.03)		
Sales Tax Reductions	**-0.97****** (0.02)	**-0.91****** (0.06)		
Pennsylvania (+)			**0.04****** (0.01)	**0.02*** (0.01)
Virginia (+)			**0.04** (0.03)	**0.03** (0.02)
Maryland (+)			**0.12****** (0.04)	**0.12****** (0.03)
North Carolina (+)			**0.32*** (0.17)	**0.24**** (0.10)
Florida (+)			**0.46** (0.37)	**0.30** (0.33)
New York (-)			**-0.15** (0.10)	**-0.15** (0.16)
Nebraska (-)			**0.31** (0.28)	**0.94****** (0.12)
Vermont (-)			**-1.09****** (0.18)	**-0.37****** (0.12)
West Virginia (-)			**-0.77****** (0.20)	**-0.28**** (0.11)
Kentucky (-)			**-0.42****** (0.02)	**-0.41****** (0.02)
Refiner Fixed Effects	YES	NO	YES	NO
Brand Fixed Effects	YES	NO	YES	NO
Hour Fixed Effects	YES	NO	YES	NO
R-Squared	0.139	0.013	0.139	0.013

Notes: (+) represents the states with a sales tax increase, while (-) represents states with a sales tax reduction; see Table 1 for the exact changes in taxes. Standard errors clustered by state are given in parenthesis; *, ** and *** represent significance at the 10%, 5% and 1% levels. The sample size is 20,574 in all regressions. Hour fixed effects control for the hour of data collection within each day.

Figure 1 – Average Gasoline Prices in Control versus Treatment Groups



Notes: In order to focus on trends over time (rather than scales), average gasoline prices of the treatment groups have been shifted such that all lines intersect on December 31st.